

# WMESS 2021

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## 7th World Multidisciplinary Earth Sciences Symposium

Eco-friendly Symposium - WMESS



### ABSTRACT COLLECTION BOOK



*the more you save the Earth  
the more you get wealth*

SEPTEMBER **06-10**  
2021  
Prague - Czech Republic

## Preface

This Abstract Collection consists of the abstracts of papers presented in the “7<sup>th</sup> World Multidisciplinary Earth Sciences Symposium – WMESS 2021” in the city of romance Prague (Czech Republic) during 06-10 September 2021. The World Multidisciplinary Earth Sciences Symposium (WMESS) aims to provide a forum for discussion of the latest findings and technologies in different fields of Earth Sciences, to give opportunities for future collaborations. WMESS wants to be a platform for sharing knowledge and experiences in the fields of Earth Sciences, to lead for providing a forum for early career researchers for presentation of their work and discussion of their ideas with experts in different fields of Earth Sciences such as; Tectonics & Structural Geology; Engineering Geology; Geotechnics; Hydro-Hydrogeological Sciences; Natural Hazards; Geomorphology; Geochemistry, Mineralogy, Petrology & Volcanology; Stratigraphy, Sedimentology & Palaeontology; Geophysics & Seismology; Geodesy, Photogrammetry & Cartography; Informatics, Geoinformatics & Remote Sensing; Mining Engineering; Mineral Processing; Blasting & New Technologies; Natural Resources; Environmental Sciences; Energy, Resources & Pollution & the Environment; Environmental Legislation; Biogeosciences; Geological Heritage & Geoparks; Urban Planning; Atmospheric Sciences – Climate; Modelling and Soft Computing Techniques in Earth Sciences; Medical Geology; Occupational Health and Safety.

WMESS 2021 was the 7th of the Annual series and the main mission of the "World Multidisciplinary Earth Sciences Symposium - WMESS" is to lead to contribute in multidisciplinary studies related with atmosphere, biosphere, hydrosphere, lithosphere and pedosphere of the Earth and interaction of the human with them. As another mission, it provides a forum for this diverse range of studies, which report very latest results and document emerging understanding of the Earth's system and our place in it. The Scientific Committee and Institutional Scientific Partners of WMESS was completed by paying strict attention, and all members were selected from well-known, very much appreciated, productive and representatives of the different countries. We are deeply grateful to the members of the scientific committee and institutional scientific partners (International Association for Engineering Geology & the Environment – **IAEG**, International Union of Soil Sciences – **IUSS**, International Geographical Union – **IGU**, The International Association of Hydrogeologists – **IAH**, Geological Sciences of Italy – **SGI**, Czech Soil Science Society – **CSSS**, Arabian Geosciences Union – **ArabGU**, The Society of Economic Geology of Romania – **SEGR**, World Meteorological Organization – **WMO**, International Medical Geology Association – **IMGA**, Russian Mineralogical Society – **RMS**, National Univ. of Science & Technology - Moscow Mining Institute – **NUST MISIS**, Geological Society of Africa – **GSAf**, University of Architecture Civil Engineering & Geodesy – **UACG**, Geological Society of Romania – **GSR**, University of Petrosani) of WMESS.

We would like to express our sincere gratitude to all participants of WMESS 2021 from different countries all over the world for their interests and contributions in WMESS 2021. We wish you enjoy the World Multidisciplinary Earth Sciences Symposium – WMESS 2021 and have a pleasant stay in the city of romance Prague. We hope to see you again during next event WMESS 2022 which will be held in Prague (Czech Republic) approximately in the similar period.

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**Prof.Dr. Marian DRUSA**  
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P.S.: All affiliations and editorial assignments related with the members had been listed in 2015. If there will be any changes, please inform the committee via e-mail to [info@mess-earth.org](mailto:info@mess-earth.org)



**World<sup>7th</sup>** WWW.MESS-EARTH.ORG 06-10 September, 2021— Prague (Czech Republic)  
Multidisciplinary Earth Sciences Symposium

**WMESS 2021**

**ABSTRACT**

**COLLECTION**



**GEOCHEMISTRY OF LOW-GRADE METASEDIMENTARY ROCKS FROM THE BIGA PENINSULA, NW  
TURKEY: IMPLICATIONS FOR PROVENANCE AND TECTONIC SETTING**

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17400, Çan-Çanakkale, Turkey**ABSTRACT**

Low-grade metasedimentary rocks are exposed on the southern part of the Biga Peninsula located in the northwest Turkey. The low-grade metasedimentary rocks were analysed for their major, trace and rare earth elements in order to reveal provenance and tectonic setting. Based on the macroscopic and petrographic observations, low-grade metasedimentary rocks are mainly composed of schist, phyllite and marble intercalations. Schists form the dominant lithology of metasedimentary rocks and are yellowish brown-coloured, well-foliated and fine to medium-grained. The main mineralogical composition of schist is quartz, K-feldspar, biotite and muscovite. The abundance of K-feldspar within schist show that fast sediment deposition took place from proximal source. Provenance discrimination diagrams based on major element geochemistry and trace element ratios (i.e., Th/Sc, La/Th, Cr/V and Y/Ni) suggest that the sediments were derived from intermediate-felsic source rocks. Similarly, the probable source areas of the low-grade metasedimentary rocks are the crystalline basement of the Sakarya Zone in northwest Turkey, which is composed of Devonian and Carboniferous magmatic and metamorphic rocks. Tectonic setting discrimination diagrams based on major elements, immobile trace elements (i.e., Th-Co-Zr/10 and Th-Sc-Zr/10) and La/Y vs. Sc/Cr plots indicate that metasedimentary rocks were deposited in a passive margin and oceanic island arc. According to the petrographical and geochemical results, the metasedimentary rocks are suspected to have double origin. One is continental bringing quartz and metamorphic fragments, and the other one is volcanic-arc type responsible for feldspar, plagioclase and volcanic fragments. In other words, the metasedimentary rocks of studied area were derived from both volcanic arc and continental source areas, which refers back-arc basin.

**SALINIZATION AND ALKALIZATION AS DEGRADATION SOIL PROBLEM AT SOUTH PART OF  
DANUBE LOWLAND (SLOVAKIA)**

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**ABSTRACT**

The contribution deals with analysis of salinization and alkalization processes of soil profile and with judgement of hazard coming out of these processes. The area, which has been investigated, is the south part of the Danube Lowland in Slovakia. It is a part of Rye Island – the most productive agricultural area of Slovakia. Groundwater is putting down as one of the most important aspects of soil salinization and alkalization. It is known that these facts impact adversely on vegetation and crops, so there is a reason why it is important to solve this problem. The contribution used the monitored data from the period of years 1989 – 2016. We collected soil samples and samples of mineralized groundwater at the area mentioned above. Subsequently was carried out their analysis to determine total dissolved solids (TDS), electrical conductivity (EC), pH, cation exchange capacity (CEC), sodium adsorption ratio (SAR). In selected locations, salt content and sodium exchange has reached the limit and slightly above-limit values. The results show that in all monitoring localities there are in motion both the process of salinization, by indicated above-limit residue values and EC values, and alkalization process indicated by above-limit values of ESP and pH. In areas where ESP stands at 5-20 %, alkalization is the dominant process. From groundwater quality indicators, monitored in the period 1989 - 2016 in selected locations, came out that during this period the groundwater quality decline in terms of salinization and alkalization.

**DIFFERENT AGE BASITES OF THE OLENEK UPLIFT (SIBERIAN CRATON)**

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**ABSTRACT**

The paper presents the results of a comprehensive study based on the analysis of petrographic and geochemical data of the different-aged basic rocks of the Olenek Uplift (northeastern part of the Siberian Craton). A rather rare combination of magmatic activity is observed here, namely, in the same area, basic rocks of Devonian and Upper Permian ages and kimberlites of Upper Devonian-Lower Carboniferous and Jurassic ages were formed. Magmatic activity was controlled by deep faults that make up the Kuoika-Ebelyakh system. The basites of the Middle Paleozoic age are found in the lower reaches of the Kuyoka River and in the valley of the Olenek River in the form of scattered dikes. The dikes are spatially confined to the marginal uplifts of the Olenek paleorift valley and its centricinal closure, i.e. in general, they characterize magmatites of the central part of the paleorift valley, where extension was dominant. This is evidenced by the repeated (at least twice) introduction of a basite melt. In coastal outcrops, there are cases of two-phase (dike in dike) dikes, or dikes that acquire an eruptive texture due to re-introduction. The presence of a contact hardened zone and zones of brecciation and crushing indicates a time gap between the embedding phases. For basites, there are only two age determinations performed by the K-Ar method in the IGABM SB RAS, 372±2 (the first phase) and 370±13 million years (the second phase). Among them, according to the features of the material composition, two groups of basites are distinguished: dikes of prismatic-phytic gabbro-dolerites and dikes of taxitophytic gabbro-dolerites. In petrographic and mineralogical terms, both groups of rocks of the Middle Paleozoic age identified here differ significantly from each other and characterize the features of the formation of intrusives. The next stage of magmatism is the formation of the Olenek trap syncline in Permo-Triassic time. At that time, magmatic activity in this area was caused by the introduction of magma of the main composition, which formed an extended deposit of the trap formation and a few dikes that play the role of supply channels. We have studied the Sektelyakh intrusion most fully. Thanks to the new data obtained as a result of drilling, it turned out that it is a disparate, tongue-shaped, multi-level reservoir body of variable power. The magma intrusion proceeded in a northeasterly direction mainly into the Permian sandstones along the interformational boundary with the Cambrian carbonate basement. Along the periphery of the Sektelyakh intrusive, it was possible to observe dike-like bodies in Permian sandstones. Dikes are differently oriented, curved, have an arc-shaped shape and are clearly fixed as supply channels – there is a gradual transition of the dike into the reservoir body. The power of dikes is from 15 to 25 m and they are usually well prepared in the relief in the form of elongated beds up to 3 m high. In all cases, the dikes are made of dolerites and olivine-containing dolerites, passing into microdolerites of the contact areas. The predominant type of rock, both for sill and in dikes, is medium – grained poikilofite dolerites.

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## RESEARCH OF ACTIVE THERMAL PROTECTION OF BUILDINGS

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### ABSTRACT

Combined building energy systems with active thermal protection (ATP) represent the optimal and most comprehensive technical solution for buildings within the meaning of Directive 2018/844 / EU, which amends Directive 2010/31 / EU on the energy performance of buildings and Directive 2012/27 / EU on energy efficiency, which introduced a new concept into our legal system - "almost Zero Energy Building (nZEB)". In terms of thermal protection of buildings, structures with an internal energy source form progressive packaging structures of buildings with active control of heat transfer (thermal barrier). From an energy point of view, they are multifunctional with one or combined functions of low-temperature radiant heating / high-temperature cooling, heat / cold storage, heat recovery, collectors for solar energy or ambient energy in combination with heat pumps. New, investigated variants of building structures with an internal energy source using exhaust air can also have the function of recuperative heat exchangers in forced ventilation of buildings. From an environmental point of view, building and energy systems with ATP have optimal use in the using of RES and waste heat. When preparing the production of electricity, for example photovoltaic power plants, buildings can be combined building-energy systems with ATO a suitable alternative for self-sufficient or to plus buildings. The paper focuses on the results of our ATO research carried out at the Faculty of Civil Engineering, Department of Building Services, STU in Bratislava since 2005, which are the sum of three utility models and one European patent.

Corresponding Author: Daniel Kalús

**CALCULATION OF PORE THROAT RADIUS PERCENTILES (25,50&75) FROM POROSITY AND /OR PERMEABILITY: ALGYO OIL AND GAS FIELD, HUNGARY**

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**ABSTRACT**

Pore throat size distribution of reservoir rocks has a great importance in hydrocarbon migration and entrapment. It is used for study permeability barriers, reservoir characterization and stratigraphic traps. In the present study 51 core samples obtained from Algyo oil and gas field were conducted to MICP laboratory technique to study pore throat size distribution. The inclusive graphical measures of grain size analysis were borrowed for pore throat size examination. Various pore throat radius percentiles such as 25,50 and 75 were calculated and related to both rock porosity and permeability. The obtained models were robust and reliable to use for pore throat radius percentiles (25,50 and 75) calculation. One of These models which predicting the 50 percentiles was verified. It shows reliable coefficients of correlation ( $R^2 = 0.77$  and  $0.79$ ) as it measured from permeability and porosity, respectively.

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## **FORECASTING ACTIVITY OF TROPICAL CYCLONES: NARRAIVES OF THE FUTURE**

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### **ABSTRACT**

We find a statistically significant multidecadal upward trend in the cumulative annual frequency of major, category 3 and above, tropical cyclones. Our finding supports the attribution of this trend to a rising trend in global mean surface temperature (land + sea). We apply statistical analysis and machine learning methodology in lieu of conventional meteorological & climatological simulations. This approach helps to establish that the timeseries of the annual change in the cumulative number of severe storms is superbly described by the parsimonious statistical model of the underlining stochastic process with an external regression on the global mean surface temperature. We apply the trained model to make annual projections of the growing risk of major hurricanes in response to different RCP and SSP scenarios of anthropogenic global warming, up to 2050. Specifically, in the worst-case scenario (SSP5-8.5), corresponding to global warming in 'a world that fails to enact any climate policies', disastrous hurricanes are projected to be on average ~ 47% more active in 2050 than in 2020. On the other hand, in the optimistic scenario (SSP1-2.6), corresponding to 'fast mitigation of anthropogenic warming' due to rapid technological development with the focus on sustainability, the projected rise of the mean annual count of major storms is ~ 23%.

Corresponding Author: Yuri Katz

## **INVESTIGATION OF THE LIQUEFACTION POTENTIAL OF COAL ASHES DUE TO SEISMIC LOADING**

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### **ABSTRACT**

Coal ashes are non-cohesive geomaterials with typical low specific weight, high porosity and metastable structure. Such type of geomaterial is significantly prone to liquefaction as a result of dynamic – seismic load. Investigation of coal ashes that are prone to liquefaction due to seismic load can use certain field methods, which are currently most frequently used in solving the same issue in sandy or silty–sandy soils. These field methods are dominated by two types of penetration tests: SPT - standard penetration test and CPT - cone penetration test. The method of investigating liquefaction caused by seismic activity was developed based on numerous penetration tests of sandy or silty–sandy soils and was elaborated in detail at the Workshop on Evaluation of Liquefaction Resistance of Soil, NCEER, Salk Lake City, USA, 1996. In the present paper, the results of penetration CPT test conducted at the coal ash tailing pond Žilina - Rosina are analyzed using methodology NCEER. Factor of safety to coal ashes liquefaction was expressed based on measured penetration resistance values in the CPT tests using software: “LiquefyPro – Liquefaction and Settlement Analysis”. Factor of safety to liquefaction of the coal ash sediment of the tailing pond was expressed based on parametric study. The parameter was the level of seeping water in the body of the tailing pond. The level of seepage water was considered to be in level with the terrain (represents an accident of tailing pond), or at the critical level as prescribed by the designer (represents the most unfavorable real condition), or at the real level in the body of the tailing pond.

Corresponding Author: Ivan Slávik

## **MONITORING OF ELASTIC DEFORMATIONS OF THE HYDRAULIC STRUCTURE GABČÍKOV**

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### **ABSTRACT**

The settlement and its calculations and monitoring are among the main factors influencing the structure and operability of hydraulic structures. Our paper focuses on the hydraulic structure Gabčíkovo which consists of the hydropower plant with an installed capacity of 720 MW and two navigation locks to ensure international ship transportation. Conventional geodetic methods of classical or very precise leveling with state-of-the-art measuring instruments are currently used to monitor deformations on navigation locks of hydraulic structure Gabčíkovo. In their subsoil, there are gravelly sediments to a depth of about 400 m. Under the gravel sediments, there are Neogene clays and silts. From the beginning of construction, deformations are measured on all structures using special tachymetric devices to monitor the elastic displacements. The obtained measured values are then processed in time dependences and compared with the limit values. During the current almost 30-year operation of the navigation locks, filling and emptying cycles, loading and unloading of the subsoil can be counted in the tens of thousands. The impact of the long-term operation, but especially the current innovation and modernization of navigation locks, aimed at increasing the safety and intensity of transport brings new knowledge and experiences. During the implementation of required improvement related to this project, the right navigation lock is empty for more than a year. The created technical conditions make it possible to monitor the influence of long-term unloading on the subsoil on the vertical displacements in detail. This unusual load condition is a motivation to present the results of measurements in the presented paper.

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**SLOPE STABILITY HAZARD AND ITS MAPPING USING DEM AND GIS FOR THE MOUNTAIN CUT  
SLOPES ADJACENT TO ZINTAN ROAD, LIBYA**

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**ABSTRACT**

The current work is an attempt to establish a susceptibility map of the predicted locations of unstable rocky mountain slopes adjacent to the Zintan road. Aside from the risks identified as a result of the existence of the different slope characteristics described by the movement risks of ground materials on the route. This was done via the GIS techniques supported and processed Digital Elevation Model, and a set of maps and information was extracted and used to calculate contour lines, slope, and aspect (inclination direction). Older classifications have been blended into another new classification that differs and includes four main levels to serve this study's objectives. Sloping maps of thematic layers were then reclassified into new themed groups. A geo-engineering map was drawn based on this, identifying the danger. On this basis, a geo-engineering map was drawn which identifies the dangerous places along the road to classify the dangerous areas of the slopes into four levels depending on the severity of the slope, which is low, moderate, relatively high, and highly dangerous areas.

## THE VISUALIZATION REPRESENTATION OF SPACE-TIME-PATH IN THE SPACE-TIME-CUBE

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### ABSTRACT

Map is a traditional visualization tool to represent distribution and interaction of spatial objects or spatial phenomenon. However, with the continuous development of acquisition and processing technologies for spatio-temporal data, traditional map can hardly meet the visualization requirement for this type of data. In other words, the dynamic information about spatial object or phenomenon cannot be expressed fully by traditional map. The Space-Time-Cube (STC), as a three-dimensional visualization environment, whose base represents the two-dimensional geographical space and whose height represents the temporal dimension, can simultaneously represent the spatial distribution as well as the temporal changes of spatio-temporal data. For some spatial object or phenomenon, its moving trajectory can be visualized in STC as a Space-Time-Path (STP), by which the speed and state of motion can be clearly reflected. Noticeably, the problem of visual clutter about STP is inevitably due to the complexity of three-dimensional visualization. In order to reduce the impact of visual clutter, this paper discusses different aspects about visualization representation of STP in the STC. The multiple scales representation and the multiple views display can promote interactive experience of users, and the application of different visual variables can help to represent different kinds of attribute information of STP. With the visualization of STP, spatio-temporal changes and attributive characters of spatial object or phenomenon can be represented and analyzed.

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## **STUDY ON SHEAR OF UNSATURATED COASTAL SALINE SOIL**

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### **ABSTRACT**

The parameters of soil-water characteristic curves which obtained by measuring the matric suction of the coastal saline soil in Lian Yungang with contact filter paper method under different water contents were obtained by fitting with Van Genuchten-Mualem model. The prediction formula of shear strength index under unsaturated state were obtained by combined the unsaturated and saturated shear strength indexes of saline soil which obtained by direct shear test with the soil-water characteristic curve. And comparison was established between the predicted and measured index of shear strength of unsaturated soil. The results showed that the volume water content of saline soil increased from 14.713% to 38.142%, and the matric suction decreased from 427.856 kPa to 10.715 kPa. There was a positive correlation between the matrix suction and the shear strength of saline soils. The value of shear strength provided by the matric suction of saline soil can be predicted by the function of matric suction, standard water content and effective internal friction angle.

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**GENESIS AND EVOLUTION OF MAGMAS ACCORDING TO DATA ON HOT HETEROGENEOUS  
ACCRETION OF THE EARTH**

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**ABSTRACT**

The obtained numerous proofs of hot heterogeneous accretion of the Earth lead to a fundamentally new solution to the problems of genesis and evolution of magmas. According to these data, the Earth's core was formed earlier than the silicate mantle as a result of the agglutination of iron particles of the protoplanetary disk under the influence of magnetic forces, because with a small body size, these forces were billions of times more powerful than gravitational ones. The accretion of the silicate mantle created a global magmatic ocean under the influence of impact heat release. Its bottom part crystallized and fractionated as a result of the pressure increase of the formed upper parts. Cumulates formed the ultrabasic mantle, and residual melts formed the magmatic ocean. The increase in ocean temperature and depth caused the evolution of bottom residual melts from acidic to ultrabasic, the appearance of corresponding layers in the ocean, and the reverse geothermal gradient in the mantle. As a result of the cooling and crystallization of the ocean from top to bottom after 3.8 billion years ago early Precambrian crystal complexes, acidic crust, and the lithosphere of ancient platforms were formed. The separation of residual melts from various layers caused the evolution of magmatism on them from acidic to alkaline-ultramafic and kimberlite. Heating of the mantle by a high-temperature core led to the appearance of a direct geothermal gradient at the end of the Proterozoic, convection in the mantle, and modern geodynamic environments. In them, magmas are formed by the frictional and decompression remelting of the differentiates of the magmatic ocean.

