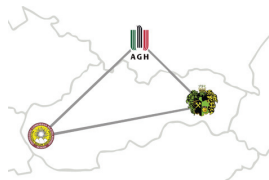# Herlandia 2011

12th International Conference of Young Geologists

Medzinárodná konferencia mladých geológov, 12. ročník

Kamienica, Poland; 28.–30. April 2011

M. Dvornik, M. Kováčová, B. Zahradníková, J. Majka, L. Zahradník, M. Gregáňová, J. Kondela, Ľ. Štrba, L. Vizi, J. Bazarnik, M. Drzymała, A. Duś-Picheta and M. Maruta

Abstract: *The 12th International Conference of Young Geologists was held in Kamienica (Poland) on 28–30 April 2011. About 70 young scientists from Poland, Slovakia and Czech Republic presented 50 lectures divided into thematic blocks, dealing with tectonics, sedimentology, paleontology, biomineralogy, mineralogy, petrology, geophysics, geochemistry, geoengineering, geoinformatics and hydrogeology. The fieldtrip presented the geology of the Magura nappe between localities Czorsztyn and Mszana Dolna (Outer Western Carpathians).*

Key words: *geological conference, contribution to geosciences*

The 12th International Conference of Young Geologists was held in Kamienica (Poland) on 28–30 April 2011. The Conference was held in the Polish Outer Carpathians, in Kamienica, located between the Gorce Mts. and the Beskid Sądecki Mts. All participants were hosted in the newly renovated Dworek-Gorce complex. The conference had been organized under the guarantee of the Slovak Geological Society (SGS), AGH University of Sciences and Technology (AGH), Cracow (PL), FaNS Comenius University (CU), Bratislava (SK), the FaBERG of Technical University (TUKE), Košice (SK). For several years the members of the scientific committee have been Prof. Dušan Plašienka (CU), Prof. Tibor Sasvári (TUKE) and Prof. Anna Świerczewska (AGH). The conference was organized by Ph.D. students from AGH and the members of the Geological Club from Bratislava.

About 70 young scientists from Poland, Slovakia and the Czech Republic presented almost 50 lectures, which were grouped into thematic blocks of tectonics, sedimentology, paleontology, biomineralogy, mineralogy, petrology,

geophysics, geochemistry, geoengineering, geoinformatics and hydrogeology. A possibility of the use of native Slavic languages has contributed to a friendly atmosphere during this conference and helped to stimulate international scientific collaboration.

The representative of the Galicia Tectonic Group (GTG) Prof. Witold Zuchiewicz has awarded as the best student presentation in English language the lecture by Marzena Kohut (AGH), presenting the new research results on Icelandic volcanic activity.

Important parts of the meeting were two "evening dinner discussions". The first evening, Maciek Dwornik (AGH)

presented slides from his expeditions to Spitsbergen. The next evening, Aneta Anczkiewicz (Polish Academy of Sciences – PAS) introduced participants to the fission track method and showed the results of this dating method being applied to the area where the post-conference fieldtrip took place.

The fieldtrip guided by Nestor Oszczypko (Jagiellonian University of Cracow), Witold Zuchiewicz (AGH) and Aneta Anczkiewicz (PAS) has aimed to present the geology of the Magura nappe between Czorsztyn and Mszana Dolna. Several interesting outcrops were visited.

The next conference will be held on 26–28 April 2012 back in Herľany near Košice, Slovakia.

mineralia slovaca

D. AXMANN: Badenian microborings from Southern Moravia area and their value for paleoecologic interpretation

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Miocene (Lower Badenian) clays in the eastern Bohemian locality Česká Třebová provided finds of a microboring *Planobola macrogota* which is significant for shallow marine settings (few dozens of metres of depth as the maximum). In comparison, South Moravian localities of the same age and rock composition provided different assemblages of microborings that are significant for depths of hundreds of metres.
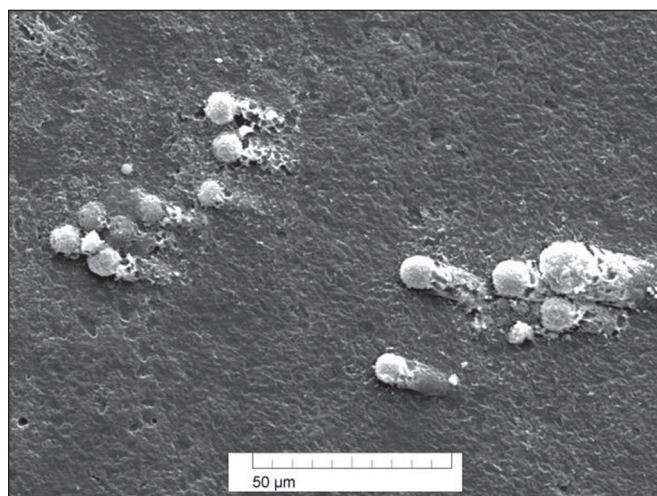

Fig. 1. Microborings *Planobola macrogota* from locality Česká Třebová-cihelna. SEM image, Erlangen University.

A. BIENIEK[1], M. PAWLIKOWSKI[1] and T. NIEDŹWIEDZKI[2]: The extent of the mineralization and the destruction of the trabecular bone: The results of the analysis of the head of femur

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In the presented interdisciplinary project, the mineralogical knowledge and analyses were used to describe the processes and

the pathologic states occurred in the human skeleton system. The material for the investigation was retrieved from the patients who had implanted a hip joint endoprosthesis. During the macroscopic observation the avascular necrosis was identified in some of the femoral heads.

As a part of the research, the Dual Energy X-ray Absorptiometry (DEXA) was carried out on the 1 cm thick pieces of a human femoral head. The analyses were performed to examine the mineral density (BMD) and the bone mineral content (BMC) of the samples. The densitometry is found as a very precise method which allows determining even the minor changes in the amount of a mass of the bone. The Dual Energy X-ray Absorptiometry analyses allowed also to define the T-score and the Z-score indicators (the T-score is the number of the standard deviations below the average for a young adult at peak bone density; the Z-score is the number of the standard deviations below an average person of the same age). The measurement of the bone mineral density was performed for each sample separately and the BMD was determined in the places for which the T-score indicator was the lowest and the highest in a particular piece of the femoral head. The DEXA analyses allowed creating a three-dimensional model of the distribution of the diminution in the bone apatite in the samples.

The microscope observations were conducted using the polarizing microscope. This allowed determining the density and the extent of the mineralization of the trabecular bone of the femoral head. The destruction of the mineral structure of the calcium phosphate was observed and the places with the greatest decrease of the bone mineral density due to the breakup of the structure of hydroxylapatite were described.

In this study, the results of the mineralogical (optical microscopy) and the medical (DEXA) analyses of the extent of the mineralization and the destruction of the femoral head were compared.

It appeared that in some cases the results of the Dual Energy X-ray Absorptiometry analysis do not reflect the actual density and the apatite – based mineralization of the trabecular bone. The cause of these observations is an objective of further examinations.

P. BOŻĘCKI, M. KOTULSKA and G. RZEPA: Variability of water composition in the AMD-type environment: The Łęknica region case study

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Acid mine drainage (AMD) environments are generated as an effect of the oxidation of sulphide minerals (often pyrite) exposed to an oxidant (usually atmospheric oxygen) and water. Due to complexity of the process, involving variety of biochemical reactions as well as different primary reactants, the water chemistry of AMD-type environments can vary significantly. The objective of this work

was to characterize that variability on the example of the Łęknica region (western Poland), where the 20th century excavation of pyrite--containing lignite caused formation of such an acidic environment. Water samples were collected at 11 sites (lakes and water outflows) in the one-month interval between October 2009 and September 2010. Selected physicochemical parameters (temperature, pH, Eh, EC, colour, turbidity) and chemical composition of the waters (main cations and anions, trace elements) were determined each time.

The analysed waters are highly mineralized (EC up to 2 920 µS/cm), acidic (average pH 3.56) and rich in iron and sulphate (up to 523 mg/L and 3 082 mg/L respectively). On the other hand, concentrations of sodium, potassium and chloride are relatively low (usually few mg/dm³) and bicarbonate is absent. However, a quite wide range of chemical composition as well as physical parameters in different sampling sites is noteworthy. For instance, the average iron concentrations range from 2.92 to 375 mg/L, those of sulphate and calcium, from 294 to 1 733 mg/L and from 50 to 345 mg/L, respectively. Similarly, average pH value extends from 2.66 to 5.33 and electrolytic conductivity from 796 to 2 673 µS/cm. Such variability may be related to different water sources, but seems to be a result of the reservoirs' dimensions as well – the smaller ones usually exhibit higher mineralization and acidity than the larger. Seasonal changes in the composition and properties of the studied water have been observed also. For example, greater part of sampling points exhibited lower electrolytic conductivity values in April, June and August 2010, thus during or just after periods of thaws or floods. A distinct negative correlation between EC and pH values has also been found in many lakes. Periodical changes in iron concentrations are probably an effect of variable sulphide oxidation rate due to weather conditions and also activity of microorganisms (mainly *Acidothiobacillus ferrooxidans* and *Galionella ferruginea*). Lower amounts of that element in lakes' water found in April and August 2010 seem to be connected with the water dilution by spring thaws and intensive rainfalls. Surprisingly, iron and sulphate concentrations are often negatively correlated. On the other hand, sulphate and calcium activities are correlated positively. Abundant gypsum precipitation was observed in dry months while this mineral appears to dissolve during humid periods. It is therefore highly probable that sulphate concentration in water is not only controlled by pyrite oxidation but by gypsum precipitation-dissolution reactions as well.

Results of this work indicate that the water composition varies, both spatially and seasonally, despite quite limited studied area, similar origin of the reservoirs and general environmental conditions (low pH, high Eh, high mineralization). These phenomena may be influenced by geological and geomorphological factors (different water source, rock type and/or lake size). Ambient conditions such as temperature, atmospheric precipitation, and microbiological activity also play an important role. However, these processes are not fully understood, so advanced research in this area, comprising longer period of time and involving biogeochemical and microbiological analyses should be done in the future.

K. BRUDECKI[1], E. GOLEC[2, 3, 5], E. TOMANKIEWICZ[1], J. GOLEC[3, 4], S. NOWAK[2, 3], E. SZCZYGIEL[4] and J. W. MIETELSKI[1]: **Plutonium, Americium and ⁹⁰Sr in human bones obtained from routine joint replacement surgery: Material and methods**

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Studied isotopes are present in investigated samples mainly as a result of nuclear weapons tests in the last century. In the case of plutonium and americium the main exposure pathway was inhalation, in the case of strontium it was ingestion. In human body radionuclides are accumulated in majority in liver and bones (Pu, Am) or only bones (Sr).

Bone tissue samples were obtained during routine surgeries – the replacement of knee or hip joints by implants. Patients belong to general population, not exposed in any special way to radioactive contamination. Surgeries were conducted in the V Military Hospital in Cracow. Studies got an approval of council for ethics in medical research. Samples were ashen in 600 °C for two days (this removed most of carbon). The ashes were gently soaked in a glass beaker with 100 ml of 6M HCl. Two subsequent precipitations of calcium oxalates were completed to obtain two fractions: 1) transuranic (Pu+Am) and 2) strontium at pH 3 and 6, respectively. Transuranic fraction was dissolved in 100 ml of 1M HNO_3. The oxidation state of Pu was adjusted to +4 using hydrazine and $NaNO_2$ and after conversion into 8M HNO_3, the fractions were passed through Dowex-1x8. Am passes the column without retention. Thorium, together with Pu remains in the column, was eluted with 12M HCl and then Pu was eluted using 50 ml of 0.1M HF – 0.1M HCl. Alpha spectrometric Pu sources were prepared directly in the solutions using NdF3 method. Am was co--precipitated with $Fe(OH)_3$ at pH 9, dissolved in 4M HNO_3 and passed through conditioned TEVA column (this step was required to remove thorium traces). Next, Am was separated from any traces of the matrix, especially from the rare-earth elements, using methanol-acid solutions. Alpha spectrometric Am sources were prepared by the same method like Pu sources. Both Pu and Am sources were measured using alpha spectrometer. Each Sr fraction was dissolved in 100 ml of 4M HNO_3, and then directly passed through the conditioned Sr--Resin column. Strontium was eluted using 30 ml of deionized water, evaporated and purified from traces of ²¹⁰Pb. Finally, each of the solutions was mixed with 15 ml of HiSafe3 liquid scintillation cocktail and measured using beta spectrometer.

Altogether 23 samples were yet analysed. The global fallout seems to be the main source of observed yet radioactive contamination of human bones from Southern Poland. Since there is no local sources of Pu, Am or ⁹⁰Sr (no nuclear industry at all in the whole country scale) this data can be used as background level for temperate zone populations of the Northern Hemisphere. We are intending also to introduce ICP-MS to more careful study on Pu isotopes ratios and thus Pu origin.

B. BUDZYŃ[1] and D. E. HARLOV[2]: **The experimental alteration of xenotime in the presence of fluids and aluminosilicate minerals**

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The experiments on xenotime alteration in the presence of fluids and aluminosilicate mineral assemblage have been performed using the hydrothermal apparatus. The starting materials included inclusion--free crystals of xenotime, albite, K-feldspar, biotite, muscovite, SiO_2 and CaF_2. Fluids included 2M KOH, 2M NaOH, 2M $Ca(OH)_2$, and $Na_2Si_2O_5$ + doubly distilled H_2O. Minerals (25 mg) and fluids (5–10 mg) were loaded into 3 mm wide, 15 mm long Au capsules and arc welded shut while the capsule was partially immersed in an ice-water bath. The temperature and pressure conditions were 450 °C and 590 MPa decreasing to 540 MPa at the end of the run over 16 days. The experimental products were analysed using scanning electron

microscope equipped with an electron dispersive spectrometer at the Institute of Geological Sciences of the Jagiellonian University in Cracow.

The xenotime alteration was observed in all runs. The experimental products include the Y-rich britholite, fluorapatite, and a mineral with a composition similar to the sodic clinoamphibole. The preliminary experimental data are partially consistent with observations in nature. The low to medium grade metamorphic alteration of xenotime in granites lead to formation of the secondary Y-rich apatite and Y-rich epidote (Broska et al., 2005), which was not observed in the experimental products. Future work will expand these experiments on xenotime stability to include garnet in the above mineral assemblage as well as expand the P-T range.

