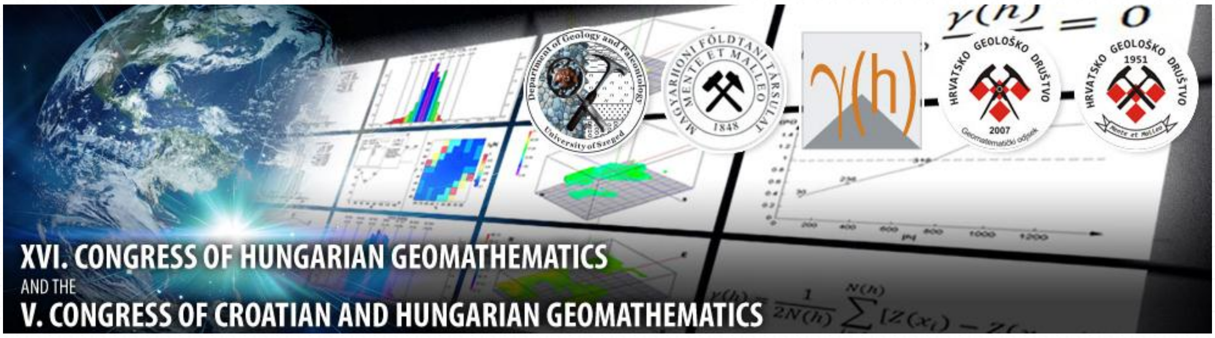

XVI. CONGRESS OF HUNGARIAN GEOMATHEMATICS

&

V. CONGRESS OF CROATIAN AND HUNGARIAN GEOMATHEMATICS

(CCHG 2013)

ABSTRACT & PROGRAM BOOK

2013

MÓRAHALOM

IMPRESSUM

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NOTE

The content of proceedings has not been passed English proof reading by native speaker, and that is why solely the authors are responsible for the quality of language usage.

The latest version-11 of Adobe Reader (free PDF viewer) is recommended for the automatic opening of the abstracts.

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You are kindly requested to arrive in time

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Moderator: László GYŐRY

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The 'Tuk-Tuk' departs at 18:30 from the square next to congress center. If you late you will walk...

From 22:00 (p.m.) shuttle 'Tuk-Tuk' is available from the site to "Termal Panzió'

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***Chairman*: Zoltán, NAGY**

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ABSTRACTS

ORGANISERS AND COMMITTEES

THE CONGRESS ORGANIZERS:

- Hungarian Geological Society
- Croatian Geological Society (Hrvatsko Geološko Društvo)
- Geomathematical Section of Croatian Geological Society (Hrvatsko Geološko Društvo, Geomatematički odsjek)
- Department of Geology and Paleonthology, University of Szeged

ORGANIZING COMMITTEE

- **Chair** of the organizing committee: **János Geiger**, associate professor, University of Szeged
- **Co-chair: Marko Cvetković**, University of Zagreb (RGNF), Croatia
- **Tomislav Malvić**, INA, University of Zagreb (RGNF), Croatia
- **Janina Horváth**, University of Szeged
- **Ágnes Kriván-Horváth**, Hungarian Geological Society
- **Andrea Wágenhoffer**, IAMG Student Chapter Szeged

SCIENTIFIC COMMITTEE

- **Chair** of the scientific committee: **Tomislav Malvić**, scientific adviser, INA, University of Zagreb (RGNF)
- **Antal Füst**, professor, Szent István University, Gödöllő
- **János Geiger**, associate professor, University of Szeged
- **József Kovács**, adjunct professor, ELTE, Budapest
- **János A. Szabó,** general manager, HYDROInform UnLTD, Hungary

SOCIAL PROGRAMS

ERZSÉBET SPA

The **Erzsébet Spa** of Mórahalom is constantly enlarging its knowledge in the field of therapeutic and wellness services. Someone who is desirous of recovery, recreation, relaxation and sporting will find all these on our field converted into a 15000 m^2garden and into 21 pools. During summertime, 21 pools are at our guests' disposal while in winter16 pools (2 outdoor and 14 indoor) are at their service.

BUFFALO RESERVATION, NAGYSZÉKSÓS

The **First buffalo reservation** of the Great South Plains was set up in 2008 on the outskirt of Mórahalom. It has been expected that the 45 young animals - 15 dams and 30 pups - will help to clear up the Nagyszéksós-lake and its area from the reed. The area was used as a fishpond in rainy seasons, especially in the seventies. The area started to dry up very quickly at the end of the eighties. In 1991-92 there was barely any open water area left. Before the introduction of the buffaloes most of the area and surrounding meadow has been covered by reed-blanket. A great part of the lake had dried up.

ABOUT MÓRAHALOM

THE CITY OF MÓRAHALOM AND CSONGRÁD COUNTRY

The town has a fortunate location near the southern borders of the country, Szeged and junctions as well. Regarding traffic, Mórahalom is a well-situated town and it serves as the 'Gate of the South'. The well-preserved roads make it possible to transport on public roads or by rail. Transportation is also accessible through water because of the closeness of the river Tisza and the airport of Szeged is suitable for passenger transport. The location of Csongrád County and Mórahalom is favorable because the frontiers of three different countries are easily accessed. The town is just 12 km from the Serbian border and the Romanian border is within 45 km. Road No. 55 runs through the town and road No. 5512 runs along the town and leads to the border crossing station of Röszke. The junction point to the M5 motorway is 8 km from the town. Inside Mórahalom the quality of the road network is perfect. The public transportation is ensured with bus service.

Despite the fact that Mórahalom is not a large town, it offers significant cultural and recreation programs. Everyone can find the most suitable occupation or activity according to his or her individual demand. Someone who wants to spend his or her leisure time in Nature has several possibilities from riding to hiking in the surrounding country. In the local nature conservation area around Madarász-tó (Bird Catcher Lake), there is an opportunity for camping. Within the town, the Erzsébet Thermal Spa stands at the service of those who are desirous of complete rest. The "Aranyszöm" Community House also provides cultural programs and performances for those who are interested in Hungarian traditions.

Mórahalom was one of the founders of the Sand Ridge Micro-region – Homokhát Kistérség in Hungarian – that organizes the cooperation of 13 local authorities. The association of these settlements has a population of 45.000 and their territory is 65,042 hectares. The determining economic sector in the area is agriculture. According to observations, owing to the long established culture of production and the local climate, we have managed to cultivate uniquely delicious fruits and vegetables that are popular not just in Hungary but abroad too.

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WORKSHOP

MEASUREMENTS OR MODELING

Moderator: László GYŐRY[1*]

[1]MOL Plc EP MOL IFA Exploration laboratories, *corresponding author: lgyory@mol.hu

Measurements require:

- Samples → sampling → representative samples
- Instruments → calibration + maintenance
- Operators → training + expertise in measurements
- Time → time is money
- Risk management → HSE issues
- Interpretations → how to convert them into sensible results
- Good sense of data usage → scope of their usage
- Opinion: real samples, real material, characteristic of the stuff itself, unveils the real nature of the material

Models require:

- Precise knowledge of the material → the limits of cognition
- Simplification → real world is too complex to be comprised
- Mathematical tools → rare knowledge
- Model development → vision based skill
- Time → time for development and time for application – two different resources
- Handling of huge amount of data → computational requirement
- Interpretations → how to convert them into sensible results – e.g. upscaling problem
- Good sense of data usage → scope of their usage
- Comparison, validation → real data are required to some extent
- Opinion: validity is always a question

How to improve the estimation method in hydrocarbon volumetrics with integrated 3D reservoir modelling using seismic attributes

János BLAHÓ[1*], Angelika SÓLA[1]

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***Key words**: 3D modelling, reservoir parameters, deltaic facies, seismic attributes, facies model.*

The paper focuses on the 3D modelling of a Pannonian reservoir in Algyő Field. Well tests and production suggest that the hydrocarbon resource (volumetrics), especially the gas initial in place has been overestimated. It is necessary to find the source of possible modelling problems. Estimation of certain properties, such as porosity or water saturation, can be influenced by the presence of gas. Particularly,gas properties bias the measured electrical conductivity and acoustic characteristics. These phenomena can cause a significant uncertainty in the reservoir model built by ROXAR IRAP-RMS software.

To improve the estimation process it is needed to build a much more reliable facies model. An appropriate way is using seismic attributes, which are cleaned from gas effect, therefore the pattern of deltaic facies can be better seen. With a correct facies model it is possible to control in modelling more accurately the 3D distribution of reservoir parameters such as porosity, permeability and effectivity (H_{eff}/H).

Modelling of water saturation based on capillary curves is more realistic than using water saturation interpreted from well logs and can be applied directly in numerical modelling.

This improved model, supported with seismic data, decreases the uncertainty in reservoir resource calculations.

Defining electro-log markers in poorly consolidated, heterogeneous clastic sediments using standard deviation data trends – an example from the Sava Depression, Pannonian Basin System

Marko CVETKOVIĆ[1]* and Tomislav MALVIĆ[1, 2]

[1] University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, Zagreb, Croatia, *corresponding author: marko.cvetkovic@rgn.hr

[2] INA Plc., Zagreb, Croatia, e-mail: tomislav.malvic@ina.hr

Introduction

E-log markers are by default derived from well logs. The oldest approach considers defining markers using only electric logs (E-logs) such as spontaneous potential (SP) and resistivity (R). The newer approaches for defining markers also rely on newer well logs such as gamma ray, compensated neutron and others. Those are all focused mainly on recognizing motifs that can be observed on well logs and then correlated Sediments in which these motifs can be recognized are mostly thick marls in which the motif itself is controlled by minor change in marl porosity (Vrbanac, 2002).

This approach is valid for sediments in which thick marl or shale intervals occur but is not applicable when a high variation in lithological composition and depositional environment is present which is characteristic for the last phase in evolution of the Pannonian Basin System (PBS) (Malvić & Velić, 2011). Therefore, for the purpose of acquiring meaningful correlation, a new method of determining E-log markers is established.

In the Sava Depression, this last phase of the evolution of the PBS corresponds to the lithostratigraphic unit of the Lonja Formation, which is composed of sediments deposited during Pleistocene, Pliocene and Holocene (Malvić & Velić, 2011; Velić, 2002). Its base is determined by a well log marker α′. The morphology of this marker differs from ones determined in older sediments. Basically it separates the thick sandstone or marlstone sequences in its base from the frequent interchange of poorly consolidated sandstones, sands, clays and silts above.

For the purpose of structural and lithofacies analysis of those younger sediments, which belong to the Lonja Formation, E-log marker α′ had to be followed among the wells in explored area.

Methodology

As only E-logs are available from within this interval and no distinct motifs could be determined, an approach of using simple mathematics to determine changes in the environment was employed. Firstly, the value of standard deviation of the SP and R log values was calculated for the data interval radius of one, two and four meters. As digitalised well logs mostly have a resolution of 0.1 m this means that standard deviation was calculated based on 10, 20 and 40 data points. After this procedure, a cumulative standard deviation curve was plotted.

The result of this analysis pointed out obvious change in trend of the data and the interpretation was made similar to the interpretation of cumulative dip from dipmeter data (Velić et al., 2012). A high cumulative standard deviation value gain per depth correlates to the high variation in lithological composition characteristic for the Pliocene (i.e. the Lonja Formation). Lower cumulative value gain per depth correlates to the less frequent changes in lithology where thick beds of either sandstones or marls occur which is characteristic for Pontian (i.e. the Široko Polje Formation). Therefore, intersection of the tangents of these two trends clearly depicts the Lonja Formation bottom, i.e. E-log alfa (Figure 1). Cumulative curves for standard deviation (CSTDEV) of one, two and four meter radius were plotted and the intersection of trend tangents was determined. The results were plotted onto two well logs together with α′ determined in the INA Plc. (Figure 1). For Well–1 the best correlation between the marker form the database and the marker from CSTDEV was in the case of 1 m radius where in the case of Well–2 very good for all three cases. Therefore only the 1 m radius CSTDEV was used for further definition of α' using presented mathematical methodology.

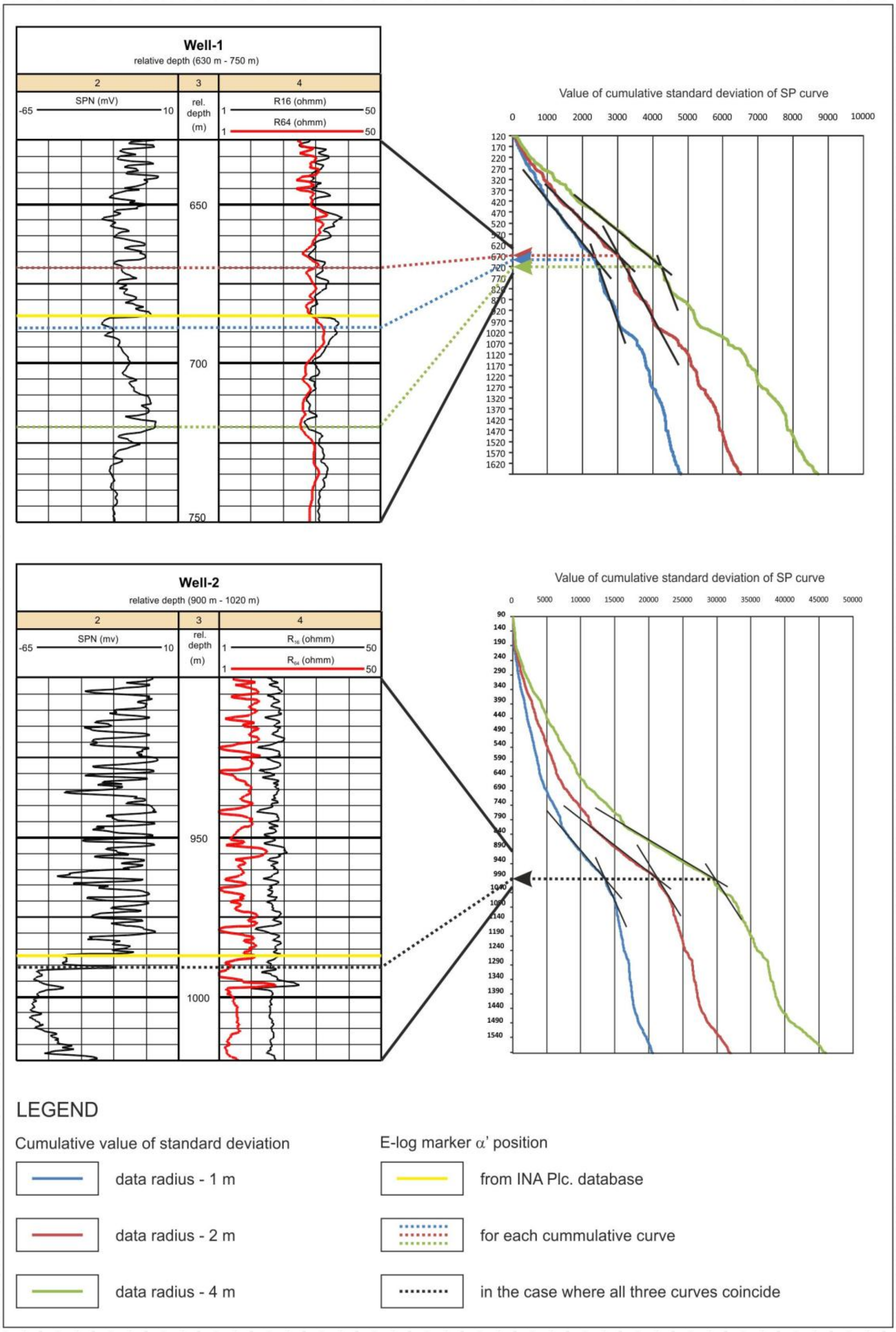

Figure 1: An example of CSTDEV curve analysis in two wells

Results

The results of the CSTDEV curve analysis for all wells were compared to the α' from the INA Plc. database. In most cases, only a minimal difference between the marker determined by CSTDEV curve. Using the 2D seismic section (Figure 2) it is easy to prove that mathematical (i.e. CSTDEV) approach was more accurate for determining E-log α' (Pontian/Pliocene) then looking for "characteristic" shape of e-log curves. Consequently, e-log determined mathematically can be used for a more accurate structural mapping of the Lonja Formation bottom.