**THE EFFECT OF DIFFERENTIATION PROCESSES IN THOLEIITE-BASALT MELTS ON THE RARE ELEMENTS DISTRIBUTION**

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Russia

**ABSTRACT**

Basite magmatism has been manifested repeatedly for a long time in various geodynamic structures within the eastern part of the Siberian platform. In the Middle Paleozoic, it was related to rifting processes, and in the Late Paleozoic-Early Mesozoic – to the initiation and development of trap synclises. Differences of the geodynamic regime of magma formation are displayed in the material composition of rocks. This report presents a generalizing study of the petro-geochemical features of the tholeiitic basaltic melts formed in different geodynamic settings. The initial magmas composition changes significantly at different stages of the magmatic system development. Using multicomponent analysis, we reviewed the impact of the fractionation processes of the basal melt, which occurred under various PT conditions, on its material composition. Among the trapp bodies there are powerful differentiated intrusions. A significant change of the composition occurs during the intra-chamber differentiation of the melt in a sequence of rock strata varied from the basic magnesian to felsic alkaline rocks. In the resulting series of rocks, the content of rare elements included in the lattice of the early femic phases decreases, as well as the accumulation of almost all incompatible elements. The evolution of melts of normal alkalinity occurs with an increase of REE content and their insignificant separation. Intrusions that have undergone the stage of high-pressure fractionation in the deep transitional chamber are of particular importance. As a result of such differentiation, a peculiar group of rocks is formed in the cross section of the Middle Paleozoic bodies, such as monzonite-porphyrries in one case and anorthosite gabbro-dolerites - in the other. . It is established that the monzoitoid type of differentiation is characterized by accumulation of LREE, LILE and elements of the zirconium group Nb, Ta, Hf and Y. Isolation of anorthosite gabbro-dolerites in the cross-section of bodies, as well as an increase in the content of aluminum, calcium, and strontium in them, is an indication of the anorthositic tendency of magmatic melt differentiation/ When the basite-tholeiite melt interacts with the mantle reducing fluid in the deep core, its metallization occurs with the release of drop-liquid separations of native iron up to the formation of its large segregations. Intrusions with a large-scale content of native iron are found among the trap formations of Siberia. All this leads to a decrease in the total concentration and activity of iron in the partially metallized silicate matrix, there is a significant increase in the content of MgO and trace elements-Ni, Co, Cr. The Fe-phase-containing intrusives are characterized by minimal LILE, HFSE, and REE contents. Start your abstract here... 250 to 500 words concise and factual abstract is required. The abstract should include the purpose of research, principal results and major conclusions. References should be avoided, if it is essential, only cite the author(s) and year(s) without giving reference list. Prepare your abstract in this file and upload it into the registration web field.

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## MINERALOGY AND GEOCHEMISTRY OF NATIVE IRON

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### ABSTRACT

Large occurrences of native iron are known from basites in Disco Island (Greenland), Europe (Germany), and the intrusions in the northern Siberian platform. Native iron forms the nodular segregations commonly 20-50 cm across, rarely forming large blocks. The weight of the iron nodules varies from hundreds of grams to a few hundred kilograms. Native iron segregations occur in bedrocks and placers, sometimes having a large areal extent. The dominant mineral in the nodules is native iron, with subordinate cohenite ( $\text{Fe}_3\text{C}$ ), troilite ( $\text{FeS}$ ) and magnetite ( $\text{Fe}_3\text{O}_4$ ). In association with native iron there are also found exotic for terrestrial conditions meteorite minerals such as schreibersite ( $\text{Fe}_3\text{P}$ ) and armalcolite ( $\text{Mg, Fe Ti}_2$ ). Iron is able to concentrate many elements that can form solutions in liquid and solid metal. Nickel and cobalt in liquid metal are dissolved in a wide range and, later on, in dissociation of already solid solution form a number of intermetallides. Geochemical analysis of native iron showed the presence of gold and platinum-group elements in concentrations hundreds and even thousands of times higher than in the enclosing silicate rocks. Along with the noble metals, the metallic liquid intensely concentrates Ge, As, Sn, Ge, Sb, W and Mo with distinct siderophile properties. Copper is poorly soluble in iron, and therefore it forms an independent phase – nickel copper, containing 0.9-2.5% Ni. It is present in the nodules as an auxiliary mineral, forming spherules in the Fe-phase. This suggests the lack of high Ag accumulations in the metallic phase of the basic rocks. Silver is quite insoluble in iron, and most likely forms small emulsion segregations, as does copper. Origin of native iron in basites of ancient platforms was due to the processes of interaction of a basaltic melt with a reducing transmagnetic fluid largely of hydrogen-methane composition, which caused the extraction of metals from the melt and reduction. In Siberia, the fluid had a predominantly hydrogen-methane composition. Studies of the gaseous phase of native iron (Djaltul intrusion) show that it consists of a mixture of gases with dominating hydrogen (>75%) and subordinate amounts of  $\text{CH}_4$ ,  $\text{Na}_2\text{CO}$  and CO.

**MINERALIZATION IN THE ANDESITIC LAVA FROM KILDYAM VOLCANIC COMPLEX, CENTRAL YAKUTIA, RUSSIA**

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**ABSTRACT**

This contribution presents the first detailed analysis of a new volcanic succession of olivine-pyroxenites, andesite, and dacite discovered in the Kildyam Late Jurassic complex in Central Yakutia. Petrographic and microprobe studies confirmed the liquid immiscibility in silicate melts during crystallization. Immiscible liquids are preserved as globules of one glass in another in andesites and as melted inclusions of native iron in matrix, clinopyroxene and plagioclase phenocrysts. Our analyses reveal the complex textural relationships between silicates and Fe-oxides, native iron and (Cu, Pb, Ag and Au)-rich phases, and provide unequivocal textural evidences, not observed previously. Purpose of this research is to preserve a very important data on IO (Iron Oxide) or IOCG (Iron Oxide Copper Gold) mineralization. Obtained results support occurrence and diverse of gold, silver, copper and lead minerals in magnetite lavas. During the early stage of fine-grained subvolcanic olivine-clinopyroxenite end pyrrhotite, globular igneous sulfides is a first proposed style of economic deposit formation. The second proposed style of economic mineralization in Kildyam is to be a magnetite-bearing lava; iron enrichment of the melilitic melt phase, followed by iron depletion and silica enrichment. The vesicle-hosted alloys and sulfides provide significant new data on metal transport and precipitation from high-temperature magmatic vapors. During syneruptive vapor phase exsolution, volatile metals (Cu-Zn, Fe-Al-Cu, Ni-Fe-Cu-Sn) and Ag-Cu-sulfides contribute to the formation of economic concentrations. Major conclusions contribute to 3-step genetic model. (1) Early-formed magmatic minerals led to partial dissolution of olivine-clinopyroxenite and their enrichment in Cu, Co and Ni relative to other metals, while troilite globules droplets grew. (2) First stage of division into two immiscible silicate and sulfide melt liquids (a) K-rich dacitic and rhyolitic glass, and (b) vesicles of heavy sulfide minerals with a large segregation and drops of native iron. (3) Lava of fused magnetite crystals and voids enriched in silver and gold, and (b) globular disseminated chalcopyrite in mineralized melilitic rocks.



**A NEW MINERAL ASSEMBLAGE FROM THE DIORITE COMPLEX IN THE FE-OXIDE-CU-AU  
ORES OF THE KIS-KUEL DEPOSIT (EASTERN YAKUTIA, RUSSIA)**

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**ABSTRACT**

This research continues our investigations of the iron-oxide copper-gold deposits in the Western Verkhoyansk region, where recent years efforts of the IGABM SB RAS led to the discovery of a new gold Kiskuel deposit. The Kis-Kuel intrusion-related IOCG deposit in Eastern Yakutia (Russia) with a wide range of mineral styles has a direct genetic link with a cooling intrusion during its formation. The IOCG worldwide and the Kis-Kuel deposit have common features for this style - the abundance of iron oxides and low of sulfides. Magmatic contribution to the Kis-Kuel deposit is significant. Intrusive rocks range from diorite to granodiorite in composition. The Kiskuel deposit hosted in diorites and granodiorites; xenoliths confirming deep mineralization represented by pyrrhotite (main), pyrite, chalcopyrite, and clinosafflorite (Co,Fe,Ni)As<sub>2</sub>, chromite, pentlandite. Clinosafflorite localized at the contact of pyrrhotite and chalcopyrite and at the contact of pyrrhotite and biotite. Chalcopyrite is found in intergrowth with pyrrhotite, where it forms bands and lenses. Parallel to the biotite cleavage, the thinnest layers of chalcopyrite are common. Clinosafflorite is rare and discovered in hydrothermal cobalt-nickel ores of the Bou-Azzer (Morocco), Cobalt (Canada), Glassberg (Germany), Silver Mine (England) and several others. Mineralization of rich mica processes occur in connection with the chromite, pentlandite, chalcopyrite, pyrite, and pyrrhotite; a common feature of the mineralized dark-colored rock is phlogopite abundance, ilmenite, potassium feldspar, calcite, rarely quartz; clinoenstatite metasomatically replaced with phlogopite and dolomite. This new evidence supports a magmatic-hydrothermal model for the formation of IOCG deposit in the Kis-Kuel, where iron-oxide mineralization sourced from intermediate magmas. The deep complex predominantly composed of chromite, ilmenite, magnetite, pentlandite, and clinocafflorite; less of galena and sphalerite. Many diverse mineralization systems from Kis-Kuel classified together as iron oxide copper-gold (IOCG) deposits. The obtained data suggest deep ore-bearing structure of the Kis-Kuel ore-magmatic cluster with the potential for discovering of a new mineral ores style. All of this help in developing a new robust prospecting model.

**SWAPPING OF THE PACIFIC AND ATLANTIC NIÑO INFLUENCES ON NORTH CENTRAL INDIA  
SUMMER MONSOON**

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**ABSTRACT**

The highly populated north central India receives 90% of annual rainfall during June to September. The interannual variation of summer monsoon rainfall is less studied compared to central and western India, due to its weak signal with the El-Niño-Southern Oscillation (ENSO). Previous studies have reported a marked decadal variation in the ENSO influences on north India rainfall, but the teleconnections of this variation are not satisfactorily understood. A pathway of the changing ENSO influences on north central India rainfall is revealed from observational data analysis and numerical experiments. While La Niña-like conditions produce anomalous northeasterly wind over India and reduce the tropospheric wind shear, the emergence of the Atlantic Niño appears to overtake this ENSO influence. The Atlantic Niño intensifies the meridional stationary wave affecting pressure anomaly over northwest Europe. This excites the Eurasian Rossby wave train along the mid-latitude producing upper-troposphere high pressure anomaly, subsequently affecting north India. Future work should examine the extent to which these teleconnections are represented in climate forecast models to aid the seasonal prediction of north central India rainfall.

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## **EFFECT OF ENERGY DISSIPATION ON SCOUR HOLE DEVELOPMENT DOWNSTREAM OF THE CHUTE**

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### **ABSTRACT**

An energy dissipation on hydraulic structures is a scientifically highly examined field of study. Gained knowledge can be used to ensure the safety of the hydraulic structures and the channels which is crucial during floods. Above that, those structures are also part of the critical infrastructure therefore their function is necessary. It is assumed that in the Czech Republic the precipitations distribution is changing due to climate change thus episodes of extreme floods may be observed more often. The paper brings brand new knowledge on the kinetic energy dissipation on the chute and in the stilling basin and its impact on the riverbed scour hole development. The presented research was conducted in the Water Management Experimental Centre of Czech Technical University in Prague, Faculty of Civil Engineering. The research aimed to examine the energy dissipation mechanism on different geometric modifications of the construction of spillway chute and stilling basin and its impact on the process of scour hole development. These various types of dams' flood safety equipment were examined in the hydraulic laboratory: an elementary form of the spillway without any stilling basin; the elementary form of the spillway and the stilling basin (crest and spillway channel had the same width); the chute width was reduced, and the stilling basin had the full width; steps were added on the narrowed chute and the and stilling basin had the full width; only the spillway crest was reduced to a half-width; only the stilling basin width was smoothly reduced; the chute's width was smoothly reduced along the chute and the stilling basin had full width; the chute's width was smoothly reduced along the chute and the stilling basin had the width reduced to a half. The flow, water levels, scour hole and deposit dimensions were measured. Then the amount of energy dissipated was computed. The correlation and connection between energy dissipation and scour hole development was investigated. These outcomes can be used as a recommendation of an appropriate construction design to provide better flood safety of the hydraulic structure.

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## **ANALYSIS OF ROCKS FRAGMENTATION BY EXPLOSIVES AND THEIR EFFECTS ON OPEN PIT STABILITY**

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### **ABSTRACT**

As a primary fragmentation in the mining process, blasting can significantly decrease the overall mining cost. However, it is a known, that, the energy released in the detonation is often greater than that necessary for an adequate fragmentation of the rock mass. This excessive energy, along with over confinement and poor blast design, will cause damage to the undisturbed rock mass beyond the intended boundaries of the blast (overbreak or backbreak). The resulting platform or bench irregularities (hollows and bumps) can be problematic, and will require ground leveling or even secondary fragmentation in case of oversized boulders or unfragmented rock mass at the bench's foot. This creates both additional costs and degradation of platform or bench quality for future mining operations. All the more, bench stability can be substantially endangered by the overbreaks, knowing that, it dictates overall slope stability and affects the use of haul road/ conveyor line (above and below it). Therefore, a study is conducted, in the limestone quarry of Ain El Kebira, Setif, Algeria; on several benches located in a highly fractured rock mass. Aiming to assess the amount /volume of rocks displaced by the blasting operation, to determine a more suitable blasting settings combination that allows a higher bench stability and a better platform uniformity, and assure at the same time, a satisfying and accurate rock mass fragmentation. The work is divided into three steps: initially, a fragmentation analysis by the Kuz-Ram model in order to obtain a rather satisfying degree of fragmentation for the quarry's blast operations. In the second step, the fragmentation analysis is performed by an image analysis of the fragmented rock's using the WipFrag program, followed by a comparison of the results obtained by the mentioned methods. As a third steps in this work, a numerical modelling approach by Finite Element Method (FEM) of the benches stability is adopted, using the "Phase 2" software, this part of the work allows the study of the benches stability at both the static and dynamic conditions.

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**APPLICATION OF FREQUENCY-RESONANCE METHODS OF SATELLITE IMAGES PROCESSING FOR  
HYDROGEN AND LIVING WATER ACCUMULATIONS SEARCHING WITHIN LOCAL AREAS IN  
EUROPE**

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**ABSTRACT**

The results of the application of mobile direct-prospecting technology of frequency-resonance processing and interpretation of satellite images and photographs at the sites of hydrogen production, drilling wells, as well as within areas of hydrogen degassing in various regions are presented. Experimental reconnaissance studies were carried out to study the features of deep structure of the hydrogen degassing areas. The developed mobile and low-cost technology includes modified methods of satellite images and photo-images frequency-resonance processing and decoding, vertical electric-resonance scanning of a cross-section, as well as a method of integrated assessment of oil and gas potential of large prospecting blocks and license areas. Separate methods of direct-prospecting technology are based on the principles of “substance” paradigm of geophysical research, the essence of which is searching for a specific substance - oil, gas, gas condensate, etc. The materials of instrumental measurements indicate that in regions of basalt volcanoes location with roots at different depths, signals at hydrogen frequencies are almost always recorded. When scanning the cross-section, responses from hydrogen are recorded from the upper edges of basaltic volcanoes to their roots. It can be assumed that basaltic volcanoes are a kind of channels through which hydrogen migrates to the upper horizons of the cross-section and further into the atmosphere. Within many basaltic volcanoes at a depth of 68 km, deep (living) water is synthesized. Hydrogen-rich water is curative and can be used for wellness purposes. All surveyed zones of longevity on Earth are located within basalt volcanoes, in which water synthesized at a depth of 68 km migrates to the surface and is used for water supply. Hydrogen deposits can be formed by basaltic volcanoes in adjacent sealed reservoirs. Within some survey areas, responses at hydrogen frequencies from limestones, dolomites and marls were recorded at shallow depths. Hydrogen deposits formed near basalt volcanoes in different types of reservoirs can be discovered and localized during areal exploration using proven methods. Direct-prospecting technology can also be used to study reservoirs in crystalline rocks (basalts including). Detailed studies and wells drilling in promising areas can be planned and carried out for hydrogen and living water at the same time. The result of investigation indicates the advisability of using direct-prospecting methods of frequency-resonance processing of satellite images to detect zones of hydrogen accumulation in areas of basalt volcanoes location, as well as in areas of hydrogen degassing. The use of mobile and low-cost technology will significantly speed up the exploration process for hydrogen, as well as reduce the financial costs for its implementation.

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**RESULTS OF THE APPLICATION OF DIRECT-PROSPECTING TECHNOLOGY OF SATELLITE IMAGES  
AND FREQUENCY-RESONANCE PROCESSING ON THE EXPLORATION BLOCKS OF SHAKAL AND  
HALABJA (KURDISTAN)**

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**ABSTRACT**

The results of reconnaissance studies within the Shakal and Halabja exploration blocks in Kurdistan are presented. Experimental studies were carried out using a mobile direct-prospecting technology, including modified methods of frequency-resonance processing and decoding of satellite images and photo images, vertical electric resonance scanning of the cross-section and a method of integral assessment of the oil and gas potential of large prospecting blocks and license areas. At the local survey site within the Shakal block, responses from oil, condensate, phosphorus and limestone were recorded. The lower boundary of the limestones was established at a depth of 4676 m. By scanning the cross-section from 2770 m, step 1 cm, the responses of oil from limestones were obtained from the intervals: 1) 2771-2794 m, 2) 2795.3-2815.45 m, 3) 2834.40-2854 m. During processing the image of the entire Halabja block, signals were recorded at the frequencies of oil, condensate, phosphorus gas, bacteria, sodium chloride and dolomite. At the 57 km hydrocarbon synthesis boundary, responses from oil, condensate and gas were recorded. When scanning the cross-section from 480 m to 4 km, step 50 cm, responses from oil were obtained from two intervals: 1) 1140-1200 m, and 2) 3310-3340 m. Within the local fragment of the block by scanning up to 5 km with a step of 1 m responses of oil from salt were recorded from the intervals: 1) 295-350 m, 2) 1190-1260 m, 3) 2015-2320 m). The response intervals within the 1st and 3rd horizons have been refined by scanning with a step of 5 cm. The results of experimental studies show that practical application of direct-prospecting methods and technologies will accelerate and optimize the exploration process for oil and gas.

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**AUTOMATED GEO-MONITORING WITH LOW-COST GNSS SENSORS**

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**ABSTRACT**

The appearance of low-cost GNSS chips and receiver modules a few years ago has brought about a paradigm shift in high-precision satellite positioning. A decade ago, centimetre accuracy was the privilege of surveyors using expensive, high-end GNSS equipment. Today, single or multi-frequency, multi-constellation mass market receivers offer high-quality measurement data, opening the door to the development of new applications while reducing costs. Alberding GmbH is a leading developer and distributor of professional GNSS software and system solutions supporting precise positioning, GIS and navigation applications. The company has many years of experience in GNSS correction and position data provision, server/client communication, data management, processing and monitoring. Alberding offers a complete system solution for deformation monitoring of natural objects (highwalls, landslide and subsiding areas) and civilian structures (dams, bridges and tall buildings). Since 2012, the company produces highly integrated GNSS positioning and telemetry sensors that can be used in automated geo-monitoring applications. The Alberding data management software running on the sensors allows for the automation of the work flow and the data flow and makes custom adaptations possible. Alberding GNSS receivers can also log and transmit digital data of external sensors (e.g. weather station, tilt sensor, geotechnical sensors) in combination with precise position information. In the Alberding deformation monitoring system, measurement data collected by the monitoring receivers and one or more reference stations is processed centrally, using AMoS (Alberding Monitoring Software), a modern cloud-based server application. AMoS can determine monitoring station positions with sub-centimetre accuracy. In the default configuration, GNSS baselines are calculated at user defined intervals in near real time. Depending on the available power supply and communication infrastructure, it is also possible to conduct RTK positioning in parallel, providing accurate real-time position estimates. The displacement results of multiple monitoring stations are displayed on a web-based user interface. Automatic alarms are sent via email or text messages to system operators in case significant movements are detected. Alberding smart sensors are also used in other innovative applications. An example is an RTK GNSS enabled floating buoy used for cm accurate water level measurements on rivers in Germany. Bridge collision accidents can cause serious property damage to the road and railway infrastructure and can even result in fatalities. To prevent such accidents, accurate and up-to-date water level information is required. Alberding GmbH in cooperation with the German Federal Waterways and Shipping Administration (WSV) have developed an intelligent buoy system for automated water level determination. Digital position information along with other river parameters (e.g. water flow velocity, temperature and pH) provided by the buoys are made available to the ships' on-board computer system through the Automatic Identification System (AIS). The obvious benefits of autonomous monitoring systems make them attractive for a variety of applications and are expected to gain recognition rapidly.

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## **ASTRONOMIC AND ASTROPHYSICS EFFECTS ON THE VOLCANIC ACTIVITY OF THE EARTH**

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### **ABSTRACT**

Volcanic activity of the earth has been controlling by some factors such as tectonic activity of the earth, internal dynamic of the earth and earth's convection currents and rock cycle which occurs around subduction zones of the earth etc. Main problem isn't to realize if volcanic activity started or not started, contrary what are the reasons for volcanic activity by using all instruments. The universal gravity laws and planetary kinematics and dynamics are also responsible from these happenings. Thus, when the moon is over the sea, we can see the gravitational effect on the earth. This effect shows itself as a diurnal tide near coast. We can see mossy rocks along the shore. This sea level changes are different from place to place because of the moon's different gravitational effects. For example, this effect causes even 21-meter sea level changes along Fundy gulf of Canada. Although the gravitational force of the moon to the earth is only  $1,98 \times 10^{20}$  N, this sea level changes are happens as a diurnal tide. Not only the moon is affecting the earth but also all planets and other astronomic objects are affecting the earth by this way when they are on suit position. When their effects are together, total effect causes many tectonic and volcanic activity on the earth. If the earth is been affected by these forces during convection current in the earth the effecting will be maximum. So we set a new hypothesis to observe and record the changing. We realized that some activity term looking parallel to these astronomic dynamics. On the other hand, convection currents are also be controlled by these effects. Another astronomical effect is microwave effects of some cosmic happening such as solar storm, solar flare or cosmic radiation. So, if we could put together these happening in one model, we can see the effects together. Because these effects working together to get enough power to affect the earth's all activities. The ancient rocks of the earth are usually magmatic and volcanic but modern rocks are not. So, there should be a term full of magmatic and volcanic activity during geological time and the moon was nearer than today.