A. CHMURZYŃSKA: **Preliminary results of mineralogical and chemical analysis of lacustrine chalk from the Szczerców Pit (Bełchatów Lignite Mine)**

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One of the associated mineral raw material from Bełchatów Lignite Mine is the lacustrine chalk. Over the years the mineral and chemical composition, deposition conditions and resources of Miocene calcareous deposits in the Bełchatów Pit was repeatedly studied, and it turned out that the mineral is characterized by significant resources, and favourable technological parameters. Similar properties are characteristic to the calcareous deposits from the Szczerców Pit, where the presence of the two continuous horizons of lacustrine chalk was discovered. The older level, a part of the Lower Miocene, occurs in the western part of the lignite deposit, mainly in the lower part of the coal complex. The younger level, is a part of the Middle Miocene. It is known from the upper part of the coal complex, mainly from central and eastern part of the lignite deposit.

The calcareous deposits are lithologically diversed and for practical reasons two main varieties of chalk were distinguished. The first one is white, that represents lacustrine limestones. The second one is dark grey, coal-bearing – calcareous gyttja. It was also known the presence of silicificated type.

Samples taken for this research, mainly belong to the calcareous gyttja. Only one sample represents the white variety – lacustrine limestone. All of the samples was detailed analysis. Chemical analysis was based on the wet sample mineralization (using HF, $HClO_4$ and HCl acids). In this solutions the contents of major and trace elements (Ca, Mg, Fe, Al, Si, Na, K) were determined by Atomic Absorption Spectroscopy (AAS) using a Philips 9100X spectrometer. In addition, other chemical properties were determined: moisture, loss on ignition. Mineral composition was performed using powder X-ray Diffraction Method on Philips APD X'pert Diffractometer. Identification of mineral phases was based on ICDD data base whit using the computer program XRAYAN.

Quantitatively the most abundant element in the limestone is calcium – a major component of minerals such as calcite or aragonite. In tested samples content of this element in the oxide form is 53.30 wt.% for a white type and av. 50.82 wt.% for the dark type. There is no significant differences in concentration levels of other measured elements in lacustrine limestone and in calcareous gyttja. The content of magnesium oxide is between 0.07–0.13 wt.%. Low concentration of magnesium is due to the fact that calcite in tested limestone has a land origin. It is well known that this type is characterized by a low-magnesium content. The content of silica oxide (SiO_2) and aluminium oxide (Al_2O_3) is relatively low – 0.23 wt.% (SiO_2) and 0.04 wt.% (Al_2O_3). The iron content, in the form of the Fe_2O_3 is 0.08 wt.% The studied limestone rocks are characterized by a low concentration of alkalies in oxides form – 0.12 wt.% for Na_2O and 0.06 wt.% for K_2O. The content of manganese and titanium oxides is 0.02 wt.%, for MnO and 0.05 wt.% for TiO_2. The results of chemical analysis were confirmed by X-ray powder diffraction research which showed the

presence of all main diffraction lines of calcite (3.861, 3.040, 2.494, 2.283, 2.096 Å).

To sum up, the preliminary results of chemical and mineralogical analyses of lacustrine chalk have confirmed that the studied rocks are almost monomineral, built predominantly of calcite.

M. CHUCHRO: **Sum of biogas production on wastewater treatment plant analysis**

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The extraction of meaningful information from the environmental time series data could be an effortless and long-lasting process. Various methods of analysis and comparison of results using statistical measure errors for noisy environmental time series will be presented in this paper.

For analysis there were used the sum of biogas production on wastewater treatment plant time series, with daily resolution and eight years duration. Analysed data are stationary with distinct seasonal component and strong irregular component. During analysis there were used the weather data, especially amount of precipitation, mean and maximum temperature, humidity and wind speed. Some analysis also included fundamental parameters of wastewater treatment, inter alia: inflow, BOD, COD, SS, nitrogen and phosphorous compounds.

Accomplished time series analyses included the standard and alternative methods of trend, seasonal component recognition, modelling and prediction on standardized, normalized and filtrated data. As a standard methods of analyses there where used: the correlation matrix, ACF, PACF, multiple regression, seasonal auto-regressive integrated moving average (SARIMA), mononomial trend, Census I, Census II variant x11, smoothing, Fourier analysis, nonlinear estimation using sine function.

As alternative methods there were used the data from mining methods with artificial neural network, trees, independent component analysis, principal component analysis, MARS. Also as an alternative method for the time series analysis there were proposed a graphical analysis of the time series grouped into a table with adjusted colour scale for numerical values. The proposed method is flexible, especially for noisy environmental data. Standard methods of pattern recognition and verification could be easily implemented to this graphical analysis. Results of modelling and predictions were tested using statistical and economical coefficients and ex-ante, ex-post tracking errors.

Knowledge about the time series structure helped to determine important components of prediction models. An ex-ante and ex-post errors were estimated for assessment model quality. The best prediction results were received for multiple regression, SARIMA and neural network prediction models. Mean absolute percentage errors (MAPE) computed for those models were lower than ten. Calculated Janus coefficients showed that predictions are accurate. Predicted values could be used separately as a three possible options with confidence range or as an average of those values with confidence range.

M. DAMRAT[1] and A. ŚWIERCZEWSKA[2]: **Modelling of Załęcze gas field (W Poland) and paleogeographical interpretation of the hydrocarbon trap**

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The aim of this study was the construction of complex model for the Załęcze gas field (western Poland) using Petrel 2010.2 software

by Schlumberger Logelco Inc. Gas occurs there in Rotliegende eolian sandstones. Hydrocarbons become trapped by impermeable Zechstein evaporitic sealing.

Modelling was carried out in two steps. At first, the depth and thickness of the deposit and morphology of the gas horizon roof were done. Thickness of impermeable Zechstein caprocks was also estimated. During the first step, the data from more than 50 drill holes were used and deterministic algorithms (Kriging) were applied for modelling evaluation.

In the next step of processing, structural model was obtained. This model was geometrical framework to estimate effective porosity and effective permeability distribution in the gas field. Because of sparse laboratory data, conditional stochastic algorithms (Sequential Gaussian Simulation) had to be used for estimation of effective porosity and effective permeability. Unfortunately, final models showing porosity and permeability distribution are disappointing.

Paleogeographical position of the Załęcze gas field in Polish Rotliegende basin and interpretation of the obtained model (Fig.) allow inferring that discussed structure is fossil dune. The differentiated compaction and reworking of the top of eolian sands by Zechstein sea resulted in shape distortions of the dune. Main elevation is located in the western part of the dune. Flanks in the western part of the dune are steeper than flanks in the eastern side. Shape of the dune is probably strongly modified and, therefore, is difficult to interpret.

Two solutions of the dune classification can be considered. According to observed denivelations and steepness of slopes, discussed dune could be either a star-shaped dune or a large-scale parabolic dune. In the first case, it is not possible to indicate main wind direction. In the second case, predominant direction of dune movement was from west to east.

Computer software was provided by Faculty of Geology, Geophysics and Environment Protection, AGH University of Science and Technology.

3D structural model of the Załęcze gas deposit
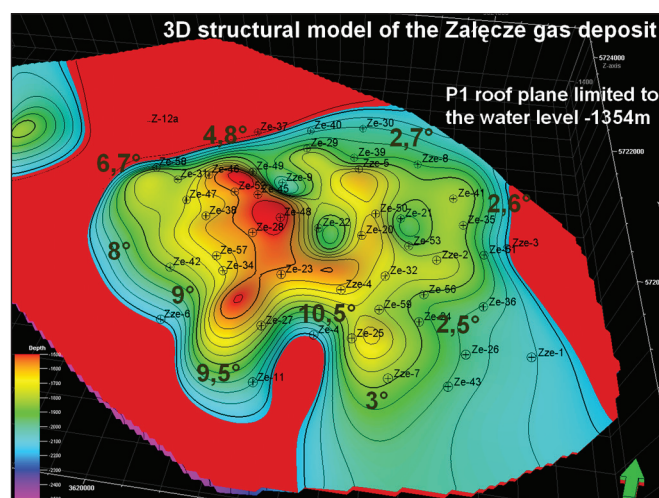
P. DUDA: **Preliminary results of mineral composition of marble from Sławniowice regarding regional metamorphism**

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Quarry of crystalline limestone of Sławniowice is one of the largest marbles deposits in Poland. It is located in the north of Nysa, near to Polish-Czech Republic border in the East Sudetes (Kodym, Fusán and Matějka, 1967). In the quarry, besides Precambrian marble, the micaschists, dolomites, pegmatites, rocks of granite type, aplites and secondary quartz veins occur (Bereś, Dumicz and Kozłowski, 1966). Deposit consists of six crystalline limestones seams, mica schists,

gneisses and sometimes amphibolite schists and amphibolite layered (Lewicki and Wyszomirski, 2005).

Mineralogical study of the crystalline limestone from Sławniowice showed that they are mainly composed of calcite, as well as none--carbonate minerals such as quartz, biotite, muscovite, chlorite, apatite, zircon, monazite, titanium minerals, iron oxides and hydroxides and Mn-Ba minerals.

In the crystalline limestones, quartz is in the form of xenomorphic crystals, generally as small, elongate inclusions in calcite or in the form of bigger, sometimes deformed blasts, often with a mosaic structure and wavy extinction filling the spaces between the carbonate blasts. Therefore, in the studied rocks two generations of quartz are present – primary quartz occurring as inclusions in calcite and metamorphic quartz crystallizing in the space between the blasts.

Dominant mineral among micas is biotite, which is characterized by a pale yellow colour and usually undergoes the process of chloritization. Muscovite is rare and generally occurs in the form of small and often deformed lamellae.

Chlorites usually form differently oriented lamellae and scales aggregates. They are represented by different varieties of chlorites showing both – normal grey and subnormal blue and brown--grey interference colours. Chlorites are secondary minerals. They were probably the product of biotite and/or other aluminosilicates transformation.

Among the accessory minerals, apatite and titanium minerals are frequently occurring minerals. Apatites form the hexagonal prisms properly crystallized. Titanium minerals in the rocks are represented by rutile and probably anatase. They are characterized by yellow and red-brown colour, weak pleochroism and a very strong relief. They occur as a small needles and prisms crystals. Occasionally, in the limestone can also be found zircon, monazite, iron oxides and hydroxides and Mn-Ba minerals.

These observations suggest that in the studied rocks stable is following group of minerals: calcite + quartz + chlorite + muscovite + biotite. They indicate the conditions of greenschist facies regional metamorphism.

M. DUNČKO: **Stability assessment of Gôtovany – Važec area for high-voltage wireway**

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The article presents landslide vulnerability assessment of high--voltage wireway in the Liptovská kotlina Basin, between Gôtovany and Važec villages. Reactivated slope deformations affect agricultural land, forests, and energy infrastructure in a form of high-voltage poles disruption causing the direct and indirect costs.

From the geological point of view, the largest area of the Liptovská kotlina Basin is built of Paleogene rocks and Quaternary sediments, mostly fluvial, glacifluvial and glacial sediments. Mesozoic rocks of the Choč and Krížna nappes are present here only marginally.

Landslides in the area of interest are frequent, being are developed in the Tertiary rhythmic flysch rocks (claystones and sandstones) and slope sediments.

The elements at risk calculation are generally based on a simple statistical calculation by the key attributes (relevant factors) that are decisive for the stability assessment.

Here-in logical trees method is used for vulnerability assessment and risk analysis. Another term frequently used for this procedure is a tree diagram or branched graph. It is a graphical representation of events in time. Logic trees determine what effect stems from an event or cause which leads to an event. Using a logic tree there can estimate the probability of a phenomenon which can be analysed adverse to the event occurrence (Pate-Comell, 1984).

Construction of each logical tree begins with preparing a scenario of relevant factors, in our case: slope, groundwater level, depth of high--voltage pole foundation and its relationship to the estimated shear surface and position of high-voltage pole to the slope deformation.

The factors are arranged in a logical tree in the form of a graduated effect on activation of slope deformation (landslide) expressed in % (probability of activation). Probability is expressed in the interval between 0 to 1, corresponding percentages of 0 to 100 %. The result is the probability of which will be used to mobilize slope deformations with their potential negative impact on high-voltage poles. The rational position of individual elements of the logical tree indicates the probability of the movement of the landslide, damaging the building environment (pole and high-voltage wireway). It is indicated by the negative probabilities of factors.

The result is presented in a form of engineering geological map, showing areas vulnerable to landsliding. This procedure is also a proposal of remediation measures by which to minimize the negative impact of landslide processes on objects (wireway poles) in the study area.

M. DWORNIK and A. PIĘTA: Stochastic inversion of seismic tomography data in VTI geological medium

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Anisotropy of seismic wave propagation is a commonly observed phenomenon. There are several causes of this, i.e. the fine layering, systems of cracks and faults, orientation of crystallographic axes. Reconstruction of anisotropy parameters is one of the modern problems, which can be solved by the seismic tomography.

Several models are introduced to describe seismic anisotropy. This work is focused on vertical transverse isotropy (VTI) model which represents almost horizontal plane-parallel finely layered media. Five independent coefficients of stiffness tensor are necessary to describe VTI model. In an isotropic case, number of independent coefficient of such model reduces to two.

Nonlinear relationship between travel time of seismic waves and model parameters eliminated traditional methods of inversion, like matrix decompositions or algebraic reconstruction methods. Stochastic algorithms represent method that can be used to obtain stiffness tensor coefficients values in a geological medium. In this work Monte Carlo methods with and without local searching and genetic algorithms have been tested. Both methods require a huge number of iterations, which increase significantly computational time. Another disadvantage of these methods is a fact that they do not guarantee obtaining a correct solution in assumed time.

Monte Carlo methods and genetic algorithms have been tested on typical velocity models of geological medium. For these geological media seismic wave propagation has been modeled. Finite difference method with staggered grid was used to obtain the real values of velocity and stress vector components. This data was used to create synthetics seismograms, which were next used to obtain theoretical travel times.

Stochastic seismic tomography inversion was done in two stages. In the first step of computation, randomly chosen velocity model was set. Then seismic wave travel times were calculated to evaluate the accuracy of obtained values. Demand of stability for the random velocity distribution models and short calculation time caused that the shortest path method was chosen to solve a forward problem. A disadvantage of this method is a less precision of estimated travel times than in the case of full wave field modelling.

Results of an inversion show problems of non-uniqueness of obtained solution. Moreover, necessity of huge number of iterations caused huge calculation time, which can be overcome by parallelization of these stochastic algorithms.

M. FRIEDMANOVÁ: Analysis of Sarmatian deposits within the East Slovakian Neogene Basin

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Currently, petroleum is a main source of energy for recent civilization, and it is also one of the most important raw materials for chemical industry. In these days, the main interesting areas include some types of sedimentary basins and areas within delta type sediments. In the past, the territories filled with the delta type sediments, belonged among the most productive areas, and today also represent the most productive areas in the production of hydrocarbons. For this reason, it is necessary to know and study the evolution of these sediments in this type of sedimentary basins.