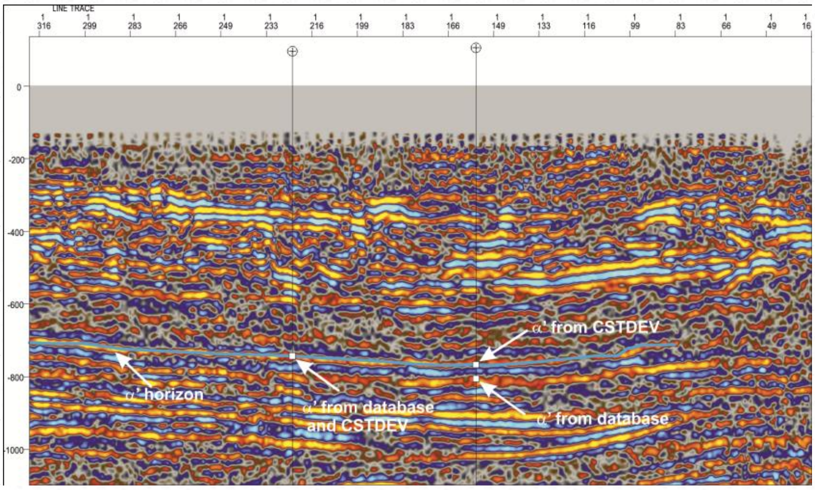

Figure 2: Seismic section showing two wells and the position of the Pontian/Pliocene border horizon and positions of the α' marker defined from logs and mathematically in two cases

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Spectral evaluation of land cover features on the floodplain of Tisza using high resolution aerial imagery

Bálint CSENDES[1*], Balázs SZENDER[1], Zalán TOBAK[1]

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Remote sensing tends to be one of the most important method of analysis at environmental studies. The spectral information stored by the spectral bands can clearly indicate the qualitative and quantitative characteristics of the materials that cover the surface. However, in some cases the research photography needs further transformations, corrections and statistical interpretations (Flat Field Correction, Principle Component Analysis, Cross Track Illumination).

Land cover features, such as soil, vegetation or water bodies are identified using image classifications. Some methods use inherent dimensionality and spectral admixture of the data, some techniques operate with the patterns of the spectrum curves and there is also a method to map the angle differences defined on spectral bands. Supervised classifications are based on training site as references (Mather, 2009). Beside the applied method, the internal coherency and homogeneity of those training areas can seriously influence the result of the process (Landgrebe, 2003). Stronger internal cohesion can lead to less classified pixels, although user's accuracy values are high. Meanwhile higher standard deviation between training pixels may predict more classified elements but lower precision.

The characterization of the sample areas requires statistical approaches. Some of these are related to the internal homogeneity of the sampling site, while some techniques use the comparison to all other endmembers and to the unknown background. Minimum, maximum and standard deviation values, represented on boxplot diagrams belong to the prior group. Disadvantage of these indices is that possible mixtures between endmembers are left unknown. In order to discover feasible mixture or overlapping among them, we can apply separability estimations (Richards and Jia, 2006). The most often used method is Jeffries-Matusita distance, it gives a score between 0 and 2, where 2 means perfect separability apart from other features. To examine the similarity we can also measure the matching among the mean spectra of reference pixel groups. For this aim, we can count the spectral angle differences, compare the bands of absorption or we can characterize the mean spectra using binary encoding as well.

The area of interest is the common floodplain of the Tisza and Maros Rivers, directly above their confluence, northeast of Szeged in Hungary. The floodplain is covered by several abandoned meanders. These wetlands were drained in the nineteenth century for agricultural land use, however, deepest parts of the region are still covered by water during periods of abundant precipitation (inland excess water). Drainage channels in poor condition are home to invasive plants, such as Amorpha Fruticosa or species of Phragmites.

According to the result of the image analysis, spectral homogeneity and uniqueness of the training pixels can clearly determine the accuracy of the image classification. Pixels of mixed coverage were identified using spectral unmixing techniques. Accuracy depends not only on the separability and homogeneity of the training sites, but on the performance of spectral corrections and data transformations as well. Classifications were examined on Minimal Noise Fraction (MNF) transformed imagery after removing bad bands and applying Cross Track Illumination correction for radiometric normalization. Most accurate image classifications were given by Spectral Angle Mapping and Maximum Likelihood algorithms.

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This research was realized in the frames of TÁMOP 4.2.4. A/2-11-1-2012-0001 „National Excellence Program – Elaborating and operating an inland student and researcher personal support system”. The project was subsidized by the European Union and co-financed by the European Social Fund.

Purpose and limits of automation in laboratory practice

Ferenc, FEDOR[1], Alexandra, NAGY[1], Viktor, FEURER[2]

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[2]Intercomp Ltd.

In laboratories it is a basic requirement for all the processes to be traceable, repeatable and available at any time. Meeting these requirements several problems arise. These problems involving human resource management, technology, methodology and finance are closely related and can cause inaccuracy, unreliability and occasional loss of valuable information acquired by laboratory measurements. The basic question is whether is it possible to build an "error-free" system or not? The authors try to find the answer through presenting the technological developments implemented in GEOCHEM laboratory.

Each member of the laboratory personnel has different qualifications and motives, using a lot of equipment, working with various programs to create their own spreadsheets and charts or filling up a database using client software. The equipments and devices in the laboratory are often not connected although the output data from one device can be input data for another one, and all the data will be integrated in the final report. Copying or re-entering the same data into various programs occurs although should be avoidable. Redundancy in manual data entry multiplies the risk of producing errors. In the following the sources of errors will be enumerated without attempting to be comprehensive.

People differ in knowledge, commitment, capacity and general work attitude. These differences mean problem during the normal operation so it is necessary to find, implement and compel a company-level standard. At the same time this standard has to be subject of change and development. Implementation of quality management system (QMS), accrediting the laboratory and implementing or developing a laboratory management software (LMS) are good ways to prevent major errors but sometimes are too expensive – due to either financial or human resource constraints – and can be barriers in way of further development or improvement. QMSs are defining principles while not offering a solution, so proliferation of them can cause extra workload for the personnel setting back resource utilization and eliminating creativity. Redundant data entry will continue to mean a basic problem. The inauguration of a QMS may encounter serious theoretical obstacles especially where the validation of measurements is not established, that is in several fields of geology.

The equipment of a laboratory consists basically of hardware, in-house developed or purchased instruments and different types of software installed on the hardware. Some instruments are supplied with a processing program, other with a control program or both of them. Latter are able to work in semi-automatic or automatic mode. Almost all elements of the technology background are different and in optimal case they are continuously improved. Transforming such a complex system into a continuously evolving framework is an expensive challenge for the IT, not mentioning its maintenance and further improvement costs.

Methodology problems are related to the operating and a number of them are in connection with the used technology. The data processing programs of instruments provide a methodological background for data processing and interpretation, developed by large teams working for years. These developments usually conform to the actual standards of the era, but often they do not constantly follow scientific development. This means no problem in the everyday work but can lead to the interpretation becoming a “routine” task due to the knowledge of the theoretical background not required. The continuous maintenance and improvement of databases is at best covered with in-house human resource, otherwise on the long term it can be an expensive task, independently of technological background. Another aspect of methodology is the structure of the system. In most cases the systems are not prepared for integration of new elements and cannot provide the necessary interface to the new elements because all the components are close coupled. This leads to increased workload on the IT or maintenance personnel and after a while the system grows too complicated for further improvements and requires a complete re-design and rebuild. This can render an unprepared company temporarily or permanently unable to operate productively. Capacity planning can also be considered as a methodology problem related to the human resource, technology and supply chain management.

For most of the smaller labs implementing the systems mentioned above, accreditation of them and auditing again every year cannot be performed cost effectively. For R&D labs it is not even practical. The procurement and improvement of an instrument park as well as the maintenance and development of the IT requires a lot of money. Usually the maintenance is more expensive and can cause more problems than the initial procurement. This is a strategic question for the company management to consider and plan the resources before undertaking the investment.

What is the solution? To build a system that provides a standard framework incorporating most of the elements, provide processes to reducing most of the errors made by the personnel and minimizes redundant data entry by chaining instruments into data flow streams. Meanwhile it has to provide an open interface system based on industry standards and best practices to help later improvements. Is it possible to build such a system? The clear answer is “not in full scale”. It is apparent that most of the errors are made by humans using advanced technologies. The aim is to make an open, modular system helping to establish reliable business processes to reduce the possibility of errors to a minimum. The GEOCHEM Ltd. undertook several developments to start building such a system as presented in the following examples:

RS-PPD-1 – automation. This device is capable of measure the permeability based on pressure decay leads. The measuring procedure involves plenty of steps therefore the errors occurring originate from human reasons. The resolution of this problem was to automate the process by developing a controller software able to perform the necessary steps in automatic of semi-automatic mode based on certain initial parameters. In semi-automatic mode the software sends warnings to the user before each step. The data collecting and processing is also automatic to reduce the possibility of human errors.

AVS-700 – automatic peak detecting. The AVS-700 device serves for the calculation of the elastic moduli with help of a measuring method based on acoustic wave propagation. The onset of the waves is determined by subjective reading on an oscilloscope screen. The aim of the development were to increase the objectivity and estimate the measuring error. Now the waves are detected by an algorithm based on Akaike information criteria, which divides the incoming wave into a random and a periodical sign (divide the real wave from the noise). The device chooses the best adaptable model minimizing the information lost. The meeting-point of the two signs is called the wave onset. In spite of this algorithm the measurements have some low error rate because in some cases the global minimum is encompassed by some local minimums. The software calculates the relative errors of the moduli and the result ranges connected to this errors.

EPS-700 – process development. The measuring of the alternating-current resistance of a core sample is allowed by the EPS-700 device. Ensue from the theory of the process the lesser the phase angle of a circuit is, the more accurate the measuring result represents the pure ohmic resistance of the core. The phase can be optimized by the frequency of the alternating-current circuit. One of the main goals of the development was the automation of the frequency tuning. Now the controller and data processing software of the device performs the phase minimizer method then sets the LCR meter to the optimal frequency. Measuring the capillary pressure curve the program always warns the users if they intend to measure outside the optimal settings.

CILAS 1180 – data processing. The CILAS granulometer serves the measurement of grain size distribution of a given sample with reduced data processing. The goal of the development was the widespread application and assay of the measuring results. The new software alloys all the basic investigational and predicamental technics of grain size analysis and allows comprehensive, user chosen analysis of the results.

The controller and data processing programs mentioned above are all capable to reduce the errors originating from human reasons and able to help the development of the measuring methods. The programs are able to automatically import and export data and to generate various reports. In order to avoid errors the input values entered by the users are monitored and in case of some basic mistakes the program warns the user. While the basic settings can be customized by the user, access to the fundamental structures is not permitted.

According to our opinion the concept of almost full automation of the instrument park, using open interfaces and the traceability of processes is realizable except the replacement of a prepared professional in interpretation and supervising roles.

Authors would like to thank the grammatical and translation help for Ms. Timea Streicher.

Geomathematical Analysis of Rn and HC COMPONENTS of Soil Gas Above Hc Reservoirs

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Introduction

In the past few decades several papers have reported about such Rn-anomalies of the soil gas which can be connected more or less unambiguously to deep HC accumulations. TEDESCO's geochemical interpretation has given an explanation about the radioactive anomalies appearing above HC reservoirs.

In this paper we report about the geomathematical modeling results of a complex radiological and organic geochemical monitoring system set up to study the possible connections between the Rn and HC contents of soil-gas samples. The statistical and geostatistical analysis carried out on a data-set containing 538 samples in which eight parameters were measured: ^{222}Rn, ^{226}Ra, Rn-Ra (the difference between the ^{222}Rn and ^{226}Ra concentrations), Rn-Ai (index of anomaly calculated by taking into account the initial concentration differences of the different soil types), C2 (methane) C3 (propane), nC4 (normal butane), nC5 (normal pentane).

Methodology

The purposes of statistical analysis were to reveal and identify those complex processes in which the Rn and HC components vary parallel (Fig.1 work-flow on the left). For these purposes we applied a combination of several multivariable statistical methods. Factor analysis and k-means clustering gave the same classifications of samples which could be interpreted on the basis of traditional geochemical model of the surface Rn-anomalies.

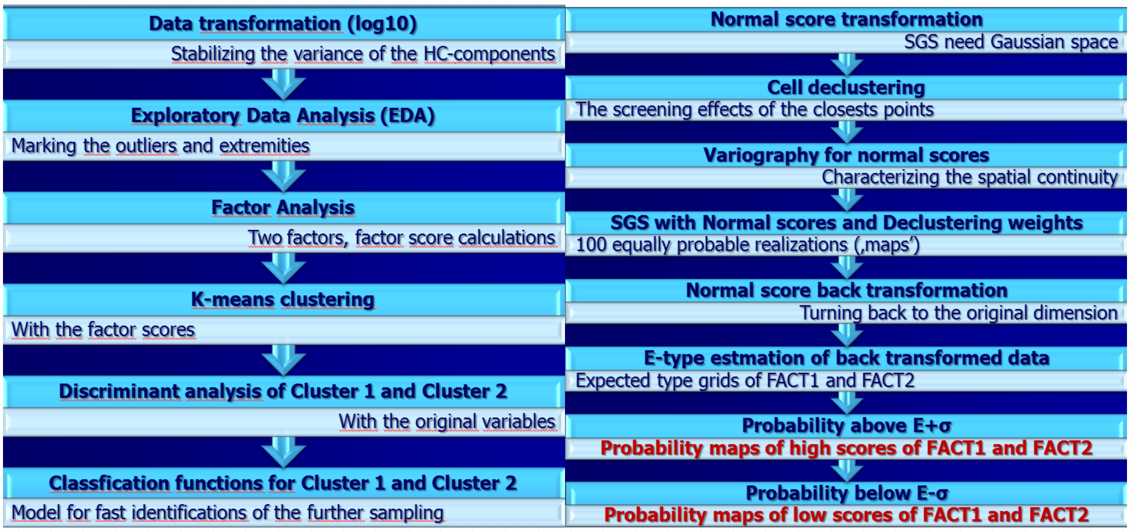

Figure 1: Work-flows for statistical (left side) and geostatistical (right side) analyses

In building the geostatistical work-flow we concentrated the spatial variability of two factors expressing the background processes which affect the radiological and HC components (Fig.1 workflow on the right). The final goal was to outline probabilistically those regions, where the co-variability of Ra-and HC components may suggest HC structures in the depth.

Results

Factor loadings have proved that two factors containing describing 65% of the total variability can increase the volume of HC components, but Factor 1 increases and Factor 2 decreases the Ra-components (Fig.2).

Variable	Factor 1	Factor 2
Rn	0.536540	-0.736023
Rn-Ra	0.570151	-0.623170
Rn-Ai	0.571089	-0.643253
LogC2	0.526628	0.540717
LogC3	0.659843	0.652462
Log(nC4)	0.545612	0.420220
Log(nC5)	0.501242	0.389047
Expl.Var	2.200757	2.389872
Prp.Totl	0.314394	0.341410

Figure 2: Matrix of factor loadings for Fact1 and Fact2. Variables with high loadings are highlighted.

The migration content of the factor matrix could be localized in the general geochemical model of Rn-migration (Fig.3).

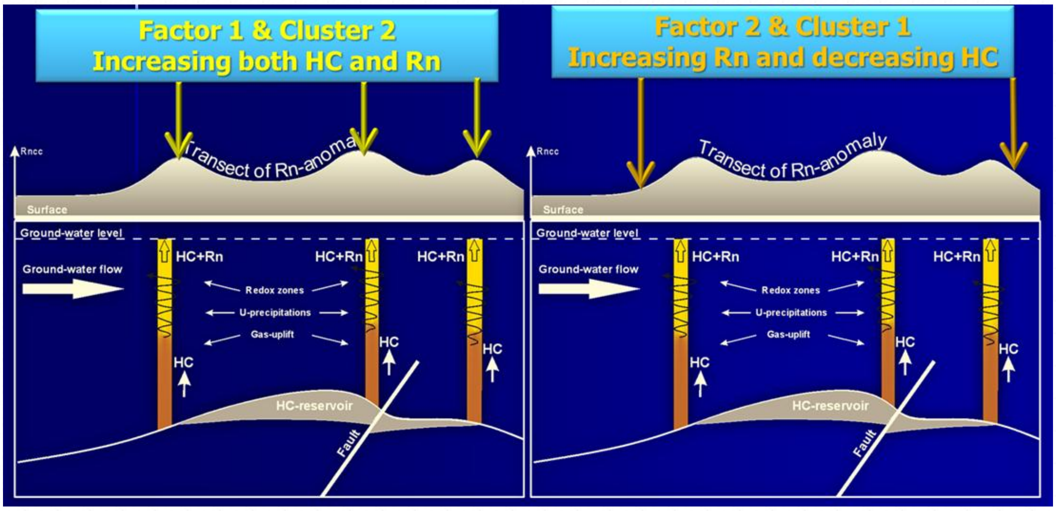

Figure 3: Geochemical interpretations of Fact1 (left side) and Fact2 (right side).