## SEDIMENTOLOGY AND PETROLEUM GEOLOGY OF SOUTH OF ULUKISLA (NIGDE)

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### ABSTRACT

This study includes the research of sedimentary features and petroleum possibilities of mostly Tertiary sedimentary basin which is located in the district Ulukışla (Niğde) and its southern area. The region was an inner marinal basin which begins to be formed after Paleocene in the North of collision zone of an old Tethys ocean. The sedimentary features of the regional sediments show that during sedimentary processes in Tethys ocean should collected some organic material which concerned with petroleum. Thus, scaled stratigraphic and sedimentary column show that the sedimentary units are already includes many evidences for petroleum deposits of the region. If previous geological information about the region and the petroleum theory which we rely on are true, there should be some petroleum deposits in this region. The science develops by not doing mistakes and losing time if the all work depends on a theory and follow the logical science methodology. This methodology follows mainly 4 steps: 1. Observations and collecting data, 2. Explanation of data with a hypothesis which can be tested. 3. Testing the hypothesis 4. If the hypothesis passed all tests, making a theory, if not set a new hypothesis. In this view we set a hypothesis to explain the all data about petroleum possibilities of the region. So, this work is an hypothetic work and have some claims. For this aim the geology and sedimentary features of the region includes some evaporites and some carbonated marinal deposits. These sediments at same time belong to deep marinal sedimentary basins such as Guney Formation or Serenkaya formation. The main importance is especially neighbor sediments which suit for reservoir rocks are exist in the region. In addition, large scale of the geology and sedimentology of the region indicate that there are some reservoir rocks and already producing some gas and carbondioxide as well in the region such as Bor or Kemerhisar. On the other hand, the evaporites of the region is connected to petroleum reservoir in the region because of their sedimentological features and environmental conditions which has relationship with some reservoir rocks according to the theory which we rely on.

## THE GEOLOGY AND MINE POTENTIAL OF ULUKIŞLA (NIGDE)

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### ABSTRACT

Ulukışla (Nigde) region is one of the old collision zones of Tethys ocean. Although the region mainly includes sedimentary rocks which are consist of mostly Tertiary sediments it contains many magmatic and volcanic rocks as well. Especially Sansartepe formation consist of pillow lavas with some dykes. Around these dykes there are many ore deposits or indicate of some rare elements' indicators with gold and silver. the distribution of these rocks has a large area. The south of Ulukışla is represented by andesites on the base and north-west of Ulukışla is represented by basalts with syenites and trachytes dykes. On the other hand, Darbogaz and Porsuk regions are full of with pillow lavas agglomerates concerned with deep marine volcano-sedimentary facieses. These volcano-sedimenter rocks and lavas in these regions include many thin or thick dykes between 5 and 10cm with ore. In general, the large scale of the region is represented by deep marine sediments, pillow lavas and some magmatic rocks and dykes on the base. Most of them together with some ore, such as manganese, ilmenite, magneto-ilmenite, chromite, gold, silver and platinum. The region is a sedimentary basin with many industrial mineral deposits including rare elements. For example, gypsum and anhydrite deposits has a very large deposit with strontium. The west of the region has a very large-scale salt deposits with some rare elements such as strontium and lithium near and around Zeyvegediği is largest evaporates deposits with 900-meter thickness. Aktoprak town and Emirler villages placed on these deposits as well. In the region there is some coal outcrop too especially south of Hacıbekirli and Kızılbayır around with some claystone layers. The thickness of the coal layers is between 10 and 80 cm. Other deposits follow fault zones in the region such as Ulukışla- Beyağıl zone, Hacıbekirli zone, Cayhan zone and Porsuk-Emirler zone. In addition, there are some faults zones south of Darbogaz and Emirler includes gold and silver with basalts and pillow lavas under the sedimentary deposits. The west of Ulukışla and Ereğli has already large amount of chromite and manganese ore concerned with magmatic activity during Paleocene.

**TYPOMORPHISM OF PLACER GOLD AND PREREQUISITES FOR THE DISCOVERY OF GOLD ORE OCCURRENCES IN THE SOUTHERN PART OF THE LENA-ANABAR TROUGH (NORTH-EAST OF THE SIBERIAN PLATFORM)**

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**ABSTRACT**

The article examines the results of exploratory work carried out in the southern part of the Lena-Anabar trough in the north-eastern part of the Siberian platform. Alluvial deposits of the Polovinnaya river, which belongs to the Uele-Udzhinsky placer cluster, were sampled for predictive assessment of commercial prospects for placer occurrences of gold. The mineralogical-geochemical features of the placer gold were studied in order to identify potential primary sources. It is proved that the Mesozoic and Cenozoic deposits are the main sources of gold. Its typomorphic features are small size (-0.5 mm), toroidal and flake shape, shagreen surface with casts of pressing of the minerals, and high fineness (950-999 ‰). The internal structures of gold particles are represented by thick high-grade shells, translation lines and high-grade intergranular veinlets. Along with this, the discovery of the autochthonous gold of ore habit in the studied gold area suggested the presence of an additional primary source. Very small size (-0.2 mm) and angular-lumpy shapes of the individuals, almost unrounded surface and low fineness are typical features of slightly altered gold. The discovery of small (3-4 mm) fragments of hydrothermal-metasomatic rocks in the alluvium of the Polovinnaya river confirms the above assumption. The epigenetic mineral composition of these fragments is represented by pyrite, potassium feldspar, fluorapatite, and quartz. Micro-X-ray spectral analysis determined the smallest (first microns) mineral phases of native gold, argentite, galena, sphalerite and greenockite in them. It is worth noting that the described fragments are quite fragile, and they are destroyed with a slight impact with a steel needle. The fragility of these fragments indicates the close proximity of the reworked ore occurrences. In addition, increased gold content in small classes of heavy concentrate material of small-volume samples was determined according to atomic absorption analysis. All this together is a prerequisite for the discovery of ore occurrences with finely-dispersed and fine gold. It is assumed that the ore occurrences can be localized in the Anabar-Eekit fault zone, which extends parallel to the Pronchishchev ridge, through the Anabar-Olenek trough, to the Sololiy uplift of the Olenek arch. In the area of the Olenek arch, this zone is associated with superimposed gold-bearing low-temperature hydrothermal mineralization, expressed by K-feldspathization and sulfidization of the Permian deposits.

**THE INTERNAL STRUCTURE OF PLACER GOLD OF THE NORTH-EAST OF THE SIBERIAN  
PLATFORM AS A RELIABLE SEARCH SIGN OF PRIMARY SOURCES**

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**ABSTRACT**

Typomorphic features of placer gold are carriers of the most important information necessary for the reconstruction of the history of the formation of placer and ore occurrences of gold and can be used as mineralogical criteria in the search for primary sources of placers. The study of these features is relevant for placer areas with unidentified gold sources, which include the territory of the north-east of the Siberian Platform. The internal structure of native gold is one of the most informative typomorphic features is. We studied the internal gold structures of modern placers and conglomerates of the Early Permian age in the north-east of the Siberian Platform. The purpose of the work: to identify the features of the internal structure of placer gold, depending on the chemical composition and the degree of its transformations, as well as the possibility of their use as a prospecting indicator. Structural etching of native gold was performed using the reagent:  $\text{HCl} + \text{HNO}_3 + \text{FeCl}_3 \times 6\text{H}_2\text{O} + \text{CrO}_3 + \text{thiourea} + \text{water}$ . As a result of the research, it was found that the well-rounded high-grade gold of modern placers has undergone repeated redeposition through intermediate sources. The discovery of slightly rounded gold with an internal structure without signs of exogenous transformation indicates that it entered the modern alluvium from a nearby primary source. This was a prerequisite for setting up ore gold exploration, resulting in identification of apocarbonate hydrothermal-metasomatic formations with disseminated gold-sulfide mineralization were identified. Thus, the features of the internal structures of placer gold in combination with other typomorphic features are additional indications of determining the sources of formation of gold-bearing placers.



## **HYBRID INORGANIC-ORGANIC MEMBRANES IN THE SERVICE OF CLEAN COAL TECHNOLOGIES**

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### **ABSTRACT**

Clean coal technologies (CCT) are all technological solutions that are designed to increase the efficiency of coal combustion, processing and extraction. They are therefore, all the technologies that will help to reduce its environmental nuisance during the production and use of coal and can be introduced at various stages of coal application. Earlier was stated that none of the energy sources (natural gas, crude oil and renewable energy sources), their native resources, the used technologies and the sources of imports are not able to eliminate hard coal from the energy mix of Poland in the near future. That is why the authors began research to create a new clean-coal technology based on the hybrid inorganic-organic membranes, which can be used for elimination of harmful substances generated during coal combustion, especially CO<sub>2</sub>. This work concerns the study of the inorganic-organic hybrid membranes based on few modified polymer matrices and various inorganic fillers. It was found that incorporation of zeolite 4A into the polymer matrix had significantly changed the gas transport parameters (D, P, S and  $\alpha$ ). In turn, the mechanical (R<sub>m</sub> and E) parameters have increased with the filler content. The application allows the initial selection of ingredients from which the final membrane will be created. The designed technology does not require high financial expenditures, and it is also highly universal. It can be used both in households, heating plants and, above all, in power plants.

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## **IMPLEMENTATION OF THE 2030 SUSTAINABLE DEVELOPMENT GOALS - AFFORDABLE AND CLEAN ENERGY IN THE EUROPEAN UNION**

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### **ABSTRACT**

One of the most important goals of the European Union is to provide citizens of the Member States security and stability in fuel and electricity sectors. The United Nations has defined 17 goals and 169 actions to achieve sustainable development of the world. The goals were to improve the quality of life, reduce the level of poverty, inequalities in the world and sustainable development in terms of climate and environmental protection. The article presents an analysis of the implementation of one of the assumed goals, i.e., sustainable development in the field of Affordable and clean Energy in the European Union. This goal is to ensure that every citizen has access to stable, sustainable, and modern energy at an affordable price. Among others, indicators such as energy import dependency, energy productivity, share of renewable energy in gross final energy consumption, final energy consumption in households per capita were analysed. The authors analysed the trends of the above-mentioned indicators in the European Union, with particular emphasis on Poland. In order to be able to predict how the analysed phenomena will develop until 2030, the authors built forecasts. For this purpose, among others, ARIMA models were used. The authors created several dozen models, from among which model with the smallest ex post errors and the lowest value of information criteria were selected. The models allowed to determine the degree of achievement of the set goals. They also allowed the designation of scenarios for the potential development of the analysed indicators.

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## **IMPLEMENTATION OF THE 2030 SUSTAINABLE DEVELOPMENT GOALS - AFFORDABLE AND CLEAN ENERGY IN POLAND**

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### **ABSTRACT**

One of the most serious challenges facing the world, including the European Union and Poland, is the climate crisis and environmental pollution. The article presents an analysis of the implementation of sustainable development goals in the field of Affordable and clean Energy in Poland. The Sustainable Development Goals have replaced the Millennium Goals and enable their continuation. They were defined at the United Nations Conference in 2012. 17 goals and 169 actions were set. Sustainable Development Goals are a set of activities, the implementation of which is to lead to the development of sustainable development in the environmental, social and economic terms. Achieving the goals will be possible among others through changes in the field of climate, education, poverty or the natural environment. The study analyses, inter alia, such indicators related to the discussed objectives like energy import dependency by products, energy productivity, share of renewable energy in gross final energy consumption by sector, final energy consumption in households per capita were analysed. This made it possible to indicate the level of achievement of the set goals, as well as to determine the possibility of achieving the goals set by 2030. The authors also presented the results of the generated for the analysed indicators forecasts. The presented results were obtained with the use of mathematical models, which were finally selected by the authors after the validation process. The time horizon of the forecasts was adjusted to the requirements of sustainable development goals. Countermeasures that can be taken to accelerate the deadline for achieving the targets were also outlined.

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## **DETERMINATION OF COAL ASH CONTENT BY NEUTRON-NEUTRON LOGGING**

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### **ABSTRACT**

The research is aimed at assessing the possibility of studying the ash content of coal seams using neutron-neutron logging in coal exploration wells drilled at the outcrops of coal seams under loose deposits using the materials of experimental work in the South Yakutsk coal basin. The prospects of using neutron-neutron logging to study coal well sections, on the one hand, is determined by the fact that hydrogen content in coal seams normally exceeds its content in the host rocks, and, on the other, by the small cross-sections of neutron capture by carbon. Within the same coal grade, an increase in its ash content both means a decrease in its hydrogen content and an increase in the content of elements with a higher capture cross section. Experimental studies were carried out at the Syllakh coal deposit. An IBN-8-1 type plutonium-beryllium source with an output of  $5 \cdot 10^4$  neutrons/s was used as a fast neutron source, and a highly efficient SNM-17 type helium gas-discharge counter was used as a slow neutron detector. The logging depth provided by the equipment was 10 - 30 cm. During the processing of the obtained field data, a correlation was established between the count rate of neutron-neutron logging and coal ash content. It should be noted that the functional dependence of the count rate of neutron-neutron logging on ash content is not continuous – in the range of ash content of 45 - 55% a certain discontinuity point is observed, after which the functional dependence changes. To simplify the assessment of the dependence, the range of rock ash content above 45% is neglected since bituminous coals with an ash content of more than 45% are classified as carbonaceous rock and are not of industrial interest. A close correlation is established between the count rate of neutron-neutron logging and coal ash content. According to the results of statistical processing, the correlation coefficient is 0.97, which makes it possible to quantitatively determine the ash content according to neutron-neutron logging data. The absolute errors in ash content determination by neutron-neutron logging over the entire dataset are up to 3.625 %. The degree of analytical moisture influence on the data of neutron-neutron logging in determining coal ash content is estimated. No regular changes in the count rate of neutron-neutron logging due to a change in the analytical moisture index have been established. It is noteworthy that, with a sufficiently large dispersion value of the analytical moisture index, the trend line of this parameter regularly changes synchronously with the trend lines of ash content and count rate.

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**AN IMPULSE FOR THE THALASSOTHERAPY ACTIVITY IN PORTUGAL TO BE FRAMED IN  
ACTIVITIES OF THE MEDICAL SPA TYPE - A PROPOSAL FOR CABO ESPICHEL (PORTUGAL)**

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**ABSTRACT**

The activity of thermalism in Portugal is millenary. Thermalism is an activity that uses natural mineral water in treatments for therapeutic benefit under medical supervision, in a Medical Spa. The exploitation of the natural mineral water, available in the Medical Spa, is the responsibility of a Technical Director, professional with know-how in the field of hydrogeology, who provides natural mineral water from the aquifer system, at the abstraction head, in order to be stored, distributed, and used in the various consumption points. Thalassotherapy, the use of salt water from seas or saltwater lakes, is already used in Portugal, either traditionally in loco or in some spas and other units, with activities or practices similar to those of thermalism. In some cases, it is already guided by a medical hydrologist, however, this activity is not yet legally framed in the same situation as thermalism. In the present work it is proposed that thalassotherapy can and should be supplied by salt water captured from an aquifer system, in full saline wedge, in order to be integrated with the proper rules of exploitation of the hydrogeological domain. Only in this way, the natural saltwater resource will have the potential to be obtained with adequate stability in its quality and thus, be able to fit into the legislative program similar to that of natural mineral waters. In this context, this paper presents some elements of an academic case study, carried out in Cabo Espichel (Sesimbra), where, it is proposed a project of a mixed spa, with a component of classic thermalism, to be supplied by water natural mineral to be captured and legalized, and with a thalassotherapy component, based on a capture of natural salt water to be captured in a free aquifer on a beach area. Finally, some detailed elements of a groundwater abstraction, with natural saltwater, idealized in a way that does not affect the environment, that is, without any negative environmental impact, are also presented.

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**GOOD PRACTICES OF QUALITY CONTROL IN THE AREA SURROUNDING OF NATURAL MINERAL  
WATER ABSTRACTION OF SÃO PEDRO DO SUL MEDICAL SPA (PORTUGAL)**

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**ABSTRACT**

São Pedro do Sul medical spa is a space with a millenary tradition in providing health services from the natural hot groundwater. The main source of supply of this thermal unit, was along the time, the Traditional Spring, which in the last decades has been controlled, and shows to have constancy in the flow rate, with about 10 L/s, with a temperature of 68.6°C in the origin. From 1999 onwards, with the construction of new abstraction, Well AC1, with 500m deep, with a maximum flow rate of 12.2 L/s, at 67°C, the exploitation potential of this resource increased. Due to the fabulous characteristics of the resource's potential (hot natural mineral water), there has been over time a great development in the spa medical activity, having already frequented these spa 25450 users per year, reflecting a maximum annual turnover of 5.4 million euros, coming from thermalism alone. Currently, there are two Bathhouses in operation and the resource is used, not only for therapeutic and wellness thermalism but also for geothermal uses and yet in the cosmetic area. This situation becomes the perfect scenario for attracting investment, increasing the circulation of people and goods, but also in the interest of building new bathhouses, hotels and restaurants and subsequently new roads, gardens, public drinking water and sanitation networks. All this pressure causes a lot of potential damage to the environment, including the underground water environment, and could eventually lead to the closure of the medical spa, if the natural mineral water from the abstractions become contaminated. In Portugal, there are several legally imposed defensive mechanisms of the mineral aquifer system, namely the implementation of the Protection Perimeter, but also the analytical control of the natural mineral water, at the abstraction head, both in chemical and microbiological terms, in addition to the orientation to have an automatic, on-line, record system associated to the abstractions, monitoring parameters such as: water level, flow rate, temperature, pH and conductivity of the water captured. However, the São Pedro do Sul medical spa go further, implementing an external monitoring system, consisting of: i) double piezometers (to sample groundwater at different depths), ii) street rainwater samplers, and iii) records precipitation and respective quality. Thus, in this paper, after a brief presentation of the importance of the resource and the physical aspects of the place (geology, hydrogeology and quality of the resource), the fundamental elements of the implemented external monitoring system and its main results are presented, showing that precipitation itself is already contaminated, that street rainwater sample presents chemical elements that are highly harmful to public health, and that groundwater sometimes presents very worrying results. Finally, some actions are mentioned that have been implemented to minimize the potential for contamination of natural mineral water from abstractions and the mineral aquifer system.

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## **STUDY OF THE INFLUENCE OF DRILLING AND BLASTING PLAN DESIGN ON THE SLOPE STABILITY IN A LIMESTONE QUARRY**

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### **ABSTRACT**

The main objective of blasting in mining is to achieve optimal rock fragmentation. This can contribute to the control and minimization of the overall cost of production and the volume of rock to blast while increasing the mineral selectivity. Now, the blasting process involves several risks mainly in relation to the stability of the land, the safety of the mine and the surrounding site. Under the conditions of the Lafarge limestone quarry (M'sila-Algeria cement factory), the determination of the optimal drilling and blasting parameters and the prediction of the granulometry of the blasted rock **pile**, allow the exploitation process to be profitable, efficient and safe. The prediction results are influenced by the parameters of the drilling and blasting operations. In this work, the stability of the mining slopes is discussed in relation to the design of the drilling and blasting plan in the Lafarge quarry. For the optimization of the drilling and blasting plans, we use a mining software called Delpat 3 that allows obtaining the rational parameters for an optimal blast with a desirable granulometry result, and we change each time the parameters in the blasting plan to analyze their influence on the slope stability that we can examine by the calculation of the safety factor using a numerical modeling software Flac/Slope. The changing of the drilling and blasting plan parameters like hole inclination, drilling pattern and the hole diameter affected the value of the safety factor for each trail, which leads to an understanding that the drilling and blasting plan design have a major influence on the slope stability.

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**THE INFLUENCE OF HYDROGEOLOGICAL FACTORS ON THE RAILWAY STABILITY IN THE  
AREAS OF ISLAND PERMAFROST DISTRIBUTION (BY THE EXAMPLE OF THE TRANS-BAIKAL  
RAILWAY, RUSSIA)**

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**ABSTRACT**

Changes in the geocryological situation at the road base and in the adjacent territory should be predicted based on an analysis of regional features of the “climate – landscape – cryolithozone – construction” system. These relationships are manifested in various ways across various cryolithozone regions, with these differences being rather poorly understood. In this regard, in 2019, the Melnikov Permafrost Institute (Yakutsk, Russia) and the Northwest Institute of Eco-Environment and Resources of the Chinese Academy of Sciences signed an agreement on joint research work in order to elucidate the evolution of frozen soils, as well as to justify the application of certain measures to stabilise the permafrost environment. These projects aim to study the cryolithozone response along the routes of projected high-speed highways and existing railway tracks. Since 2019, the Institutes’ representatives along with specialists from the Tynda permafrost station (the branch of Russian Railways), North-Eastern Federal University (Neryungri, Russia), Zabtransproekt (Chita, Russia) and the Institute of Natural Resources, Ecology and Cryology of the Siberian Branch of RAS (Chita, Russia) have been investigating individual sections of the Far Eastern and Trans-Baikal railways in Russia. Some areas here are characterised by the continuous distribution of permafrost soils, while others – by island permafrost distribution. These areas share such common features, as the significant lifetime of linear structures (lasting for several tens of years) and the presence of deformations of the railway track, which appeared in the first years after construction. Railway track sections installed in high-temperature frozen soils are of particular interest for monitoring. However, the construction deformations are not always caused by frozen soil degradation. This article presents the results of surveys at one of such objects – a section of the track confined to the Chernovskaya station of the Trans-Baikal railway.