Evolution of the East Slovakian Neogene Basin was still controlled by the character of subduction between the Carpathian Orogene and the North–European Platform.

Based on the surface and subsurface studies, there was defined and interpreted the evolution of Sarmatian deposits in the East Slovakian Neogene Basin as well as the depositional environment in this Neogene basin. The Early Sarmatian deposits in the East Slovakian Neogene Basin are built of the Stretava Formation. The surface analysis consists of the sedimentological profiling, logging and determination of depositional facies including their facial associations. Subsurface analysis aims at the interpretative correlation of drill cores, well logs and seismic profiles. After subsequent analysis of all information there was defined the sedimentological facies associations.

Final correlation and analysis based on all data and information obtained from surface and subsurface sediments research of the Stretava Formation support the assumption of the delta environment at the margin of Neogene basin that southeastwards passed to a shallow sea.

A. GŁUSZYŃSKI: Structural interpretation of 3D seismic data from the Carpathian front at Pilzno (SE Poland): Preliminary results

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3D seismic data recently acquired by the Polskie Górnictwo Naftowe i Gazownictwo S.A. (Polish Oil and Gas Company) near Pilzno allow an accurate recognition and description of the deep geological structure of the studied area. The aim of this paper is to present the geometry of the contact zone between the Carpathian orogen and the foredeep and within its Permo-Mesozoic substratum. The interpretation was facilitated using Kingdom (™SeismicMicro) and Petrel (™Schlumberger) software packages, relying on, among others, seismic attributes.

It appears from the interpretation of the seismics that the folded and overthrust Miocene strata of the Zgłobice Unit above the triangle zone's frontal backthrust were displaced toward the northeast along an oblique ramp in the west and were thrust upon a frontal ramp of E–W strike in the north. Fault-bend frontal anticlines developed above both the ramps. A SW-plunging syncline was also formed parallel to the oblique ramp in the west. Its SE limb overlies the triangle zone's frontal backthrust. Below the frontal backthrust the tectonically thickened and folded Miocene evaporites occur, attaining as much as ca 700 m in thickness. The Mesozoic basement of the Carpathian foredeep in Pilzno area is dissected by the SW--throwing normal faults together with accompanying subordinate lower-order events. The throws on those faults reach up to several tens of metres.

E. GÓRSKA-MRUK: **The different velocity models for time to depth conversion of Zechstein complex in the southwest part of the Polish Lowlands**

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The main aim of seismic survey is to locate the reflectors correctly in the depth domain. Effective time to depth conversion of salt diapirs requires accurate modelling of velocity data. The author is presenting an overview of different velocity models for the conversion of time to depth using the set of seismic section from Murowana Goślina – Kłecko survey (the southwest part of the Polish Lowlands) and 22 wells with full set of borehole geophysical data and stratigraphic data.

The velocity model for the time to depth conversion of 2D seismic data (9 profiles) was constructed in several steps. They included preparation of a structural framework within which procedures of loading and editing stacking velocity data, building the 3D interval velocity model from stacking velocities and the final calibration were subsequently implemented. The structural framework was created on the basis of the time maps of the interpreted 10 horizons (using software: GeoGraphix Discovery and SMT Kingdom). Provided seismic velocities were interpolated in the structural frame and were smoothed by a wide bell shaped filter and were calibrated by the use of formation tops. It was first velocity model, which was created using the DepthTeamExpress and Promax software. In the next versions of the velocity models there was modelled interval velocity only in Zechstein complex by using the constant interval velocity and the function two-way traveltime isochores vs. interval velocity on the base time – depth table (using Petrel software).

The results of conversion using the different velocity models are presented on several graphs (e.g. Fig. 1) for comparison the precision of solutions.
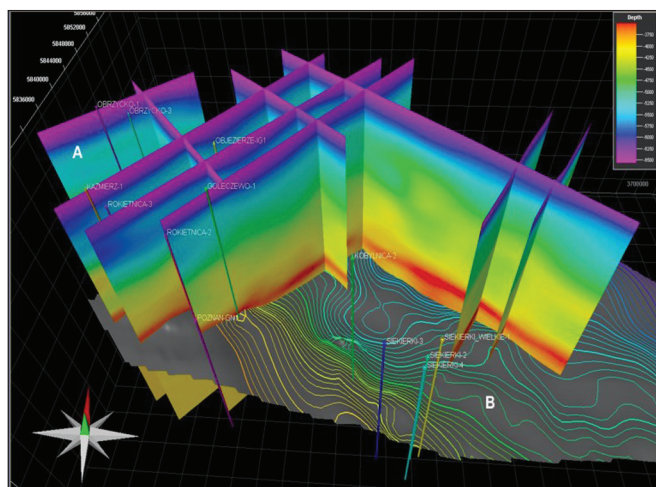

Fig. 1. One of the discussed models of velocity distribution. A – one of the seismic sections presenting the created velocity field, B – shape of the bottom of the Zechstein.

W. GRZYWACZ and J. MATUSIK: **Methanol complexes with kaolin minerals of low structural order: IR study**

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Kaolinite is a 1 : 1 layered dioctahedral aluminum silicate – $Al_2Si_2O_5(OH)_4$. The layers are held together by hydrogen bonds. Inner surface OH groups are prone to reactions with guest molecules and therefore it is possible to obtain organo-mineral complexes with interesting properties. As kaolinite world production exceeds 20

million tons/year, hybrid nanomaterials based on this mineral are more often synthesized and may have great potential in scientific and industrial applications. Kaolinite-methanol intercalate is an important precursor which increases mineral reactivity towards the intercalation processes with e.g. amines and polymers. Therefore the purpose of the study was to examine the efficiency of kaolinite-methanol intercalate formation with kaolins of low structural order.

For the experiments "Jaroszów" kaolinite (J) and "Dunino" halloysite (H) (AGFI index: H = 0.63; J = 0.37) from Polish deposits were used. Minerals intercalated with dimethyl sulfoxide (DMSO) were used as precursors. The J and H samples (~2 g) were mixed with 30 ml of 3 % H_2O/DMSO solution at 70 °C for 2 h. Formed JDS and HDS samples were centrifuged and dried at 60 °C. Afterwards, JDS and HDS were stirred with 40 ml of CH_3OH for 10 days. Samples were collected every 24 h (JM1-10 and HM1-10). After each sample collection the suspension was centrifuged and dispersed in a fresh portion of methanol. Samples were characterized using XRD and IR analyses. The CHNS elemental analysis was also performed.

The presence of d_{001} = 11.26 Å peak in the XRD patterns confirmed the formation of JDS and HDS complexes. The presence of 3 540 cm^{-1} and 3 505 cm^{-1} bands and a decrease in intensity of a band at 3 700 cm^{-1} confirmed the formation of hydrogen bonds between mineral OH groups and DMSO. Intercalation degree reached: 82 % for HDS and 75 % for JDS. Intercalation of methanol was confirmed by the appearance of four bands at 2 960 cm^{-1}, 2 926 cm^{-1}, 2 876 cm^{-1} and 2 840 cm^{-1} attributed to C-H stretching vibrations of methanol molecules (JM and HM samples). The increase of intensity of these bands (in normalized IR spectra) throughout the experiments suggested that the amount of methanol molecules in the interlayer space increased in the ab plane as the d_{001} value of dried samples was constant ~8.6 Å. DMSO was completely removed after 96 h for JDS and 144 h for HDS which was confirmed by the disappearance of DMSO characteristic IR bands. On the basis of CHNS analyses chemical formulas of the final JM10 and HM10 complexes were calculated to: $Al_2Si_2O_5(OH)_{2.84}(OCH_3)_{1.45}$ and $Al_2Si_2O_5(OH)_{2.55}(OCH_3)_{1.16}$, respectively. It is suggested that about one third of inner surface OH groups was grafted forming methoxyl OCH_3 groups which is sterically acceptable (Fig. 1). The rate of grafting was higher for the H sample with higher structural order.
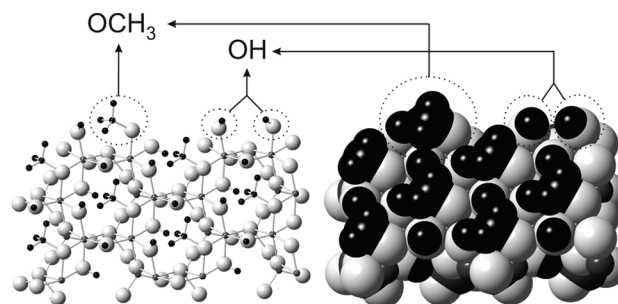
Fig. 1. Methoxyl OCH_3 groups.

H. Q. MAN: **Deltaic facies classification using Log data**

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Rock type model is an important input for reservoir modelling because it provides information about the vertical and lateral variations between reservoir and non-reservoir rocks, ultimately constraining the distribution of their petrophysical properties. Each sedimentological facies has a certain set of features, like dominant directions, geometrical pattern of material distribution, and petrophysical properties within the framework of the reservoir,

field or basin that must be considered. Rock types derived from core description are discontinuous and do not guarantee a geometrical distribution pattern that can be understood in geological terms. Thus, well log data could be useful for interpretation the rock type patterns.

In the Z gas deposit of the Miocene formation of the Carpathian Foredeep in SE Poland, many rock types are recognized on the basis of core description and responding to depositional facies such as large mouth bars, distribution channels, lagoon, shallow marine and others clastic sediments that are deposited in deltaic environment. In that horizon sandstone layers with gas are difficult to be identified because of low contrast of parameters between sandstone and shale.

Unsupervised learning method offers the possibility of exploring the structure in the well log data without guidance in the form of class information from core data. It can often reveal features not previously expected or known. It includes the division of data into a number of smaller groups, each with separate identifiable properties. In the study, basic on well log data the 6 rock types (Fig. 1) were classified by using K-mean clustering method. The derived results will be imported to the facies modelling.
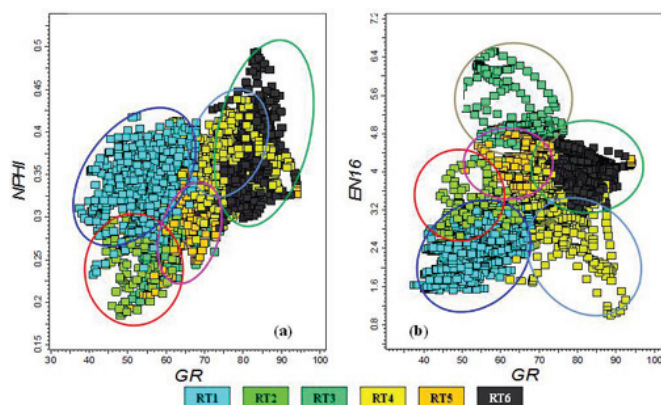

Fig. 1. The cross plots in well Z76 shows result of 6 rock types (RT). a – GR/NPHI, b – GR/EN16.

E. HAŁAJ: Prospects for direct–use application of geothermal water and energy in chosen areas of Mogilno-Łódź Trough

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The Mogilno-Łódź Trough is located in the central Poland. It is placed between the main structural units as follow: Fore-Sudetic Region, Szczecin Trough, Pomeranian Swell, Kujawy Swell, Miechów Trough. The Mogilno-Łódź Trough formations have good geothermal conditions.

Geothermal energy is one of the sources of renewable energy. Geothermal water and energy could be used indirectly and directly. Electricity generation in a proper cycle is an indirect application of geothermal energy. Direct–use application is when hot geothermal water or other fluid heated by the geothermal energy is provided. The geothermal water and energy could be used for the space heating, mostly systems for a greater number of consumers, deicing of roads and pavements or in other industrial and agricultural processes where hot water or heat is needed. Water with proper mineral composition could be utilized in balneotheraphy and recreation in swimming pools, also after decreasing its temperature in a heating system. There are many applications possible. Some elements from the geothermal water could be also recovered. Direct–use applications is connected with chemical and physical properties of geothermal water, mostly its temperature, TDS, chemical composition and content of trace elements.

The geothermal water and energy in the Mogilno-Łódź Trough are mostly connected with Mesozoic, Jurassic and Cretaceous aquifers. These aquifers have the best conditions for the occurrence of such water. The temperature of the geothermal water could vary between 70–80 °C. In chosen areas there are shown general geological conditions of the occurrence of geothermal water as well as water properties. A possibility of its direct–use application for some purposes depends also on social–economic conditions existing in these areas. This possibility is assessed.

M. JAMRICH: Preliminary results of calcareous nannofossil assemblage study from Dubová (Danube Basin) in correlation with foraminifers

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During Miocene times the Danube Basin was a part of the Central Paratethys. From the Late Badenian to Early Sarmatian the sea level dropped rapidly in the whole Paratethys and the area lost connection with the open sea (Rögl and Steininger, 1983). This isolation resulted in reduction of salinity, causing extinction of stenohaline organisms, corals, radiolarians and many species of molluscs, foraminifers, ostracods and calcareous nannoplankton. New paleoecological and isotopic studies (Látal et al., 2004; Pilier and Harzhauser, 2005) indicate that the isolation of the basin did not result in a decrease of salinity everywhere. A new transgression started at the beginning of the Sarmatian and formed a large epicontinental basin situated between the Alps in the west and the Aral Sea in the east (Paramonova, 1994). The basin was characterized by high alkaline waters oversaturated with carbonate (Pisera, 1996), by uniform environmental conditions (Rögl, 1998), and by episodic connections with the Mediterranean (Paramonova, 1994). During Early Sarmatian transgression, the sedimentation started with shallow water deposits (Kováč, 2000) characterized by the occurrence of large foraminifers of the *Elphidium reginum* Biozone in the sense of Grill (1941). Late Badenian sediments of Báhoň and Pozba Fms. of Bulimina/Bolivina Zone are known from the whole area of Danube Basin. They were deposited in the lower to upper neritic environment. Sedimentary infill of the northwestern part of the basin is represented by the grey calcareous clays, mudstone and siltstone with sands and sandstone layers. Sarmatian sediments of the Vráble Fm. are deposited in brackish shallow neritic environment. Sedimentary infill is composed of the green-grey calcareous clays, siltstones and sands. Basinal margins are composed of conglomerates, organodetritic limestones, coquinas, sandstones, acidic tuffs, coal clays and coal beds (Kováč, 2000). In order to obtain new data from the Danube Basin on the basis of calcareous nannofossils a recent research has been performed. The aim of the research was to distinguish the transition between the Late Badenian and Early Sarmatian according to the presence of calcareous nannofossils. Typical association of calcareous nannofossils in Dubová is composed of *Coccolithus pelagicus*, *Reticulofenestrids*, *Helicosphaerids* and *Braarudosphaerids*. We can define the association as Late Badenian because there are no marker species for Sarmatian such as the large *Reticulofenestra pseudoumbilicus*, *Calcidiscus macintyrei* and *Perforocalcinella fusiformis*. The assemblage contains NN6 Zone species. There are many reworked species of Cretaceous and Paleogene in the studied samples. Also foraminifera proved the Late Badenian age of Bulimina/Bolivina Zone by the presence of typical zonal markers such as *Elphidium macellum*, *E.* cf. *margaritaceum*, *Globigerina bulloides*, *Globulina gibba*, *Guttulina austriaca* and *Reussela spinulosa*. There is no evidence of Sarmatian nannofossils until now. The results prove the Upper Badenian age of the sediments until now. The Upper Badenian layers from Dubová (Danube Basin) reflects proper conditions for marine organisms such as molluscs, ostracods, bentic foraminifers, echinoids spicules, fish teeth and otolithes.