In that though, Fact1 describes the 'traditional' model of the interpretation of surface Rn anomalies. The content of Fact2 could be interpreted as Rn anomalies in the surface projection of the CH reservoirs above the water body, where HC migration may be restricted, but the parent-elements of Rn may still migrate.

Factor 1 shows a short and very long scale of heterogeneity. The short one had 1800 m of range, while 19200 m of range belonged to the large scale heterogeneity. In fact, about 60% of the total spatial variability cannot be characterized by any linear geostatistical model.

Factor 2 has a short (8000 m) and very long scale (20000) heterogeneity. In this situation about 58% of the total spatial variability cannot be characterized by any linear geostatistical model.

Based on the interpretations of Fact1 and Fact2, those regions are suggested for further seismic researches where (1) Fact1 or Fact2 have high positive scores or Fact2 appears with low negative scores.

The maps outlining these requirements with more than 0.5 probability were generated by sequential Gaussian simulations of the scores of Fact1 and Fact2 (Fig.4).

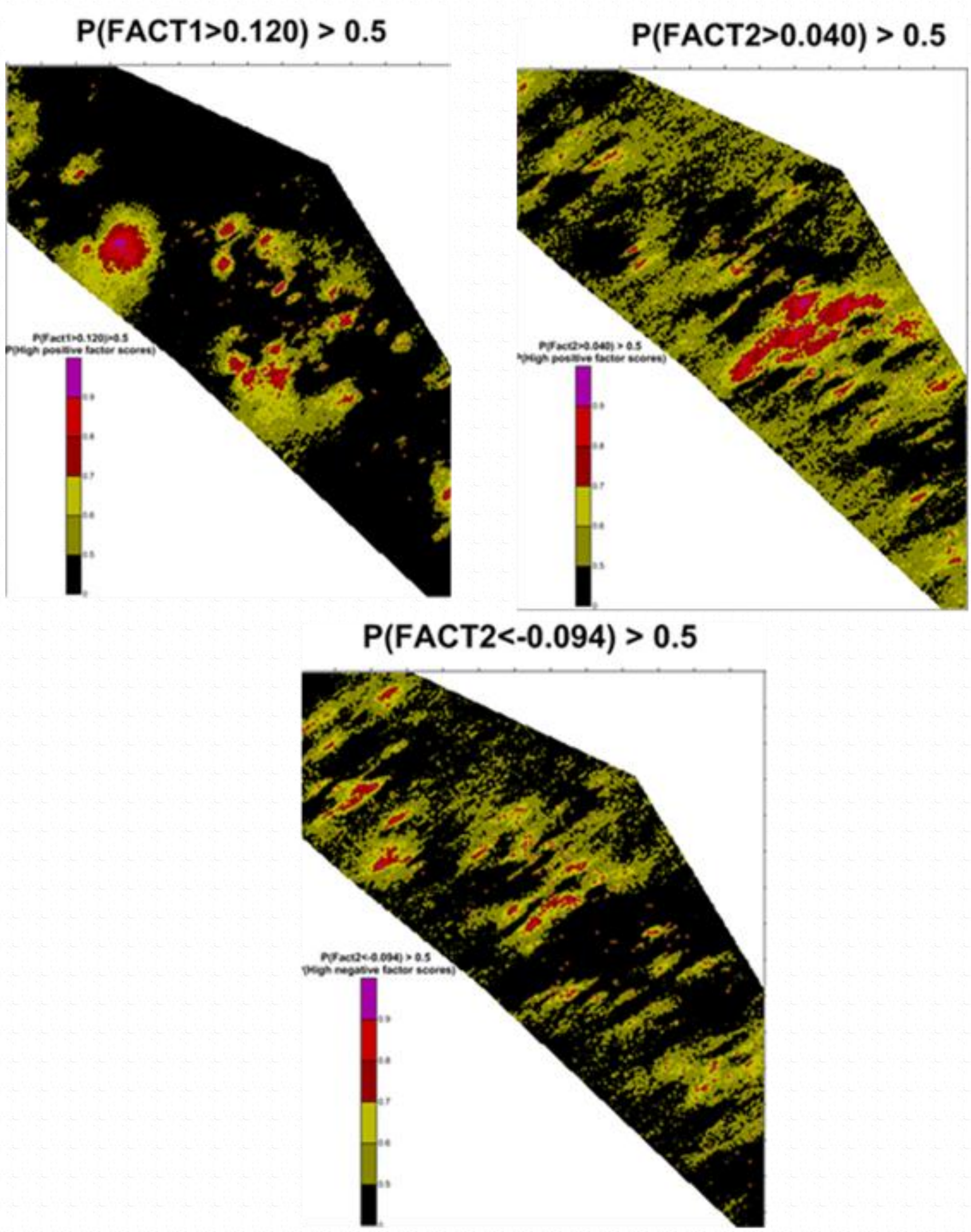

Figure 4: Regions with high positive scores of Fact1 (top left map) and Fact2 (top right map) and low negative scores of Fact2 (bottom map).

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Rock typing and water saturation modeling in a turbidit reservoir from two aspects

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The paper aims to investigate the causes of differences in hydrocarbon volumetrical calculation’s results, and try to prove the necessity of detailed geostatistical analysis and importance of appropriate trend usage. In order to define gas initially in place and oil initially in place (later only abbr.:GIIP and OIIP) water saturation (Sw) of the hydrocarbon (HC) reservoir is an important parameter. There is sufficient amount of measured data available thus several techniques can be applied to prepare the distribution of it. Basically in IRAP RMS as input, it is possible to use log or core data, for the different calculations. Log data must be considered carefully, because the long production history can result in the modification of initial values in wells measured recently.

The favourable analytical situation is the huge amount of core analysis data (porosity, permeability, water saturation etc.). In order to calculate the appropriate Sw parameter, it is necessary to define properly the rock types (classified according to their petrophysical properties). The base of such analysis is the determination of adequate cut offs. Here are separated two different rock typing methods. During the data analysis capillary curves were created for each different petrophysical property groups, than they were converted to reservoir conditions for both gas and oil phase (the capillary properties of oil and gas are different). This study regards a gas capped oil reservoir. One aspect of rock typing is based on predefined permeability groups (below 10×10^{-13} m^2 ~ 1mD (later only mD as industrial unit),1-10 mD , 10-100 mD, above 100 mD). The other cut offs are more complex and consider the shale volume as function of porosity and permeability. That second group of cut-off variations is more subjective, concerning the group boundaries.

Here is investigated the differentiation of the HCIIP in the two different way of thinking. The goals were getting answers for the following questions:

- What are the most important trends for Indicator facies - and petrophysical modelling?
- How does the variogram modelling influence the parameter distributions?
- How large differences occur in Sw model if some reservoir parameters are changed during capillary curve calculations?
- How net/gross ratio can be defined: as a value or 3D trend in volumetric calculation?

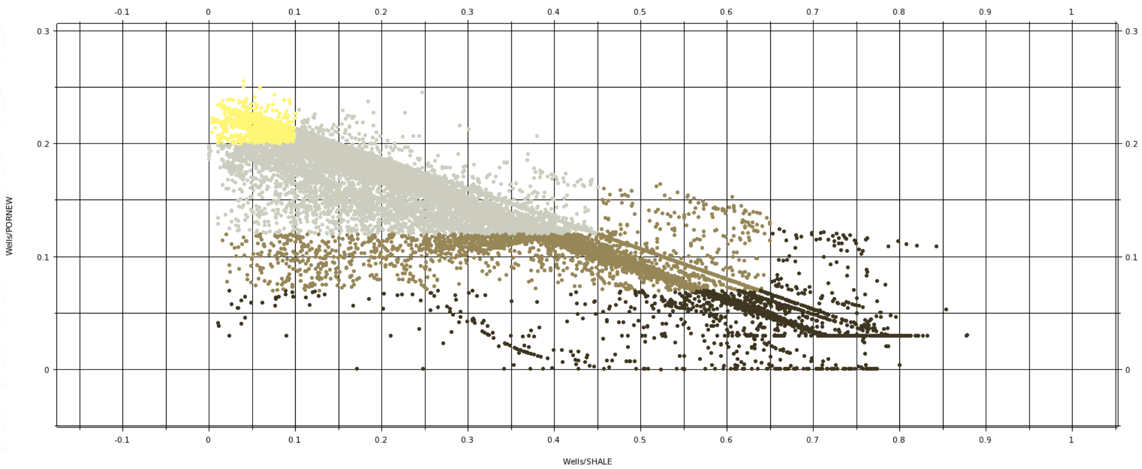

Figure 1: Scatter plot of shale volume as function of porosity colored by rock types.

Yellow- good sand

Grey- moderate sand

Light brown- week sand

Dark brown- shale

The first type of facies classification contains the separation only the reservoir/non reservoir rock volumes. The cut off value of effective sandstone (second type of rock classification) is lower, (figure 1) in the case of rocktype classification concerning the porosity, but, there is no lower control of shale volume content.

This presentation discusses the effects of rocktyping on water saturation distribution as a key parameter in volumetric calculations.

Climatic fluctuations inferred for the Middle and Late Pleniglacial (MIS 2) based on high-resolution (~ca.20 y) preliminary environmental magnetic investigation from the loess profile of Madaras brickyard (Hungary)

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The Madaras brickyard profile found at the northernmost fringe of the Backa loess plateau is one of the thickest and best developed last glacial loess sequences of Central Europe. In the present work high-resolution (at 2 cm) magnetic susceptibility measurements were implemented on samples from the 10 m profile corresponding to a period between 29 and 11 ky cal b2K. One aim was to compare the findings with the ice core records of northern Greenland in order to establish a high-resolution paleoclimatic record for the last climatic cycle and with findings documented in other biotic and abiotic proxies so far. Statistical analysis of the results including descriptive statistics and distribution analysis was performed using the software SPSS 11. The values were also graphed using the software Golden Software Grapher 7.0. Results were compared with dust accumulation and temperature records of the NGRIP ice core as well as reconstructed mean July paleotemperatures via cross-correlation after harmonization to the same temporal scale and resolution of 20 years. Cross-correlation between the recorded MS values and the referred Greenland ice core parameters as well as the local mean July paleotemperatures was assessed for the entire profile and selected temporal windows. The temporal windows chosen embedded the period from the start of the profile up to the last glacial maximum (LGM, ca. 26 ka), the entire last glacial maximum (LGM, ca.26-19 ka), as well as the terminal part of the LGM to the topsoil part of the profile (ca. 19-11 ka b2k).

Our results revealed a strong variability of loess/paleosol formation during MIS 2. Millennial time-scale climatic events that characterize the North Atlantic during the last climatic cycle have been identified. From 29ka up to the start of the LGM, the recorded MS values show a weak, negative correlation with the temperature proxy, and a weak positive correlation with the dust concentration of Greenland. A strong correlation was observed with the local paleotemperatures. Local climatic factors must have had a more prominent effect on loess/palesol development than the climate shifts over Greenland here. During the LGM the same pattern is seen with a stronger correlation with the dust concentrations and a weaker correlation with the local temperature. Local climatic factors, plus dust accumulation must have had a prominent influence on loess/paleosol development here. From the terminal part of the LGM a strong positive correlation of the MS values with the temperature proxy for Greenland accompanied by a strong negative correlation with the dust concentration values is observed. Correlation with local paleotemperatures is positive and moderate, strong. Here climate shifts over Greenland, as well as local endowments equally had an important role on the development of the MS signal.

Keywords: environmental magnetism, susceptibility, bidecadal variations, paleoclimate, late Quaternary, SE Hungary

Packing generation for pore level modeling of core analyses

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The easiest way to generate a grain packing for modeling purposes if real shaped grains are replaced for spheres, which has a lot of advantages from modeling's point of view. Such algorithms have been constructed and studied in the framework of iCore project, too, using the methods and examples available in the literature. If the sphere replacement is deemed to be an oversimplification of the packing generation, there are other regular shapes that can be used for packing generation purposes. These can be super-ellipsoids or Platonic solids to give more realism to packings generated. In this paper a new approach is described to grain packing generation, which uses randomly shaped convex bodies for modeling packings instead of simple spheres. This approach applies various sources of measured data to give a more realistic grain size and shape distribution and a more complex algorithm to move the grains in the virtual space imitating both sedimentation and compaction.

Geostatistical analyses of a Radon-monitoring system and the evaluation of its regional uncertainty

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Radon monitoring is an innovative and cost-effective method, which can be used in CH exploration. The detailed concept behind this method was worked out by VÁRHEGYI (2008), according to his work a geochemical flow forms between the surface and the CH reservoir, which creates redox barriers in the soil. These redox barriers can cause the selective adsorption of radioactive components - mainly uranium - dissolved in the flowing groundwater, and as a result circular radon-anomalies may form in the soil, as radon is a daughter element of uranium, and has the best migration potential among the radioactive elements. These kinds of radon-anomalies in the vicinity of CH reservoirs and uranium deposits have been documented several times by researchers in the past (MALMQVIST, KRISTIANSSON, 1984).

During out work we implemented the geostatistical analyses of a radon monitoring and sorbed CH component measurement results from the upper 0,5m of the soil of a Hungarian study area. After the exploratory data analysis we identified the two processes accountable for distributing the radon and CH concentrations in the soil with principle axis factoring which was followed by cluster analysis. On the basis of the outputs we assume that the two processes determining the radon and CH concentrations the soil are the effects of the oil phase and water phase of the CH reservoir.

The next step was the modeling of the spatial variation of the identified factors using indicator approach, followed by modeling the spatial uncertainty by utilizing sequential indicator simulation. These steps were executed accordingly to GOOVAERTS (2006).

After producing the E-Type maps for the factors and evaluating the regional uncertainty we were able to identify two parts of the study area where the explicit effects of the oil phase of the CH reservoir prevail.