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**USE OF EMPIRICAL FORMULAS FOR DETERMINATION OF SATURATED HYDRAULIC  
CONDUCTIVITY OF BED SILTS ALONG CHOTÁRNÝ CHANNEL - ŽITNÝ OSTROV.**

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**ABSTRACT**

The aim of this study is the evaluation of permeability of the bed silts located along the Chotárny channel at Žitný ostrov area, Slovakia. Chotárny channel is one from three main channels at this area – the flat lowland with channel network. Whole ŽO area has very low slope, so longitudinal slopes of all channels are also very low. This fact was the cause of silting on the channel bottom. The bed silt permeability impacts the water movement between surface water channel and its surrounding groundwater in the scope of their mutual interaction at ŽO area. The bed silt permeability is expressed by saturated hydraulic conductivity value. The bed silts were extracted as disturbed samples and as undisturbed samples. In this study we give heed to disturbed samples extracted from Chotárny channel. Because of that the empirical formulas based on the grain size analysis were used for saturated hydraulic conductivity determination. All values obtained over grain size analysis are only approximate, but the only possible ones in case of impossibility to sample an undisturbed sample. The disturbed samples of bed silt were extracted in three levels of silt layer - top, middle and bottom part of silt and after that as mixed samples in each selected profile of the Chotárny channel. The selection of sampling place was depended on the bed silt thickness in the measured cross-section profiles. The values of bed silt saturated hydraulic conductivity from disturbed samples  $K_d$  were computed by three empirical formulas: 1. Bayer – Schweiger formula; 2. Špaček I. formula and 3. Špaček II. formula, firstly for samples from the top, middle and bottom part of the silt and then for mixed samples. The valid values  $K_d$  from single parts of the silt layers reached from  $1.29 \times 10^{-08}$  to  $1.19 \times 10^{-04} \text{ m s}^{-1}$ , the valid values  $K_d$  from mixed samples reached from  $1.38 \times 10^{-08}$  to  $4.11 \times 10^{-06} \text{ m s}^{-1}$ . From comparison of values  $K_d$  from single silt layers and  $K_d$  from mixed samples it is not possible expressly to gauge the reliability of assessment of saturated hydraulic conductivity values by this method. For that reason, it will be necessary to compare these results with the values of bed silt saturated hydraulic conductivity from undisturbed samples determined by the laboratory method.

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## **IMPROVING CHARACTERISTIC PARAMETERS OF MEMRISTOR BASED ON HfO<sub>2</sub> ACTIVE LAYER**

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### **ABSTRACT**

The improvement of the characteristic parameters of the memristor depends on the factors such as thickness and surface area of the active layer. These parameters define leakage currents, which is the main disadvantage of the memory storage device and to improve the electrical features the leakage currents must be dropped to the zero in ideal case. In the presented work is described the electrical isolation of the active layer from the substrate by the thin layer of photoresist, which is an electrical insulator. For reducing area was used the new fotomask, which is able to reduce area 100 times. The memristor structures are designed in the form of "crossbars", which allows us to individually investigate each memristor and create a database with the possibility of incorporating it into the microchip in the future. In this work is presented also research outcomes regarding to selection memristor's contacts and active layers. As contacts are overviewed tungsten (W), titanium nitride (TiN) and aluminum (Al). Is considered metal and transition metal oxides as active layers WO<sub>x</sub>, HfO<sub>2</sub>, WO<sub>x</sub> + HfO<sub>2</sub>, HfO<sub>2</sub> + HfO<sub>x</sub>. The oxide electrical and structural properties is defined from I-V, C-V, XRD and XPS characteristics.

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## **EFFECT OF MICROWAVE PRETREATMENT ON LEACHING OF TETRAHEDRITE**

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### **ABSTRACT**

In mineral processing, the use of microwave radiation is important especially in pre-treatment processes. At present, there is an acceleration of processes as well as an increase in the efficiency of metal recovery. One of the main problems in copper recovery from complex sulphide ores is the removal of impurities such as antimony, arsenic, mercury. In the hydrometallurgical processing scheme, the key step is the leaching. The extraction process can be influenced by the selection of suitable leaching reagents or by suitable pre-treatment of the ore. The article describes the effect of microwave radiation on the leaching Sb, As and Hg of tetrahedrite and tetrahedrite concentrate. The samples were irradiated at the power 900 W for 30 and 80 seconds. The leaching of irradiated and non-irradiated samples was realized in an alkaline sodium sulphide. The positive effect of microwave radiation was confirmed by an increase in the recovery of Sb about 6% and As about 15% after 15 min of extraction. After leaching of irradiated tetrahedrite samples, the yield of Sb was 42.6%, after extraction of microwave irradiated tetrahedrite concentrate, the yield of Sb was 77.3%.

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**CHARACTERIZATION OF POLYMETALLIC ORE AND FLOTATION CONCENTRATE FROM THE MÁRIA MINE (ROŽŇAVA, SLOVAK ORE MTS., EASTERN SLOVAKIA)**

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**ABSTRACT**

The contribution deal with the study on composition of tetrahedrite-bearing siderite ore from Maria Mine nearby Rožňava and of tetrahedrite concentrate prepared from this ore by froth flotation. The Rožňava ore field consists of two main vein systems, namely Mária and Strieborná (Argenteous/Silvery) ones, respectively. The both vein systems are situated in the Early Paleozoic Gelnica Group of the Gemeric Superunit, in Bystrý Potok Formation (Upper Silurian) and in the Drnava Formation (Early Devonian). The filling of vein systems is formed mainly by siderite, quartz, tetrahedrite, pyrite, arsenopyrite, chalcopyrite, ankerite, albite, pyrrhotite, marcasite, less tourmaline, sericite, chlorite, apatite, magnetite, etc. The rock surrounding is represented by quartzite metapsammite, sericitic-quartzite and sericitic-graphitic phyllites (Jakubiak, 2008; Blišťan, 2009; Varga, 2013; Mikuš, 2018). Thus, metal ore as a feed to froth flotation and obtained concentrate were subjected to grain size analysis. The grain size fractions were assayed using GA, AAS and CHNS. Mineral composition of samples was studied using XRD. So, metal ore contains 18.99 % SiO<sub>2</sub>, 37.01 % FeO, 1.84 % MnO, 7.36 % C, 2.36 % Cu, 1.70 % Sb, 0.15 % As, 2.32 % S, 770 ppm Ag and 216 ppm Hg. Tetrahedrite concentrate containing 25.59 % Cu, 19.68 % Sb, 1.19 % As, 20.08 % S, 0.57 % Ag, 1.20 % Hg, 1 % SiO<sub>2</sub>, 16.16 % FeO, 0.48 % MnO and 2.17 % C at a mass yield of 4 % was prepared. XRD study showed that siderite occurs as a dominant mineral in metal ore. Quartz, tetrahedrite and sericite are presented as accompanying minerals. Accessories are represented by chlorite, probably clinocllore. As to flotation concentrate, tetrahedrite is dominant mineral, which accompanied by siderite. Accessories can be represented by chalcopyrite, arsenopyrite, sericite, pyrite, quartz and chlorite.

Corresponding Author: Slavomír Hredzák

## **STUDY OF HEAVY METALS TOXICITY LEVEL IN WORKPLACE ATMOSPHERE BY ALTERNATIVE METHODS**

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### **ABSTRACT**

Promoting safety and health at work, as part of the overall improvement of working conditions, is an important strategy, not only to ensure well-being of workers, but also to make a positive contribution to productivity. Health, safety and well-being of workers are therefore prerequisites for improving quality and productivity and are important for equitable and sustainable socio-economic development. Toxicological investigation of an industrial objective involves both knowledge of working conditions and the dynamic establishment of occupational pollutants in the workplace atmosphere, as well as bio-toxicological evaluation, being a synthetic representation of the aggressiveness of pollutants entering the body by various paths (respiratory, cutaneous, digestive, etc.) with reference, at the same time, to the adaptability of respective employees. Evaluation of the toxicological investigation has a role in following the evolution of working conditions and health of employees in time, potential technological changes with possible impact on employees' health, as well as if new conditions occur, requiring the completion of previous toxicological investigations. Use of heavy metals in different industries has increased the quality of products from different production sectors but on the other hand also led to an increase in the toxicity of workplace atmosphere, which requires an assessment of the negative impact produced. The current paper aims at an alternative analysis of the determination of heavy metals content (Cu, Cd, Pb, Ni, Cr) in workplace atmosphere, using, on one hand, the method of spectroscopy of atomic emissions with inductively coupled plasma and, on the other hand, fluorescence with X rays. Following statistical processing of data gathered by the two alternative methods, the accuracy, reproducibility, relative standard deviation as well as the fidelity of methods expressed by the coefficient of variation will be established.

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## **EFFECTS OF INCORPORATING PRECIPITATION SPATIAL DISTRIBUTION PATTERNS IN HYDROLOGIC AND HYDRAULIC DESIGN FOR ANDEAN WATERSHEDS**

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### **ABSTRACT**

In hydrometeorological data-scarce regions, generation of flood maps from hydrographs estimated by precipitation runoff models is a recurrent task, in the processes of hydrological design and flood hazard estimation. Due to the lack of rainfall gauge stations, a uniform distribution of precipitation or a spatial distribution derived from the interpolation of the information in the few available stations is usually assumed, a fact that does not agree with the real distribution of precipitation on the watershed. In this paper, the effect of spatial distribution patterns in the results of hydrological and hydraulic modelling is assessed. We compare results of flood areas calculated from two different hydrological responses for a watershed considering the same rainfall event. The first response is obtained without considering precipitation distribution patterns for the watershed. The second one is simulated by observing the spatial distribution patterns of precipitation found in the case of study. Both flood maps are compared to the real flood map modelled from radar data. Spatial distribution patterns of precipitation were estimated using the spatial moments of precipitation fields. We simulated the hydrological response using the TETIS model, which is a rainfall runoff distributed model. The hydraulic model IBER is implemented to estimate the flood maps. As main conclusion, it can be acknowledged that the incorporation of the spatial distribution patterns in the hydrological and hydraulic modelling allows to improve the estimation of the floods, in terms of a better approximation to the peak times and to the real depth.

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## ECOTOXICOLOGICAL TESTS OF METAL-CONTAMINATED SOILS

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The raw steel production plays a key role in the economic development of Slovakia. Unfortunately, the technology of steel production, agricultural and industrial activities contribute to contamination of the soil in the region Eastern Slovakia. The purpose of this study was to investigate the effect of heavy metals in urban soils from the Košice area, using bioassays on earthworms and phytotoxicity. An earthworm avoidance test has potential advantages for use in evaluation of hazardous soils sites and proved as a quick approach to determining the presence of contaminants. The earthworm (*Dendrobaena veneta*) takes up and retains metals from soil containing of heavy metals. Assessment of soil phytotoxicity was based on germination and seedling growth of the terrestrial plant (mustard *Sinapis alba*). The level of Cr, Co, Cd and Hg were assessed in 8 industrial soils (4 agricultural areas and 4 grass-plot areas) from the area U.S.Steel Košice. The highest levels contaminations of chromium (278mg/kg), cobalt (39mg/kg), cadmium (21mg/kg) and mercury (0.80mg/kg) were determined for the grass-plot soils (main gate of the U. S. Steel-plant). Phytotoxkit results for the agricultural soils from around Košice showed that, the potential toxicity values are lowly, represented by a lower percentage of inhibition in germination range between 5 and 33 % and the average percentage of growth inhibition was 12-39 % for *Sinapis alba*. The results for the grass-plot areas soils from around Košice showed the percentage of inhibition in germination range between 13 and 47 % and the average percentage of growth inhibition was 19-49 % for *Sinapis alba*. Low mortality effects were recorded in the tests with *Dendrobaena veneta*. The distribution of the worms found in the double control was within the range 10–90 % for all areas of the agricultural soils and grass-plot soils, for after 48h. The significant ( $P<0.05$ ) avoidance by *Dendrobaena veneta* were 90% in soils of areas Gomboš and from main gate of the U. S. Steel-plant, Košice. The above results reflect that not only may the worms be able to detect metals, but in fact they may also change their behavioural response over time.

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**CHARACTERISTICS AND SEASONAL VARIATIONS OF ATMOSPHERIC DEPOSITION OF SELECTED ELEMENTS IN THE URBAN AND INDUSTRIAL ENVIRONMENT OF KOŠICE (SLOVAKIA)**

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**ABSTRACT**

The aim of this study is to evaluate the impact of local emission sources on the environmental load through a detailed analysis of the atmospheric deposition (AD). The main sources of pollution are neighboring iron and steel works and typical urban sources, such as the municipal heating plant, transport, construction, etc. Total atmospheric deposition i.e. both wet and dry ones, were sampled from the eleven sampling sites have been placed on the roofs above the height of the surrounding buildings at a distance of between 1 and 15 kilometers from the main source of pollution in the urban and suburban area. The atmospheric deposition fluxes of selected major and trace elements (Fe, Al, Mn, Zn, Pb, Cu, Cr, Cd, As) were determined separately for “water soluble” and “insoluble phase” (solid particles) as well as in terms of the heating season for summer and winter half-year. The results from 2009–2020 are introduced. Regression analysis confirmed the relationship between fluxes of the AD of the monitored elements and the distance from the ironworks mainly for Fe, Mn, solid particles, Cr and Al. The highest values of correlation coefficients were calculated by Pearson correlation analysis for the elements whose dominant source are ironworks technologies, namely manganese, iron and chromium. The monitored elements are bound to the insoluble component AD in the order of Al, Fe, Mn Cr, Pb and As. Cadmium and zinc are preferably bound to the soluble phase for sites north of the ironworks. In winter, slightly higher or balanced values of AD were found for the elements Pb, Cr, Fe, Mn, Cu and Cd. In the case of zinc and arsenic higher values were recorded in the summer period. The smallest seasonal differences for all observed components were found at localities near the ironworks. The study of the qualitative composition and analysis of the deposition fluxes of the monitored elements confirmed the impact of the metallurgical industry on the environmental load of the monitored urban environment.

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## **EVALUATION OF WATER CONTENT IN SOILS OF THE ZITNY OSTROV FROM THE POINT OF VIEW OF EXPLOITATION FOR BIOSPHERE**

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### **ABSTRACT**

The lithospheric zone between the soil surface and the first ground water horizon, respectively the ground water table, has a character of three-phase system. It consists of solid phase having fine to rough disperse granularity. This creates a structure of porous environment with characters that can be physically determined. The water occurs in pores in different forms of state and its bond with solid phase. Its energetic bond is clearly quantified with the moisture retention curve. The gas phase fills pores with the water up to the value of the full porosity, i.e. it fills the part of pores that is not saturated with water. Therefore, this lithospheric zone is named the soil aeration zone. The volume of water occurring in the soil aeration zone corresponds to the concentration of water in the framework of hydrological cycle components. This water serves as the water resource for the vegetation cover. The data used for calculation were particular soil types in the area, depth of ground water table, hydrolimits of the soil moisture (wilting point, point decreased availability, field water capacity) and aeration zone thickness. The water content in the soil aeration zone between hydrolimits field water capacity and wilting point is the critical interval of water content for vegetation cover in a given locality, because only water from this interval is available for the vegetation cover. This water has no properties of free water, and plants have to have a developed root system and such suction pressure, that is able to overcome the bond between water and soil. Calculated results were verified with the help of monitored water content. Both calculated and measured values of soil water content in the aeration zone show that the water content is affected by appurtenant soil type. The human activity in a landscape directly affects the dynamics of this water resource, either from quantitative or qualitative viewpoint. This effect is shown in changes of the ground water regime, i.e. changes of ground water table and amplitude of its fluctuation. The paper brings results of water content evaluation in the soil aeration zone in the Zitny ostrov area.

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## **CREATING A THEMATIC GEODATABASE FOR MONITORING THE LANDSLIDE PROCESSES OF THE LANDSLIDE CIRCUS “DALGIA YAR”**

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### **ABSTRACT**

Impact on the process of landslide origin and activation is result of many factors both endogenous and exogenous. The purpose of this study is to provide possibility for analysis and assessment of the geo-processes in the "Dalgia yar" landslide located at Northern Black Sea coast of Bulgaria in order to prevent risks and disasters of natural and anthropogenic origin. An important stage was to seamlessly include data from different sources such as geodetic measurements, satellite SAR (Synthetic-aperture radar) data as well as geological and geophysical data. The established geodatabase structures the collected information on dangerous geo-processes in the mentioned area and introduces them into the GIS (Geographic information system) environment. Its purpose is to facilitate the analysis of the available geological data for this landslide and to integrate them with results of measurements from regular monitoring. Interferometric images (IFIs), data from permanent GNSS (Global Navigation Satellite Systems) stations and from local geodynamic GNSS network, geological, seismic and geophysical data, updated geological maps and maps of the risk of landslide processes are included in the database. The IFIs have been produced using well established procedure for processing large number of Sentinel-1 SAR data of the purposely created local archive. Other key element used to improve the final results of SAR data processing and important part of the geodatabase is the precise Digital Elevation Model (DEM), which is much better in terms of horizontal and vertical resolutions than the open accessed ones (SRTM). The coordinates and velocities of the GNSS points are obtained from adjustment and analysis of two epoch measurements of the geodynamic control network of landslides "Dalgia yar". Since the area has complex geological structure, small scale maps reflecting the geological and geophysical hazards are integral part of the geodatabase. Having all this information the analysis concerning the ongoing geodynamical processes in the study area is significantly improved and more reliable information is produced for better regional planning by the local authorities and residents.

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**THE INFLUENCE OF CLIMATE CONDITIONS AND METEOROLOGICAL FACTORS ON THE  
NUTRITIONAL VALUE OF WHEAT (*TRITICUM AESTIVUM* L.) USED FOR HUMAN AND ANIMALS  
NUTRITION, IN ROMANIA**

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**ABSTRACT**

Wheat (*Triticum aestivum* L.) is the basic cereal in human and animal nutrition. Every month, wheat is harvested somewhere in the world. In Romania, a country with a temperate-continental climate, the wheat is harvested between June and July, while the sowing is carried out between September and October. Climatic and meteorological factors during these periods can influence the nutritional quality of wheat. The aim of this study was to analyse the influence of annual average temperature and the amount of precipitate on the chemical composition and on the value of metabolizable energy of the wheat, respectively. The climatic and meteorological data used in this study come from NMA database. Were analysed the periods September 2017 - July 2018 (period 1, noted with 2018 - the year of harvesting) and September 2018 - July 2019 (period 2, noted with 2019 - the year of harvesting), respectively. For the chemical analysis, the NIR (Near InfraRed spectroscopy) method was used. The calculation of metabolizable energy was performed based on the ATWATER system, a system applicable to both human and animal nutrition. The statistical analysis of the climatic and meteorological data showed that the annual average temperature for period 1 was lower compared to the temperatures of period 2. Also, the precipitations were more abundant in period 1 compared to period 2. There were no significant statistical differences for any of the climatic and meteorological factors assayed during the analyzed periods. Following the statistical correlations between the nutrients studied by chemical analysis, for those 2 periods, significant differences were observed ( $p < 0.001$ ). The humidity of wheat grains harvested in 2018 was higher (average = 13.03%) compared to that of grains harvested in 2019 (average = 10.72%). The protein content was lower in 2018 (average = 10.02%) than in 2019 (average = 11.04%); and similar results were obtained for the fibre content (average 2018 = 2.17%; average 2019 = 2.96%). Also, the value of metabolizable energy was lower for wheat harvested in 2018 (average = 3517.90 kcal / kg) compared to 2019 (average = 3611.04 kcal / kg). In conclusion, the results of this study highlight the influence of temperature and precipitation on the chemical composition of wheat, thus having a direct impact on the nutritional quality of this grain for human and animal nutrition.