M. JAMRICHOVÁ: **Microfacial study of the particular sections of the Czorsztyn Unit (Pieniny Klippen Belt, Western Carpathians)**

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The Czorsztyn Unit represents a shallow-water Pienidic Unit. Its sedimentary record reflects the evolution of the Czorsztyn Swell (Birkenmajer, 1977; Mišík, 1994) on which it was deposited. A classical scheme of this evolution, introduced by Birkenmajer (1963, 1977) was mostly inferred from the Polish part of the Pieniny Klippen Belt. In the last time, new data mainly from the Slovak part was obtained and complemented previous knowledge. Selected new sections in the western (Hrebeň, Štepnická skala II, Čertova skala-Dohňany, Červený Kameň and Erdúdsky Kostol) and eastern parts of the Pieniny Klippen Belt (Pod Gregoriánkou, Čertova skala and Lom Jarabina) were studied in order to obtain more precise lithological, microfacial and stratigraphical data. In the majority of studied sections, alterating grey to pink-red crinoidal limestones were formed by the crinoidal microfacies with abundant clastic admixture. This alterating complex of the crinoidal limestones occurs instead of Krupianka and Smolegowa Limestone. Higher up they pass into micritic crinoidal limestones, in some cases partly nodular, with crinoidal-filamentous microfacies. In this formation a condensed sedimentation was registered. After the interruption of the sedimentation, the Czorsztyn Nodular Limestones sedimented. These limestones consist predominantly of the filamentous microfacies, which were replaced by *Globuligerina* microfacies (Oxfordian-earliest Kimmeridgian) and these are followed by *Saccocoma* microfacies (Kimmeridgian-Early Tithonian). The Czorsztyn Limestones continued by Tithonian-Early Cretaceous Dursztyn Formation with *Saccocoma* microfacies in the lower part and *Globochaete*, radiolarian and calpionellid microfacies in the upper part. In this formation calcareous dinocyst zones (Parvula, Moluccana, Pulla, Tithonica, Malmica, Semiradiata and Tenuis) a calpionellid zones (Chitinoidella Zone with Dobeni and Boneti Subzones, Crassicolaria Zone with Intermedia, Brevis and Colomi Subzones, Calpionella Zone with Alpina and Ferasini Subzones) were recognized. In the Dursztyn Formation, Malmica Zone precedes Tithonica Zone and synchroneous FO event of *Colomisphaera pulla* (Borza) and *Carpistomiosphaera tithonica* (Nowak) were registered. The youngest observed members were grey and red limestones of Aptian up to Albian age with *Hedbergella* sp. (Erdúdsky Kostol).

M. KLÚZ: **Mathematical model of the groundwater flow at the SE part of the East Slovakian Basin**

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Mathematical models of the groundwater flow became the important tools for understanding the hydraulic properties of the hydrogeological units during the changing conditions. Well designed and calibrated models enable to plan, predict and exploit groundwater resources with appropriate quantity and desired quality. Aim of this short article is to introduce the mathematical model of the groundwater flow of the Quaternary fluvial sediments of the SE part of the East Slovakian Basin. Model has been designed and calibrated for the steady-state flow in commercial program VModflow 2010.1. Conceptual model is based on the site investigation, data obtaining from archives of Geofond, as well as meteorological and climate data from SHMÚ. A requirements for model consist: a) physical framework – geological map of the Neogene and Quaternary sediments, topographical map, GIS data, isopach maps and hydrological maps; b) hydrogeological framework – water table, potentiometric maps, hydrographs of the groundwater heads and surface water levels, discharge rates, maps and cross sections through the hydraulic parameters, storage properties of the aquifers and spatial and temporal distribution of rates of evapotranspiration, groundwater recharge, surface–groundwater interaction, groundwater pumping and discharge. Basemap of the model is in the scale – 1 : 25 000, and occupy 67 km^2 of surface. Site is artificially bounded by the Hungarian border on the south, Ukrainian border on the east and on the west by imaginary line between villages Pribenik and Leles. On the north, the natural boundaries are made by the river Latorica and partly on the south-east by the river Tisa. Grid domain contains 8 272 center meshed cells from which 1 482 are inactive. Modeled upper layer is considered as homogeneous of the Quaternary sediments with unconfined aquifer (fluvial sands) and the Neogene sediments are concerned as aquitard (Neogene clay). Pumping tests determined basic hydraulic parameters that have been modified during calibration. Initial heads have been set by the long term groundwater level investigation and have been interpolated by the Surfer software. Deposition of the Neogene sediments was interpreted from archive well logs. Hydraulic parameters of the model were calibrated using error analyses of predicted and observed groundwater level. Designed and calibrated model showed variation of the groundwater divide based during the rain and dry seasons of the year. We have found that the nearby Boťany waterworks do not influence the large surrounding groundwater body. Waterworks therefore depend on the flow of the Latorica river. A question to the discussion is how there could be improved an accuracy of the model by extending modeled area behind the state borders – eastward to Ukraine and southward to Hungary? Could we extend modeled area without exact data just with extrapolation method of known properties?

M. KOHUT: **Eruption of Eyjafjallajökull volcano as a manifestation of increasing volcanic activity in Iceland**

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Eyjafjallajökull is a subglacial volcano in the southern Iceland. Its eruption on 20 March 2010, after 187 years of silence, released huge amounts of volcanic dust, pyroclastic material and lava. From historical data it is known that in 1 821 the volcano manifested periodic volcanic activity for about two years, and then in 1 823 an explosion of adjacent much more dangerous Katla volcano took place. Nowadays, disturbing signs of increased volcanic activity of southern Iceland are observed also.

During geological expedition to Iceland in August 2010 the samples of rocks and volcanic ash were collected from this recent volcanic eruption of Eyjafjallajökull volcano. The study was focussed on mineralogical and petrographic characterization of the recent eruption products. Samples were analysed using petrographic microscope and X-ray diffraction. Additionally, a petrologic interpretation based on the results of chemical analysis (from the University of Iceland) was carried out. Based on the historical data and obtained results of mineralogical and geochemical analysis (e.g. TAS diagram, AFM plot, geochemical discriminant diagrams and spider diagrams) the conclusions about the origin of lava and volcanic ash were drawn in the context of the geology of Iceland.

Eyjafjallajökull eruption is a classical manifestation of Icelandic volcanic activity. It represents the basaltic type of magma. The origin seems to be more complicated and ambiguous, combining elements of both – an active oceanic ridge and the impact of hot spots whose presence is confirmed by the geophysical surveys. In connection with continued seismic activity an analysis of the number and strength of shocks on Iceland, being registered by the Department of Geophysics and Icelandic Meteorological Office, was made. After the period time of volcanic eruption, there were observed periodic, highly active shocks, located in southern island which could be another evidence of the approaching period of increased volcanic activity.

P. KOLARZ: **Secondary mineral paragenesis from the Ni--Co-As Khovu-Aksy ore deposit (Tuva Republic, Russia): Preliminary studies**

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The Ni-Co-As Khovu-Aksy ore deposit is a part of the Uvs-Nuur--Khovu-Aksy cobalt bearing zone and it is situated close to Kyzyl, the capital of Tuva Republic in Russia. Samples were taken during the geological expedition in 2010 from the Severnyi and Yuzhnyi districts of the ore field.

There are two main hydrothermal-metasomatic stages forming the Khovu-Aksy ore system: the skarn and hydrothermal stages. The hydrothermal mineralization is hosted by skarns of two main types: pyroxene and garnet-pyroxene.

The ore stages are divided into: early arsenide, main arsenide, late arsenide and post-arsenide (sulphide-sulphoarsenide-fahlore). The formation of primary mineral paragenesis is mainly connected with the early, main and late arsenide steps. The Ni, Co and Fe arsenides and sulphoarsenides form the main ore minerals in the deposit. Nickeline, rammelsbergite, loellingite, safflorite and skutterudite were identified.

Paragenesis of secondary minerals occurs usually together with minerals of "so-called" post-arsenide stage and they are mainly produced by the weathering of Cu sulphides as chalcopyrite, bornite, covellite, tennantite and tetrahedrite and less by weathering of Co and Ni arsenides. Mainly cobalt and copper arsenates were formed. Erythrites, tyrolite, in less amounts of azurite were indentified macroscopically and conichalcite and cornwallite have been recognized by the X-ray powder diffraction studies.

Z. KOMPANÍKOVÁ and I. ŠIMKOVÁ: **The thermal degradation of rocks with increased temporal temperature**

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This research is oriented into evaluation of the high temperature into the thermal degradation of stones. Two types of travertines and sandstones were tested in the laboratory to evaluate the change of petrophysical properties after heating at 200, 400, 600 and 800 °C. The rate of sample heating or cooling was set at 6 °C/min and 3 h dwelling. The changes of the physical properties, such as coefficient of the linear thermal expansion were examined by ultrasonic velocity, water absorption, spectrophotometry, optical surface analyses and thermodilatometer. Non-destructive testing (NDT) was used to evaluate a quantitative measure of pores and cracks within a rock volume before and after heating. Water absorption was performed to determine the real density, apparent density, open porosity and saturation in evacuation vessel. Spectrophotometry was used to measure the chromatic parameters on the surface of the stone specimens before and after heating. Optical surface analyses were used to obtain 3D-topography maps (25 mm^2) and the average R_a, R_q and R_z roughness parameters and surface roughness profiles measured on the top and bottom surface of the stone specimens. To characterize the linear thermal expansion behaviour of the rocks two parameters were chosen: thermal expansion coefficient α and residual strain ε. Five short-term temperature cycles (+20 °C to +70 °C) were carried out during the tests with the thermodilatometer. The thermally induced fracturing appeared mainly in the boundaries of mineral grains of stones at the lower temperatures due to the different thermal expansion of different minerals while heating the stones. At low temperatures (200–300 °C) a damage was limited to colour changes. At high temperatures (500–600 °C) the strength of most stones was seriously affected. Our results show a major episode of cracking in the 500–600 °C when the quartz α-β transition is reached, to the extent that at 800 °C some of the stones types disintegrated. The research in thermal decay may lead to improved

determination of natural building stones that have been damaged by fire.

G. KOZUB and J. PRŠEK: **Hydrothermal carbonate – Cu rich vein type mineralization in "Jóremeny" gallery, Dobšiná, Slovak Republic**

Department of Economic Geology, AGH-UST, Cracow, Poland

The hydrothermal carbonate–quartz–sulphide veins in the area of Dobšiná, Slovak Republic are hosted by phyllites, acid metavolcanic and metasedimentary rocks of the Gemeric Superunit. The samples of ore from "Jóremeny" gallery have been studied in order to identify and describe the ore mineral assemblage occurring within the carbonate veins. The minerals have been identified using the optical microscope with reflected light. The chemical compositions of minerals have been determined using a FEI QUANTA 200 Field Emission Gun Scanning Electron Microscope equipped with an energy dispersive spectrometer.

The ore mineral assemblage includes tennantite, enargite, luzonite, chalcopyrite, bornite, rarely digenite, pyrite, gersdorffite, arsenopyrite, Bi sulphosalts, galena and Se-, Pb-bearing minerals. Ore minerals form small veinlets occurring outside of carbonate veins, and form contact between carbonates and host rocks. Occasionally, enargite and luzonite form individual pristine crystals in the carbonate veins.

The textural features indicate a presence of two populations of chalcopyrite. The first type forms cracked grains associated with bornite and digenite and is partially replaced by tennantite. The second type forms tiny inclusions and small veinlets in former enargite-luzonite crystals, which are enclosed in tennantite. Tennantite fills cracks in luzonite-enargite crystals or replaces both minerals, which indicate the earlier crystallization of the minerals from enargite-luzonite join. The tennantite crystals occasionally show zoning in the BSE images. These zoned crystals and veinlets are concentrated in the areas where Bi, Se, and Pb minerals occur. The zonal crystals of tennantite are enriched in Bi (up to 11 wt.%), whereas the zonal veinlets are enriched in Pb, Bi and Se. Small crystals (<5 μm) of mineral with composition similar to clausthalite (PbSe) and crystals of wittichenite (Cu$_3$BiS$_3$) occur in these veinlets. Additionally, the wittichenite forms individual crystals with small mineral inclusions (<50 μm), reflecting composition similar to bohdanowiczite (AgBiSe$_2$), with elevated contents of S and Cu. The inclusions of galena are observed in tennantite, enargite and luzonite.

P. KRAKOWSKA and M. NIEPSUJ: **Influence of pore space saturation on P- and S-wave velocities using a *fluid substitution* option**

Department of Geophysics, AGH-UST, Cracow, Poland

P- and S-wave velocities are the key parameters in seismic and well logging interpretation. In the case of perspective zones interpretation they are the essential indicators of hydrocarbons saturation in the pore space. The saturation degree in pore space influences the P- and S-wave velocities in different way. One of the methods to analyse this behaviour is the *fluid substitution* option.

Analysed data come from A well which is located in Tunezja. It drills pelagic chalk (Upper Cretaceous) which is built by foraminiferal nannofossils. Selected interval, which is saturated by gas, equals 4 800–4 900 m. All calculations were carried out in *GeoGraphix Discovery* software *fluid substitution* tool (Landmark_AGH UST University Grant).