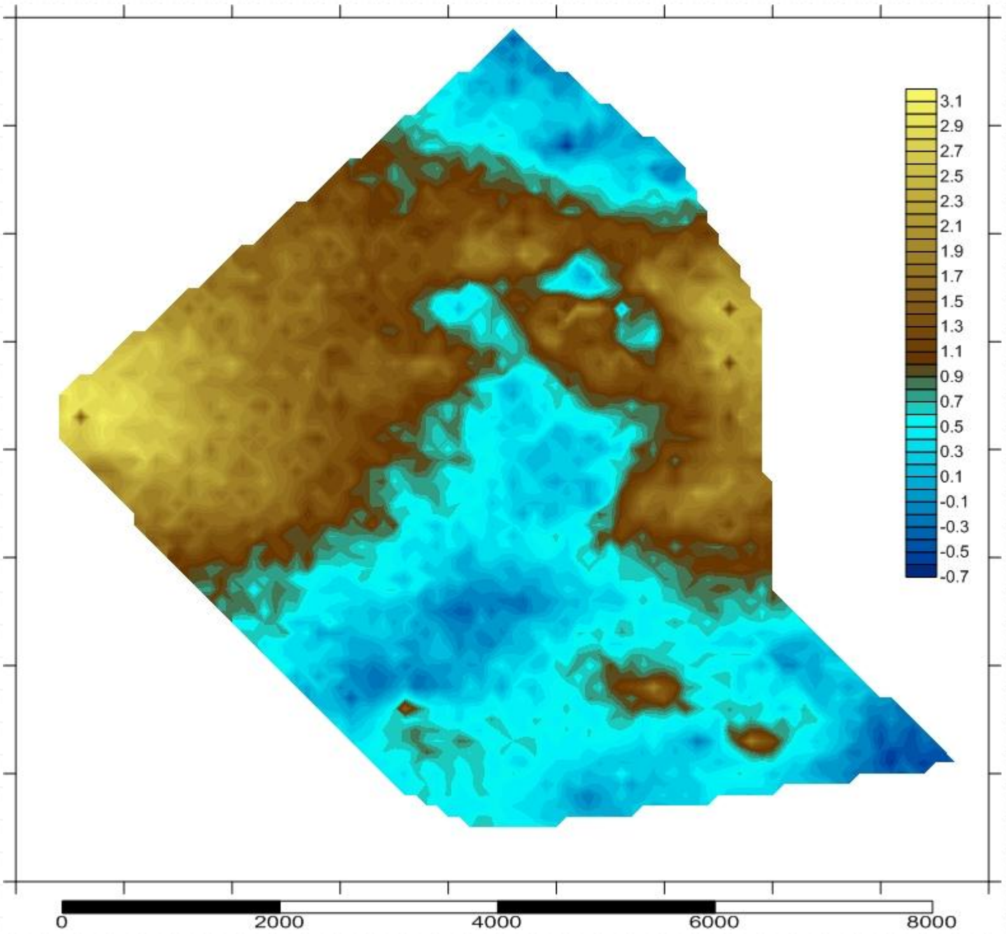

Figure 1. The E-Type map for the effects of the oil phase of the reservoir

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Differences in Air Quality in Summer and Late Autumn in the Area of Gas Processing Facilities Molve

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Abstract: At the location of Molve Gas Field measurements of pollutant emissions into the air are carried out since 1990, in the purpose of monitoring air quality and emissions reduction. The results of measurements are interpreted according to the Regulation on the Levels of Pollutants in the Air (OG no. 117/2012), the Air Protection Act (OG no. 130/2011) and the Regulation on Air Quality Monitoring (OG no. 3/2013). In the year 2011 the measurements of hydrogen sulphide, mercaptans, and sulphur dioxide emissions were conducted in the summer (11th July – 10th August 2011) and autumn (16th November – 16th December 2011), to indicate how a mining activities production and purification of the natural gas affect the quality of the air in summer and late autumn. Measured concentrations in the area of Molve Gas Field are mapped by geostatistical method "Nearest Neighbourhood". While concentrations of sulphur dioxide do not exceed the emission threshold values at any measurement station, hydrogen sulphide is showing the greatest exceeding.

Key words: Molve Gas Field, air emissions, hydrogen sulphide, mercaptans, sulphur dioxide, summer, autumn, Nearest Neighbourhood method

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Identification of absolute permeability on the basis of pore-scale and plug-scale flow simulations

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Cores, in physical form, are often missing in the locations of special interest of reservoir modeling; therefore numerical analysis of synthetic samples has practical relevance. Statistically meaningful representation of pore space topology requires virtual specimens built of several thousand solid particles forming a highly complex 3D pore space. In the framework of the iCore research project, the lattice-Boltzmann method was used for the simulation of flow in the voxel representation of the highly complex geometrical configuration. Grid dependency of the results was investigated by using several different voxel resolutions and the modeling accuracy was increased with the help of Richardson extrapolation. Pore space distribution was investigated as well by means of the simulation of Mercury intrusion experiments in the voxelized sample. Both models were validated against laboratory measurements using sintered brass specimens of various constitutions. Furthermore, a single phase flow model was developed for a plug, having dimensions of those used in laboratory measurements with the help of finite volume method implemented in OpenFOAM CFD solver.

Geomorphic response of streams to neotectonic deformation in low relief areas: case study of Bilogora Mt. (NE Croatia)

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Understanding about tectonic and surface processes which control topography and development of landscape features represents the core for many quantitative morphotectonic investigations using nowadays widely available digital elevation models (DEMs).

This work is aimed to identify areas with neotectonic deformation signature in Bilogora Mt. area by means of DEM based morphometric analysis combined with geological, geophysical and seismotectonic data (Prelogović & Velić, 1988 & Herak et al., 2009).

Bilogora Mt. (average elevation <300 m) represents c. 90 km long and 10 km wide hilly terrain along the southwestern margin of the Drava River basin in northern Croatia. According to recent studies it formed due to transpression along the Drava basin boundary fault system that was inverted from previously normal into predominantly dextral sense of slip during Pliocene and Quaternary times (e.g. Prelogović et al., 1998). Bilogora Mt. is composed of deformed Neogene and Quaternary clastic series highly variable in thickness, covering pre-Neogene basement units (e.g. Prelogović & Velić, 1988). Database on historical seismicity reports rare occurrences of moderate earthquakes with intensity of VI°-VIII° MCS concentrated in the northwestern part of the area, close to towns of Koprivnica and Virovitica (Herak et al., 2009).

In order to analyze a potential geomorphic response of streams to on-going tectonic activity we employed a DEM raster with cell resolution of 10 m modeled according to procedure described in Matoš et al. (2012). Study area was truncated into 130 drainage units *(Figure 1, Table 1)*, each unit was analyzed by computing its morphometric parameters that include: hypsometric integral-***Hi***, absolute asymmetry factor-***AF(abs)*** and statistical parameters of longitudinal stream profiles *(Figure 2, Table 1)*, i.e. maximal concavity-C_{max}, distance from the source-***Δl/L*** and concavity factor-C_f.

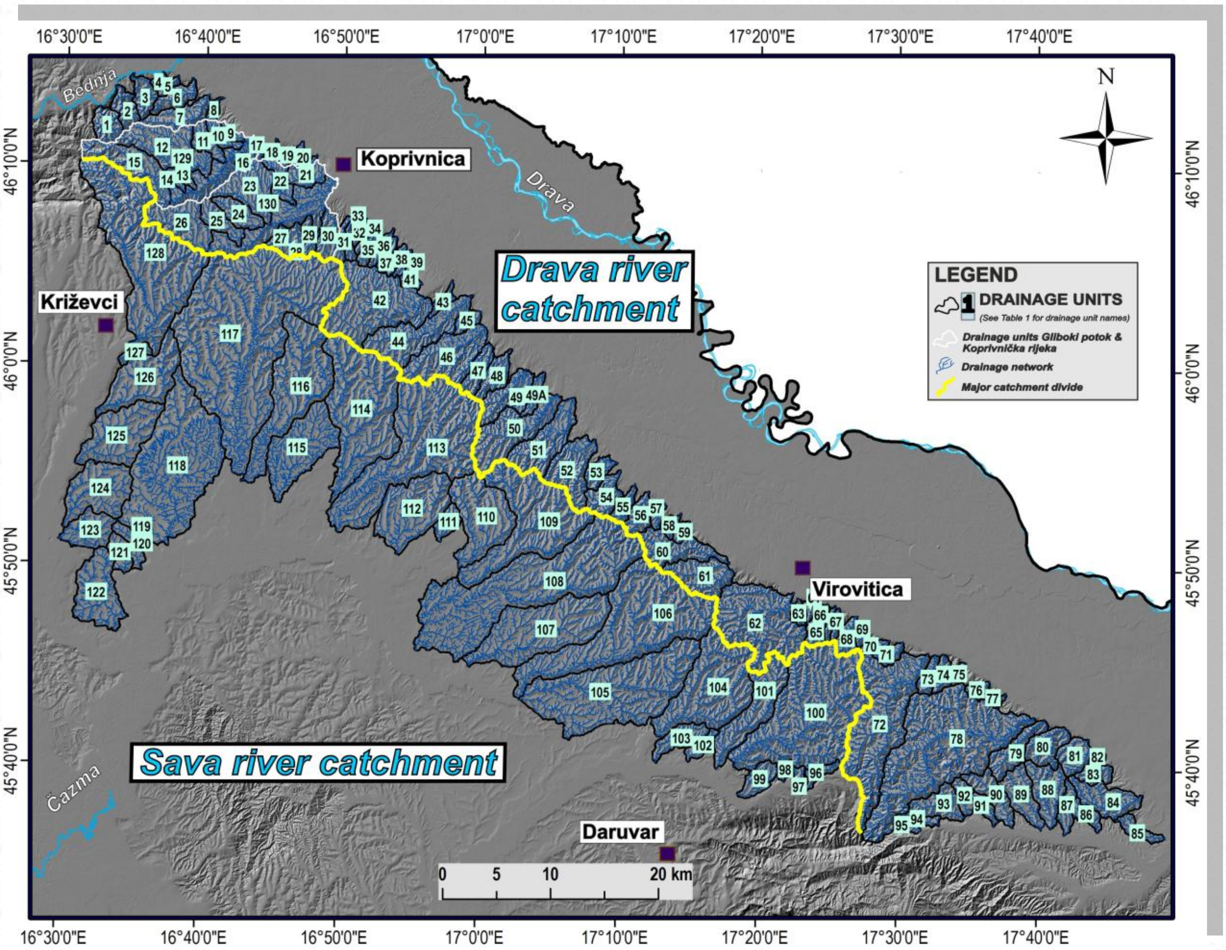

Figure 1: DEM hillshade of Bilogora Mt. area with analyzed drainage units.

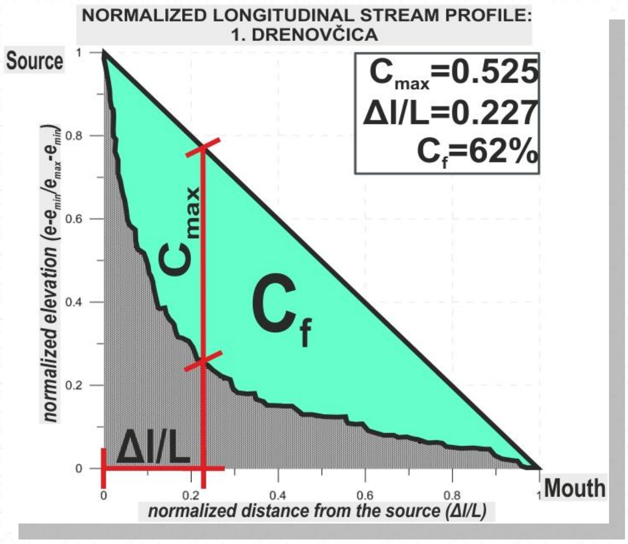

Figure 2: Normalized longitudinal stream profile with statistical parameters.

Calculated ***Hi*** values range between 0.12-0.55 *(Table 1)* and shows that most catchments in a young stage of landscape evolution with highest values of H_i≥0.50 are recorded in NW and central part of Bilogora Mt. *(catchments No. 5, 8, 16-17, 19, 27-32, 34-39, 41, 43, 45-47)*, while in SW and SE part only three catchments *(No. 97, 98 and 119) obtained the same value.* Extrapolation of ***AF(abs)*** was addressed to recognition of possible active tectonic block tilting. Very high values of Af(abs)≥0.25 pointed out to several catchments in NW part *(No. 11-12, 23, 37, 122 and 128),* central part *(No. 54, 106 and 109)* and SE part (No. *81*, 87 and 99) of Bilogora Mt. Finally, parameters C_{max}, ***ΔI/L*** and C_f have been used to identify on-going tectonic warping of main streams. Obtained values of C_f≤32.16% and C_{max}≤0.265 positioned (ΔI/L) in upper reach of streams suggests that those streams *(No. 4, 8, 14, 19, 27-30, 32, 36-40, 43-44, 46-47, 49A, 56, 97-98)* are less graded and in non-equilibrium state, probably as a result of on-going tectonic deformation. Based on obtained values of geomorphic indices (including slope and elevation data), combined and correlated with results of previous studies we conclude that catchments in NW part *(No. 4-5, 7-8, 17-19, 29-32, 36-39 and 41)*, in central part *(No. 44-49, 52 and 56)*, and in SE part of Bilogora Mt. *(No. 89, 95, 97-99)* correspond to areas of possibly on-going tectonic deformation that is reflected in a present-day landscape geomorphology.

Table 1: Drainage units with calculated and highlighted anomalous values of morphometric parameters referring to possible on-going tectonic active areas.