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## **MICROFUNGI ON SANDY BEACHES – POTENTIAL THREATS FOR PEOPLE ENJOYING LAKESIDE RECREATION**

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### **ABSTRACT**

Research on basic bacteriological and physicochemical parameters conducted by state institutions (Provincial Sanitary and Epidemiological Station and District Sanitary and Epidemiological Station) are limited to bathing waters under constant sanitary and epidemiological supervision. Unfortunately, no routine or monitoring tests are carried out for the presence of microfungi. This also applies to beach sand used for recreational purposes. The purpose of the planned own research was to determine the diversity of the mycobiota present on supervised and unsupervised sandy beaches, on the shores of lakes, of municipal baths used for recreation. The research material consisted of microfungi isolated from April to October 2019 from sandy beaches of supervised and unsupervised lakes located within the administrative boundaries of the city of Olsztyn (North-Eastern Poland, Europe). Four lakes, out of the fifteen available (Tyrsko, Kortowskie, Skanda and Ukiel), whose bathing waters are subjected to routine bacteriological tests were selected for testing. To compare the diversity of the mycobiota composition on the surface and below the sand mixing layer, samples were taken from two depths (10 cm and 50 cm), using a soil auger. Micro-fungi from sand samples were obtained by surface inoculation on an RBC medium from the 1st dilution (1:10). After incubation at 25°C for 96-144 h, the average number of CFU/dm<sup>3</sup> was counted. Morphologically differing yeast colonies were passaged into Sabouraud agar slants with gentamicin and incubated again. For detailed laboratory analyses, culture methods (macro- and micro-cultures) and identification methods recommended in diagnostic mycological laboratories were used. The conducted research allowed obtaining 140 yeast isolates. The total average population ranged from  $1.37 \times 10^{-2}$  CFU/dm<sup>3</sup> before the bathing season (April 2019),  $1.64 \times 10^{-3}$  CFU/dm<sup>3</sup> in the season (May-September 2019) and  $1.60 \times 10^{-2}$  CFU/dm<sup>3</sup> after the end of the season (October 2019). More microfungi were obtained from the surface layer of sand (100 isolates) than from the deeper layer (40 isolates). Reported microfungi may circulate seasonally between individual elements of the lake ecosystem. From the sand/soil from the catchment area beaches, they can get into bathing waters, stopping periodically on the coastal phyllosphere. The sand of the beaches and the phyllosphere are a kind of filter for the water reservoir. The presence of microfungi with various pathogenicity potential in these places is of major epidemiological importance. Therefore, full monitoring of not only recreational waters but also sandy beaches should be treated as an element of constant control by appropriate supervisory institutions, allowing recreational areas for public use, so that the use of these places does not involve the risk of infection.

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**BRACHIOPODS OF THE CARBONIFEROUS-PERMIAN BOUNDARY DEPOSITS OF THE KUBALAKH SECTION (LOWER REACHES OF THE LENA RIVER, NORTHERN VERKHONYANIE)**

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**ABSTRACT**

The paper presents new data on the vertical distribution of brachiopods in the Carboniferous-Permian boundary deposits (the Kubalakh Formation) of the Kubalakh section (lower reaches of the Lena River). The deposits of the Kubalakh Formation are divided by the valley of the Kubalakh Creek into two outcrops, which are suggested to be considered as subformations. A brachiopod complex *Jakutoproductus protoverkhoyanicus* Kaschirzew, *Verchojania abramovi* Makoshin, *Verchojania* cf. *monstrosus* (Ganelin), *Verchojania* sp., *Cancrinella? alazeica* Zavodowsky, *Tornquistia kolymensis* Afanasjeva, *Tornquistia* sp., *Rhynoleichus* sp., *Rhynchopora* sp., characteristic of the *Jakutoproductus protoverkhoyanicus* Zone of the Kygyltasian Horizon of the Verkhonyanie is recognized in the Lower Kubalakh Subformation. A brachiopod complex *Jakutoproductus verkhoyanicus* (Fredericks), *Jakutoproductus crassus* Kaschirzew, *Waagenoconcha* aff. *wimani* (Fredericks), *Orbiculoidea* sp., *Rhynchopora* sp., characteristic of the *Jakutoproductus verkhoyanicus* Zone of the Khorokytian Horizon of the Verkhonyanie is recognized in the Upper Kubalakh Subformation. Based on the data presented, the Carboniferous-Permian boundary should be drawn within the Kubalakh Formation, rather than at the base of the Tuora-Sis formation, as is was accepted on the basis of the latest Unified Regional Scheme of Permian Deposits in the Verkhoyansk-Okhotsk region.



**PRODUCTION OF FERROBORON FROM WASTES BY SHS-METALLURGY AND INFLUENCE OF  
LIGATURES ON THE STRUCTURE/PROPERTIES OF CAST IRON**

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**ABSTRACT**

Waste, generated during the industrial process negatively affects the environment, but at the same time it is a valuable raw material and can be used to produce new marketable products. The study of the effectiveness of Self-propagating High temperature Synthesis (SHS) methods, which are characterized by the simplicity of the necessary equipment, the purity of the final product and the high processing speed, is under the wide scientific and practical interest to solve the set problem. The work describes technological aspects of production of ferro boron by the method of SHS - metallurgy from iron-containing wastes of rolled production for alloying of cast iron and results of effect of alloying element on degree of boron assimilation with liquid cast iron. Features of Fe-B system combustion have been investigated and the main parameters to control the phase composition of synthesis products have been experimentally established. Effect of overloads on patterns of cast ligatures formation and mechanisms of structure formation of SHS products was studied. It has been shown that an increase in the content of hematite  $\text{Fe}_2\text{O}_3$  in iron-containing waste leads to an increase in the content of phase FeB and accordingly, the amount of boron in the ligature. Boron content in ligature is within 3-14%, and phase composition of obtained ligatures consists of  $\text{Fe}_2\text{B}$  and FeB phases. Depending on the initial composition of the wastes, the yield of the end product reaches 91 - 94%, and the extraction of boron is 70 - 88%. Combustion processes of high exothermic mixtures allow obtaining a wide range of boron-containing ligatures from industrial wastes. In view of the relatively low melting point of the obtained SHS-ligature, the positive dynamics of boron absorption by liquid iron is established. According to the obtained data, the degree of absorption of the ligature by alloying gray cast iron at 1450 ° C is 80 - 85%. When combined with the treatment of liquid cast iron with magnesium, followed by alloying with the developed ligature, boron losses are reduced by 5 -7%. At that uniform distribution of boron micro-additives in volume of treated liquid metal is provided.

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## **MODELLING OF FLUIDITY DURING HOT COMPACTION OF Ti-B SYSTEM SYNTHESIZED MASS**

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### **ABSTRACT**

Developing the scientific basis for making new materials with pre-planned, physical and mechanical properties by SHS (self-propagating high temperature synthesis)-compaction is a fundamental problem of modern metallurgy, which can be solved by imaginative modeling of the structural-phase state of materials. Among the many methods of obtaining metal-ceramic tiles, the ease of process management, cheapness, ecological cleanliness and the possibility of obtaining high-quality products are significantly distinguished by the innovative SHS electrical rolling process developed at the F. Tavadze Institute of Metallurgy and Materials Science, which, by maintaining the equilibrium velocities of the rolling and combustion fronts, ensures hot deformation of the hot viscous plastic mass in the deformation core under conditions of continuous compensation of heat losses.

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**STRUCTURAL EVOLUTION OF ORE-CONTROLLING TRANS-CRUSTAL FAULTS OF THE OLCHAN–  
NERA ZONE: CONSTRAINTS FROM THE KHANGALAS ORE CLUSTER, YANA–KOLYMA  
METALLOGENIC BELT, NE RUSSIA**

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**ABSTRACT**

The article studies the structural evolution of ore-controlling trans-crustal faults of orogenic deposits and occurrences of the Khangalas ore cluster located in the southeastern part of the Olchan–Nera metallogenic zone, in the Upper Indigirka sector of the Yana–Kolyma metallogenic belt, North–East of Russia. Studies have shown that the formation of tectonic structures occurred during four Mesozoic deformation stages. Accretionary thrust stage D1 resulted in formation of the main pattern of the Mesozoic tectonic structures of the region. Further tectonic evolution occurred in a strike–slip setting of the accretionary D2 and post-accretionary D3–D4 stages. Post-ore strike-slip faults activate and complicate the earlier formed structures of the reverse and thrust paragenesis. Mineralization associated with the strike–slip faults has not been established, whereas formation of the gold–antimony mineralization is associated with sinistral strike-slip faults in the Adycha–Taryn metallogenic zone located to the southwest. The new data obtained are consistent with the previously proposed model of the evolution of the deformation structures of the Khangalas deposit.

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**ORE GEOLOGY, RE–OS ISOTOPE GEOCHEMISTRY OF THE AU AND AU-SB MINERALIZATIONS,  
KULAR–NERA TERRANE, NORTHEAST ASIA: IMPLICATIONS FOR TIME OF FORMATION AND ORE  
GENESIS**

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**ABSTRACT**

The paper presents the first results of investigation of the Re–Os isotope system of native gold from the Malo-Tarynskoe, Khangalas, Bazovskoe, and chalcopryrite from the Dvoynoe orogenic gold deposits and stibnite from the Maltan Au-Sb deposit in the Kular–Nera terrane, Northeast Asia. The deposits are spatially related to NW-trending lithospheric-scale major brittle faults or controlled by subsidiary faults and fracture zones. Such zones served as pathways for fluids rising from below the crust, and they have a long tectonic and reactivation history. The Kular–Nera terrane consists of Upper Permian, Triassic, and Lower Jurassic clastic sedimentary-rock sequences, metamorphosed to initial stages of greenschist facies. Magmatism is manifested by Kimmeridgian–Berriasian S- and I-types granitoids and mafic dikes of the Tas–Kystabyt magmatic belt. Re concentration in gold varies from 0.168 to 6.997 ppb, and that of osmium – from 0.068 to 1.443 ppb. Chalcopryrite from the Dvoynoe deposit occurrence contains 0.1522 ppb Re and 0.499 ppb Os. Stibnite from the Maltan Au-Sb deposit occurrence contains 0.236 ppb Re and 0.903 ppb Os. The Re–Os ages of gold from the Malo-Tarynskoe ( $147.8 \pm 3.8$  Ma) and Bazovskoe ( $147.2 \pm 1.8$  Ma) and Khangalas ( $137.1 \pm 7.6$  Ma) orogenic deposits and the Maltan Au-Sb deposits ( $69.7 \pm 1.9$  Ma) are determined. Malo-Tarynskoe and Bazovskoe represent the earliest known orogenic gold mineralization in the Kular–Nera terrane. The data obtained permit us to correlate the initiation of orogenic gold-ore systems with the completion of the formation at the end of the Late Jurassic Uyandina–Yasachnaya volcanic belt, crystallization and subsequent cooling in the Late Jurassic–early Early Cretaceous of granitoid massifs of the Tas–Kystabyt magmatic belt, and subduction–accretionary events at the northeastern active continental margin of the Siberian craton. Maltan Au-Sb deposit is related to completion of the formation of the Albian–Late Cretaceous Okhotsk–Chukotka volcano-plutonic belt. Contrasting mantle and/or crustal sources of ore-forming material are established. The osmium initial isotopic ratio in gold  $^{187}\text{Os}/^{188}\text{Os} = 0.2210\text{--}0.4275$  and antimonite (0.2543–0.2976) is typical for the ore-forming material from the fertile mantle reservoir, and for chalcopryrite (3.1904) – from the crust.

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**EARTHQUAKE MAGNITUDE ESTIMATION USING PRECISE POINT POSITIONING**Jakub Nosek <sup>1,2</sup>, Pavel Václavovic <sup>2</sup><sup>1</sup> Brno University of Technology, Veveří 331/95, Brno, Czech Republic<sup>2</sup> Geodetic Observatory Pecný, RIGTC, Zdíby 250 66, Czech Republic**ABSTRACT**

An accurate estimation of an earthquake magnitude plays an important role in targeting emergency services towards affected areas. Along with the traditional methods using seismometers, site displacements caused by an earthquake can be monitored by the Global Navigation Satellite Systems (GNSS). GNSS can be used either in real-time for early warning systems or in offline mode for precise monitoring of ground motion. The Precise Point Positioning (PPP) offers an optimal method for such purposes because data from only one receiver are considered and thus not affected by other potentially not stable stations. Precise external products and empirical models have to be applied, and the initial convergence can be reduced or eliminated by the backward smoothing strategy or integer ambiguity resolution. The product for the magnitude estimation is a peak ground displacement (PGD). PGDs observed at many GNSS stations can be utilized for a robust estimate of the earthquake magnitude. We tested the accuracy of estimated magnitude scaling when using displacement waveforms collected from six selected earthquakes between the years 2016 and 2020 with magnitudes in a range of 7.5–8.2  $M_w$ . We processed GNSS 1Hz and 5Hz data from 182 stations by the PPP method implemented in the G-Nut/Geb software. The precise satellites orbits and clocks corrections were provided by the Center for Orbit Determination in Europe (CODE). PGDs derived on individual GNSS sites formed the basis for ground motion parameters estimation. We processed the GNSS observations by the combination of the Kalman filter (FLT) and the backward smoother (SMT), which significantly enhanced the kinematic solution. The estimated magnitudes of all the included earthquakes were compared to the reference values released by the U. S. Geological Survey (USGS). The moment magnitude ( $M_w$ ) based on SMT was improved by 20% compared to the FLT-only solution. An average difference from the comparison was 0.07  $M_w$  and 0.09  $M_w$  for SMT and FLT solutions, respectively. The corresponding standard deviations were 0.18  $M_w$  and 0.22  $M_w$  for SMT and FLT solutions, which shows a good consistency of our and the reference estimates.

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## REDUCING BLASTING-INDUCED GROUND VIBRATIONS AT THE VELKOLOM ČERTOVS SCHODY-ZÁPAD QUARRY

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### ABSTRACT

The study discusses the use of the electronic initiation system and software modeling to reduce ground vibrations induced by blasting works. The main part compares non-electric and electronic initiation systems, namely how the system-type affects the peak vector sum (PVS). The study evaluates blasting works conducted between 2011 and 2020 at the Velkolom Čertovy schody quarry. Koněprusy limestone deposit mined from a quarry Velkolom Čertovy schody belongs to one of the most significant mining locations in the Czech Republic. The main mining technology used in breaking rock mass at the Velkolom Čertovy schody quarry is blasting (namely bench blasts and overburden blasts). Blasting generates ground vibrations that affect the surroundings of the quarry. The information on ground vibrations is continuously collected at the predetermined measurement sites through a monitoring network. The network constantly monitors peak particle velocity (PPV), PVS, frequency, and other parameters. The key measurement site appears to be Prošek Dome (M15) in the Koněprusy Caves. At this measurement site, the limit value of the PVS is stipulated at 3.0 mm s<sup>-1</sup>. If this value is exceeded, it is necessary to establish measures which lead to blasting restrictions (e. g. decrease in the weight of the deck charge, bench blast rows reduction). To meet the criteria, the Velkolom Čertovy schody-západ quarry started to use the electronic initiation system E\*STAR along with the specialized software Paradigm for vibration modeling. This study, using data collected at the measurement sites Prošek Dome (M15) and Koněprusy No. 19, compares the PVS generated by the nonelectric initiation system (Shock\*Star) without modeling and by the electronic initiation system (E\*STAR) with modeling. As reference years for non-electric initiation were stipulated years 2011, 2012, 2013, and for electronic initiation years 2018, 2019, and 2020. An analysis of 467 bench blasts executed at the quarry was conducted – or rather, the analysis of the PVS values collected at the pre-selected measurement sites. The analysis shows that the average value of the PVS at the measurement site Prošek Dome (M15) decreased from 2.05 mm s<sup>-1</sup> to 1.64 mm s<sup>-1</sup> when using the electronic initiation system with vibration modeling. The decrease in the PVS value was observed at the measurement site Koněprusy No. 19 as well, namely from 0.48 mm s<sup>-1</sup> to 0.31 mm s<sup>-1</sup>. In addition, significantly fewer occasions of exceeding the PVS limit value were reported at the measurement site Prošek Dome (M15), specifically from 6.7 % to 2.7 % of the blasting works conducted within the selected reference years. The study also describes fundamental principles of work with the Paradigm software. Based on the vibration analysis, parameters of the bench blasts need to be adjusted: timing, number of deck charges or rows, etc. Finally, the study summarizes the benefits of the electronic initiation system with modeling.

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## **UNDRAINED SHEAR STRENGTH $c_u$ AND UNDRAINED ELASTIC MODULUS $E_u$ OF ANTHROPOGENIC SOILS FROM LABORATORY TESTS**

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### **ABSTRACT**

Undrained shear strength  $c_u$  and elasticity modulus  $E_u$  are one of the basic mechanical parameters describing soil properties in engineering practice. Undrained shear strength  $c_u$  is one of the basic classification parameters of soil, usually determined in the uniaxial compression or triaxial compression tests. In a simple way it can be established also by fall cone test. In soil mechanics, modulus of elasticity  $E$  is replaced by undrained secant modulus  $E_{u50}$ . In the laboratory, the modulus  $E_{u50}$ , can be simple determined from the stress-strain curve obtained from the uniaxial or triaxial compression tests. The paper presents the results of investigations of  $c_u$  and  $E_{u50}$  parameters of anthropogenic soils prepared in the laboratory under uniaxial compression and with a fall cone test. The soils used in the study represented different types of materials used in earthworks - containing different share of clay fraction. The soils were compacted using the standard Proctor method. For samples of different moisture and density, the values of undrained shear strength  $c_u$  and modulus of elasticity  $E_{u50}$  were determined. A certain inconsistency was observed in the values of  $c_u$  obtained with different methods. However, a correlation was found between the undrained shear strength determined by fall cone method and the module  $E_{u50}$  determined in uniaxial compression tests. The paper proposes a method of estimating  $E_{u50}$  on the basis of cone penetrometer tests. Such test does not require any additional preparation and can be performed directly on the soil compacted in the cylinder of the Proctor's apparatus, which allows for a quick assessment of the soil elasticity parameters.

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## THE DIVERSITY AND ECOLOGY OF MACROMYCETES ON SOILS OF ADJARA, GEORGIA

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### Abstract

The publication is devoted to the study of the diversity of the species composition of macromycetes on different soils of Adjara, Georgia. The aim of the study was to identify and determine the composition of on different macroscopic fungi in different soils; establishment of the scale of development and spread of macromycetes in adverse and favorable conditions. Morphological features of collected fruiting bodies, such as shape, size, colour, odor, hymenophore and velum types, etc., were analysed. Spore slides were prepared in glycerin and fuchsin acid and observed under a light microscope. Some samples were isolated on a Malt agar medium, and macroscopic and microscopic characteristics of isolates were observed for precise identification. Identifications were done using relevant literature. At locations in the outdoor area and in the greenhouse, a total of 165 macrofungal species were recorded fruiting on soil, between them 35 species are considered edible, 14 poisonous, while 106 species are inedible. Most of the species belong to the division Basidiomycota (151) and only 14 to the division Ascomycota. Identified species distributed in 5 Classes, 13 Orders, 36 families and 68 Genuse. The highest number of soil-inhabiting basidiomycetous macrofungal species was in the forest soil plot (116), followed by the Pasture soil (29). The on families with the highest number of species was Russulaceae (17%), Agaricaceae (15%), Boletaceae (12%), Cortinariaceae (9%) and Psathyrellaceae - 8%, The remaining 31 families -39% . Lactarius, Cortinarius, Russula, Amanita and et al., were the richest genus. All 6 substrates studied, it observed that the species that had a higher frequency were *Agaricus subrufescens*, *Calvatia cyathiformis* and *Leucocoprinus cretaceus*, occurring in soil, soil/litter and pasture. On the other hand, *Agaricus campestris*, *A. rufoaurantiacus*, *Chlorophyllum hortense* and *Volvopluteus earlei* among others, were collected only from two substrates (soil/ and plant residue). The other genera (most of it) occurred in only one substrate. Peaks macromycetes was in May and October, when the average temperature remained between 22 - 26°C and relative humidity between 78% and 92%. The occurrence of macromycetes was higher in May, when the temperature was milder and stable on average 24°C. Found that Adjara support a large and diverse community of macrofungi fruiting on soil, many species of which are previously undiscovered and undescribed. On this basis, works of longer duration and more intensive sampling are needed to obtain data regarding fungal communities, with more attention to specific variables such as microclimate, soil moisture, soil type, soil pH and vegetation types.

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**SEISMIC ANALYSIS OF A LIMESTONE ROCK SLOPE THROUGH NUMERICAL MODELLING: PSEUDO-STATIC vs. NON-LINEAR DYNAMIC APPROACH**

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**ABSTRACT**

Earthquake-induced landslides represent one of the main hazardous effects of strong seismicity in mountainous areas and pose a severe threat to human lives and settlements. When considering rock slopes subject to seismic waves, cyclic loading associated with the ground motion can determine localised, overstressed areas within the rock mass where intact rock fracturing initiates and propagates through the coalescence of pre-existing discontinuities. During the seismic shock, crack growing can lead to the enucleation of a fully persistent failure surface, thus leading to the slope collapse. In the present work, a seismic analysis has been performed in advance on a natural rock slope (height = 150 m) outcropping along the Tagliamento River valley, in the Friuli Venezia Giulia Region, north-eastern Italy. The analysed rock slope is made up of stratified limestone and is characterised by a strong rock mass damage, thus resulting in a critical stability condition. A number of internal unstable blocks are susceptible to failure along a partially formed bi-planar rupture surface (unstable volume = 200,000 m<sup>3</sup>). The seismic analysis has been performed adopting the 2D finite difference method (FDM), in order to investigate the stress-strain behaviour of the rock mass. For comparison purposes, both a pseudo-static approach and a non-linear dynamic approach have been adopted. In the pseudo-static approach, only seismically induced inertial forces have been considered and different values of the Peak Ground Acceleration (PGA) have been assumed, according to the reference acceleration values provided by the seismic hazard map for Italy (MPS04). In the non-linear dynamic approach, a real earthquake record has been considered. The seismic input has been implemented in the simulations according to the expected characteristics at the study site. Model outcomes demonstrate that the seismic motion induces internal, localised ruptures within the rock mass. However, some important differences in the mechanical behaviour of the rock slope have been highlighted, depending on the specific modelling approach assumed. When adopting a pseudo-static approach, the slope failure occurs for PGA values ranging between 0.056 g and 0.124 g, depending on the different initial static stability condition assumed for the slope (Strength Reduction Factor SRF = 1.00–1.15). According to the non-linear dynamic approach, the slope failure is achieved for PGA values varying between 0.056 g and 0.213 g, depending on the assumed initial stability condition. Slope displacements before failure calculated with the pseudo-static approach (12–15 cm) are much greater than those obtained through the non-linear dynamic approach (0.5–3 mm). The modelling results obtained through the non-linear dynamic analysis also testify to that the seismic topographic amplification is 1.5 times the target acceleration at the slope face and 2.5 times the target acceleration at the slope toe. The outcomes of the numerical simulation highlight that the pseudo-static approach is also weightier compared with the non-linear dynamic analysis.