Fluid substitution is an option used to analyse the variation of saturation based on different methods e.g. Greenberg-Castagna.
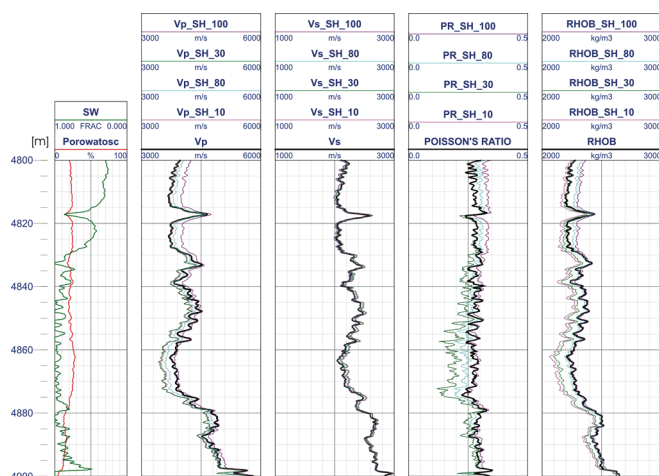
Fig. 1. Fluid substitution results for measured P- and S-wave velocities (symbols: **SW** – input water saturation; **K_P** – porosity; **V_P** – measured P-wave velocity; **$V_P\_SH\_10,30,80,100$** – estimated P-wave velocity at water saturation: 10 %, 30 %, 80 % and 100 %; **V_S** – measured S-wave velocity; **$V_S\_SH\_10,30,80,100$** – estimated S-wave velocity at water saturation: 10 %, 30 %, 80 %, 100 %; **POISSON'S RATIO** – Poisson's ratio; **$PR\_SH\_10,30,80,100$** – estimated Poisson's ratio at water saturation: 10 %, 30 %, 80 %, 100 %; **RHOB** – density; **$RHOB\_SH10,30,80,100$** – estimated density at water saturation: 10 %, 30 %, 80 %, 100 %.

Fig. 1 shows the results of *fluid substitution* carried for different saturation S_w: 10 %, 30 %, 80 % and 100 %. Input curves (black) are the measured P- and S-wave velocities, estimated density and Poisson's ratio. Gas saturation in pore space of reservoir rocks causes the changes of petrophysical parameters such as waves velocities and density, which are so important in seismic and well logging. P-wave velocity decreases suddenly even at low gas saturation. S-wave velocity does not change considerably for the different saturations. It is caused by a fact that S-wave velocity depends on rock stiffness and density. Rock stiffness equals zero for the fluid and gas (shear modules equal zero), so S-wave velocity changes slightly with the saturation change (as a result of density changes). Analysis of only velocity curve, to determine the gas saturation degree is difficult. *Fluid substitution* method was made in this purpose to analyse the trend change of the measured velocity curve depends on saturation. Observing P-wave velocity curve and comparing to estimated P-wave velocity for the different saturations allow determining of the zonation of reservoir rock. In the upper section of the analysed interval, the measured P-wave velocity is located near the estimated P-wave velocity for S_w = 10 and 30 %. In the further part of the section gas saturation decreases and it is observed that measured P-wave velocity approximates to curves calculated for S_w = 80 and 100 %. Remaining curves behaves similarly.

P- and S-wave velocities, P- and S-wave velocity ratio and Poisson's ratio are the essential indicators of hydrocarbon zones. From all analyses there is concluded that there is possibility of qualitative interpretation of reservoir parameters with saturation zonation determination of reservoir rock.

Authors would like to thank BG Group plc. (Reading, Great Britain) for data as well as to our professors J. Jarzyna and K. Pietsch for care and help.

K. KRONOME: **Preliminary correlation of the Upper Triassic limestones of the Silica nappe in the Drienčany and Slovak Karst areas on the base of microfacies analysis**

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The Drienčany and the Slovak Karst areas belong to the tectonic unit of the Inner Western Carpathians and are built dominantly by the complexes of the Silica nappe. This study is mainly focused on the microfacies analysis of Tuvalian-Sevatian pelagic Hallstatt Limestones. The outcrops selected for this study in the Slovak Karst are: *SB – Trench:* section 1 km west of the village Silická Brezová, *outcrop "PNLL"* located in the woods below the "Nový Lom" quarry and *locality BO* – Bohúňovo. In the Drienčany Karst area the studied locations were: *DP* – Drienocká pustatina, *KA-A*; *KJ-B* – Kamenný jarok gorge in the vicinity of village Slizké and *BUD* – Budikovany village.

Based on microfacies analysis the individual limestone facies types were classified according to schemes of Facies Zones by Wilson (1975) and Standard Microfacies Types – SMF by Flügel (1982). From this point of view the most complicated is the SB-Trench outcrop. Despite that on the base of the outcrop the Tisovec–Waxenec Limestones are present, the bulk of the section is built by the Hallstatt Limestones in various facies types and the top of the section is built by the Dachstein Limestones. The assumed sedimentary area of the Tisovec–Waxenec Limestones is an agitating environment FZ 4, SMF 5, or environment of open lagoon near channels connecting the lagoon area with open marine environment FZ 7, SMF 9 indicated by presence of open marine faunistic elements, ammonoids and thin-shell bivalvias. The Hallstatt Limestones in this outcrop belong to several facies types. Since the first type shows that the sedimentation area started to deepen, we propose an open shelf to margin of the deep water basin environment – SMF 3, FZ 1. The second type can by assumed to SMF 3, FZ 3 – toe of the slope. Limestones of the next facies type can by ranged into SMF 3, FZ 3, or SMF 9, FZ 2 – deep shelf, inasmuch as that SMF 9 representing slope facies. Limestones of the peloidal grainstones beds belong to SMF 2, FZ 2 to 3. The Dachstein Limestone represents SMF 17 – environment of shallow water sedimentation on the platform. The outcrops PNLL, BO, KJ-B, BUD and upper part of section KJ-A can be classified as SMF 3 – pelagic mudstone/wackestone, FZ 1 – environment of the deep sea. The limestones of the lower part of KJ-A section are falling into SMF 2 – microbioclastic peloidal calcisiltit, FZ 3. The limestones of the locality DP can be ranged to SMF 9 – burrowed bioclastic wackestone, FZ 2.

Based on the interpretation of microfacies in these outcrops we can preliminarily conclude, that the Hallstatt Limestones occurring in the Slovak and Drienčany Karst areas were deposited mainly in the deep water environment. While during the deposition of sediments outcropped in the SB – Trench locality an event of temporary shallowing had taken place to the toe of slope environment, the limestones on the locality DP sedimented entirely in the environment of the deep shelf. More detailed correlations of the sections will be done after completion of detailed stratigraphic evaluation on the base of conodont study.

K. KULICKI, G. SKROBOT and A. ŚWIERCZEWSKA: **Relics of pre-folding illite-smectite diagenesis in the Magura nappe, Outer Carpathians (Poland)**

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The X-ray diffraction studies of illite-smectite mixed layer minerals can be used for reconstruction of burial and thermal history of the rocks involved as well as for dating of tectonic deformation in relation to degree of smectite to illite transformation. Composition of illite-smectite minerals provides information on maximum paleo-temperature to which involved rocks were submitted. This method can be used for temperatures 75–200 °C.

In present studies the correlation between the age of rocks and the degree of smectite to illite transformation was applied for each unit of the Magura nappe along profiles running parallel to fold axes. These detailed studies represent a continuation of a previous complex investigation on thermal evolution of the Magura nappe. The aim of the recent study was to indicate these portions of the Magura nappe where it would be possible evidently to distinguish between pre- and postfolding transformations of smectite to illite. The situation, when older rocks are affected by the higher paleotemperatures then younger rocks, presents an evidence that transformation of smectite to illite took place before folding. On the other hand, the reverse situation, or complete lack of correlation between the age of rocks and their thermal alteration indicates that diagenesis occurred after folding.

In the present studies, such correlation analyses were carried out in small segments of parallel fold axes profiles in Krynica, Bystrica, Rača and Siary units. At first, studied profiles were subdivided into 2 parts: northern and southern, and later they were analysed in smaller portions depending of samples abundance. Each portion was analysed in terms of variation of paleotemperature in relation to age.

Analyses of correlation between the age and maximum paleotemperatures in the Krynica Unit show that thermal structure of the unit relates to maximum thermal alteration which took place after folding. Only in one part of Bystrica Unit profiles, the observed thermal structure may result from the maximum diagenesis which took place before folding. More portions where such diagenesis took place before folding were recognized in Rača and Siary units.

M. KWAŚNIAK-KOMINEK, M. MANECKI and G. RZEPA: Mechanisms of alternations of rock-forming minerals in the foreland of retreating glacier, Werenskioldbreen, SW Spitsbergen

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The area of this study is a foreland of the Werenskiold glacier (SW Spitsbergen). This glacier has been continuously retreating during the last century by several meters a year. It was established elsewhere that carbonate dissolution and sulphate oxidation dominate in the youngest glacial sediments, while silicate weathering is dominative reaction in the older sediments.

The objective of this study is an identification of inorganic mechanisms of weathering of minerals in the foreland of retreating glacier. Retreating glacier uncovers fresh regolith, evolution of which is dominated by few relatively simple processes: dissolution/precipitation and oxidation/reduction. Chemical weathering and soil forming processes contribute to high chemical denudation observed in this region. Micro-scale characterization of mineral skeleton associated with chemical characteristics of pore waters is necessary for fully understanding the mechanisms of weathering.

The samples of soils and waters were collected at three localizations: 20 m, 950 and 1 700 m from the front of the glacier. The sediment closest to the glacier was uncovered from underneath the glacier within the last 10 years while the furthermost – nearly 100 years ago. Samples of percolating waters, collected from 30 cm deep trenches, were analysed in the field for temperature, conductivity, pH, Eh, O_2 content and HCO_3 (alkalinity titration). Mineral composition of the sediments was determined using petrographic microscopy in polarized light, X-Ray diffraction and scanning electron microscopy. PHREEQC calculations were used to explain mechanism of minerals dissolution.

The soils are almost entirely composed of primary minerals: rock-forming minerals coming from amphibolites, quartz-mica schists, carbonate schist, phyllites, etc. Secondary minerals resulting from weathering include kaolinite, vermiculite, illite, smectite and goethite. Secondary clays were identified only in the oldest soil sample. The correlation between the composition of the waters and the distance of the glacier front was also observed. Maturity of analysed soils increases with the distance from the glacier. Dissolution of carbonate minerals (mainly calcite, dolomite, ankerite and siderite) is a dominating weathering process which explains the vast majority of HCO_3^-, Ca^{2+} and Mg^{2+} contents. Some Ca^{2+} and Mg^{2+} results from weathering of rock-forming aluminosilicates as well. The oxidation of pyrite (and possibly other sulphates) is a major source of SO_4^{2-}. The waters evolve from carbonate-dominated to sulphate-dominated. This might indicate that pore waters in more matured soil reach the equilibrium with carbonate minerals while being continuously supplied with SO_4^{2-} from oxidation of sulphates.

W. MACHOWSKI: Base case to dynamic simulation of CSEGR – Carbon sequestration and enhanced gas recovery – for depleted Wilków gas field

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Within the framework of the Polish National Program "Assessment of formations and structures for safe CO_2 geological storage, including monitoring plans", semi-detailed analysis of the Wilków-Szlichtyngowa anticline was carried out. This depleted gas-bearing formation is considered optional for CO_2 storage with double goals: CO_2 sequestration and enhanced gas recovery at the same time.

Undertaken analyses suggest that carbon dioxide can be injected into Wilków-Szlichtyngowa depleted gas reservoirs to enhance methane (CH_4) recovery for periods on the order of 10 years, while simultaneously sequestering large amounts of CO_2.

Although the idea of injecting CO_2 into depleted natural gas reservoirs for carbon sequestration with enhanced gas recovery (CSEGR) has been challenging for more than ten years. The analysis of the physical processes involved in CSEGR has suggested that mixing would be limited because of the high density and viscosity of CO_2 relative to CH_4. Furthermore, simulations suggested that CSEGR could enhance gas production by a factor of five relative to continued primary recovery over the same period for Wilków gas field.

Gas-water contact was calculated on –1 507 [m] for Wilków and –1 472.5 [m] for Szlichtyngowa. Complicated contours situation and different natural gas compositions (60 % N_2, 37 % C1 and 0.25 % of He) brings a lot of difficulties during dynamic modelling. Based on static 3D model, constructed by in Department of Fossil Fuels author made simulation of CO_2 injection using simulator Eclipse 2009.

At the present state of recognition of the configuration and size of the structure, without history of exploitation, physically possible quantity of injected CO_2 is hard to calculate. Presented results can be assumed as the idea or one of the dynamic scenario for gas sequestration in the depleted Wilków gas field.

G. MADEJA and P. MROWCZYK: Issues of sandstone tors morphology in the Silesian Beskid

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Natural sandstones and conglomeratic tors as well as rocky walls are rarely found in the flysch Carpathians; however, their accumulation is relatively greater in the Silesian Beskid. They are located both in open area and woods, mainly on mountain ridges or hogbacks but also on hill tops. They are found in groups or individually. They adopt a great variety of morphological forms; most common are: walls, mushrooms or pulpits.

The Silesian Beskid is mainly composed of flysch units of the Silesian nappe, and slightly folded layers in the area are monoclinal and dip southwards. Tors found within this block occur among thick-bedded sandstones and conglomerates belonging mainly to middle and upper Godula Beds, lower and upper Istebna Beds, but also to Ciezkowice Beds.

The morphological form is strictly related to strike and dip of beds, and the place of their localization as well as their relation to dorsal direction. Microrelief is principally connected to lithological, structural and textural characteristics of deposits which built the tors, but also to joint cracks which are responsible for ultimate shape a tors takes. Main erosion processes affecting the tors surface include: insolation, congelifraction, ablation, dissolution and leaching.

Tors are built of sandstone layers, conglomeratic sandstones, and more rarely of conglomerates, whose common feature is high thickness – around 1 m, sometimes reaching even few meters. Sandstones exhibit a diverse granulometric composition – usually coarse-grained and uneven grain-sized, fine-grained are sometimes found in hanging layers. Quartz grains compaction of sandstones plays an important role in erosion resistance, just as volumetric density and water absorption by weight. Furthermore, sandstones which have clay-carbonate binders undergo weathering more quickly than sandstones with clay and silica binders. The binder in specific layers can differ and be distributed to different degree, which additionally favours selective weathering. Fractional graining occurs in layers of conglomeratic sandstones and conglomerates, and it can be incomplete, with an unevenly separated fraction.

The lithological diversity of individual layers in tors affects significantly their morphology. The layers of conglomeratic sandstones and conglomeratic ones have usually negative relief, whereas sandstones positive. In layers which have uniform lithology the walls are usually flat.

The issues related to mechanic weathering of tors surface, and the relation of tors surface relief to petrographic composition of specific lithological layers were shown in presentation. A special attention was also paid to relation between microrelief and content variability of binders in tors. A preliminary research methodology, relevant to such objects in terms of their morphology and variety of geological conditions, was also indicated.