No.	Drainage unit	Hi	Af (abs)	Cmax	ΔI/L	Cf (%)	No.	Drainage unit	Hi	Af (abs)	Cmax	ΔI/L	Cf (%)
1	Drenovčica	0,38	10,82	0,525	0,227	62,00	66	Katinac	0,35	6,19	0,421	0,168	48,57
2	Slanje	0,43	5,62	0,457	0,191	55,60	67	Travni potok	0,35	4,50	0,500	0,095	51,72
3	Tinavčice	0,39	8,50	0,354	0,322	43,40	68	Dabrovica	0,38	6,29	0,558	0,141	64,15
4	Vinograci	0,44	10,00	0,247	0,449	28,20	69	Borova	0,41	11,01	0,393	0,246	42,59
5	Vinogradi Ludbreški	0,50	17,25	0,326	0,155	40,40	70	Bukova	0,40	7,29	0,466	0,159	53,75
6	Črnoglavec	0,42	0,43	0,333	0,244	43,40	71	Bukovi jarak	0,43	6,85	0,463	0,160	56,31
7	Šegovina	0,47	13,56	0,269	0,428	34,44	72	Brežnica	0,13	19,07	0,611	0,261	71,90
8	Bolfan	0,55	4,84	0,208	0,277	25,01	73	Žubrica	0,35	3,24	0,522	0,195	60,13
9	Rasinja	0,36	1,60	0,403	0,165	44,73	74	Budanica	0,37	1,79	0,433	0,253	52,59
10	Cesarova jama	0,35	12,60	0,395	0,235	43,70	75	Cabuna	0,46	2,38	0,472	0,183	51,39
11	Crna Rijeka	0,44	30,03	0,386	0,319	43,76	76	Bistrica	0,43	7,09	0,408	0,207	47,44
12	Medenjak	0,39	30,54	0,362	0,165	45,59	77	Markovac	0,40	15,10	0,354	0,260	41,66
13	Ciganski potok	0,48	16,79	0,262	0,352	33,85	78	Čadavica	0,12	12,76	0,605	0,203	75,89
14	Veliki poganac	0,48	7,24	0,170	0,291	18,56	79	Lukavčić	0,34	3,40	0,496	0,146	57,28
15	Gliboki potok	0,33	5,51	0,417	0,277	52,08	80	Jova rijeka	0,37	11,15	0,585	0,204	65,62
16	Martinčec	0,50	9,38	0,452	0,102	45,27	81	Grabovac	0,34	30,31	0,514	0,149	60,13
17	Kostanjevac	0,51	7,61	0,307	0,084	36,37	82	Kozički potok	0,40	10,58	0,364	0,226	40,88
18	Subotica Podravska	0,46	3,13	0,289	0,348	32,40	83	Vodenička	0,36	17,94	0,475	0,231	59,24
19	Drakšin	0,51	3,63	0,264	0,473	30,59	84	Branica	0,33	15,63	0,410	0,131	49,85
20	Zvirišće	0,41	4,21	0,396	0,314	42,91	85	Mikleuš	0,42	0,00	0,430	0,304	52,50
21	Prespa	0,35	18,44	0,437	0,266	51,06	86	Radusnovac	0,45	13,62	0,330	0,231	44,20
22	Mučnjak	0,37	11,34	0,303	0,557	40,12	87	Ljeskovački potok	0,38	26,10	0,271	0,183	37,30
23	Velika Mučna	0,47	38,07	0,291	0,317	37,52	88	Konik	0,42	3,67	0,451	0,083	55,92
24	Kraljevac	0,38	23,41	0,329	0,275	39,88	89	Duboki potok	0,45	22,01	0,368	0,185	44,84
25	Dubrava	0,39	2,68	0,369	0,259	43,42	90	Martin potok	0,43	0,81	0,437	0,155	49,04
26	Koprivnička rijeka	0,37	18,11	0,499	0,126	59,56	91	Macute	0,49	1,08	0,305	0,201	30,59
27	Rojanov jarak	0,53	3,85	0,179	0,277	22,32	92	Šermečanci	0,43	7,44	0,471	0,148	54,89
28	Srnski potok	0,52	4,09	0,229	0,342	27,53	93	Lisičina	0,32	11,77	0,514	0,151	61,00
29	Kamenica	0,54	6,34	0,237	0,348	31,51	94	Pasjak	0,32	6,39	0,449	0,319	50,21
30	Jagnjedovac	0,53	9,76	0,252	0,273	29,37	95	Rakovac	0,48	0,00	0,262	0,275	32,36
31	Draganovac	0,50	16,24	0,241	0,331	32,31	96	Lipovac	0,41	4,55	0,280	0,306	32,78
32	Petrov Dol	0,52	6,54	0,238	0,277	30,55	97	Dujakovac	0,54	20,97	0,122	0,750	11,55
33	Ivanačka	0,45	2,82	0,307	0,311	35,17	98	Selnički potok	0,55	2,43	0,147	0,377	16,51
34	Bakovčica	0,53	0,00	0,271	0,280	33,61	99	Krivaja	0,46	27,64	0,277	0,484	32,16
35	Riđina Barica	0,50	1,62	0,333	0,155	40,37	100	Ilova	0,34	7,38	0,553	0,096	63,47
36	Jaružnica	0,50	20,35	0,187	0,404	24,35	101	Rastovac	0,41	15,91	0,439	0,207	51,66
37	Borovljanski potok	0,53	25,57	0,180	0,097	23,17	102	Ivanovo	0,46	3,65	0,444	0,172	53,06
38	Brzava	0,52	8,63	0,131	0,469	15,75	103	Rašenički potok	0,46	19,20	0,411	0,222	53,34
39	Vlaislav	0,53	8,42	0,165	0,452	21,61	104	Peratovica	0,40	18,19	0,461	0,134	55,32
40	Plavšinac	0,48	7,63	0,265	0,199	31,12	105	Barna	0,32	10,45	0,490	0,128	58,78
41	Prkos	0,52	13,29	0,290	0,122	31,38	106	Grđevica	0,35	32,33	0,471	0,104	58,44
42	Komarnica	0,37	6,53	0,459	0,216	52,71	107	Kovačica	0,33	19,39	0,471	0,238	60,01
43	Novigrad Podravski	0,53	7,56	0,172	0,306	20,87	108	Račačka	0,25	4,29	0,543	0,060	66,13
44	Zdelja	0,48	6,49	0,233	0,096	25,45	109	Bedenička	0,31	36,58	0,545	0,097	67,21
45	Podgorice	0,52	9,66	0,328	0,349	33,19	110	Severinska	0,30	4,46	0,523	0,145	65,23
46	Hotova	0,50	16,42	0,147	0,186	16,22	111	Gaj	0,29	3,92	0,281	0,428	39,27
47	Sv. Anski jarak	0,50	8,91	0,264	0,119	30,39	112	Tomaška	0,30	2,27	0,437	0,227	56,55
48	Tumarski potok	0,49	14,84	0,289	0,068	33,58	113	Bjelovačka	0,36	1,24	0,486	0,197	58,20
49	Barna potok	0,48	11,51	0,277	0,066	23,54	114	Plavnica	0,31	2,34	0,565	0,126	67,41
49A	Budrovac	0,45	3,04	0,186	0,165	19,90	115	Bokana	0,34	5,04	0,422	0,312	52,61
50	Sirova Katalena	0,48	3,99	0,332	0,211	40,50	116	Konjska rijeka	0,30	2,72	0,547	0,145	64,41
51	Suha Katalena	0,45	13,65	0,410	0,120	45,04	117	Velika rijeka	0,26	18,78	0,570	0,157	68,24
52	Kozarevac	0,41	22,08	0,391	0,090	46,60	118	Dunjara	0,25	3,19	0,477	0,210	60,47
53	Lepo Vrelo	0,34	20,43	0,353	0,324	42,91	119	Smrdenec	0,55	5,12	0,288	0,244	33,25
54	Rijeka	0,36	25,46	0,531	0,156	61,42	120	Kučara	0,49	4,30	0,333	0,228	38,98
55	Velika Črešnjevica	0,38	0,44	0,396	0,249	46,37	121	Podlužan	0,48	0,42	0,316	0,241	40,07
56	Josina rijeka	0,39	6,18	0,239	0,185	24,10	122	Dragićevci	0,41	26,06	0,416	0,180	51,23
57	Konački jarak	0,40	9,53	0,300	0,281	35,05	123	Ladina	0,39	13,79	0,412	0,319	51,83
58	Vukosavljevica	0,49	17,05	0,265	0,232	34,05	124	Koritna	0,39	22,32	0,365	0,227	43,74
59	Drobnašica	0,43	5,65	0,353	0,237	39,64	125	Lubenica	0,40	17,48	0,417	0,224	50,20
60	Lužnjak	0,39	0,85	0,438	0,079	52,56	126	Prašnica	0,34	14,67	0,430	0,202	53,38
61	Lendava	0,35	14,19	0,435	0,229	50,43	127	Rečica	0,44	11,80	0,329	0,344	42,62
62	Odenica	0,38	14,51	0,609	0,129	67,79	128	Glogovnica	0,21	25,42	0,580	0,130	72,09
63	Bošnjakuša	0,42	3,64	0,305	0,113	36,10	129	Gliboki (area)	0,26	22,56	0,463	0,201	57,53
64	Čavina jama	0,45	2,90	0,338	0,228	39,11	130	Koprivnička (area)	0,44	19,10	0,355	0,132	38,17
65	Novi Rezanovac	0,38	4,90	0,512	0,186	58,81		mean value	0,41	10,96	0,37	0,23	44,50

ACKNOWLEDGEMENTS

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Geometric classification of brittle and semi-brittle tectonites at borecore-scale

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Introduction

The intensively fractured hard-rock reservoirs have an increasing weight in water and hydrocarbon production worldwide (Nelson, 2001), where the brittle fault zones play a key role their hydrodynamics. The hydraulic character of a brittle fault zone primarily depends on the consisting tectonites, as the various types of fault rocks own extremely different flow-properties. For proper classification of these lithologies, several studies (e.g.: Storti et al., 2007) demonstrated connection between certain clast geometric parameters of fault rocks and their formation conditions. The aim of this study is to shed light on possible applications of these geometric parameters.

Applied methods and measured parameters

The clast geometric parameters were analysed by the Petrographic Image Analysis (PIA) approach, which is based on the processing and analysis of digitized geological structures by image analysis softwares. In this case, two-dimensional images of samples (borecores and thin sections, respectively) were processed and measured using Adobe Photoshop and ImageJ programs, while IBM SPSS Statistics was applied for the statistical evaluation of the clast geometric data. In order to determine the characteristic geometric features of the different type of tectonites, the following clast geometric parameters were measured: dimension of cumulative particle size distribution (*PSD*) and clast boundary complexity (D^R), the relative standard deviation of particles long axes angles in samples (*Angle*), the ratio of original particle area/the convex area (*Conv*), the elongation (*AR*) and the circularity of the clasts (*Circ*).

Case-study: Crystalline basement of the Pannonian Basin

The intensely fractured Variscan metamorphic basement of the Pannonian Basin (PB) consists of numerous hard-rock hydrocarbon reservoirs, one of the most important of them is the Szeghalom Dome (SzD) (Nelson, 2001). One of the major fault zone of the SzD was penetrated by a well (Sz-180), which quite diverse internal petrographic structure makes detailed microstructural investigation possible.

In order to classify tectonites based on their geometric parameters and reveal connections between the parameters and mechanisms of deformation, multivariate statistical methods were applied. Accepting the petrographic classification (Group 1: breccia, 2: cataclasite, 3: gouge), the tectonite types were compared pairwise to each other – D(1,2), (1,3) and (2,3) - in the 6-dimensional space of the measured geometric factors to separate the groups based on scores of the calculated discriminant functions (Fig. 1). The results of prediction for ungrouped samples indicate that the cataclasites are more similar to breccias than to gouges.

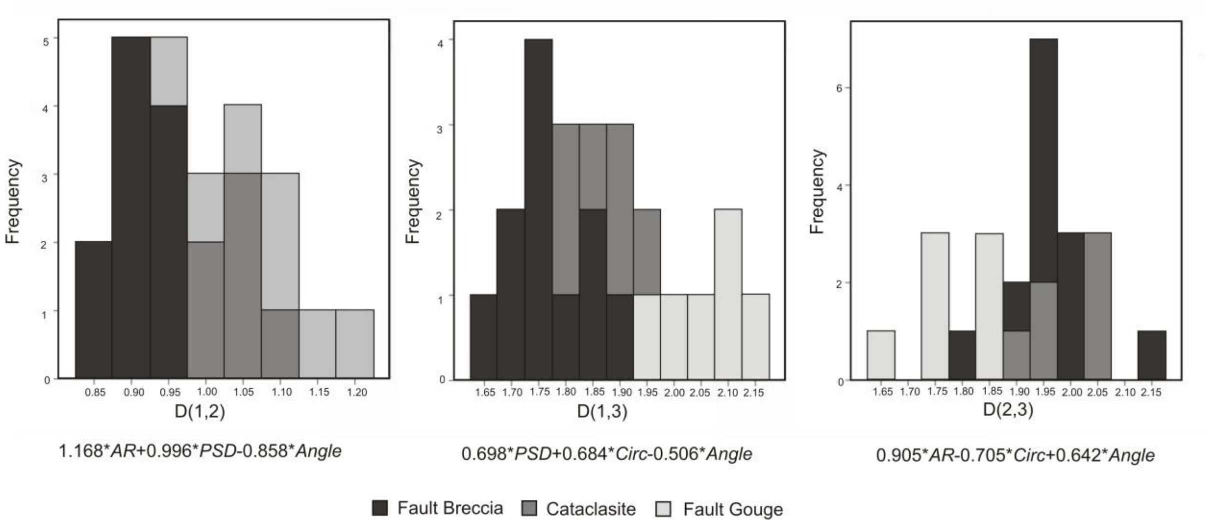

Figure 1: Histograms of discriminant functions D(1,2), (1,3), (2,3).

For the next step, the three groups of tectonites were compared to each other by calculating the D1-D2 discriminant functions (Fig. 2/a). These combinations of parameters successfully separated the fault rock types, without any overlap. The D1 function – which is influenced by *PSD*, *Angle* and *Circ* values – presumably increases parallel to the observed deformation. The discriminant function D2 is strongly determined by the *AR*. This probably relates to the evolved particle elongation, especially in the cataclasite samples. The parameters not mentioned (D^R and *Conv*) have only limited role in both discriminant functions.

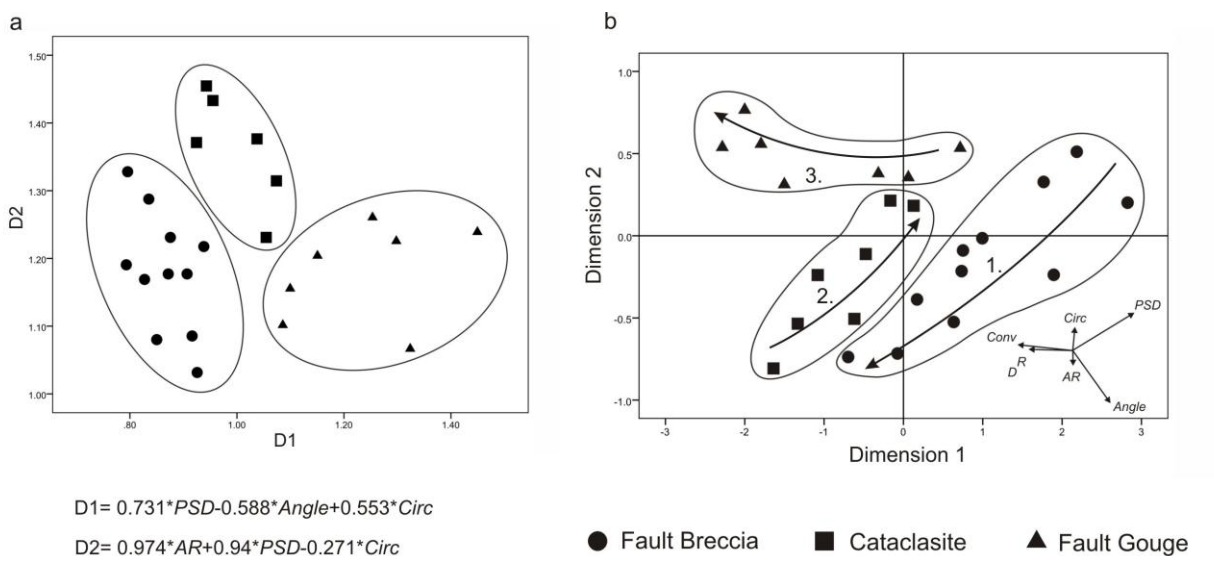

Figure 2: a: The plot of D1 and D2 discriminant functions. b: The projection of multidimensional scaling, with deformational mechanisms. The vectors indicate the direction and strength of the parameters

Multidimensional-scaling algorithms were used to compute the relative positions of the samples in the theoretical six-dimensional space of parameters. The two-dimensional projection clearly illustrates these relative positions, as well as developmental trends of the different tectonites (Fig. 2/b). The initial fragmentation mechanism (Process 1) is observable most characteristically by the increasing *AR* values coupled with the chaotic fabric of fault breccias. The onset of cataclastic deformation (Process 2) is marked by the appearance of orientation with clast elongation. The advanced deformation of fault gouges transform to the drastically distinct evolution pathway of Process 3, through the development of an oriented structure with strongly fragmented and rounded clasts.

The observed petrographic and clast geometric parameters revealed the strong connection between particle size/shape and the fluid flow properties of fault zones. The angular clasts of fault breccias maintain enhanced transmissibility (Storti et al., 2007); while the gouge-bearing zones can act as hydrodynamic barriers with their reduced permeability and rock-mechanical weakness ("fault-weakening"). The examined fault zone is under the control of gouge-bearing layers, as these are able to compartmentalise the hydraulic regimes in the fault zone (Caine, 1996). The measured geometric parameters provide an opportunity to discriminate the different tectonite samples and determine their position in a theoretical basement fault zone, moreover, to extend the results into spatial data, which can answer the overall behaviour of the fault zone.

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HOW WE DID IT?
LESSONS LEARND FROM THE UNCERTAINTY MANAGEMENT PRACTICIES APPLIED DURING THE DEVELOPMENT OF THE RADWASTE DISPOSAL FACILITY IN BATAAPATI

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The first Hungarian deep geological final disposal facility for radioactive waste has been opened in Bátaapáti in December last year, in 2013. About 40 000 m^3 low and intermediate level radioactive waste originating from the NPP will be finally disposed of in this facility. The facility will be closed after 100 year uptime and the closed facility together with its surroundings will be controlled institutionally during some 50 years if it works well.

The safety of the facility should be documented by safety assessment, and the safety assessment should be reviewed regularly, because the operating license for a final waste disposal facility could be issued for determined duration, for 10 years at most, which – in case of meeting the operating conditions – can be extended for at least 10 years more on request.

The final disposal facility is counted to be safe, if in case of conditions postulating the expected behavior of the disposal system, after closure, the radiation exposure of the individuals of the control group of the population due to the effects of the disposed waste shall not exceed the effective dose of 100 µSv/year.

The lifetime of the deep geological repositories depends on the type of the radwaste disposed of in the repository and it changes between 100 000 and 1 000 000 years. It may be easy to see, the effective dose for so long timeframe can be quantified only with a certain uncertainty.

A key output from safety assessment is the identification of uncertainties that have the potential to undermine safety.

During the safety evaluation of the final disposal of the radioactive waste, the uncertainty of the used data and applied assumptions, and their effect on the compliancy of the safety requirements must to be evaluated.

Uncertainties in the safety analysis have to be characterized with respect to their source, nature and degree, using quantitative methods, professional judgments or both.

It may be said with full reason, the treatment of uncertainties accompanies the lifetime of a repository from the arising the idea of the establishment of a repository until the end of the active institutional control of this repository.

With the intention to learn lessons from the practice of treatment of uncertainties applied during the establishment of the geological repository in Bátaapáti, a report has been prepared by the geoscientists have been taking part in the development process of the repository.

The report addresses the treatment of uncertainties relating to the following professional geoscientific fields: borehole geophysics, geology-tectonics, geotechnics and hydrogeology.

Considering the content of report, it may be concluded:

- Geoscientists had their own interpretation and application of treatment of uncertainties, without knowing how the data and its uncertainty would be used in safety assessment and by the other geoscientists attending the other elements of geosynthesis.
- The level and manner of treatment of uncertainties between the elements of geosynthesis (geological description) are different because of the different geoscientists coming from different professional field have different opinions and knowledge about the treatment of uncertainties.
- To build up the harmony in the treatment of uncertainty between the elements of geosynthesis, different guides to handling of

uncertainties depending on the professional field have to be produced by PURAM.