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**COMBINED FIELD AND STRUCTURE FROM MOTION SURVEY TO IDENTIFY ROCK DISCONTINUITY SETS OF A SHALLOW ROCKSLIDE**Alberto Bolla <sup>1</sup>, Alberto Beinat <sup>2</sup>, Paolo Paronuzzi <sup>1</sup>, Chiara Peloso <sup>2</sup><sup>1</sup> Polytechnic Department of Engineering and Architecture, University of Udine, via Cotonificio 114, 33100 Udine, Italy<sup>2</sup> Polytechnic Department of Engineering and Architecture, University of Udine, via delle Scienze 206, 33100 Udine, Italy**ABSTRACT**

Rock slope failures are controlled by a number of factors, including among others, the degree of fracturing of the rock mass involved in the rupture and the specific orientation of the geological discontinuities within the rock mass. Therefore, the identification of the discontinuity sets affecting the unstable rock mass is mandatory to properly predict the potential failure mechanism, the unstable volume and the related slope stability condition. In common practice of rock mechanics, discontinuity sets affecting a rock mass are recognised on the basis of a representative statistical sample of joint orientation measurements acquired from the field through a traditional geological compass. However, field operative conditions may result as dangerous owing to possible block collapses or not feasible for inaccessible or highly vertically extended outcrops. To obviate these limits, in the last decade Remote Sensing (RS) techniques have been increasingly applied. Among them, the Structure from Motion (SfM), an automated photogrammetric technique based on computer vision algorithms, allows for the reconstruction of a high-resolution and an accurate 3D virtual model of the surveyed outcrop by means of a large set of overlapping images taken with a common digital camera, along with a limited set of accessory Ground Control Points (GCP). The reconstructed geometrical model consists of a dense 3D point cloud that is subsequently analysed by a discontinuity set extractor to estimate rock joint orientations within a surveyed rock mass. However, discontinuity sets extracted from point clouds are rarely compared with a significant statistical sample of joint orientation measurements directly acquired from the field. This prevents thorough awareness of the strengths, and especially, of the drawbacks in the use of 3D digital models produced by RS techniques to analyse the structural arrangement of rock masses. To address this issue, the present work shows the results of a combined field and SfM survey performed on the detachment surface of a shallow rockslide that occurred in the Rosandra Valley (Trieste, NE Italy), which was aimed at testing the use of 3D models obtained from RS techniques to identify joint sets affecting unstable rock masses. According to discontinuity orientation data acquired from the field ( $N = 223$ ), the investigated rock mass is affected by eight joint sets characterised by a notable variability. The extraction of joint sets from the 3D point cloud representing the surveyed rock outcrop was strongly sensitive to the point cloud density and the values of the controlling parameters of the density function embedded within the discontinuity extractor. This work demonstrates that, in order to properly identify rock joint sets, the exclusive application of a RS approach cannot fully substitute the traditional field survey, and the estimation of discontinuity sets should be integrated with joint orientation data acquired using a geological compass. To maximise its capabilities, the semi-automatic discontinuity set extraction from 3D point clouds should always be supported by a significant statistical sample of joint orientation measurements that are preliminarily collected from the field.

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## **DYNAMIC ANALYSIS OF THE TANK FOR BIOGAS PRODUCTION**

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### **ABSTRACT**

Global warming is a phenomenon that increase our awareness of the importance of protecting nature. The today's biggest problems are the lack of water in the world and the treatment and disposal of waste. This is the main reason why we try to recycle, use more renewable energy sources and treat waste ecologically. Due to the lack of water, there is a need to design drinking water tanks. On the other hand, in the management of waste, we need to design sludge tanks for wastewater treatment. Currently, there is a development of the use of tanks for biogas production, the so-called fermenters. For built-up areas, respecting space usability, it is more appropriate to design tanks with a rectangular floor plan (rectangular tanks). We can also use a system of rectangular tanks and thus achieve the most efficient use of space that is intended for them. This article shows the solution of a rectangular tank with floor plan dimensions of 11 x 7.5 meters. The height of the tank is 2.0 meters and the wall thickness is 200 mm. The structure is placed on an elastic subsoil. The elastic subsoil was modeled using the Winkler model. The solved tank is intended for biogas production, where the digestive sludge had a height of 1.5 m and its specific gravity was 12 kN/m<sup>3</sup>. In the first stage of the calculation, a modal analysis was performed, where the natural frequencies of the structure were calculated. The first natural frequency was 28.9 Hz. The second part of the calculation followed - spectral analysis. The seismic load was using the excitation spectrum taken from the EC (Eurocode) standard regulations. The spectral analysis resulted in tank deformations caused by seismic loading. The internal forces in the tank walls were also achieved by calculation. These were bending moments and normal and shear forces. The tank was modeled in the ANSYS program, which calculates on the basis of finite element method. In order to prevent damage to tank's structure caused by the filling, the design of the structure must be observed, as well as the material from which it is constructed during construction phase of the tank. The sludge may also contain substances that could contaminate the environment and groundwater. Thanks to detailed calculations in the field of dynamics, the integrity and load-bearing capacity of the tank will be ensured and there is no risk of leakage of its filling.

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**ON THE DETERMINATION OF A LOCALLY OPTIMIZED ELLIPSOIDAL MODEL OF THE GEOID  
SURFACE IN SEA AREAS**

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**ABSTRACT**

Deriving a local geoid model has drawn much research interest in the last decade, in an endeavour to minimize the errors in orthometric heights calculations, inherited by the use of global geoid reference models. It is well known that in most parts of the earth, the local geoid surface may be tens of meters away from the Global Reference biaxial Ellipsoid (WGS84), which create numerous problems in topographic, environmental and navigational applications. Several methods have been developed for optimizing the precision of the calculation of the geoid heights undulations and the accuracy of the corresponding orthometric heights calculations. The optimization refers either to the method used for data acquisition, or in the geometrical method used for the determination of the best fit local geoid model. In the present work, we focus on the reference ellipsoid used for the geometric and geoid heights determination and develop a method to provide the one that fits best to the local geoid surface. Moreover, we consider relatively small sea regions and near to coast areas, where the usual methods for data acquisition fail more or less, and we pay attention in two directions: To obtain accurate measured data and to have the best possible reference ellipsoid for the area at hand. In this due, we use the “GNSS-on-boat” methodology to obtain direct sea level data, which we induce in a Moore Penrose pseudoinverse procedure to calculate the best fit triaxial ellipsoid. This locally optimized reference ellipsoid minimizes the geometric heights in the region at hand. The method is applied in two closed sea areas in Greece, namely Corinthian and Patra’s gulf. Taking into account all factors of uncertainty, the precision of the mean sea level surface, produced by the “GNSS on boat” methodology, was estimated at 5.43 cm for the gulf of Patras and at 3.76 cm for the Corinthian gulf. The average difference of this surface and the local triaxial reference ellipsoid, calculated in this work, is found to be less than 7 cm, whereas the corresponding difference with respect to WGS84 is of the order of 30m.

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## ENZYMATIC ACTIVITY OF BACTERIA ISOLATED FROM POLAR MICROBIAL MATS

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### ABSTRACT

Polar environments, characterized by extremely conditions as very low temperatures, low availability of nutrients and water, from years have been the subject of a variety of scientific research, including biological research. Bacteria living in extremely environments, due to the creation of unique metabolic pathways, they can have properties that are potentially useful in a variety of biotechnological applications. Enzymes produced by bacteria from extreme environments are often used by humans, which encourages to searching for new strains and potentially useful enzymes produced by them with application potential, for example in biotechnology or various industries. Research material was 50 strains of bacteria isolated from microbial mats occurring in watercourses in the foreground of the Ecology Glacier (King George Island, Southern Shetland Islands, Antarctica). The ability of bacteria to produce hydrolases and to fix molecular nitrogen was investigated. Production of proteases was checked on medium with addition of skimmed milk powder, lipases production on medium with addition of Tween-20, production of amylases was checked on starch agar, and solubilization of phosphorus compounds on PVK medium (Pikovskayas agar). Also, ability to fixing of nitrogen from atmosphere was tested on medium not containing ingredients with that element. Inoculation of testing plates was made through puncture the inoculation loop with bacterial colony from R2A agar. Inoculated plates was incubate in 6°C by 14 days. From analyzed strains 3 did not showed any of tested ability - no growth on the medium for diazotrophic bacteria and no growth, or growth but no reaction, on the remaining test media. Only one strain did not produce not even one of tested enzymes, but show ability to nitrogen fixing. In total nitrogen-fixing ability showed 37 from tested strains, 38 strains had ability to proteases production. The same number of strains produced lipases. Capability to solubilization of phosphorus compounds was detected in 22 strains. Only 36% of isolated bacteria was characterized by amylases production. In terms of number of produced enzymes, 40% of strains were produced 3 enzymes, 22% one kind of enzyme and 14% two of them. Ability to produce all from 4 tested groups of enzymes showed 8 bacterial strains. All of the most active strains had the ability to fixing of atmospheric nitrogen. Obtained results indicate high metabolic activity of microorganisms living in microbial mats. Due to extreme conditions in the environment of the presence of microbial mats (low temperature (c.a. 2°C), high level of UV radiation, low nutrient concentration) high physiological and enzymatical activity favors development of microorganisms using trophic components found in mats, dominated by autotrophic algae and cyanobacteria. The fact that the occur in multi-species, and often multi-domain consortia, additionally increases the competition between microorganisms present in them.

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## **INFLUENCE OF CONTROL POINTS CONFIGURATION ON THE MOBILE LASER SCANNING ACCURACY**

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### **ABSTRACT**

Mobile mapping systems (MMS) are becoming widely used in standard geodetic tasks more commonly in the last years. The paper is focused on the influence of control points (CPs) number and configuration on mobile laser scanning accuracy. The mobile laser scanning (MLS) data was acquired by MMS RIEGL VMX-450. The resulting point cloud was compared with two different reference data sets. The first reference data set consisted of a high-accuracy test point field (TPF) measured by a Trimble R8s GNSS system and a Trimble S8 HP total station. The second reference data set was a point cloud from terrestrial laser scanning (TLS) using two Faro Focus3D X 130 laser scanners. The coordinates of both reference data sets were determined with significantly higher accuracy than the coordinates of the tested MLS point cloud. The accuracy testing is based on coordinate differences between the reference data set and the tested MLS point cloud. There is a minimum number of 6-7 CPs in our scanned area (based on MLS trajectory length) to achieve the declared relative accuracy of trajectory positioning according to the RIEGL datasheet. We tested two types of ground control point (GCP) configurations for 7 GCPs, using TPF reference data. The first type is a trajectory-based CPs configuration, and the second is a geometry-based CPs configuration. The accuracy differences of the MLS point clouds with trajectory-based CPs configuration and geometry-based CPs configuration are not statistically significant. From a practical perspective, a geometry-based CPs configuration is more advantageous in the nonlinear type of urban area such as our one. The following analyzes are performed on geometry-based CPs configuration variants. We tested the influence of changing the location of two CPs from ground to roof. The effect of the vertical configuration of the CPs on the accuracy of the tested MLS point cloud has not been demonstrated. The effect of the number of control points on the accuracy of the MLS point cloud was also tested. In the overall statistics using TPF, the accuracy increases significantly with increasing the number of GCPs up to 6. This number corresponds to a requirement of the manufacturer. Although further increasing the number of CPs does not significantly increase the global accuracy, local accuracy improves with increasing the number of CPs up to 10 (average spacing 50 m) according to the comparison with the TLS reference point cloud. The accuracy test of the MLS point cloud was divided into the horizontal accuracy test on the facade data subset and the vertical accuracy test on the road data subset using the TLS reference point cloud. The results of this paper can help improve the efficiency and accuracy of the mobile mapping process in geodetic praxis.

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**MAGNETIC PROPERTIES OF IMPACT UHPHT GLASSES, MELT ROCKS, SUEVITIC BRECCIA  
AND TARGET ROCKS OF THE GIANT KARA METEORITE CRATER  
(PAY-KHOY, ARCTIC SEASHORE, RUSSIA)**

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**ABSTRACT**

The shock waves can strongly change the physical properties of the target rock minerals including their density and magnetism which determine petrochemical properties of impactites finely as a rule are resulted in astroblemes contours on geophysical maps. Following to the aero-magnetic mapping data the non-magnetic sedimentary rocks of the Kara target create a zero and negative magnetic field with an average intensity of -1 nT, against the background the southwestern region of the Kara astrobleme provides the positive magnetic anomalies with an intensity of 1 to 3 nT which are in a good correspondence with the Pay-Khoy ridge structure general orientation. The Kara dome is characterised with an isometric negative anomaly of intensity -5 nT. Here we present the magnetic properties of the different kinds of the Kara impactites including impact ultra-high pressure high temperature (UHPHT) melt glasses, melt rocks and suevitic breccia compare to sedimentary target rocks. The petrophysical measurements presented the specific magnetic susceptibility of the impactites in the range of 8 to  $48 \times 10^{-8}$  SI units, where the UHPHT glasses have the limits from 9 to  $38 \times 10^{-8}$  SI units ( $15 \times 10^{-8}$  SI units, in average). The sedimentary target is characterised with essentially lower level of magnetic susceptibility – no higher than  $15 \times 10^{-8}$  SI units, where limestone has it about zero. Following to the similar level of the iron content within the impactites and target rocks the magnetism of the Kara impact melts is explained rather by changing of magnetic properties by the impact process. One of the possible source of magnetism can be partially an iron-containing matter of the asteroid component in the form of pyrrhotine accompanied with Ni and Co impurities. Also, we cannot exclude partial presence of magnetic iron component directly within the quenched impact glasses including UHPHT variety.

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**PRELIMINARY PETROLOGICAL AND GEOCHEMICAL STUDIES OF DOLERITE DIKES AT THE KARA  
ASTROBLEME CENTRAL UPLIFT, COMPARISON WITH UHPHT IMPACT MELT GLASSES (PAY-KHOY,  
RUSSIA)**

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**ABSTRACT**

Recent find of the ultra-high pressure high-temperature (UHPHT) impact melt glasses among the impactites of the Kara astrobleme has a high interest in nicely preserved 70 Ma glass with potentially unusual structure and properties. By the moment, it is important to understand about the substance source for the UHPHT glasses. The Kara target is characterized with complicated rock material preferably presented with Paleozoic sedimentary units. At the same time, the target has in a sequence Devonian sills and dikes of gabbro-dolerites. The latter appear on the surface at the Kara dome being a material which probably have been affected by the strongest impact. Here we for the first time describe the results of preliminary analysis of petrological and geochemical features of the magmatic dikes of the central uplift with the aim to understand their probable genetic source for the UHPHT impact melt veins matter. The provided studies point to essential difference between the compared materials, that means the UHPHT impact melts do not correspond to the magmatic material of the Khengursky complex of gabbro-dolerites of the Pay-Khoy Ridge (Russia).

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**PETROLOGY OF GRANITOIDS OF THE SELENNYAKH RIDGE (VERKHoyANSK-KOLYMA OROGENIC BELT)**

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**ABSTRACT**

The Verkhoyansk-Kolyma orogenic belt is characterized by intense Late Mesozoic granitoid magmatism. Numerous granitoids plutons form longitudinal belts, elongated parallel to the boundaries of major tectonic structures (Main and Northern), and transverse belts, oriented across or at an angle to them. The Main belt is dominated by massifs of granodiorite-granite composition, accompanied by tin-tungsten, boron-tin, and gold mineralization of various scale. Therefore, understanding their petrological and genetic characteristics and crystallization conditions leading to the generation of mineralization is of not only theoretical but also practical interest. The aim of the research was a detailed study of petrography, geochemical features and crystallization conditions of granodiorite-granite massifs of the Selennyakh block of the Omulevka terrane of the Kolyma-Omolon microcontinent that forms part of the Verkhoyansk-Kolyma orogenic belt. It was found that the formation of granitoids took place in an active continental margin setting and was long-term and complex. During the evolution of magmatism, the homodrome character of development (granodiorites → granites → leucogranites and aplites) was replaced by the antidrome one (granite-porphyries and granodiorite-porphyries). The Rb-Sr isotopic age of the rocks varies from 136 to 122 Ma. The generation of the parent melts for the granitoid massifs occurred within the lower crust at the boundary between amphibolite and dacite-tonalite substrates at temperatures of 1070–990° C and a pressure of 1.1–0.9 GPa. These parameters are comparable to those of the melt that formed the granodiorite- porphyry dikes: 990° C and 0.94 GPa. Maintaining high temperatures of the melt formation from initial to final derivatives at deeper levels of the magma chamber with a simultaneous increase in their fluid saturation requires the supply of juvenile heat and fluids. The main mineral in the territory is tin. The formation of mineralization is associated with late fluid-saturated derivatives of the granitoid melt. During the crystallization of leucogranites and pegmatites, fluorine was the main Sn-extracting agent. With depth, in the course of crystallization of granite and granodiorite porphyries, boron and then sulfur became the major extractants of tin.

**POLYFORMATIONAL AGDAI MASSIF (VERKHOFYANSK-KOLYMA OROGENIC REGION)**

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**ABSTRACT**

The earliest Mesozoic granitoid formations of the Verkhoyansk-Kolyma orogenic region are derivatives of the Late Jurassic-Early Cretaceous gabbro-diorite-granodiorite formation, involving gold and polymetallic mineralization. Late Cretaceous alkaline-feldspar or alkaline granites with associated rare-earth mineralization complete the granitoid magmatism of the region. The Agdai massif, which combines both of the mentioned groups of rocks, was the object of our research. Therefore, understanding their petrological and genetic features is of great interest. It is determined that the eastern part of the massif is composed of diorites and granodiorites and includes autoliths and xenoliths of gabbro-diorite composition. The isotopic K-Ar age of gabbro-diorites is 154 Ma, diorites –148 Ma, granodiorites –117–124 Ma, and dike granites – 114 Ma. The rocks are characterized by disequilibrium mineral assemblages: early magmatic pyroxene-Labrador, typical for the basic rocks, and late - micropegmatite granitoid. The origin of the parent melts occurred within the lower crust in amphibolite substrates at temperatures of 1000–1150°C and a pressure of 1.4-1.6 GPa under the influence of the mantle main melt and the partial mixing of the latter with the resulting crustal melt. The western part of the outcrop was formed at the beginning of the Late Cretaceous (the isotopic K-Ar age of the granites is 92±3 Ma) and is composed of alkaline feldspar leucogranites. According to all petro- and geochemical parameters, the rocks are defined as post-orogenic or rift-related granites of the A-type. The presence of inclusions of pyroxene-labrador composition, titanomagnetite, zircon of morphotype D and the ratio of the basic petrochemical parameters allow us to refer them to A-type granites related to continental rifting. High melt temperatures (990-1030°C) at relatively low pressures during magma generation (0.7–0.8 GPa) could be achieved only when additional heat was supplied from an external (deep) source. The presence of nonequilibrium mineral associations indicates a possible syntax of the granite and the main melt. In general, the Agdai massif is a polyformational, polygenic structure formed by the intrusion of melts through common or closely located magma conduits.

## GEOCHEMICAL CHARACTERISTICS OF THE DEEP-SEA SEDIMENTS FROM A HIGH POLYMETALLIC NODULES AREA IN THE CLARION-CLIPPERTON FRACTURES ZONE, NE PACIFIC

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### ABSTRACT

Geochemical characteristics of the deep-sea sediments from a high polymetallic nodules area in the eastern part of the Clarion-Clipperton Fractures Zone (CCZ), NE Pacific were studied. Box-core samples from six stations in individual depth layers 0–3, 3–5, 5–10, 10–20 cm were collected from 4,300–4,500-m depth during the 2019 Interoceanmetal cruise. The on board processing documented light brown siliceous silty clay down to 45-cm with a semiliquid dark brown clay variety (7–12 cm thickness) on the top, denoted as geochemically active layer (GAL). The GAL Eh ranges between +462 and +545 mV and decreases with depth while pH data vary in short span (7.01–7.52). An amorphous phase (biogenic opal, authigenic Fe-Mn (hydr)oxides and clay minerals) predominates. The crystalline phases are presented by illite, kaolinite, chlorite, quartz, andesine, halite, cristobalite and barite. The chemical composition of the studied samples is compatible to this of pelagic sediments (Li and Schoonmaker, 2014) having high concentration of Na, S, Sr, Ba, Sc, Ge, Cu, Ag, Sb, W, Y, MREE, HREE and low concentration of Al, Si, Fe, Mn, P, V, Zr, Nb, Ta, Pb, As, Mo, Ce. Based on their high Al/(Al+Fe+Mn) ratio (0.57) the sediments can be considered as non-metalliferous, although they host significant quantity of Fe-Mn nodules. Manganese content varies from 0.16% to 0.70% (average 0.49%) being the highest in the first layer (0-3 cm) and in the GAL and decreases in depth. Iron content is from 4.10% to 4.99% (average 4.60%) and does not have any significant variation in depth. The Mn/Fe ratio varies from 0.03 to 0.16 (average 0.11) being the highest in the first layer (0-3 cm) and decreases in depth. Barium, Co, Ni and Cu have the highest concentrations in the first (0-3) and second (3-5) layers and decrease in depth. The different type ternary diagrams classify the samples as hydrothermal or as hydrogenetic sediments.  $\Sigma$ REE in the studied samples varies between 195.84 and 357.79 ppm (average 245.79 ppm). Similarly the  $\Sigma$ REY varies between 247.44 and 457.91 ppm (average 315.48 ppm) but they have low variations between layers. Chondrite-normalized REE reveal similar patterns with negative Ce (0.73) and Eu (0.77) anomalies. Both NASC and PAAS-normalized REE patterns show similar values for LREE and significant enrichment of MREE and HREE with strong negative Ce anomaly and weak positive Eu and Y anomalies. The geochemical characteristics of the studied sediments infer polygenic origin. The negative Ce anomaly, Eh values, redox sensitive oxides and barite show oxidizing environment of formation. The survey of the polymetallic nodule resources requires knowledge on both sediments and nodules in order to estimate their value and the anticipated environmental impact during the potential mining operations.