M. MARUTA and E. MIREK-JONKISZ: **The "Rock oil" at your fingertips: Hydrocarbons' signs at the surface in the Polish Carpathians Area**

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The fact that hydrocarbons exist in the Carpathians has been known for centuries. The Polish geologist, Stanisław Staszic in his book "About Earthborn of the Carpathians and other mountains and Polish plains" (1815) mentioned about a black smudge of oil from the rocks. Local people have learned soon how to take advantages of using a crude oil in a daily life. They used it as a wood preservative, a lubricant and for many other applications, including the use of the oil refined products. It is said, that the crude oil from village Klęczany, which is a colourless liquid, also had benefits for health.

Hydrocarbon seepages, as a naturally oil and gas basins spontaneous manifestation on the surface, for the long time have been the main indicator for starting exploration of oil in the Carpathians since the mid-nineteenth century. Basing on the hydrocarbon seepages, dozens of oil and gas fields had been discovered. However, nowadays their resources are largely exhausted.

In this work authors describe 6 examples of present locations of oil and natural gas surface symptoms located at Brzegi Dolne, Łopienka, Płowce, Stebnik, Uherce Mineralne and Zahutyń.

There are also shown relationship between location of hydrocarbon seepage and the background of a complex geological structure of the Carpathians, where seepages occur. Range of this study covered an area of the Carpathians located east of Ropa river valley to the Polish-Ukrainian Border at the Magura, Dukla, Silesian and Skola nappes.

Analysed seepages are grouped primarily on the outcrops of the Inoceramian Beds of the Magura nappe and the Krosno Beds of the Silesian nappe at the Upper Cretaceous-Paleocene and Oligocene ages. They are connected with primary and secondary migration as well as remigration of hydrocarbons.

Documented seepages of hydrocarbons occur almost in the valleys of the rivers and their tributaries, mostly within the outcropping eroded anticline folds and joints on their flank, and less frequently along the tectonic dislocations zones. A considerable number of them was also found in the Quaternary river sediments and waste covers mostly in the form of mining pits and hand-dug well located close to revealing seepages in the beds of watercourses water.

Intensity of oil seepages is also associated with the problem of assessing their potential impact on the environment. In the case of exploitation of oil fields, there must be assessed an effect of the exploitation process. This is a subject of understandable concerns of environmental organizations and local authorities. An impact of the presence of hydrocarbons seepages on the daily live of local people and to the environment are presented in the contribution as well.

M. MICHNA: **Difficulties associated with 3D modelling of the Nowy Targ – Cracow cross-section (Outer Carpathian, Poland)**

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The goal of 3D static modelling is to show a spatial variation in reservoir properties. Proper designation of the structural framework is very important and can significantly affect the distribution of petrophysical parameters. The study presents difficulties associated with the construction of such a model. A complicated tectonic heterogeneity of the Outer Carpathians requires application of such advanced techniques and tools in 3D modelling as Petrel software.

Three-dimensional reservoir modelling was based on the Nowy Targ – Cracow cross-section cutting all major structural units of the Outer Carpathians. It was prepared for the geothermal potential evaluation of the studied area. Structural geological interpretation performed by Tomasz Malata had to be simplified. A GRID-based software was used for this modelling. Two separate 3D models were created. Upper model was composed of 4 zones consisting of thee uppermost Eocene-Oligocene, Eocene, Upper Cretaceous--Paleocene and Lower Cretaceous rocks. The lower model was represented by the Lower Cretaceous rocks, Krosno Beds, Menilite Beds, Hieroglyphic Beds and Inoceramian Beds. The total amount of 3D cells was set on over 10 000 000.

Structural framework was populated with petrophysical para-meters using stochastic and deterministic methods. The petrophysical models reflect the distributions of the clay content (VCL), porosity (PHI; Fig. 1), saturation with water (SW) and permeability (K), determined on the basis of interpretation of the well-log curves. The permeability model was formed applying the method of Zawisza (1993) that is based on the well-log curves and describes the relationship between the porosity and the clay content of rocks.

The best reservoir properties within this cross-section occur in the Upper Cretaceous-Paleocene rocks of the Magura nappe. The results of modelling also show that potential, though poor geothermal reservoirs are related with the Krosno Beds. In the area between Skomielna Biała and Obidowa (southern part of the cross-section)
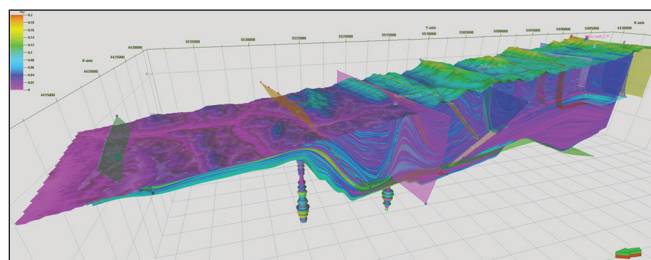

Fig. 1. Distribution of porosity in the petrophysical model.

they reveal porosity about 10 %, permeability of 5 mD and clay content 45 %.

For construction of 3D models the Petrel 2009.2 program was used. The program was delivered by SIS Schlumberger for the Faculty of Geology, Geophysics and Environment Protection, under the agreement about supporting the educational and scientific activities.

L. PETRÝDESOVÁ[1], P. LIŠČÁK[2] and R. PUTIŠKA[3]:
Geophysics measurements and stability analyses of selected landslides

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Recently increased attention is paid to the question of slope deformations (mainly landslides). In the Slovak Republic they represent one of the most common and most dangerous exogenous geodynamic phenomena, which often create a barrier for rational land use. The inventory of slope deformations in Slovakia was completed in 2007 reaching a total of 21 190 slope failures (5.25 % of total land area). Every year, landslides are the cause of damage to roads, existing settlements, and destruction of cultivated land, wooded areas etc.

One of the basic engineering problems in the estimation of the slope stability is the determination of the causes of slope movement. Without knowing the cause it is not possible to predict the subsequent progress of slope movement and also to design effective remediation methods. For the determination of the cause it is vital to know the conditions under which landslides have occurred and the triggering factors.

For stability calculations a thorough knowledge of engineering geological and hydrogeological conditions of the landslide areas is important. In compiling of the slope geotechnical model it is necessary to know the details of territory geology and shear parameters of all lithological complexes making up the slope. As the model sites two landslides from the landslide areas on the left side of the river Váh between the towns of Hlohovec and Sereď were selected, having in mind a concept of waterwork construction in the future. Slope deformations are very heterogeneous and the interpretation of geology based only on the engineering geological boreholes would be subjective, so we performed there geophysical measurements using electric resistivity tomography (multicable method). The resulting model of the resistivity was adjusted according to the lithology from boreholes especially within the transformation part of the landslide, where no boreholes were at hand, and completed. The clay and sand strata were clearly distinguished in the final resistivity model. Although the individual layers were relatively exactly determined, the slope had to be generalized because the stability program which was applied (Geo5 slope stability) could not calculate with the lens-like objects (e.g. small sand lenses). Stability analyses were carried out using Sarm's method on polygonal slip surfaces identified by the survey and calculated for 3 levels of the ground water table levels (for a ground water level met, as well as for the maximum and minimum levels). In one of the selected landslides the geophysics identified a basal slip surface depth of more than 40 m probably crossing underneath the river Váh bed up to its other side. The resulting degrees of stability for both landslides were negative even at the minimum height of ground water table level. Since the sections are considering with the construction of the waterwork an improper intervention may lead to activation of landslides with consequent negative impacts. This can be avoided by the appropriate remedial actions.

D. PIETRUCIN and D. SALA: **Chemical composition of waters and bottom sediments from lakes in the Osielsko region**

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The aim of this study is the estimation of contamination level of water reservoirs in Osielsko region, located about 10 km north–east from Bydgoszcz. In terms of hydrography this area belongs to drainage basin of Vistula and Brda rivers. Discussed area was covered by ice during the last glacial period, what brings geomorphological, hydrographic and soil consequences, visible in the landscape types.

In order to determine pollution level of the water reservoirs, five water and bottom sediment samples were collected during the field works. The electrolytic conductivity (EC), reduction potential (Eh), pH and temperature of the water were measured *in situ*. The chemical analyses of the water included: determinations of main cations and anions by the titration and AAS methods and marks of the trace metal levels by the ICP–MS method. In addition, selected physico-chemical parameters, such BOD (biological oxygen demand) and COD (chemical oxygen demand) were performed. In the sediments, the concentrations of trace elements (As, Cd, Cu, Cr, Ni, Pb, Zn) were estimated in fraction <0.063 mm using AAS and ICP–MS methods. Moreover, in the sediments to determine the content of fine particles – the sand ratio test was done in accordance with the Polish Standard (PN–EN 933–8:2001).

As a result of analysis it was derived that the waters from lakes are neutral (pH 7.01–7.74) with variable conductivity (values range from 318 to 987 μS/cm) and reduction potential (226–252 mV). The waters of study area show very low ion concentrations with the prevalent $HCO_3–Cl–Ca–Mg–Na$ and $HCO_3–SO_4–Cl–Ca–Mg–Na$ water types (according to Altowski–Szwiec classification) with predominant calcium and bicarbonate. In the case of physico-chemical parameters, the quite high BOD and COD values reaching 3.17 O_2/L and 51.65 O_2/L were found in the lakes which have in the substrate large amount of organic matter.

The trace metal concentrations in the bottom sediment are relatively low and depend on the location of the lakes. Accumulation ranges are as follows: 0.13 to 0.15 mg/kg for arsenic, 0.04 to 0.18 mg/kg for cadmium, 2.89 to 11.10 mg/kg for copper, 2.79 to 9.38 mg/kg for chromium, 1.65 to 6.72 mg/kg for nickel, 2.48 to 7.06 mg/kg for lead and 20.00 to 48.53 for zinc. Moreover, comparison of the heavy metal contents with the LAWA classification indicate that the bottom sediment samples may be classified to the first purity class as uncontaminated.

Therefore, the field observations and laboratory results suggest that the water and bottom sediment samples from the lakes are not polluted. Only the highest content of phosphate (up to 12.40 mgPO_4/L) was recorded in lakes, which clearly demonstrates the continuing processes of eutrophication for the studied lakes in the Osielko commune.

M. PSYKAŁA and J. MATUSIK: **Intercalation of dodecylamine into kaolinites of high structural order**

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Kaolinite is a dioctahedral 1 : 1 layered mineral. It is the most abundant mineral among clay minerals. New hybrid materials based on kaolinite are synthesized and more often used for industrial and environmental purposes. There is an increasing demand for hydrophobic mineral nanoparticles which can be used as fillers for production of e.g. polymer nanocomposites. Therefore the goal of this study was to prepare and compare intercalates of highly ordered kaolinites with dodecylamine. Amine intercalation changes the surface character of mineral to strongly hydrophobic and significantly

increases the interlayer space thus enabling better dispersion of mineral particles in the polymer matrix.

For the experiments kaolinites of high structural order were chosen: Maria III (M) from the Polish deposit (Hinckley index HI = 1.57), Capim (C) from Imerys® company (HI = 1.33) and kaolinite from Carter® products (N) (HI = 1.33). Kaolinite-dimethyl sulfoxide (DMSO) complex was used as a precursor. For this purpose 2 g of kaolinite reacted with 27 ml of DMSO/3 ml of H_2O at 70 °C for 2 hours. The samples were centrifuged and dried at 60 °C for 24 hours (KDS). Secondly KDS (500 mg) was stirred at room temperature with CH_3OH (7 ml) for 24 hours. The process was repeated 7 times (KM). Finally, wet KM was mixed with saturated dodecylamine (C12N) solution for 24 hours. This step was repeated 2 times (KDA). The samples were examined by XRD, IR and elemental analyses (CHNS) were carried out.

The formation of KDS complexes for all samples was confirmed by the presence of d_{001} = 11.2 Å peak in the XRD patterns. IR bands related to hydrogen bonds between DMSO and kaolinite OH groups were observed at 3 540 cm^{-1} and 3 504 cm^{-1}. The formation of KM was confirmed by the disappearance of peaks characteristic for the KDS and change in intensity and positions of peaks in the 19-23°2Θ range. IR spectra revealed the presence of bands related to C-H stretching vibrations at 2 960 cm^{-1}, 2 924 cm^{-1} and 2 840 cm^{-1}. Disappearance of bands at 3 540 cm^{-1} and 3 504 cm^{-1} confirmed the removal of DMSO. Insertion of C12N into structure of NM and MM samples was confirmed by the presence of d_{001} = ~42 Å peak. The intercalation did not occur for the CM sample. The natural M sample showed highest susceptibility towards intercalation in contrast to industrially modified N and C samples. IR bands at 2 958 cm^{-1}, 2 926 cm^{-1} and 2 854 cm^{-1} (C-H stretching) were observed for the new complexes in positions similar to these for pure C12N. This confirmed bilayer, all-trans conformation of amine chains. The model of MDA intercalate with chemical formula: $[Al_2Si_2O_5(OH)_{2.96}(OCH_3)_{1.04}](C_{12}H_{27}N)_{0.73}$ was proposed on the basis of XRD and IR data taking into consideration the size of the C12N molecule (Fig. 1).
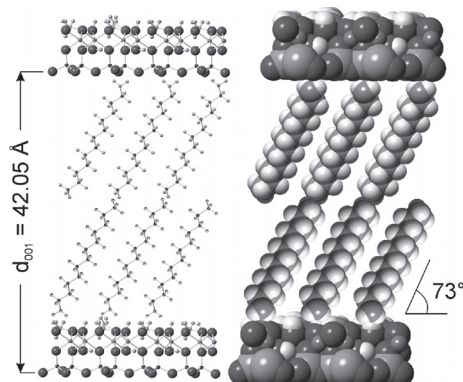
Fig. 1. Dodecylamine C12N molecule.