- This report may be treated as a constat about the knowledge and practice of the domestic geoscientists participating in the development of the geological repository in Bátaapáti.

Integrated geological model of a HPHT tight gas reservoir

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***Key words**: 3D modelling, reservoir parameters, unconventional resources, hydraulic fracturing*

This paper discusses an unconventional gas reservoir's geological model, which is a rather new challenge for reservoir geologists and engineers in Hungary. According to the world trend, less and less easy-to-access hydrocarbon deposits are economic to develop, thus the deep, HPHT (High Pressure – High Temperature) unconventional fields have to be explored as well in Hungary as well. The analysed reservoir is a tight gas field with significantly low permeability (<9.8x10-18 m2 ≈ 0.01 mD), high temperature (>200°C) and high over-pressure (~250-300 bars). It had to be hydraulically fractured so that its gas reserve could be produced within a relatively short time interval, i.e. with profit (Economides et al., 2007).
Similarly to regular cases, this field and its pay-zones were modelled in order to have estimation about the OGIP, probable production forecast, and further treatments to improve production rate and/or recovery factor. Several types of data such as seismic, log, core, PVT etc. were used. The main challenge was how to handle an unconventional system with properties out of the limits of measuring tools, methods and how to model fluid saturation. In addition, it was needed to include the effects of fracturing, faults and the extreme environment. Roxar Irap RMS program package was used to set up the geological reservoir model and solve this unconventional system with modified approaches known for conventional environments.

For example we had to use modified capillary curves (Vavra et al., 1992), needed to estimate Free Water Level and Gas Water Contact, and build a rocktype model based on very limited information.

Such modified methods and the challenges met and solved will be presented.

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Increased hydrocarbon recovery and CO_2 management, a Croatian example with PVT relations and volumes

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Key words: carbon dioxide, enhanced oil recovery, Ordinary Kriging technique, reservoir variables

Due to additional oil and gas production, the pilot project of alternating water and carbon dioxide injection, performed on limited part of the Ivanić Field (the Sava Depression) has proved feasibility of the EOR (Enhanced Oil Recovery) project (VRBOŠIĆ et al., 2003; PERIĆ & KOVAČ, 2003; NOVOSEL, 2010). Further modeling of sandstone reservoirs in order to calculate volumes available for CO2 injection was done. First phase modelling was related to results of laboratory testing on the core samples. Analogies with world-known projects of CO2 geological storage were also applied (BENNACEUR et al., 2004; CHADWICK et al., 2002; MARTENS et al. 2012. Further modelling was made by using of the Ordinary Kriging technique. It covered variogram analyses of reservoir variables (porosity, depth and reservoir thickness) and their mapping with the purpose of determine reliable average values of the Upper Pannonian reservoir volumes. Consequently, the volume of CO2 expressed at standard condition, which can be injected in the "Gamma 3" and the "Gamma 4" reservoirs (supporting miscible conditions) is approximately 15.5 billion m3.

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Quest for the Reef – comparison of different geostatistical and geomodelling approaches in paleo-environmental reconstruction

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Abstract

Identification of paleoenvironment is a key factor when building a reservoir facies or rock type model. Over the years plenty of methods has been developed in order to recognize the emergence and sedimentation processes of hydrocarbon reservoir rocks.

This study is devoted to the Middle Miocene Badenian age shallow marine carbonates of the Pannonian Basin System. During the Badenian many carbonate buildups of Lajta (Leitha) Limestone Fm. were developed on paleohighs in the Hungarian part of the Central Paratethys. Around these paleohighs heteroptic facies limestones have been deposited in some extent in fore-reef and back-reef environments, but these have much lower reservoir quality than the reef itself. Some of these carbonate buildups form significant hydrocarbon reservoirs in Hungary. Separation of the different limestone facies in subsurface conditions is often difficult due to the similar chemical content.

Facies classification within the shallow marine and shoreface Middle Miocene environments can be performed upon various methods, eg. mudlogs, petrophysical interpretations, core studies, well test measurements and seismic surveys. A case study is provided below in order to check the usability of some above mentioned methods. The subject of the investigation is an extremely heterogeneous Middle Miocene

mature oil and gas field located in the Kiskunhalas area, Hungary. In order to reduce uncertainty when planning further EOR methods based on dynamic modelling of the whole field, it was decided to compare all the available methods to delineate the different quality reservoirs and thus help to determine the extent of the reefal system. In this paper we compare conceptual facies models built upon petrophysical interpretations, core descriptions, paleobiological investigation of cores, well test measurements and 3D seismic attributes.

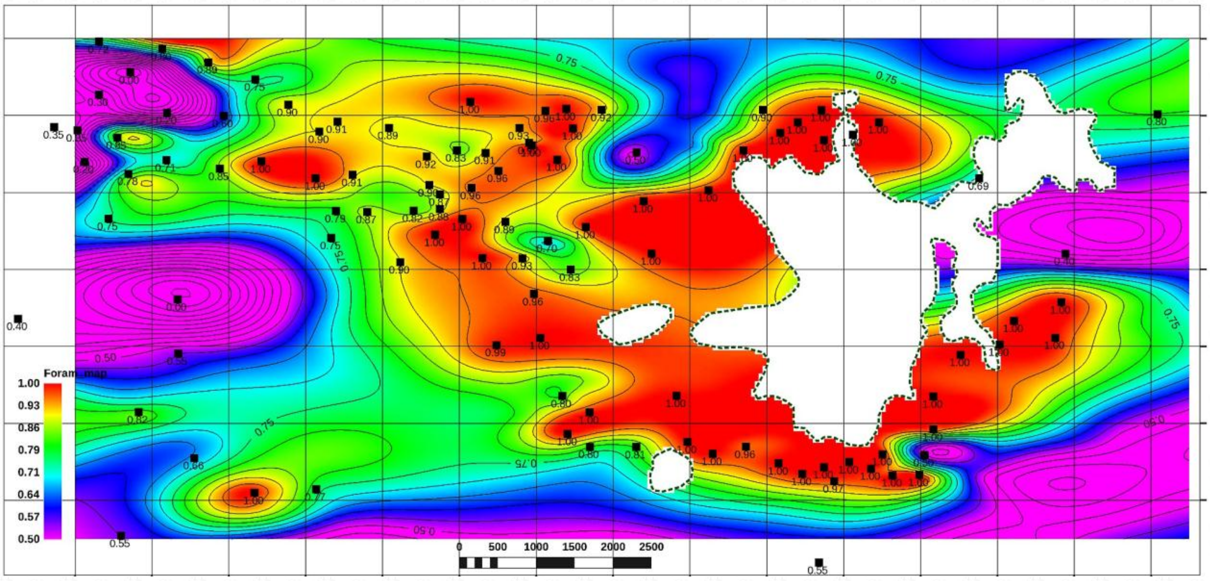

Figure 1: Proportion of benthic foraminifer species against all foraminifer species

As the main appraisal and development phase of the given oil and gas field took place at the turn of the 60s and 70s, principally no modern wireline logging program was carried out in the majority of the wells. Thus distinction of different limestone facies is basically impossible upon petrophysical interpretation. Different methods of core data investigation were applied to solve this problem. Where detailed core description was available, differences in rock fabric and texture were used to delineate the reefal carbonate facies. In general very few detailed core descriptions were available, but basically all Middle Miocene cores were investigated earlier from the point of fossil content in MOL Plc. and its predecessor's internal laboratory. A massive database was constructed which includes all the identified foraminifers on a per well basis. Foraminifer species were divided into benthic and planktonic forms and benthic/total ratio was mapped for the Middle Miocene sediments in order to delineate the reef core area. The resulting map was in good correlation with other reef extent determination techniques like well test results, production history, seismic amplitude maps (where available) and petrophysical analysis of core poro-perm relationship. During final 3D stochastic facies modelling this foraminifer ratio map and other maps derived from core plug petrophysical analysis were used as lateral trend maps to help populating the 3D facies model. However dynamic modelling and history matching is still ongoing, the facies model already helped to resolve some long known issues about the compartmentalization of the field.

Reservoir quality ranking using wire-line logs and bottom hole cores, Lower Cretaceous rocks, South East Sirt basin, Libya

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***Key words**: Nubian Sandstone, reservoir quality, hydraulic unites.*

The purpose of this work was, to study the Petroleum potential of the Nubian sandstone in Sirt Basin, one key well was selected to carry out this study for Lower Cretaceous formation, In order to identify the most attractive potential reservoirs and to rank them according to their properties.

This paper will discuss the reservoir characteristics of different reservoirs related to the Nubian formation (Lower Cretaceous), reservoir units which distributed in the Upper (Nubian), the Middle and Lower Nubian sands, including the description of the methods used and illustration of the input and output data.

The scope of this case study consists in ranking the reservoirs of the Nubian sequence, namely the Upper Nubian Reservoirs, Middle Nubian Reservoirs and Lower Nubian Reservoirs, which have been penetrated in the selected well.

More precisely the different tasks are defined as follows:

- To rank the processed interval by the quality of the rock composition has been obtained by well logs: effective porosity, volumetric shale fraction and sand fraction, fluid saturations, permeability.
- To rank the processed interval by the quality of the recognized facies have been obtained from core description.
- To rank the processed interval by the quality of hydraulic unites have obtained from the FZI analysis of the core measurements.

General Geoscience Database

ALFA(Általános Földtudományi Adatrendszer)

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Background

In 2007 the European Community has started a large program called INSPIRE. The aim is to provide fully harmonized and seamless access to spatial data systems in Europe. Data themes defined in the annex of the directive cover 34 domains that are closely bundled to environment and spatial information. More than 3000 institutions are going to be involved in the progress. The ambitious plan requires common technology and common language. First means the use of OGC web services, the second means a set of standardized markup languages designed by domain experts and integrated into a common application schema.

Implementation

The INSPIRE Application Schemas provide excellent starting point to create a general geoscience data model. The ALFAm schema was created to support the internal and external data services of MFGI. It is a simplified representation of the INSPIRE data model, modified according to a number of internal requirements. On this conceptual basis the ALFAb hybrid XML – relational database was implemented. The aim is to serve both internal and external needs. The number of spatial object types provided by the system is large, and is continuously growing. At present it covers important features from many fields of geosciences:

Geology

- Geologic unit
- Borehole
- Specimen

Geophysics

- Measurement (Borehole log, seismic line, 3D seismics, etc.)
- Model (result maps, profiles, etc.)
- Campaign
- Project

Mining activities, environmental information

- Area management zone
- Natural risk zone
- Hazard event

Provided data is strongly coupled to spatial object types that are mutually linked together simulating their real life connections. Due to the complexity of the modelled phenomenon spatial object instances are stored in XML records validated against the ALFAm schema. To improve operational speed most frequently searched attributes are indexed in relational tables. Different type of data requests are served from SQL views of joined spatial objects. One of the most important design principles was compliance to open standards. Along with the INSPIRE schemas ALFAm is in accordance with the ISO 19139 Metadata, and the ISO 19156 Observation and Measurements Standard. For encoding observation results and procedures GML, sensorML and SWE markup is used. Content harmonisation is achieved by using SKOS (Simple Knowledge Organisation System) vocabularies.

Geometry is stored in PostgreSQL geometry fields making it possible to link to Geoserver, an Open Source GIS tool and provide WFS (Web Feature Service) and WMS (Web Map Service) services.

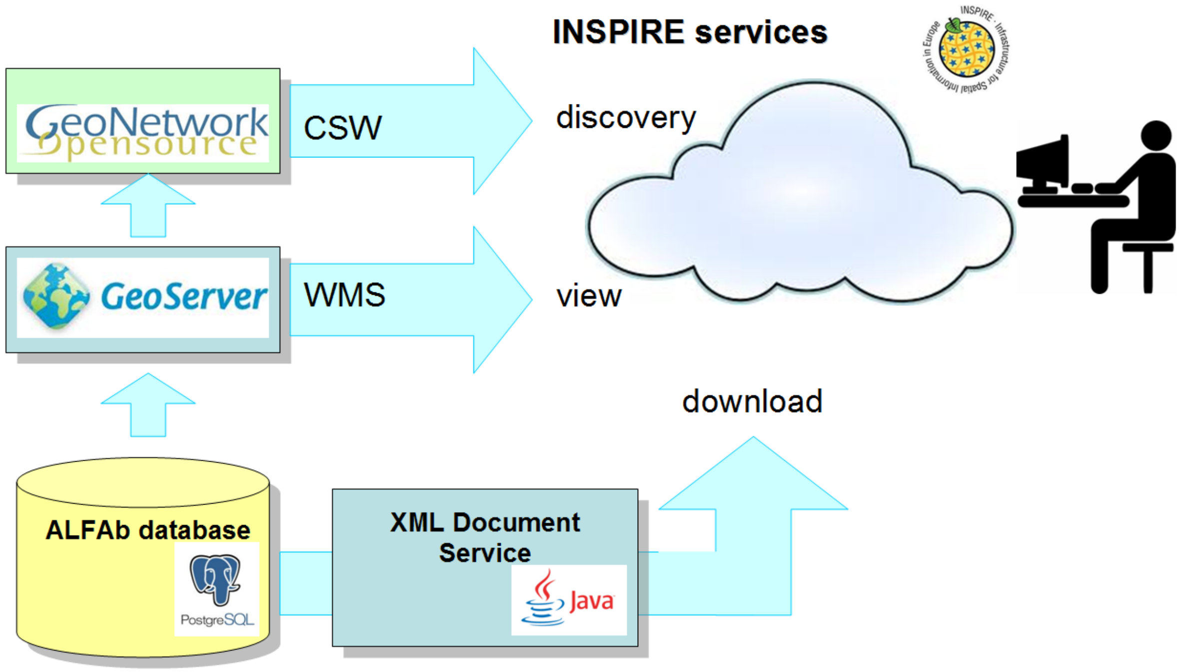

Figure 1: INSPIRE web services based on the ALFAb database system

WMS and WFS services are published in ISO 19139 Metadata and loaded into Geonetwork Catalogues. This way public GIS services can be found by external users through CSW (Catalogue Service for the Web) as required by the INSPIRE directives.

XDS - XML Document Service is a flexible interface between the ALFAb database and the client applications. It provides download access to spatial objects both in native XML and HTML format. XSL converters make it possible to serve spatial data in other format as well, most preferably XMLs validated against the INSPIRE Application Schema.

Benefits

The ALFA system provides high level data integration throughout the whole object hierarchy from generic metadata down to observation results. As different data services are based on the same underlying database, updates or changes are abruptly reflected in the user's view and no additional data manipulations are needed. (p.e. creating shape files)

Related objects are linked together, and thus very flexible joint queries can be carried out using attributes of separate objects. Geometry is also stored in the database that enables the user to perform spatial queries. (p.e. find seismic lines that crosses a specific administration area with outdated designation period)

WMS and WFS services allow the use of OGC compliant GIS tools. New versions of ESRI programs also support the use of WFS and WMS. ArcGIS analysts may benefit from accessing new dynamic map layers, while using their old familiar working environment.

Participation in European projects - where INSPIRE conformant spatial data environment will be expected – becomes easier.

Application development based on XML technologies (JAXB, XFORMS, AJAX) can be faster in adapting to new user requirements

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Review of geotechnical and rock mechanical data of Mórágy Granite Formation

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Between 2004 and 2012 huge amount of information were collected in the National Radioactive Waste Repository projects that allow the researchers and the designers to get to know the host rock more precisely and try to quantify its rock mechanical and geotechnical properties well. The first geostatistical review on rock mechanical data of Mórágy Granite Formation was prepared in 2009 by Geiger et al. (2009) which was followed by Geiger and Kovács (2010). Since then further information has been collected and then evaluated in Somodi et al. (2013).

During clearing the database some errors, bias were developed, which have been made uncertainties in the previous evaluations and interpretations (For example: different kind of laboratory technologies to determine same type of rock mechanical properties). With knowing these inaccurate or wrong information source we tend to get more reliable database and more responsible statistical analyses.

The analyzed geotechnical information contains dataset of the rock mechanical laboratory tests and the rock mass characterization of drilling cores which were collected during the construction of the whole waste disposal project. Dataset of the rock mechanical laboratory were analyzed both in point of the whole project database and the zone of Chamber group No 1 with great and small loop tunnel system.