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**CLASSIFICATION AND MODELLING OF FRACTURED ROCK MASSES FOR SLOPE STABILITY  
ASSESSMENT IN A LIMESTONE QUARRY: A CASE STUDY**

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**ABSTRACT**

Various types of instability can develop in quarry slopes according to the characteristics of the different geological structures, the nature of the rock mass and the ability of the rock. The aim of this research is to identify the different modes of failure likely to develop within the fractured limestone quarry jebel Medjounes (Setif-North eastern Algeria) as a case study. The results of the RMR, GSI classifications, indicate that the rock mass of the quarry of jebel Medjounes constituted of formations of average to good qualities. These results used, by the following, for the evaluation of the mechanical parameters of the rock mass of the quarry. The results of the SMR classification show that the quarry presents possibilities of ruptures of various types (planar, dihedral, tilting) at the level of the rock formations. We also performed an analysis using the Rock Stability Geo-Structural Analysis software with the same rock slope profile studied analytically. From the results of the analytical study made and the results obtained from the analysis of the stability of the rocky slope, we can draw the following results: -The safety factor decrease considerably with the increase of the water level in the traction fracture.-The formation of a tensile fracture also contributes to the decrease of the safety factor for the case of planar failure. The filling of cracks with seepage water from precipitation has a very destabilizing effect because of the forces exerted by this water. -The existence of ridge cracks influences the safety coefficient because it minimizes the forces resisting sliding.

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## **PERFORMANCE MEASUREMENT IN CZECH CONSTRUCTION COMPANIES WITH REGARD TO THE ENVIRONMENTAL RESPONSIBILITY**

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### **ABSTRACT**

The importance of environmental protection is growing rapidly among the construction industry. Performance measurement as an important tool for a more effective construction process reflects this new direction of business thinking. Performance measurement systems have been implemented new criteria for measurement with respect to the environment. The main aim of this paper is to evaluate if Czech construction companies measure these new implemented environmental criteria. Most important criteria such as waste management, emissions production and water management were emphasized. Original data were collected using a questionnaire survey. The survey was also focused on construction materials responsibility and recycle/reuse measurement as well. The results of the study show that less than half of construction companies in the Czech Republic actively measure the impact on the environment. However, almost three-quarters of companies are aware of its importance for the future of the construction industry and environmental responsibility. Only 2 % of Czech construction companies do consider that environmental responsibility is not important at all. The most frequently measured criterion is waste management, on the contrary, the least frequent is the number of recyclable materials used on the construction site. There is a need to accelerate efforts to help construction companies identify appropriate ways how to start measure environmental criteria. Construction companies that do not measure environmental criteria need to be widely informed about the importance of the sustainability in the construction industry. The best tool to achieve this is an information campaign. The appropriate form of the campaign and its content should be most important part of follow-up research.

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**THE COLLECTIONS OF THE ARCHIVE OF THE HISTORY OF GEOLOGY A GEOHISTORICAL  
HERITAGE AT THE UNIVERSITY OF VIENNA**

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**ABSTRACT**

The collections of the Archive of the History of Geology at the University of Vienna go back to the initiative of the former head of the Geological Institute Alexander Tollmann (1928-2007). He collected documents from the 1970s at the former institute and transferred them into a separate depot when relocating of the institute in 1997 to the present Geozentrum in the 19th district of Vienna, Althanstrasse 14. He arranged and labeled a number of documents. Many documents of the institute were collected and preserved in various files during the management period of Alexander Tollmann including also his personal records. Thus, there are documents about new acquisitions of the institute and also books about excursions. Partial, but also entire estates of various geoscientists, were collected in colorful boxes. An interesting part of Eduard Suess's (1831-1914) estate, the first professor of the Geological Institute, contains a lot of handwritten records. Alexander Tollmann sorted and described a small number and put them into files. Likewise, part sorted or unsorted estates were obtained from well-known geoscientists, such as Martha Cornelius-Furlani (1886-1974) and her husband Peter Cornelius (1888-1950). An extensive estate by Walter Medwenitsch (1927-1992) was found in colorful boxes in an extremely chaotic state. As a side note: there is a beautiful collection of beer mats and even collectors magazines. This gives an indication for the preference of Medwenitsch for beers. These legacies were already rearranged and labeled by the author. A geological map of the Eastern Alps painted by Leopold Kober (1883-1970) had been restored. Kober named it "Tektonogramm", dated in 1937. A large collection of slides with geological content from the estate of Alexander Tollmann has been preserved. Similarly, many slides of Walter Medwenitsch exist in a disorderly state. In the estate of Tollmann and Medwenitsch there are a series of photos of geoscientists and of geological excursions. A collection of about 1000 pieces of black and white glass photo plates, in excellent condition, are already digitized. An extensive collection of hammers dating back to the time of Eduard Suess has already been brought into shape. At the request of the current head of the institute, Prof. Mag. Dr. Bernhard Grasemann, the author took up the task of organizing, systematizing, digitizing and making accessible this extensive collection in modern archive boxes to the interested audience, professors and students alike.

## GROUNDMASS CHROMOSPINELLIDES FROM KIMBERLITES OF KHOMPU-MAY KIMBERLITE FIELD

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### ABSTRACT

Chromospinelles from the kimberlite mesostasis of the Erel, Turakhskaya, Manchary, Aprelskaya, and Artemova pipes Khompu-May kimberlite field (Central Yakutia) are presented. Despite the similar texture and structure features and mineral content of kimberlites of the Khompu-May field, the composition of chromospinelles within each of pipes is individual. Groundmass chromium spinel of kimberlites of the Aprelskaya and Erel pipes is characterized by highest content of aluminum oxide (> 10 wt. %) in contrast to other kimberlite bodies of the Khompu-May field and, most likely, crystallized before the mesostasis phlogopite. Chromites from the Erel and Turakhskaya pipes, as well as a small part from the Manchary pipe, form a single field of compositions in a  $\text{Cr}_2\text{O}_3$  vs  $\text{TiO}_2$  coordinates, with low titanium oxide contents (< 4 wt. %). Such a low amount of titanium in the mineral may be interpreted by the presence in the bulk of perovskite, as main titanium concentrator mineral. In other pipes of the Khompu-May field perovskite is occur in minor amounts and  $\text{TiO}_2$  content in chromites in this case reaches up to 12 wt.%. As a result of the study of microcrystals of chromospinelles, two trends in the evolution of the mineral described by Mitchell (1986) were identified – ulvospinel, appropriate to typical kimberlites, and titanomagnetite, which is characterized by micaceous kimberlites. Chromites from the Turakhskaya and Artemova pipes are characterized only by the ulvospinel trend, as are the chromospinelles from the Aprelskaya and Erel kimberlite pipes. For spinellides from the Manchary pipe, in addition to the ulvoshpinel trend, there is also a titanomagnetite one, that evidence two stages of mineral crystallization. At the first stage, groundmass spinel crystallized before mesostasis phlogopite formation, and at the second stage - simultaneously with the mica, which took aluminum and magnesium from melt before formation of the spinel main part. The presence of titanomagnetite trend is associated with crystallization of phlogopite, which is occur in bulk of least modified kimberlites from deep horizons of the Manchary pipe.

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## **IMMISSIONS PROFILING USING AI**

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### **ABSTRACT**

Continuous development of modern society, based on quantitative expansion of industrial activities, diversifies the nature of pollutants and intensifies the processes of atmospheric emissions, which are transferred to a receiver as immissions. Magnitude and evolution of pollutants resulting from industrial activities, in the atmosphere, is dependent on local climatic conditions and is differentiated depending on the type of industrial activities carried out. The main objective of the research is identification of immission profiles according to the type of industrial activities. Hierarchical cluster and silhouette analysis algorithms applied on chronological sets of records, were used for the analysis. Additionally, the first three main components were used to visualize the clusters found. The first part of the paper briefly analyses the issue of environmental protection and specific regulations at national and European level, followed by a presentation of the database of environmental parameters and description of the theoretical concept of data processing. The last part of the paper is dedicated to discussing results, which indicate the occurrence of immission patterns (profiles) measured in different locations and time periods. The (anonymized) location was taken into account for investigating location influence over immission profiles. Due to using the mobile laboratory, high leap in the temporal dimension was considered as starting timing for a new location. The records' dimension space was augmented with a parameter resulting from R/S analysis (Hurst exponent) for further characterization of immission persistence. Analysis of the topology of clusters associated with immission profiles highlighted the presence of sparse clusters that have large deviations from daily average values and the presence of dense clusters with small deviations from daily average values. The suggested method allows the classification of industrial activities according to immission profile obtained, for objective comparison of effects generated on ecosystems in other regions.

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**COMPARATIVE CHARACTERISTICS OF STRUCTURAL-TEXTURAL, MINERALOGICAL AND  
PETROCHEMICAL FEATURES OF MELT ROCK IMPACTITES OF THE KARA ASTROBLEME:  
PRELIMINARY DATA (PAY-KHOY, RUSSIA)**

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**ABSTRACT**

The Kara astrobleme is one of the largest astroblemes known on land. Its diameter is ~65 km, the age is about 70 million years. The astrobleme is located at the northeastern part of the Pay-Khoy anticlinorium at the Kara river mouth region (Kara sea coast, Russia). It is a unique object of impact genesis due to the presence of a variety of suevites and melt impactites. Melt rocks are products of the highest degree of impact transformation of target rocks. The diversity of melt rock impactites of the Kara astrobleme and obtaining their complex comparative mineralogical and petrochemical characteristics are important for solving the fundamental problem for studying of the typomorphism of the impactitogenesis products of melt rocks both – the impactites of the Kara astrobleme and other astroblemes in general. In the Kara astrobleme region there are at list two different types of massive melt rocks bodies – a cover melt rock at the Anaroga River (I) studied by previous researchers and an unexplored body of melt rock impactite at the Kara River (II) spatially connected with ultrahigh-pressure high-temperature glasses just recently discovered. Our preliminary data indicate that the melt rock varieties of the Kara astrobleme have significant differences in texture and structure. The considered melt rocks are mostly composed of a matrix represented by a “mixture” of amorphous and cryptocrystalline masses of predominantly feldspar composition with a subordinate SiO<sub>2</sub> content. According to the data of energy dispersive analysis the compositions of the studied melt rocks are similar and have minor deviations within the first percent. The difference in the shape of silicate segregations in melt rocks may indicate that the impact melt could have a high temperature with a shorter time interval for the solidification of melt rock II on the Kara river, in contrast to the massive melt rock I on the Anaroga River, where the impact melt had large volume and, accordingly, was cooled longer at lower temperatures. The data obtained complement the specificity of the Kara melt impactites, which may play a role in complementing the geological model of the Kara astrobleme. The reported study was funded by RFBR, project number 20-35-90065; the analytical equipment has been used at the Center for Collective Use “Geonauka” (IG Komi FRC SC UB RAS, Syktyvkar, Russia); the author expresses his gratitude to Isaenko S.I. for analytical work using Raman spectroscopy; Tropnikov E.M. for help in performing microprobe studies.

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**PETROGRAPHIC AND PETROCHEMICAL CHARACTERISTICS OF SUEVITE MATRIX, WESTERN  
PART OF THE KARA ASTROBLEME (RUSSIA)**

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**ABSTRACT**

The Kara Astrobleme is a unique geological object located in the northwestern part of the Arctic zone of Russia. Impactites from the Kara crater are diamondiferous to various degrees. At present the Kara suevites are relatively poorly studied. Until now the petrographic features of the matrix have been described in general terms, and petrochemically the cementing mass of the suevites has not yet been studied. In 2015 suevite breccias of the southern part of the Kara Astrobleme were subdivided into three different types. It was later suggested that the suevites of the western part of the impact crater, located at the Put'yu and Sayakha rivers, could be type II suevites, but at the same time they had a number of distinctive features which might be associated with different formation conditions of these rocks. Hence it is relevant to study the matrix of the suevites of the mentioned areas to clarify their facies and formation features. The paper presents results of a comprehensive study with a detailed description of the suevite matrix at Put'yu and Sayakha rivers conducted for the first time for the suevites of the Kara Astrobleme. Through optical and microprobe studies we described petrographic and petrochemical features of the cementing mass of the suevites. We discovered that the matrix of the studied rocks was characterized by the similarity of the mineralogical composition, but differing in structural and content features. We found that all the studied rocks belonged to the aerodynamic ejection facies, within which they differed in the temperature conditions of formation which might be associated with the different initial position of the suevite material in the impact cloud. The research results clarify the type and facies of suevites in other areas of the impact structure that will allow defining facies variability and detail characteristics of suevite breccias of the Kara Astrobleme. The obtained data demonstrate genetic regularities of impactites and allow predict the diamond content of the Astrobleme as a whole.

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**RAILWAY TUNNEL PORTAL AS PART OF RAILWAY MODERNIZATION**

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**ABSTRACT**

Tunnels can be built using the cut-and-cover method that consists in temporary removal of the surface above a trench or the tunnel is built on the surface and is buried later. The geological properties of the area are very important for correct construction of all types of tunnels. A geological and hydrogeological survey must be carried out to provide the necessary data on the local engineering-geological and hydrogeological conditions at the construction site. It is important to obtain sufficient amount of data on the geomechanical properties of the surface rock and rock massif for the elaboration of documentation and evaluation of possible changes of the hydrogeological regime caused by the construction. The structure of the analyzed tunnel block is a reinforced concrete vault with a base plate. The length of the block is 10.0 m. The base plate has the shape of a horizontal "C" letter with two thicknesses. The plate is 2.58 m long. At its edges on both sides its thickness is 1.47 m and elsewhere it has a thickness of 1.0 m. The total width of the base plate is 14.4 m. The reinforced concrete vault has a variable thickness. At the bottom of the base plate, the thickness of the vault is 0.975 m and at the top of the vault it is 0.5 m thick. The vault is bevelled at the beginning of the block and at the end its top is 8.87 m from the base plate. The supports are designed as flat supports on the lower surface of the base plate with regard to the geological structure of the subsoil. The RF-SOILIN additional module of the RFEM program was used. The aim was to create a model of the portal part of the railway tunnel and its subsequent analysis using the RFEM program by Dlubal Software Company. The first westward tunnel block of the portal part of the cut-and-cover tunnel called Diel situated near Púchov in Slovakia has been analyzed in the paper. The demarcation coordinates available in the project documentation were used to create the model in the RFEM program by Dlubal Software Company. After creating the model, all types of loads acting on the structure were considered. Subsequently, the individual load cases and their mutual combinations were entered. Boundary conditions were specified using the RF-SOILIN additional module, which allows the geological conditions of the subsoil to be taken into account. After the calculation, the obtained values of deformations were analyzed and the stress analysis of the reinforced concrete structure was performed. The results are presented at the end of the paper in graphical form.

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## **SYNTHESIS AND EXPLOSIVE COMPACTION of Fe-W-Al-Ti-Ni-C-B MECHANICALLY ALLOYED POWDERS**

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### **ABSTRACT**

The interest towards the High Entropy Alloys (HEAs) leads to the development of composites with improved physical and mechanical properties. The presented paper describes experimental investigations for obtaining HEAs in Fe-W-Al-Ti-Ni-B-C system. For the experiments were used powders of five major metallic and two minor non-metallic B and C elements of above mentioned system. Mechanical Alloying (MA) technology was use for the synthesis and ultrafine/nanoblend formation from Fe-W-Al-Ti-Ni-B-C compositions which was used as precursor for the fabrication of bulk High-Entropy Alloy (HEA) by explosive compaction (EC) technology. Results of MA of powders are described in the research paper. For MA experiments laboratory vibrating sieve was used for sorting the initial coarse powders. Coarse Titanium, Aluminum, Carbon and Nickel powders were preliminary checked and verified by “Explorer 5000 XRF” by Skyray instrument. For The experiments two different compositions with the following molar ratio: Fe<sub>20</sub>W<sub>15</sub>Al<sub>15</sub>Ti<sub>20</sub>Ni<sub>20</sub>B<sub>5</sub>C<sub>5</sub>; Fe<sub>25</sub>W<sub>25</sub>Al<sub>10</sub>Ti<sub>15</sub>Ni<sub>15</sub>B<sub>5</sub>C<sub>5</sub> were selected The MA was realized on the high energy ball mill. Ball to powder mass ratio was 10:1 during MA process. Rotation speed of the jars was 500 rpm The time of mechanical alloying was 5h, 10h and 14 h, 28h. The MA powders were prepared for EC experiments. After using EC technology bulk HEAs were produced and prepared for Investigations. The SEM, optical microscopy and hardness measurement results of obtained composites are presented in the paper.

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## **A HYDROLOGICAL DIGITAL TWIN BY ARTIFICIAL NEURAL NETWORKS FOR FLOOD SIMULATION IN GARDON DE SAINT-CROIX BASIN, FRANCE**

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### **ABSTRACT**

Understanding, simulating and forecasting dynamic and nonlinear natural phenomena are necessary in a climate change context and increased sensitivity of societies to natural hazards. Nevertheless, even though powerful computing tools and algorithms have been widely used to understand and to predict natural disasters, these tasks are still challenging for scientists. Indeed one of the most dangerous natural phenomenon, flash floods keep being a challenge for modellers, despite (i) the existence of some effective hydrological simulating tools, and (ii) the increasing availability of descriptive data, especially rainfall and discharge. In particular, on one hand, environmental data contain an important amount of noise leading to additional uncertainties and on the other hand, physically based models strongly depend on assumptions about the behaviour of the basin, that is often more variable in space and time than what is modelled. With the objective of applying data assimilation to improve forecasting properties of the physical model, it is necessary to dispose of a differentiable model. In order to mitigate this issue a hybrid physical and statistical approach is proposed in this study. It was shown in previous works that deep neural networks are able to identify any differentiable function thanks to the universal approximation property. Deep neural networks are then good candidates to perform the digital twin of the physical model. Thus, three different neural networks models were designed in this study and, each one is implementing a different type of non-linear filter model, in order to achieve the dynamic character of the catchment area (recurrent, feedforward and static models). The study area is the Gardon de Sainte-Croix basin (France), which is known for its sudden and violent floods that caused casualties and a lot of damage. The chosen physical-based model is semi distributed conceptual hydrological SOCONT model, RS Minerve (<https://www.crealp.ch/down/rsm/install2/archives.html>). Neural networks design was done by using a rigorous complexity selection and regularization methods to promote a good generalization. The three models obtained were thus compared. The feed forward model gave the best results on tests events (Nash score=0.98-0.99), making full use of the inputs with previous observed discharges whereas the recurrent model gave interesting results representing satisfactorily the dynamics of the physical model (Nash score=0.8-0.97). The static model, whose inputs contain only rainfall, is less efficient, showing the importance of dynamics in that kind of system (Nash score=0.62-0.84). Beyond data assimilation, these results open paths of inquiry for building digital twins of physical model, allowing also a great reduction of computing time.

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**OPTIMIZATION OF BLOCK CAVING STOPE BOUNDARY AND THE UNDERCUT LEVEL, CASE STUDY:  
SONGUN COPPER MINE**

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**ABSTRACT**

As mineral resources in near-surface deposits are being depleted, mining operations are focused on deepening. Rising environmental concerns prefer underground mining because its damage is less than that of surface mining. Among the underground mining methods, block caving is a method with low operating costs and comparable production rate to open-pit mines. In developed countries, the current tendency for this method is high and can give economic acceptable results. Optimization studies in mine design and planning process are performed to make sure the optimal use of natural resources and minimal extraction costs. Stope boundary optimization with the aim of effectively integrating different technical aspects, plays a key role in the underground mining planning process, and numerous algorithms have been proposed in that regard. In this paper, considering the block caving method, first the procedure of determining the parameters required for the stope boundary optimization are discussed. These parameters are defined such that they would customize the floating stope algorithm for the case of block caving method. Then the customized algorithm optimizes the boundary of the underground block caving stope. Finally, in order to determine the optimal boundary and the undercut level, the effective cross-section analysis method was used and the minable reserve is estimated at 617 million tons with an average grade of 0.53% copper.