L. RYŠAVÁ: **Correlation of the Upper Jurassic to Lower Cretaceous sequences of the Hrušové section (Čachtické Karpaty Mts., Western Carpathians) with coeval deposits derived from the borehole Borský Jur 15 (the basement of the Vienna Basin)**

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The Mesozoic basement of the Slovak part of the Vienna Basin partially consists of the nappes of the Northern Calcareous Alp, which continue towards NE and they appear on the surface as Veterlín, Havran, Jablonica and Nedzov nappes in the Malé Karpaty Mts. (Hamilton et al., 1990). The Hrušové section comprises the complex of Jurassic and Lower Cretaceous sediments, which Hanáček (in Salaj et al., 1987) classified as the Hrušové Group of the Nedzov nappe. The borehole Borský Jur No. 15 revealed various Upper Jurassic to Lower Cretaceous facies uncovered under the Neogene fill of the Vienna Basin in the Borský Jur area. It can be supposed that the sediments of the Hrušové section and the Borský Jur area developed in the adjacent area. The sediments studied were divided as follows:

Callovian–Oxfordian

The limestones with the cherts belong to packstones to grainstones of the filament microfacies passing locally to wackestones to packstones of the radiolaria-filament microfacies and sponge-radiolarian microfacies. They contain cysts of calcareous dinoflagellates – *Cadosina parvula* Nagy, *Colomisphaera fibrata* (Nagy), *Schizosphaerella minutissima* (Colom), *Colomisphaera pieniniensis* (Borza), rare globochaetes, fragments of hyaline and agglutinated foraminifers, *Lenticulina* sp., crinoids, aptychi, ostracods and bivalves. Radiolarians, sponge and filaments are locally silicified. Studied limestones contain the biomarkers of the Late Oxfordian Fibrata Zone (sensu Reháková, 2000).

Samples from the core 3 (3 103–3 107 m) contain calcified radiolarians, globochaetes, fragments of crinoids, ostracods and foraminifers.

Kimmeridgian–Lower Tithonian

Wackestones to packstones with radiolaria-sponge and sponge--radiolaria microfacies. They contain saccocomas, filaments, bivalves, ostracods, crinoids and cysts of calcareous dinoflagellates – *Stomiosphaera moluccana* Wanner, *Schizosphaerella minutissima* (Colom), *Cadosina parvula* Nagy, *Colomisphaera pulla* (Borza), *Carpistomiosphaera borzai* (Nagy), *Parastomiospahera malmica* (Borza) indicating the Upper Kimmeridgian Borzai Zone and Lower Tithonian Malmica Zone (sensu Reháková, 2000).

Samples from the core 8 (3 526–3 530 m) contains wackestone of radiolaria-saccocoma microfacies with calcified radiolarians, saccocomas and fragments of aptychi and filaments.

Upper Tithonian–Lower Berriasian

Wackestones of radiolaria-calpionella and calpionella--globochaete microfacies with crinoids, bivalves, sporadically saccocomas, sponge spicules, ostracods, aptychi, foraminifers and calpionellids – *Crassicollaria parvula* Remane, *Crassicollaria colomi* Doben, *Calpionella alpina* Lorenz, *Calpionella elliptica* Cadisch, *Tintinopsella carpathica* (Murg. et Filip.), *Remaniella ferasini* (Catalano), *Remaniella borzai* Pop, *Remaniella catalanoi* Pop. *Calpionellids indicate* Late Tithonian Crassicollaria Zone (Colomi Subzone) and the Berriasan Calpionella Zone (Elliptica Subzone, sensu Reháková, 1995).

Samples from the core 6 (3 394–3 398 m) are built with wackestone of radiolaria-calpionella microfacies with *Calpionella alpina* Lorenz, *Tintinopsella carpathica* (Murg. et Filip.). Sediments are tectonically reworked. Samples from the core 5 (3 321–3 325 m) and 7 (3 497 to 3 497.7 m) are built with wackestone of radiolarian-calpionella microfacies with *Calpionella* sp., *Crasicollaria* sp., *Tintinopsella* sp., *Calpionella alpina* Lorenz.

Thus, in the Borský Jur area the Jurassic and Lower Cretaceous sediments are standing and folding into slices.

V. ŠIMONOVÁ: **Paleostress reconstruction based on kinematic analysis of multiple fault structures of selected localities in the Manín Unit (western Slovakia)**

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This study reconstructs the chronology of paleostress evolution and faulting in the western part of the Pieniny Klippen Belt. The Manín Unit experienced polyphase deformation at the boundary

between the Tertiary accretionary wedge of the External and the Cretaceous nappe systems of the Central Western Carpathians. It was incorporated into the PKB and attained its tectonic style after its nappe emplacement during mid-Cretaceous times. It represents a frontal nappe element of the Fatric nappe system (Plašienka, 1995) and is composed of Jurassic–Cretaceous sedimentary succession dominated by bedded limestones, which were subjected to structural analysis. Based on kinematic analyses of meso--scale faults (slickensides), several brittle deformation stages characterized by certain properties of the reconstructed stress field have been discerned. We have employed the program Win_Tensor for the computation of stresses and the separation of the faults into homogeneous groups. Relative superposition of individual paleostress states was derived from the field structural relationships; their tentative stratigraphic age was estimated mainly by the comparison with other published data.

This study presents the paleostress analysis of three localities in the Manín Unit: Butkov quarry, Tunežice quarry and Mojtín quarry. Paleostress analysis revealed the existence of six different stress fields in the period from Early Eocene to Quaternary.

During the Eocene, E–W compression and perpendicular tension affected the area. This stage was accompanied by the formation of strike-slip faults (NE–SW trending dextral faults). During the earliest Miocene, the deformation was characterized by the transpression. Orientation of the compressional stress axis was in the NW–SE direction. The evolution between Ottnangian – Early Badenian was influenced by the compression regime. The middle Miocene to Pliocene was characterized by a progressive rotation of the paleostress fields from NW–SE to the NE–SW direction of the maximum principal compressional stress axis (σ_1). The younger fault population was activated under NNW–SSE oriented extension. Gradual reorientation of the stress field resulted in the development of variable, often reactivated fault structures. This general clockwise rotation of the Eocene to Quaternary paleostress field could be explained by both – the effect of the counter-clockwise rotation of the ALCAPA microplate and by the regional stress field changes.

P. SKIBOVÁ: **Characteristics of the Neogene stratigraphic structures suitable for underground gas storages in the Košice Depression, Eastern Slovakia**

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Efforts for improving environment and for having back-ups for an abrupt cut off of gas import, thus for the economic independence, motivated wide range of works aimed at prospection of structures suitable for the underground gas storage (UGS) constructions and their economic evaluation. There are several types of UGS of which the most effective are storages using mined-out former hydrocarbon traps. Such storages are formed by the stratigraphic, structural and structural-stratigraphic traps.

One of the first steps in the UGS evaluation process is estimation of their suitability from the point of view of lithology, petrophysical parameters, geometry, tectonic distortion and pressure-temperature conditions. The first evaluation of perspectiveness of the Košice Depression for the occurrence of UGS is mostly done on the basis of seismic and well analysis. This work was concentrated on stratigraphic type of UGS. Analysis of 2D seismic sections revealed possible occurrence of such traps built up by the sandstone and conglomerate bodies of fluvial channels and deltaic interdistributary channels. Another type of stratigraphic UGS, which occurrence may be assumed in the Košice Depression, is unconformity type represented by the Late Badenian sediments overlapping older surfaces.

Based on seismic profiles, it is assumed that potential stratigraphic type of UGS is represented by the low-volume storages that are more suitable for a short-time gas delivery during possible interruption of its normal supply (Janočko and Skibová, 2011).

T. ŚLIWA[1] and E. PAŃCZYK[2]: **Nuclear techniques for the protection of alabaster sculpture from the chapel of the Purification of the Holy Virgin Mary and chapel of SS Mathias and Matthew (Wawel Cathedral)**

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Alabaster gypsum ($CaSO_4 \cdot 2H_2O$) has been used for artworks throughout history due to its fine-grained texture, pure white colours and its softness making it easy to work. Like other types of artefacts, it may be crucial for art historians or museum conservators to assign correctly the provenance of the raw material on order to validate or invalidate hypotheses based on iconographic or stylistic comparisons.

European sources of alabaster exploited for decoration since Middle Ages are present in England (S. Derbys and Staffs), France (Paris), Spain (e.g. Mérida) and Italy (Volterra and Castellina), while German deposits have given material since the 18th century. In Poland, alabaster gained particular popularity in the Renaissance and Baroque period, when its decorative value (e.g. transparency) could be utilized best by contrasting with other rocks as compact limestone, especially black limestone from Dębnik (Poland).

This forgotten today beautiful stone was also mined in the Ukrainian part of the Carpathian Foredeep. There are a number of quarries exploiting Badenian (middle Miocene) alabaster gypsum (in particular Tyras suite) are known since the 16th century (e.g. Zhuravno, Vasiuchyn). Its applications in Cracow date back to the period before the World War Two.

The main aim of this work is to compare the content of the trace elements in alabaster obtained from many gypsum exposures occur along the Dnister River in eastern Galicia, Podolia, Bukovina (West Ukraine) and tombs of Bishop Filip Padniewski and Cardinal Jan Aleksander Lipski. The analysis of the samples was carried out by INAA using standards of the elements to be determined. Major components of alabaster have a low (n, γ) reaction cross section which is of advantage for carrying out the analysis. The irradiation was carried out in the MARIA reactor at Świerk near Warsaw, at a neutron influx of $8 \cdot 10^{13} n/cm^2 s$. The samples were irradiated for 24 h and cooled for 12 h.

Nuclear techniques can play an important role for the study, restoration and conservation of cultural heritage, helping to determine to age and origin and production these objects. Such techniques can also verify authenticity and provide information on the composition of original materials.

M. SMREČKOVÁ: **Radiolarians from the Cretaceous formations of selected units of the Western Carpathians and their paleoecological implications**

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The paper focused on radiolaria-bearing sediments from the Lower, Middle and Upper Cretaceous formations of the western part of the Pieniny Klippen Belt and Manín Unit.

The Lower Cretaceous microfauna of radiolarians has been studied in locality Horné Srnie – Samášky. Radiolarians society in

this location came from the chert inserts in the Pieniny Limestone Formation – succession in the Kysuce Klippen Belt. Radiolarians microfauna from this locality presents stratigraphic interval of Upper Valanginian – Hauterivian.

The rate of diversity S/N obtained from samples indicates relative sea-level lowstand in the given period and following transgression.

The Middle Cretaceous radiolarian microfauna has been studied in Červená Skala and Vršatec localities. Variegated marlstones of Czorsztyn Succession of Pieniny Klippen Belt (Jaworki Marl Formation) were evaluated biostratigraphically. They correspond to stratigraphic range from the Middle Cenomanian to the Turonian in locality Červená Skala and to the stratigraphic range from the Turonian to the Coniacian in locatity Vršatec. Based on the proportion of diversity as well as composition of foraminiferal microfauna in the samples from localities Červená Skala and Vršatec it may be stated that the biosilicite productivity and the concentration of radiolarians are an unambiguous evidence of eutrophication of underground water segments. In both locations radiolarians are dominated by the forms indicative of unstable environmental conditions, which correspond to the Ocean Anoxic Event 2 from the Late Cenomanian to the Early Turonian.

The youngest radiolarian microfauna from the Late Cretaceous is represented by the radiolarian horizons in the Hrabové Formation at the Praznov locality. It is a part of the Manín or Podháj units, which attribution has not been solved yet. These occurrences of radiolarians represent the first findings of this microfauna in the Slovak territory. Radiolarian associations correspond to the stratigraphic interval from Coniacian to Campanian.

From the obtained proportion of S/N we can assume that attendant assemblage show likely deterioration of environmental conditions responding to previous significant biotic event during Santonian – Campanian.

Summing up, it may be assumed that radiolarians horizons in the Cretaceous formations from given localities of the Pieniny Klippen Belt and the Manín Succession were arising in common environmental conditions. The main evidence was the eutrophication of surface water layer affected by a great input of nutrients into the pelagial part of the ocean as a result of relative fall of the sea level and following transgression. Stress conditions for microfauna are the reason of a high production of forms tolerating eutrophic conditions.

The paper is a contribution to APVV LPP 0120-09, VEGA 2/0140/09, VEGA 1/0744/11 and UGA 09-000-28 projects.

P. SZATAN, A. PIÓRKOWSKI, T. DANEK and A. PIĘTA: **Client side web-based simulations of geophysical phenomena**

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The model of a client side processing becomes very popular in the last decade. Thin clients are equipped with a high performance hardware; therefore a client side processing is available. The scope of this work is to select an adequate technology to create a web-based application that simulates some of geophysical phenomena.

The authors implemented two models for important geophysical phenomena – seismic wave field and geothermal field. In the first case the acoustic wave equation solving is needed. Classic Alford's finite different solution was used. In the second case the heat-conductive equation was solved for two-dimensional isotropic medium. Both simulations are very time consuming, therefore the choosing of an adequate web technology for computing and visualization is pivotal.

There are several popular technologies to present client-side visualization. The most popular is Adobe Flash. Worth mentioning are haXe and Adobe Alchemy. The component environments provide own platform for a client-side processing. The Sun Java platform offers an applet technology that enables to run smart code portions of a bytecode in the client's browser. The equivalent technology for Microsoft.NET is Silverlight. The Silverlight executables can be run also under Linux in Moonlight (Mono) environment.
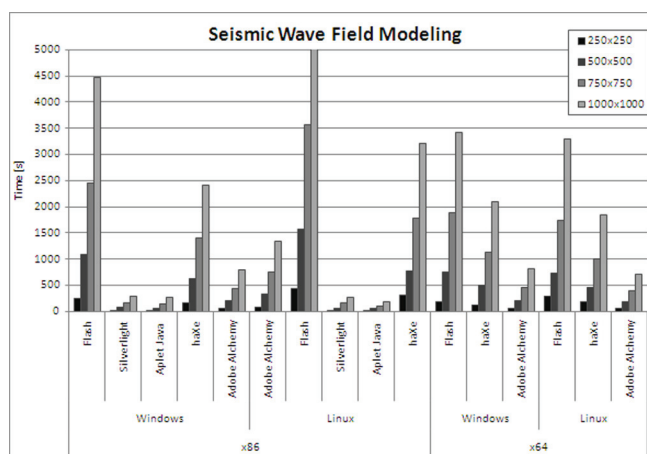

Fig. 1. Selected efficiency analysis results obtained using different internet technologies.

The authors tested the performance of simulation code executions in presented technologies. There were four dimensions of input data selected: 250 x 250, 500 x 500, 750 x 750 and 1 000 x 1 000 points. The results are presented on the figure placed below the text. Tests show that the Java Applet and MS Silverlight technologies provide the fastest code execution. The slowest is Flash. Unfortunately, the results show that smooth animation is only possible for small (educational) models.

M. VĎAČNÝ: **Rare earth element geochemistry of Late Paleozoic sandstones from the Malužiná Formation in the Malé Karpaty Mts.: Provenance and tectonic control**

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The rare earth elements (REE) are generally considered to be immobile, exhibiting only minor changes during sedimentary processes. Their abundance in source rocks and weathering conditions in the provenance region have been considered as the major factors controlling the REE in sediments. Syn- and post--depositional processes such as exchange reactions during transport, deposition and diagenesis are insignificant in altering the REE content of sediments. The main goal of this study is to show the relationship between REE characteristics, provenance type and the tectonic setting of the source area for the Malužiná Formation sandstones (a part of the Ipoltica Group) in the Malé Karpaty Mts.