On the basis of the results of rock mass ratings we can appoint significantly similar pattern of aplitic and alkaline-volcanic rocks due to vein-type occurrences. This can discourse about average RMR values of contaminated monzonite, contaminated monzogranite and mixed type groups. In consequence borehole sections of these rock types are not dissevered in RMR ratings. These observations lead us to divide Mórágy Granite Formation to four main types: monzogranite, monzonite, hybrid made from the mixtures of these two and vein-type, near dyke rocks.

According to discriminant analysis in point of laboratory measurements the six main rock types are not recognizable. It is suggested handling separately as monzonite and monzogranite groups, because statistical patterns differ only in this separation (Figure 1). Larger number of tests made on monzogranite rocks cause monzogranite-dominant pattern in the whole statistical population of rock mechanical data (Shown in Figure 1). It is emphasized that monzonite type rocks has higher strength and elastic laboratory values and better rock mass rating patterns.

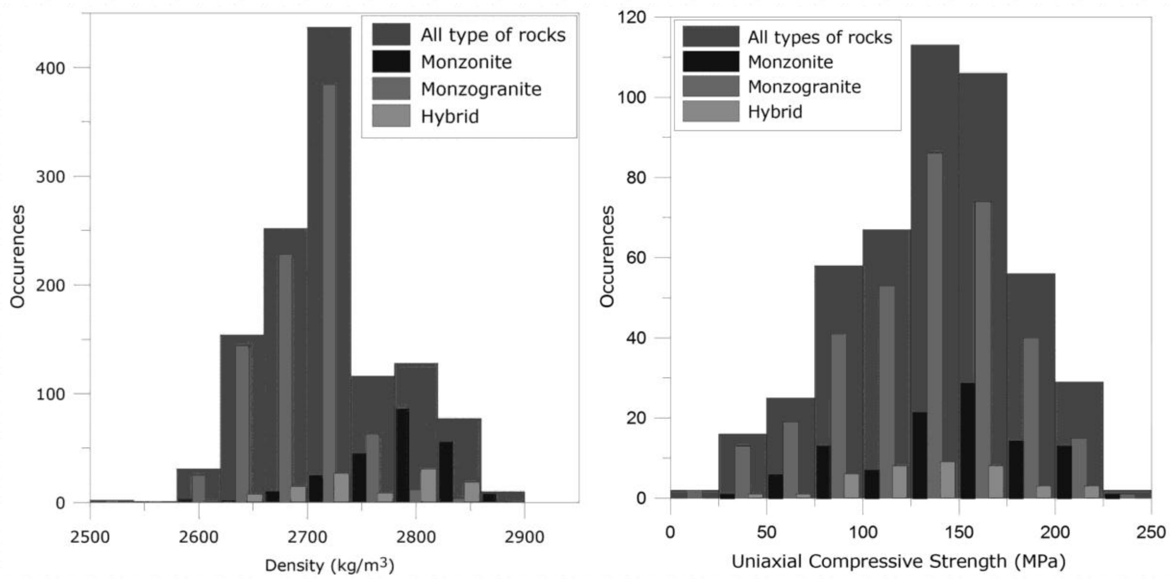

Figure 1: Density and UCS values of rock mechanical laboratory specimens.

It is squarely statable that there are differences between values of laboratory investigations on the strength of depth and location. Differences seem to follow petrologic zones however it is hard to settle separated groups among rock types of hybrid and mixed mineral content, because the clear monzonite and monzogranite rock types has wide scatters. These heterogeneous patterns originated from the structural events of the Mórágy Granite Block.

The continuously developing rock mechanical information created the conditions for performing the statistical analyses needed for calculating the input design parameters and gave the opportunity to finish the pre-treatment of Geotechnical Integration Report 2012 (Kovács et al., 2012). Further detailed data analysis is needed for continuing the work and taking steps toward geostatistical simulation.

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Pebble abrasion in the Williams River, Australia

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A controversial question in fluvial geomorphology is connected to the size diminution of pebbles observed along numerous recent gravel-bed rivers, a phenomenon called *downstream fining* (Ferguson et al., 1996). That phenomenon has been attributed to two main processes: abrasion and size-selective transport of clasts. While the first process explains the observed size diminution by the abrasion of particles during their downstream transport, the latter means the preferential transport of small particles which can also result in a downstream decrease in size. There is a long-standing debate on the relative importance of these two processes (e.g. Bradley et al., 1972; Ferguson et al., 1996; Seal and Paola, 1995; Lewin and Brewer, 2002; Surian, 2002). Most authors have emphasized sorting by size-selective transport as the dominant fining mechanism. There are surprisingly few field studies which examine the evolution of grain size and shape simultaneously in a natural stream (e.g. Bradley et al., 1972; Mikos, 1994), although possible downstream variation in shape can clearly indicate the relative importance of abrasion. Also, models in the literature (e.g. Le Bouteiller et al., 2011; Parker, 1991; Ferguson et al., 1996) do not precisely describe the role of abrasion in the changes of the shape and size; they only deal with the size of the particles and mostly focus on size-selective transport.

We collected basalt particles along a 100 km reach of the Williams River, New South Wales, Australia and measured their size and shape. Compared to some other natural streams, the small downstream fining rate observed in the river strongly indicates that abrasion plays a key role (Surian, 2002). In addition, we demonstrate that pebbles get flatter and thinner along the river, also, so-called *aquafacts* (Kuenen, 1947), i.e. pebbles with sharp edges and planar faces emerge in the downstream reaches (Figure 1). These are especially rare pebble shapes similar to *ventifact* shapes (specifically, to *ein-, zwei-* and *dreikanters*, Greeley et al., 2002).

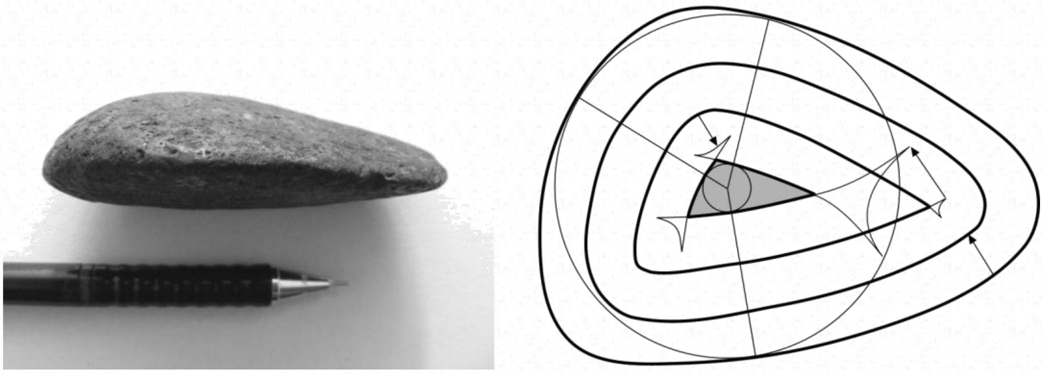

Figure 1: Aquafact shape found in the Williams River and the formation of sharp edges (Domokos et al., 2009)

Based on the field observations, we present a new numerical abrasion model to reconstruct the downstream variation in grain size and shape in the Williams River. The model relies on a recent theoretical result called the *box equations* (Domokos and Gibbons, 2012). Box equations describe the collective evolution of size and shape in large pebble collections as a Markov process, due to mutual abrasion and friction. Based on the predictions of the box equations, the occurrence of aquafacts reflects that collisional abrasion by small abraders („sandblasting") is important in the downstream reaches (Domokos and Gibbons, 2012; Domokos et al., 2009). Model results verify that abrasion is sufficient to produce the desirable exponential downstream fining, at least for the small diminution coefficient observed in the Williams River. The new numerical model is expandable and transparent, so it is easily adaptable to other sedimentary environments as well.

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High-resolution mapping of soil organic matter content based on Regression Kriging in a study area endangered by erosion in Hungary

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Recently, the digital mapping of soil variables (these can be continuous, discrete or categorical) and/or creating spatial soil information systems (SSIS) in various scales is a very important task of the soil science. The increasing power of tools such as geographic information systems (GIS), GPS, remote and proximal sensors, geostatistics, data sources such as those provided by digital elevation models are suggesting new ways to solve this task (McBratney et al.,2003; Pásztor et al., 2006). Here aim was to test digital mapping methods with geostatistical approaches for a continuous soil variable on a study area endangered by water erosion. An additional goal was to try mapping in the "D2" resolution (pixel size: 5 – 20 meters, cartographic scale: 1:5,000 – 1:20,000) (McBratney et al., 2003) because this resolution is the most appropriate to the small-catchment planning. The Regression Kriging interpolation technique was used to the spatial prediction. That interpolation method combines a regression of target variable on auxiliary variables with Simple Kriging of the regression residuals (Odeh et al., 1995; Hengl et al., 2004).

The study site (its area is approximately 1.3 km^2) is located in the southern part of Hungary, on the Szekszárd Hilly region, near Szálka village. The climate of the catchment area is continental with a submediterranean aspect, the mean annual air temperature exceeds 10.5 °C, and the mean annual precipitation is approximately 600 mm (Borcsik et al., 2011). The catchment area can be characterized by Cambisols and

Luvisols. The area consists mainly of arable lands (Figure 1) affected by various degree of erosion, providing evidence of the high erosion rate.

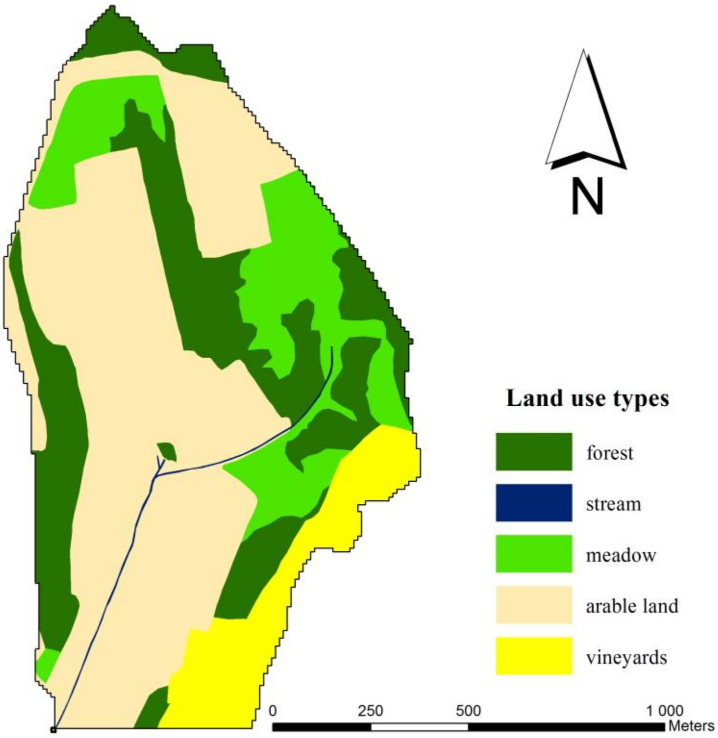

Figure 1: Map of land coverage ("land use") types of the study area

No. of 54 topsoil samples were collected in March 2009 to quantify the soil organic matter (SOM) content in percent by weight (Borcsik et al., 2011). Exploratory data analysis was performed on the raw data, and the outliers were removed from the observations. The remaining data have normal distribution, which was proved by the Shapiro-Wilk normality test.

Auxiliary data were derived from the digital elevation model (DEM) and from the land use map of the study area. From the DEM the following morphometric parameters were derived: elevation, aspect, slope, plan and profile curvature, topographic wetness index (TWI) and LS (or topographic) factor from the RUSLE water erosion model (Renard et al., 1991). The land use types were converted to indicator variables, respectively. To avoid multicolinearity effect of the secondary data in the multiple linear regression analysis (MLRA) a principal component (PC) analysis was performed and the resulting PCs were used as independent variables in the MLRA. The significance level was 0.05 and stepwise selection was used along the regression analysis. Afterward, the regression residuals were derived and their experimental semivariogram was calculated.

The performance of the interpolation method was assessed by Leaving-One-Out cross validation (LOOCV) (Isaaks and Srivastava, 1989). The mean error (ME), the mean absolute error (MAE), the root mean square error (RMSE) and its standardized form (RMNSE) (based on the estimated prediction variance) were calculated.

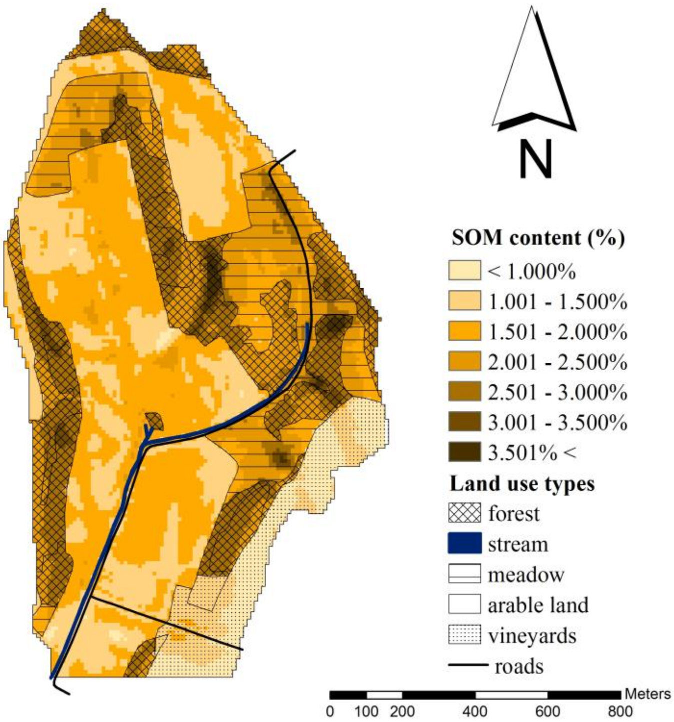

Figure 2: Map of soil organic matter (SOM) content based on regression kriging

The regression model selected seven PCs (these were significant on the 0.05 level), the R^2 value of the model was 0.81 which shows that the regression explained 81% of the total variability of the SOM data. Afterward, a theoretical model was fitted semi-automatically to the experimental semivariogram of the regression residuals in the "R" software with the "gstat" package. With the regression model and with the fitted semivariogram model I did the spatial prediction using regression kriging (Figure 2). The pixel size (or resolution) of the SOM map is 10 meters. The accuracy of prediction was assessed by the LOOCV method.

The calculated ME, MAE, RMSE and RMNSE were 0.002, 0.210, 0.255 and 1.069, respectively. These can be considered good results so the map of SOM matches well to the observed spatial distribution of SOM, since the expected value of ME is 0 and the expected value of RMNSE is 1. Also the value of RMSE and MAE were relatively low.

Results showed that the Regression Kriging is an appropriate technique to mapping continuous soil variables with 10 meters pixel size in the 1:10,000 cartographic scales on an area affected by soil erosion.

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Groundwater – surface water interaction in the branch system of the Danube (Szigetköz – HU), a case study

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On 25th October 1992, former Czechoslovakia diverted the bordering Danube at the rkm 1851.75 to its own area. After the diversion the original runoff reaching the Szigetköz was decreased by 80%. This started a fast and devastating change in its ecosystem. With the help of the Hungarian Geological and Geophysical Institute (former Geological Institute of Hungary) many studies tried to follow these changes, analyzing and evaluating the data extracted from the Geological Monitoring System and subsurface samples taken directly from the riverbed's vicinity (Fig. 1). These sampling of 56 physical and chemical parameters was carried out quarterly.