The Malužiná Formation is a clastic sedimentary formation with sporadical chemogenic sediment interbeds of variable thickness. Synsedimentary andesite-basalt volcanics with the tholeiite magmatic trend are the most significant component of the formation. The Malužiná Formation ranges from the Lower to Upper Permian in age.

Sandstones are the most frequent sediments in the Malužiná Formation. Examined sandstones mainly represent a group of arkosic sediments. These sandstones contain variable admixtures of acid and basic volcanic material of intraformational origin. Quartz (~57 %) and feldspars (orthoclase, microcline, microperthite, plagioclases; ~24.5 %) are the main components of the sandstones. They are associated with clastic micas and rock fragments (~15.8 %), mostly of synsedimentary volcanics, but also metamorphic lithic fragments were identified (e.g., sericite- and quartzose phyllites). The matrix

of the sandstones (~2.7 %) is slightly recrystallized and changed into an illite-sericite aggregate with quartz, carbonate, and chlorite. Quartzose, carbonate, illite, and ferruginous cements are preserved.

The REE characteristics of terrigenous sedimentary rocks reflect the tectonic setting of the sedimentary basin. Generally, in sandstones there is an increase in the total abundance of REE (ΣREE), a light to heavy REE ratio (ΣLREE/ΣHREE) and a decrease in the chondrite normalized Eu anomaly (Eu/Eu*) with the increase in SiO_2/Al_2O_3 and K_2O/Na_2O ratios. This is due to the change in the dominant source rocks from andesite to dacite, granite-gneiss and sedimentary rocks. On the plots of SiO_2/Al_2O_3 and K_2O/Na_2O versus REE parameters, the Malužiná Formation sandstones follow a general trend consistent with their derivation from the dacitic, granite-gneiss, and sedimentary source rocks. The chondrite-normalized REE distribution patterns are about the same for all studied sandstones and are similar to that of the average Post-Archean Australian Shale (PAAS). The predominantly felsic composition of the sandstones from the Malužiná Formation is supported by the REE plots which show enriched light REE, negative Eu anomaly and flat or uniform heavy REE. The abundances of La (~25.02 ppm), Ce (~48.57 ppm), ΣREE (~113.77 ppm) and the Eu/Eu* (~0.78) ratio of the Malužiná Formation sandstones are similar to those of continental island-arc sandstones. These features signalize a mixed provenance from a dissected magmatic arc-recycled orogen and a continental island-arc type of tectonic setting for the Malužiná Formation sandstones. Contrary to this general tendency, the La/Yb (~19.19), LaN/YbN (~12.97), and ΣLREE/ΣHREE (~11.61) ratios of the Malužiná Formation sandstones indicate their derivation dominantly from a rifted continental crust in the back-arc position.

P. VRŠANSKÝ: **Pterosaur ectoparasites**

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Paleontological Institute, RAS, Moscow, Russia

In 14th century, when flea–borne plague killed a third of all Europeans, we catch lapidarous evidence for the importance of ectoparasites. They represent as much as 10 % of all species of organisms and often control whole ecosystems. The oldest ectoparasites have been recently described by us from the Middle Jurassic of Daohugou in China. Paragliders were parasitizing extinct flying reptiles – pterosaurs and now are housed within a separate (43rd, 12th exclusively extinct) insect order Nakridletia, characterized with a sucking beak, "nippers" for attaching to host, gill-like appendages with ctenidia-like function, and unsclerotized body serving as blood reservoir. They are extremely similar to unrelated pediculid lice infesting humans and thus are expected to live on "warm-blooded" hosts. Diversity of this wingless order with complete metamorphosis was rather high – five specimens belong to four species, two genera and two families (figured is *Vosila sinensis*).

Fig. 1. Ectoparasite *Vosila sinensis*.

M. WALICZEK and M. BAŁA: **Calculation of radiogenic heat of Zechstein and Carboniferous strata based on well--logging data from the Brońsko reef area (SW Poland)**

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The goal of this paper was to evaluate the radiogenic heat (A). The calculations were performed for boreholes B-2, B-3, B-4, and B-8 that were located in the central part of the Brońsko reef. The reservoir is built of reef sediments, which have been dated of Zechstein Limestone. Well measurements were done in five lithostratigraphic units: Basic Anhydrite, Upper and Lower Anhydrite, Main Dolomite, Zechstein Limestone (Zechstein, Permian) and Carboniferous rocks.

Three elements ***potassium, thorium*** and ***uranium*** during ratio decay generate ***radiogenic heat*** in rocks. According to oil geology the most significant element is uranium due to the fact that an occurring of uranium is associated with presence of an organic matter.

Based on spectral gamma ray and Litho-Density Logs measurements the quantitative concentration of radioactive elements including uranium, thorium and radioactive isotope of potassium (^{40}K) was evaluated which, together with bulk density, were used to calculate the radioactive heat. To compute radiogenic heat GeoWin Program and Rybach's equation was used.

The measurement was shown as a:
- Combination of GRS (API), NPHI (%), RHOB(g/cm^3), DT(us/m), and components of potassium C_K (%), thorium C_{Th} (ppm) and uranium C_U (ppm) and calculated radiogenic heat A ($\mu W/m^2$) at a depth interval 2 160.0 – 2 245.0 m of borehole B-4
- Crossplot Pe – RHOB – A for Zechstein and Carboniferous deposits in borehole B-8.
- Crossplot U – Pe for Zechstein and Carboniferous deposits in borehole B-8.
- Histogram of radiogenic heat A for Zechstein and Carboniferous deposits in borehole, B-8 (Fig. 1).

Increased values of A were characteristic of Main Dolomite, Zechstein Limestone. The highest Radiogenic Heat Production Rates occurred in Carboniferous sediments. Due to the present of clay and potassium salt intercalations RHP is higher. Sediments of Basic Anhydrite and Upper and Lower Anhydrite are characterized the lowest RHP rates.

The mean value of radiogenic heat production rates for Zechstein and Carboniferous deposits contains between 0.255 ($\mu W/m^3$) for salt deposits and 1.79 ($\mu W/m^3$) for Carboniferous mudstone and sandstone.

Rocks with higher kerogene transformation ratio, which is an important to petroleum prospecting indicator of hydrocarbon generation, generate more radiogenic heat.
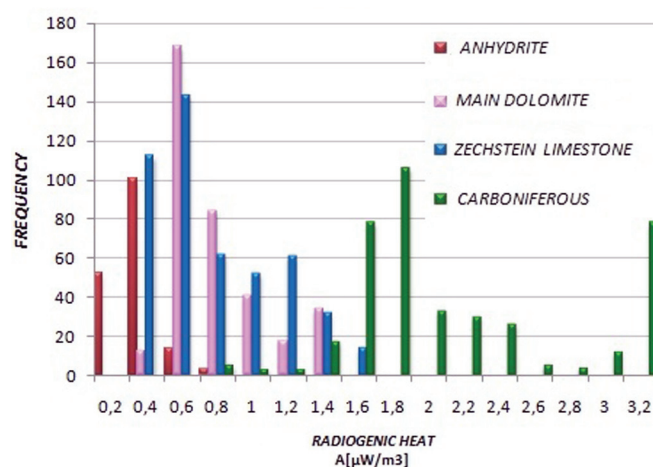

Fig. 1. Histogram of radiogenic heat A calculated in borehole B-8.

According to higher RHP rates in Carboniferous mudstone and sandstone it can be claimed that those rock could be the source rocks for Brońsko deposit.

K. WĄTOR: **Assessment of chemical composition of therapeutic water from Busko Zdrój using principal component analysis**

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Techniques of multivariate data analysis might be effectively used to classify and analyse similarity between objects. These methods are often applied during analysis of spatial variation of water chemical composition. They let us educe objects (samples, monitoring points) which are similar in terms of analysed qualities (e.g. concentrations of physical and/or chemical indicators of the water). The most common method is principal component analysis (PCA).

Principal component analysis is one of the factor analysis techniques. These methods let us reduce number of variables or indicate relevant correlations between variables described multivariate effects. Methodology of principal component analysis is described in literature (e.g. Mazerski, 2009; Rószkiewicz, 2010; Marengo et al., 2008).

In this paper principal component analysis is used to appraise similarity between therapeutic water samples collected in the region of Busko Zdrój Spa (seven intakes: 8b Michał, 13 Anna, 16A Wiesława, 17 Ignacy, B-4b Aleksander, 15 Henryk oraz B-19 Małgorzata). These are specific mineral waters (Dz.U. z 2006 r., Nr 80, Poz. 565) because mineralization is higher than 1 000 mg/L and they contain specific components: (1) *sulphides and other sulphur (II) compounds*, (2) *fluorides*, (3) *iodides* and (4) *iron* (II).

Physicochemical results of analysis performed between 2005 to 2010 by certified Hydrogeochemical Laboratory of Hydrogeology and Geology Engineering Department of the University of Science and Technology in Cracow (Polish Centre for Accreditation certificate number AB 1050) were used. All samples were collected by certified sampler according to PN-ISO 5667-11:2004 standard (one sample per year for each intakes) and analysed using ICP-MS (PN-EN ISO 17294:12007 and PN-EN ISO 17294-2:2006) and ICP-OES (PN-EN ISO 11885:2009) methods. Concentrations of major ions and several specific components (Na, K, Mg, Ca, Cl, SO_4, HCO_3, F, J, Fe) were used to principal component analysis.

In analysis IBM SPSS Statistics v. 19.0 software was used.

All data were normalized and Kaiser-Mayer-Olkin and Bartlett's tests were done to appraise correlations between data and adequacy of input data to PCA idea.

The next step was a choice of principal component numbers. On the basis of three criterions: (1) *total variance explained*, (2) *eigenvalue* and (3) *scree plot* two principal components were extracted. This let us to chart a correlation between two extracted principal components and assess similarity of analysed intakes. Objects which are nearest center of the graph are the most similar to each other.

F. ZALEWSKI: **Application of gypsum ($CaSO_4 \cdot 2H_2O$) for production of blocks of Abu Roasz pyramid**

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On Abu Roasz hill, there are the ruins of pyramid. Until recent the entrance to the ruins has been forbidden, because of the proximity of a military area. One of the first teams of archeologist, which received a permission to do excavation work, was a French team.

By the results of their research, the Abu Roasz pyramid was built by the king Dzedefre, ruler of IV dynasty. They also observed that for filling up the space between monument's blocks, the gypsum was used as a binder. This is the oldest example of the gypsum use as a binding material in building, being proved by the science.

In 2006, the ruins of pyramid have been examined by the geologists from Academy of Mining and Metallurgy in Cracow. The scientists also have observed crystals of gypsum in the blocks of the pyramid. To eliminate possibility of secondary re-crystallization of gypsum, the samples have been taken for further examination. Thin sections were prepared and petrographic examination ruled out the possibility of re-crystallized gypsum. Also some bubbles of air with some none-transparent material inside have been observed. This allowed setting a hypothesis about the artificial origin of the blocks.

A laboratory experiment has been done. The same ingredients of rock samples that were observed in samples from Abu Roasz pyramid were used. Crystalline gypsum, sand from Sahara desert and cuttings of limestone rocks from the Giza plateau were used for the experiment. Crystalline gypsum has been crushed, milled, and parched in 130 deg of Celcius. Then all ingredients were mixed using water and poured in the molds for the implementation of mini-blocks. After hardening (24 hours) a microscope samples have been made for observation under polarization microscope. Petrologic studies show complete coincidence of samples from blocks of Abu Roasz pyramid with the samples made in laboratory. For a final conviction the petrographic thin sections of touches of modern concrete and the Middle Ages ceramics have been made. The petrographic picture of air bubbles, expressly confirms that both materials have artificial origin. Research confirms and establishes a hypothesis about technological production of blocks for the pyramid building using the gypsum. It is the world's first scientifically and experimentally validated example of the use of gypsum for the manufacture of blocks during the Old Egyptian Country.

R. ZUBAJ: **Minerals of crichtonite group: Product of alteration of monazite in metagranitic rocks of the Western Tatras area**

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Minerals of crichtonite group were identified in the mylonitized Hercynic metagranites of the Ostrý Roháč massif in the Western Tatras area. Members of crichtonite group minerals are complex oxides with general formula $^{XII}A^{VI}B^{VI}C_{18}{}^{IV}T_2O_{38}$ (Orlandi et al., 1997), where the main cations are: A = Sr, Pb, Ca, Na, K, REE, Ba, U; B = Mn, Y, REE, U, Zr; C = Ti, Fe^{3+}, Cr; and T = Fe^{3+}, Mg. From the studied rocks there were described crichtonite, dessauite-(Y), phase composition corresponding with crichtonite, but important is a dominant content of Fe^{2+} at position B ("Fe-crichtonite") and a phase composition identical with loveringite, but with a dominant content of Mn ("Mn-loveringite"). Crichtonite occurs in the form of irregularly shaped grains or inclusions (size up to 120 μm) in muscovite, biotite, clinochlore along with other members of crichtonite minerals group, monazite, apatite, rutile, allanite-(Ce), zircon and ilmenite. Chemical composition is dominated by TiO_2 50–59 wt.%, content of $FeO+Fe_2O_3$ is 25–28 wt.%, content of ΣREE oxides is 2–5 wt.% and content of SrO is 2–3 wt.%. Dessauite--(Y) forms irregular grains in muscovite max. 50 μm large along with other minerals of crichtonite group, biotite, allanite-(Ce) and apatite in sericitized albite. "Fe-crichtonite" was described from chloritic biotite, where it forms grains max. 60 μm high. Along with this mineral also rutile, apatite, zircon, monazite and sericitized albite are present. Mineral phase named "Mn-loveringite" made irregular grains max. 50 μm large in muscovites with titanite, rutile, monazite, chlorite, other crichtonites and sericitized plagioclase. Origin of crichtonites is bound to postmagmatic process of monazite alteration and breakdown. Other products of monazite alteration along crichtonites are epidote minerals group enriched of REE, apatite and yttrocrazite-(Y). Genesis of crichtonite group minerals can be expressed by the following equation: biotite (Ti) + plagioclase (Sr, Ca) + monazite (REE) → crichtonite + chlorite + REE-epidote + rutile (± titanite, ilmenite). This is a new type postmagmatic alteration of monazite in an environment rich in Ti (chloritized biotite) and Sr (sericitized plagioclase).