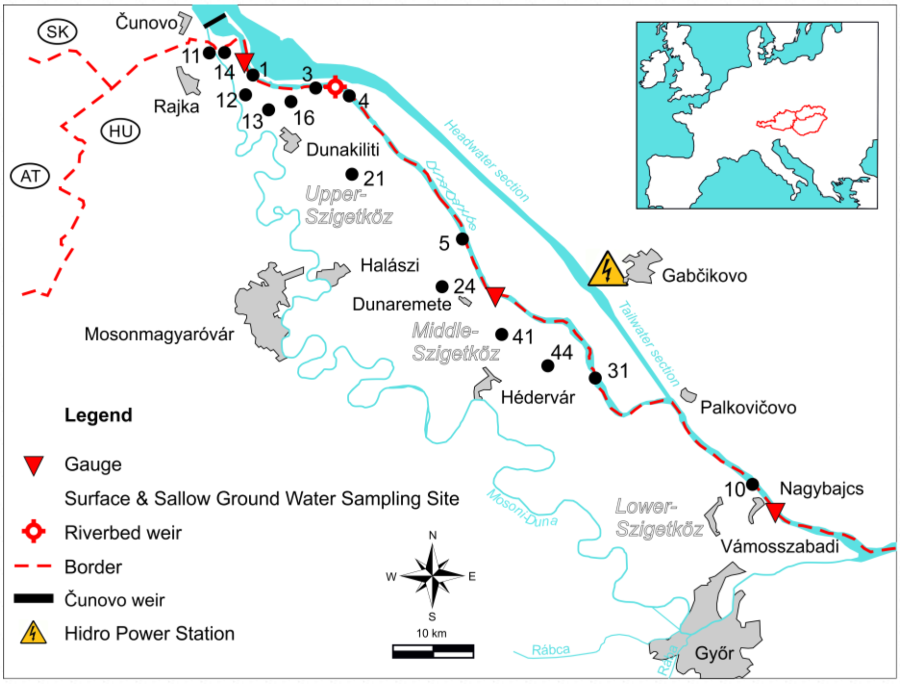

Fig. 1. Location of the study area

The task of study was to analyze this 10 year dataset. After understanding the flow system, in order to obtain a wider perspective of the data the descriptive statistics of the dataset was created and the parameters' stochastic relations were sought for. With periodicity analysis the parameters and sampling sites (those which were describable with a highly developed periodicity were determined. Regarding the periodic parameters, based on the analyses three quite distinct anomalies were observed in 1997 & 2002 & 2003-2004 which are shown through Na, Cl and U values (Fig. 2). In most of the cases the phenomena were pointed out as well laying behind the periodicity.

With the complex application of the methods described before, the sampling sites were separated to ones which have inflow from the Danube and which have inflow from the aquifer. By examining the organic parameters the riverbed clogging of the SE riverbed sections became clear. The reasons behind this phenomenon were the slow flow, small runoff and the accumulation of fine fractioned alluvial deposits originating from the downstream canal's backfilling. With cluster analysis two distinct time periods were determined. The results prove that the area cannot be divided up spatially; the characteristics of the certain sampling sites depend on local effects. With principal component analysis the conditions of certain parameters being "inherited" to the subsurface water were shed light on. Especially if the second principal component is taken to account, the heavy ions' (Al, Fe, Mn, Cr, Co, Cu, Zn, As, Cd, Pb, Sb Mo, U) determining high factor loadings becomes clear, and this way the important function of the redox conditions in the subsurface regions. Presumably these phenomena lay behind the continuous decrease of the trace elements' concentrations in the waters, and the ad hoc delayed increase in their concentration after the 2002 floods.

The results highlighted, that in case of changing redox and pH conditions, the heavy ions could remobilize and contaminate the subsurface waters. To understand these processes, further analyses are needed. In order to assess the high (close to environmental limits) concentration of heavy metals, further geo-environmental investigation is needed, especially at sampling site 31 area.

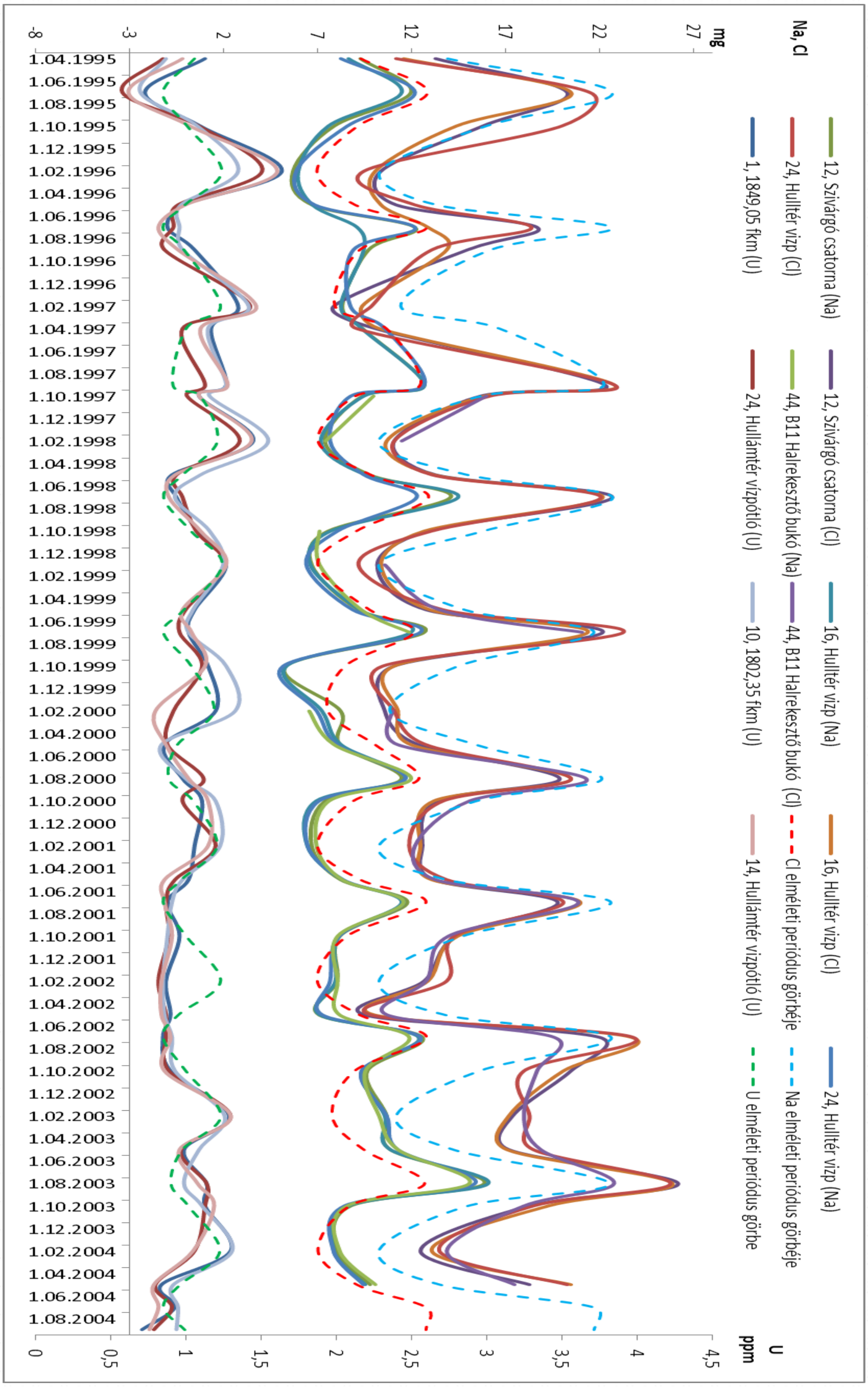

Fig. 2. Periods of Na^{+}, Cl^{-}, U

Geothermal Potential Estimation

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Key words: compaction trends, porosity, specific heat capacity

The geothermal potential according to the recommendation of International Geothermal Association (IGA) is the exploitable geothermal energy during a year. This definition in the viewpoint of geoscience is not precise, because the exploitable energy depends from the technical and economical parameters, too. According to that the estimation of reserve can be handled properly with the tools of geoscience. For the sake of estimation of geothermal reserves there are two kinds of prognosis, the physical geological modeling and the prediction from production data set. Within the frame of geological model for the estimation of geothermal energy reserves is required to make a calculation on the following volumes of the earth's crust:

Free water-filled pore volume and permeability of neogene so called Pannonian basin filling clastic sediments;

Pore volume of alteration zone of the crystalline basement and basal conglomerate at the bottom of Pannonian Basin;

Pore volume of the carbonate rocks in the basement under Pannonian Basin filling sediments;

Pore volume of the tectonised rocks of neotectonic fault zones.

The specific heat capacity and heat conductivity is in close connection with the porosity hence the geothermal model parameters of the basin filling sediments can be calculated from the porosity. Should the porosity vs. depth data not be available, the porosity and the geothermal parameters can be estimated from the average compaction trend of the density and the sonic velocity (Mészáros, Zilahi-Sebess 2001). Besides the measured temperature data also artificial temperature data (Fig. 1.) were calculated from depth of the basin and were used in the model.

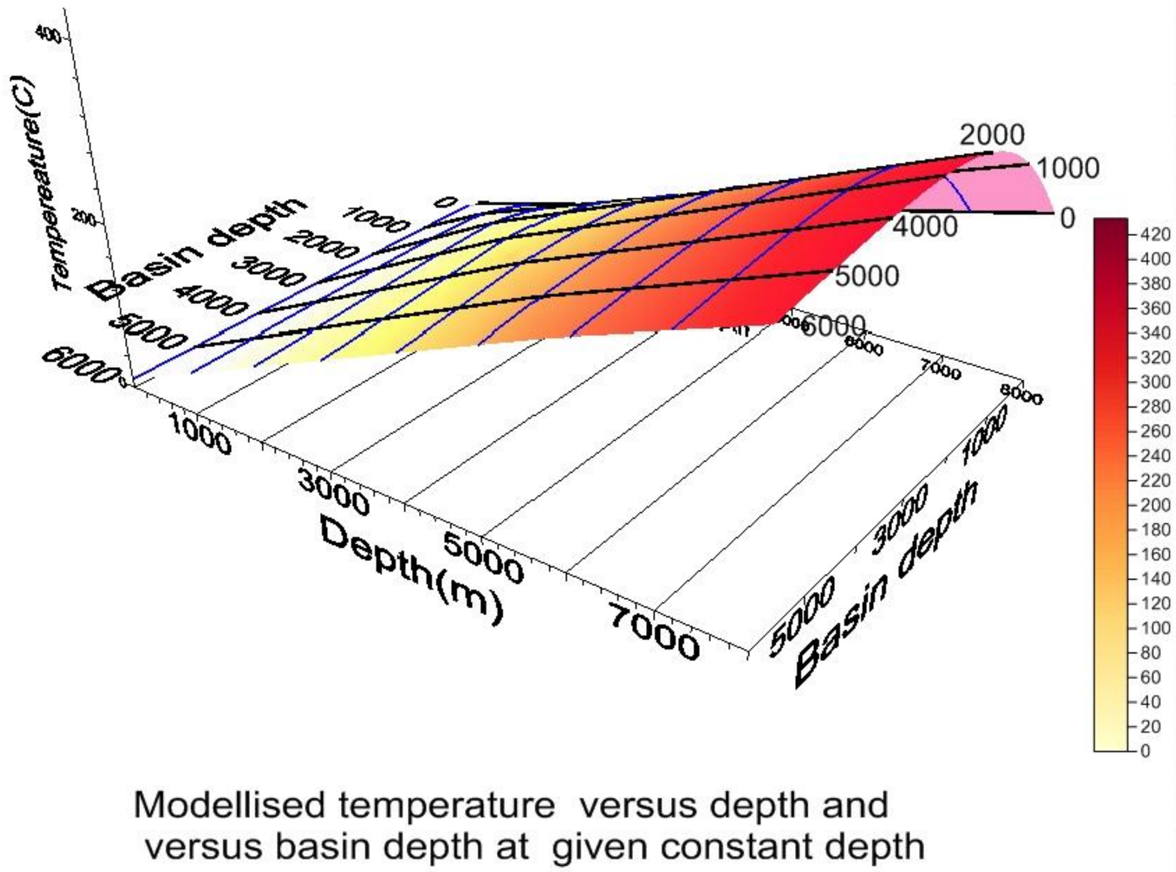

Fig. 1. Modeled temperature versus depth and basin depth.

The internal energy of pannonian basin filling sediments was calculated from the Pannonian Basin depth, porosity, temperature and specific heat capacity (Fig. 2.).

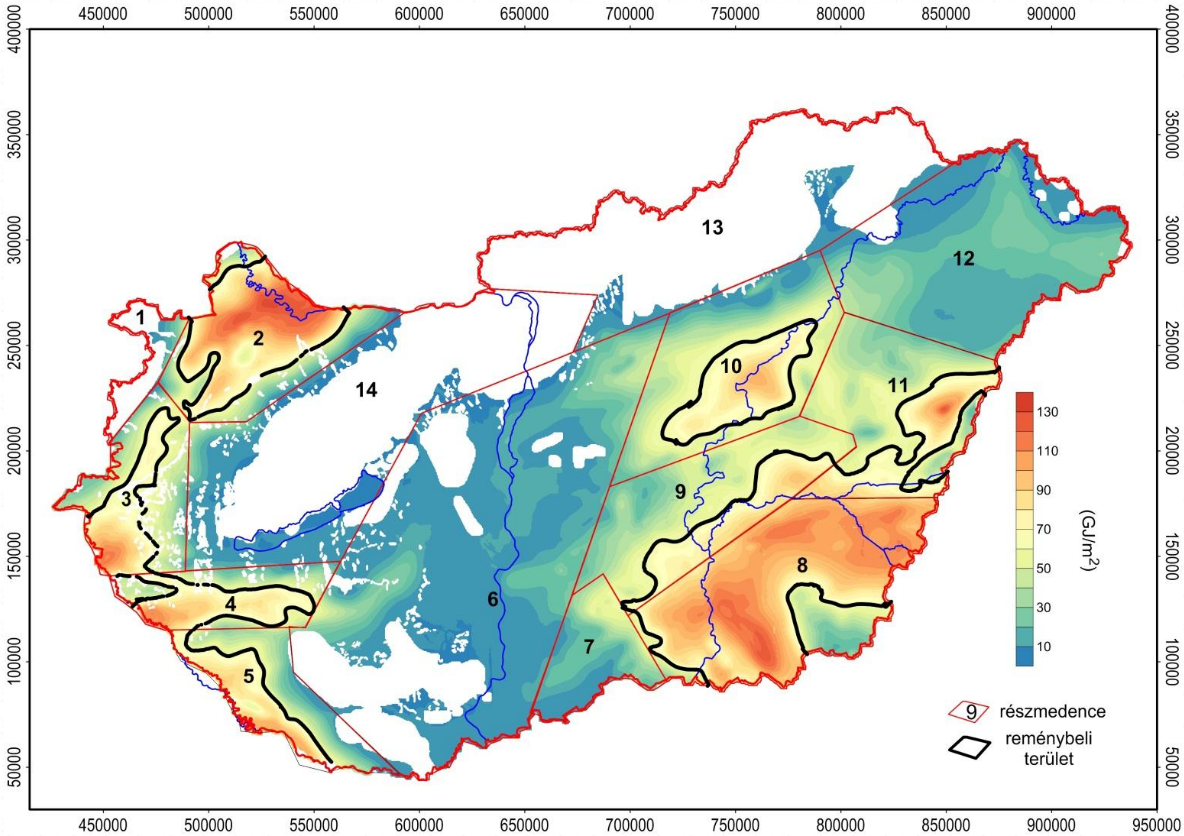

Fig. 2. Specific inner energy content of the basin filling sediments

Estimation of pore volume of the alteration zone and the basal conglomerates was based on the presumption that the thickness of this porous zone is in close connection with the ongoing development of the morphology of Pannonian basement. According to the viewpoint of permeability all rock formations covered by the Pannonian basin sediments are the part of the basement. Because nearly everywhere – even in the deepest troughs - the lithology starts with the Miocen basic conglomerate, it migth be assumed that the development of the morphology of the Pannonian basement might be occur in neogene. Probably the depth of basin in the time of deposition of the Endrőd Marl Formation (part of Lower Pannon) was nowhere deeper than 500m, therefore the most part of present morphology may have formed during the subsidence of the basement. Pore volume of the carbonate rocks in the basement is founded on the map of the carbonate spread (Map of carbonate in the Pannonian basement, VKGA 2004: Vízkészletgazdálkodási atlasz. 2004, VITUKI MÁFI 2004) in the crystalline basement. The thicknesses of the carbonates were estimated from their depth position. The pore volume of tectonic zones could be characterized through the geological analogies, and more important thing these zones represent the shortcuts between the surface and depth unreachable for drilling for hot water. We characterize the basement neotectonics with an artificial parameter — the fault density. Since the volume heat estimation is not enough for the estimation of potential, so the local geothermal potential can be defined from the production parameters of an arbitrary standard well (given area of screen and given depression) and given permeability. The permeability of sedimentary rocks can be estimated from compaction trends, but for the other three categories we have to use the water productivity data.

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