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**DIABASE FROM DRAČA OPEN PIT MINE IN CENTRAL SERBIA – QUALITY ASSESMENT FOR BUILDING STONE PURPOSES**

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**ABSTRACT**

Vast masses of basic rocks are present as tectonic blocks and slices along the Eastern deep fault of the Vardar zone of Serbia. They are predominantly comprised of gabbro, with smaller part made up of diabase, and occurrences of granite, aplite and pegmatite dykes. Basic rock masses are trending along the line Kragujevac (Ždraljica)-Velika Pčelica-Bogalinac ~8 km west of Rekovac. A significantly smaller diabase massif is present along the same tectonic line, further toward SE, at Prevešt village by Kalenička River, approximately 13 km south of Rekovac. Drača open pit mine is situated in this diabase massif. Geologic explorative works have confirmed the reserves of 1 846 695 t of stone mass for building purposes. For over a decade, Drača mine has been producing various types of building stone, mainly graded stone aggregate with favourable physico-mechanical properties for road-construction works. Chemical analyses and petrographic study have shown typical composition and fabric for this type of rock. Main constituents are plagioclase and pyroxene, with opaque minerals as accessory and varying secondary minerals – chlorite, calcite, in some places epidote and limonite. Pyrite enrichment is visible in some areas of the massif. Chlorite, calcite, epidote and pyrite are the products of propylitic alteration. Although products of alteration are present throughout the rock mass with variable intensity, as is typical for the basic rocks of the former ocean floor sequences, petrologic properties are favourable for building stone purposes. Physico-mechanical properties of diabase have favourable values and varying scattering degrees. Dry state uniaxial compressive strength average values from seven analyses vary in the range 130-169 MPa. Resistance to abrasion average values vary in the range 9.04-17.07 cm<sup>3</sup>/50cm<sup>2</sup>. Apparent density varies within the span 2759-2926 g/cm<sup>3</sup> and real density 2804-2951 g/cm<sup>3</sup>. Water absorption values vary within the range 0.08-1.04 %. Resistance to weathering through testing of stability using Sodium-sulphate values vary from 0.00 to 0.15 % and through frost resistance from 0.00 to 0.04 %. Porosity values are almost constant at 0.8 %. In more tectonised parts of the rock mass, porosity reaches 1.6 %. Graded crushed aggregate has favourable values of Los Angeles coefficient 14.2 and 14.3 % for gradation B. Taking into consideration all performed tests and analyses, it is concluded that diabase from Drača mine can be used as a building stone for production of aggregate for use in concrete and for road-construction (asphalt paving mixtures for moderate, light and very light traffic load as a top wearing layer; for lower and upper bearing layers; for classic and modern road foundations); for production of crushed and hewn stone for building; as crushed stone for railroad ballast. Also, it can be and is used as a raw material for production of stone wool for thermal insulation purposes.

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## **STATISTICAL ANALYSIS AND TREND DETECTION OF THE HYDROLOGICAL EXTREMES OF THE DANUBE RIVER AT BRATISLAVA**

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### **ABSTRACT**

Three types of hydrologic changes may result from regulation of rivers: increased frequency of high flows; redistribution of water from periods of base flow to periods of storm flow, and increased daily variation in stream flow. These changes do not necessarily occur in all regulated rivers, but they are common and need to be addressed as part of any comprehensive effort to rehabilitate regulated rivers. The territory of the Danube River Basin is one of the most flood-endangered regions in Europe. The flow regime conditions of the Danube River are continually changing. These changes are the result of natural processes and anthropogenic activities. In the present study, we focused on the statistical analysis and trend detection of the hydrological extremes of the Danube River at Bratislava. In the first part of the paper, the changes in correlation between water levels of the Danube River at Bratislava and Kienstock were analysed. Studied period of 1991–2013 included one or three hour measured water levels of the Danube River at Bratislava and Kienstock and shorter periods (1991–1995, 1999–2002, and 2004–2013) were selected for identification of the water level change at Bratislava. One of the factors that recall the necessity to establish empirical - regression relationships was increasing of water levels of the Danube River at Bratislava (due to sediments accumulation at Bratislava). The results of this part of the analysis indicated an increasing of water levels corresponding to the same flood flow observed in the past. We also can say that travel time of the Danube floods between Kienstock and Bratislava did not change significantly during the analysed period. In the second part of the paper, we have identified changes in commonly used hydrological characteristics of annual maximum flows, annual discharge and daily discharges of the Danube River at Bratislava during the period of 1876–2019. We examined whether there is a significant trend in flows of the Danube River at Bratislava.

## DISASTER FLOOD SCENARIO: CASE STUDY OF THE UH RIVER IN LEKAROVCE (SLOVAKIA)

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### ABSTRACT

The occurrence of extreme floods in several river basins of the countries of Central and Eastern Europe over the last thirty years has drawn the attention of the public (as well as the competent authorities) to the problems of flood protection. Although the development and operational use of non-structural measures (such as flood forecasting and warning systems), represents one of the effective flood protection measures, the structural means (flood protection, levees, flood control reservoirs) are of great importance, too. Especially in the upper parts of the river basin, where the time between the detection of the causes of the flood (heavy rainfall) and its consequence (flood) is short and does not affect the effective protective activity (eg evacuation). Over the last 30 years, flood protections have been built along the Uh River (Slovakia, Ukraine) to protect the environment from floods. These dams adversely affected the storage capacity of water in the basin. This resulted in an increase in flood flows on the lower sections of the Uh River in Slovakia. These facts need to be demonstrated by the need to evaluate the proposed design values for those sections. The presented study presents an analysis of the long-term flood regime of the river Uh in the section Uzhhorod (Ukraine) - Lekárovce (Slovakia). The first part analyses the trend changes in the time series of maximum annual discharge  $Q_{max}$  in the stations Lekárovce and Uzhhorod on the basis of the observed  $Q_{max}$  data in these profiles (period 1931–2019). These  $Q_{max}$  series were subsequently used to estimate the maximum N-year discharge at the Lekárovce station for the changed conditions of the Uzhhorod - Lekárovce section. Using these derived data and the observed form of the flood hydrograph from November 1992, a 100-year flood scenario was developed for the Uh River in Lekárovce. The achieved results indicate a further increase in flood risk in Lekárovce.

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**USING HEAT FLOW DENSITY VALUES OBTAINED IN THE GULF OF CADIZ AND GORRINGE BANK,  
ATLANTIC OCEAN**

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**ABSTRACT**

The geothermal heat flow measured at the surface of the Earth is originated by different heat sources located at different depths of the planet. The main sources of heat flow in the crust are associated with radioactive decay of Uranium, Thorium and Potassium, in rocks. In some regions, additional heat sources must be considered such as exothermic chemical reactions. The value of the heat flow coming from deep regions, designated by “heat from the mantle”, must be obtained using indirect methods. In this work, the geoid height was used as indicator of alterations in “heat from the mantle” values, considering that the density decrease in regions with geoid height increase is related to high temperature values in the upper part of the mantle. The region on study is located in the Atlantic Ocean, SW of Cape St. Vincent and Cadiz Gulf. Temperature-depth values were obtained in twelve points of the region considering heat flow by conduction in the vertical direction, using published heat flow and thermal conductivity data. Layered models were made using data obtained in published seismic profiles. Moho depth values were used as lower boundary of the crust and mantle heat flow variations were made according geoid height increases. Ocean depth values between 2.5 and 4.3 km were used. A value of 5°C was used for temperature at the upper boundary (ocean bottom) of the models. Temperature calculus stops when a value of 1350 °C was attained. Lithosphere thickness is obtained considering this temperature value as temperature at the bottom of the lithosphere. Heat flow density values from 36 to 65.8 mW m<sup>-2</sup> were used in the work with “heat from the mantle” values from 33 to 35 mw m<sup>-2</sup>. Curie Point Temperature (600°C) depths from 33 to 36 km were obtained. Lithosphere thickness values about 97 km were obtained in all the models.

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**PALEONTOLOGICAL MONUMENT OF NATURE “MAMONTOVA GORA” EXPOSURE (YAKUTIA,  
EASTERN SIBERIA, RUSSIA)**

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**ABSTRACT**

The Mamontova Gora (“Mammoth Mountain”) exposure is the Neogene – Pleistocene key section of Siberia. This outcrop is located in the lower reaches of the Aldan River, 325 km above its mouth and extends for almost 12 km. It consists of an 80-meter structural plateau (80-meter terrace), 50- and 30-meter alluvial terraces. Sediments from the Middle Miocene (16-10 Ma) to the Upper Pleistocene are exposed on the 80-meter terrace. The basement of the 50-meter terrace is composed of Middle Miocene sediments, overlain by Pleistocene sediments. On a younger 30 m terrace, the deposits are dated from the Upper Pliocene to the Upper Pleistocene. The Mamontova Gora outcrop is one of the richest localities of the Neogene flora of Eurasia. There are numerous finds of remains of Miocene evergreen and thermophilic plants (tree stumps, leaf imprints, cones, nuts, seeds). More than 250 genera of fossil plants have been found on Mamontova Gora. This outcrop is also well known to paleontologists due to the abundance of bone remains of mammals of the Middle Pleistocene (early type mammoth, eastern horse, broad-fronted moose, long-horned bison) and Late Pleistocene (representatives of the mammoth fauna: woolly mammoth, woolly rhinoceros, Lena horse, reindeer, saiga-antelope, steppe bison, Arctic fox, wolverine, cave lion, etc.). It was revealed that the ancient frozen sediments on the Mamontova Gora outcrop abound with viable microorganisms and traces of their vital activity. A strain of microbe *Bacillus* sp. was isolated from ~ 2 - 3 Ma permafrost layers of this outcrop. A large group of microorganisms including fungi was isolated from the ancient ice wedge. Pleistocene permafrost deposits contain invertase, urease, catalase and dehydrogenase enzymes. Mamontova Gora is a unique geological object in Russia. By the decree of the Council of Ministers of the Yakutia Autonomous Soviet Socialist Republic of 18.02.1987 No. 56 Mamontova Gora was given the status of a “natural monument” and a specially protected natural area of regional significance. The article presents the main results of studies of ancient flora and faunas of Mamontova Gora.

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## **NEOTECTONIC INDICATIONS FROM THE WESTERN AND SOUTHERN DESERTS OF IRAQ**

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### **ABSTRACT**

The Iraqi Western and Southern deserts are part of the Iraqi Stable Shelf (Inner Platform) that belongs to the Arabian Plate. Therefore, both deserts lack tectonic forms like folds, faults; however, very rarely faults and regional lineaments can be seen in both deserts. Although both deserts are considered to be tectonically stable; but tens of Neotectonic indications can be seen everywhere in both deserts. Among those indications are: Straight valleys, perpendicular valley bending's, sinkholes aligned along straight lines, dislocated valleys, knickpoints within valleys aligned along straight lines, regional lineaments, anomalous valley shapes, trends and types, dissected alluvial fans. We have used existing geological maps of different scales and high-quality satellite images to recognize those Neotectonic indications. All those recognized features are excellent indications that both the Iraqi Western and Southern deserts are tectonically not stable. Accordingly, new terminology is suggested instead of the Stable Shelf (Inner Platform) that is "Less Disturbed Shelf".

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**PARACOCCLUS HOMIENSIS IS ABLE TO CONVERT VOLATILE FATTY ACIDS INTO  
POLYHYDROXYALKANOATES**

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Mazury in Olsztyn, Oczapowskiego 1A St., 10-719 Olsztyn, Poland**ABSTRACT**

The consumption of fossil resources and the global environmental problems associated with the disposal of petrochemical waste prompted scientists to study the synthesis of biopolymers as one of the possible alternatives to plastics. Especially, polyhydroxyalkanoates (PHAs) have gained much attention due to their unique properties, constitute an ecological alternative to synthetic polymers. PHAs are bacterial polyesters synthesized intracellularly during nutrient limitation as a source of carbon and energy. Due to their biodegradability, thermoplasticity or biocompatibility, PHAs can be used in many areas. Although PHAs have useful properties, their commercial production is limited by the high production costs compared to petrochemicals, therefore there is still a need to improve the efficient productivity of PHAs using a variety of carbon sources. Therefore, the aim of the present study was to investigate the ability of *Paracoccus homiensis* to synthesize PHAs during growth on synthetic and bioprocess-derived volatile fatty acids (VFAs). Shaking flasks cultivations supplemented with different types and concentrations of VFAs as carbon sources were conducted to support bacterial growth and PHAs production. The monomeric composition of the purified biopolymers was analyzed by gas chromatography (GC). The thermal properties of extracted PHAs were determined using differential scanning calorimetry (DSC) and thermogravimetric analysis (TG). The results showed that *Paracoccus homiensis* is able to grow and synthesize PHAs using synthetic and bioprocess-derived VFAs. It was also confirmed that the type and concentration of VFAs affected the amount and type of the biopolymers produced. The maximum accumulation of PHA (26.1% of CDW) was achieved when the cultivation was supplemented with 0.3% of pure acetic acid. Whereas, using the VFAs effluent the highest production of PHAs (16.46% of CDW) was recorded in the cultivations fed with 15% of this substrate. It was also shown that increasing the concentration of VFAs effluent in the cultivations adversely affected the accumulation of PHAs by the test strain. The results showed that the *P. homiensis* synthesized mainly poly(3-hydroxybutyrate) homopolymer [P(3HB)] in the cultivations fed with acetic, propionic, butyric, caproic acid, and with VFAs effluent. Based on chromatographic analysis, the presence of poly(3-hydroxybutyrate-co-3-hydroxyvalerate) copolymer was revealed in the cultivations supplemented with valeric acid. The DSC analysis showed that the amount of 3HV monomers contained in the PHA molecule affected the thermal properties of the tested biopolymers. The content of 3HV in the copolymer influenced the crystallization and melting processes. It was shown that the purified biopolymers differed in thermal stability. The P(3HB) from acetic acid had the highest thermal resistance, which was probably due to its high degree of crystallinity. The results showed that *P. homiensis* was able to grow and accumulate PHAs using VFAs. The analyses showed that the monomeric composition of PHAs influenced the thermal properties of the produced PHAs.

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**COMPARISON OF INVASIVE AND NON-INVASIVE METHODS IN SITE RESPONSE, CASE STUDY:  
SOIL DEPOSITS OF LA ESTRELLA**

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**ABSTRACT**

A great part of the Colombian territory is under medium to high seismic hazard due to the complex tectonic condition, which in turn affects, particularly, areas where the population density is highest. A response spectrum analysis of the ground is currently required by seismic design codes for site response analysis. For this, the shear wave velocity ( $V_s$ ) profile must be established. The use of seismic invasive methods such as Down Hole or Cross Hole for the determination of the shear wave velocity ( $V_s$ ), has been typically recommended. In recent years, significant progress has been made in non-invasive seismic methods such as MasW (Multichannel Analysis of Surface Waves) and ReMi (Refraction Microtremor), in order to estimate the  $V_s$  profile from surface waves analysis. Due to the accessibility and low cost, these methods represent a viable alternative to determine the profile of  $V_s$ . In this project, the seismic response of soil deposits was evaluated in the La Estrella municipality located in the south of The Aburra Valley. One-dimensional (1D) models were simulated by characterizing the soil profile through the shear wave velocity with MasW and ReMi seismic tests. The results were compared with models based on shear wave characterization through Down Hole methods. The 1D response spectrums were determined with an equivalent linear model in DEEPSOIL and GTS NX software. The resulting spectra were compared through relative difference and correlation coefficient. Final results demonstrated that the spectra present low relative differences for long periods, moderate relative differences for moderate periods, and low to moderate relative differences for short periods. The general correlation coefficients were 0.6. This was evidence that non-invasive seismic methods allow an appropriate response spectrum analysis.

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**MATERIAL COMPOSITION OF THE MESOZOIC ALKALINE ROCKS OF THE YUKHTA MASSIF  
(SOUTHERN YAKUTIA, CENTRAL-ALDAN ORE REGION)**

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**ABSTRACT**

The paper considers the petrographic composition of the Mesozoic alkaline igneous rocks of the Yukhta massif. It is part of the Central Aldan ore region and is spatially located in the central part of the Nymnyr block. The massif is a large multiphase structure, of the most productive stage of the territory's development – the Mesozoic tectonic-magmatic activation of the Aldan-Stanovoy shield. Determination of the qualitative quantitative-mineralogical characteristics of the 2 and 3 phases of intrusion (emplacement) most promising for gold-radioactive mineralization with the help of crystal-optical methods was the main goal of this work. As a result of petrographic studies of Mesozoic alkaline igneous rocks, it is defined that, the Yukhta massif is a multiphase magmatic structure, with decrease of the content of dark-colored minerals in rocks from the early to later phases of intrusion. In general, the rocks of the massif bear significant traces of secondary changes, which are related to the gradual formation of the massif. According to the features of the composition of the massif rocks, it was found that the latter could be formed from residual differentiates during the fractional crystallization of rock-forming minerals with the involvement of plagioclases. The Yukhta massif is associated with the large Samolazovskoye gold deposit, which formation is related to an intense contact-metasomatic impact on carbonate rocks. Hydrothermal-metasomatic transformations of the latter are the products of multi-stage silica-alkaline metasomatism associated with the second and especially with the third phases of the massif intrusion, and with further weathering processes, involving karst formation, disintegration of gold-ore metasomatites and the formation of a thick oxidation zone. From whence it is concluded that uranium being a chemically active element does not accumulate in a hypergenic form within the Yukhta massif. Where the weathering crust is intensively developed, a gold-ore type of mineralization is observed. On the other hand, the rocks of the massif itself, in particular syenites of the 2 and 3 phases of intrusion, may be promising for the uranium-thorium-rare earth (U-Tn-REE) type of mineralization. In general, these studies in this direction will provide insight into a number of issues related to the study of the evolution and metallogeny of the Mesozoic tectonic-magmatic activation of the Aldan-Stanovoy Shield.

**PETROGRAPHY OF THE MESOZOIC ALKALINE ROCKS OF THE TAEZHNIY MASSIF (SOUTH YAKUTIA, ALDAN-STANOVY SHIELD, LEGLIER ORE CLUSTER)**

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**ABSTRACT**

The article is concerned with the petrographic compositions of the Mesozoic alkaline igneous rocks of the Tazhny massif and its small bodies (dikes). The Tazhny massif is located in the central part of the Nimnyr block (Aldan-Stanovoy shield). According to our field observations, it was first determined that the Tazhny massif has a two-phase structure, its rocks contain syenite-porphyry and leucocratic syenites. The rocks of the massif intrude the Archean granites, and are themselves intruded by late dikes of bostonites and vogesites. Based on petrographic studies, we also identified two phases of intrusion in the Tazhny massif – syenite-porphyry and leucocratic syenites. The difference of them is as follows: in the syenite-porphyry rocks, plagioclase predominates over K-feldspar, and the content of dark-colored minerals reaches 10%. The rocks of the second phase are characterized by the predominance of K-feldspar over plagioclase, with the content of dark-colored minerals up to 5%. The order of intrusion of the massif formations is determined by the presence of xenoliths of syenite-porphyry rocks in leucocratic syenites. The rocks of the bostonite dike cutting the massif are characterized by the absence of amphibole and an increased content of pyroxene. This is most likely due to the fact that, the rock contains xenoliths of the host rocks of biotite-pyroxene composition. The dikes also contain xenoliths of the second phase rocks, which indicates a later age of this dike. The bostonite dike located in the immediate vicinity of the massif is almost identical to the dike found in the massif, except an amphibole in the composition of the rocks. The only dike of vogesites that intersects the body of the massif is characterized by the presence of two varieties of amphibole: common hornblende and a sufficient amount of barkevikite, which phenocrysts stand out clearly against the background of the total microcrystalline mass. Also, in the course of crystal-optical studies, it was noted that in the structure of the massif there is an increase in the leucocratic magmatism (лейкокрастовости магматизма) from the early phase to the late, but with a decrease in this indicator, taking into account the introduction of vogesite dikes at the late stages of magmatism development. Based on this, the conclusion is made about the antidromic development of the rocks of the Tazhny massif. When comparing the evolution of magmatism of the Tazhny massif with the Ryabinovy massif, a possible gold-ore specialization of the studied object is suggested.

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**MINERALOGICAL AND GEOCHEMICAL FEATURES OF NATIVE GOLD FROM PLACERS OF EVOTA  
GOLD-BEARING REGION (RUSSIA, ALDAN SHIELD)**

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**ABSTRACT**

Evota gold-bearing region is located in south of Republic Sakha (Yakutia) within the Nimnyr terrane of Aldan shield. A large numbers of gold-bearing placers are known on studied territory, but the primary sources for them have not been established. In this work, based on the study of the mineralogical and geochemical features of gold from alluvial deposits of the Evota gold-bearing region, possible genetic types of primary sources are considered. Obtained data showed that native gold in the studied objects has a very high, high and medium fineness. The roundness of gold is different. Almost ore crystals with sharp edges and well-rounded individuals with polished faces were found. The fineness of the studied gold grains was determined by microprobe analyzer Cameca Camebax-micro and varies in the range from 812 to 1000 ‰. A thin (up to 20 µm) high-grade rim was found in two grains (cr. Zolotoy). The central part of one of them has a fineness of 865 ‰, and in the edge part it reaches 1000 ‰, which indicates that this gold was in the hypergenesis zone. Admixture elements determined as traces and are presented Cu, Pd, Fe, Ni. Minerals-microinclusions - quartz, potassium feldspar, pyroxene, staurolite, maldonite, bismuthite revealed in gold grains. In some watercourses, for example, in the creek Sukhoi, only very high fineness gold (993-1000 ‰) was found. The presence of high-grade gold (cr. Sukhoi), intergrowths of gold with bismuthite (cr. Zolotoy), as well as inclusions of maldonite (cr. Yagodny) gives opportunity for assuming that primary sources could be basic ores such presented in the P. Pinigin deposit. At the sites (cr. Elovyi, r. Evota), both medium-grade and very high-grade gold were found, the fineness range varied from 827 to 998 ‰. The presence of gold with medium fineness and good roundness in studied watercourses probably indicates an additional supply of gold from primary sources formed as a result of the alkaline magmatism development of the Mesozoic age. Thus, for gold with high and very high fineness by admixture-elements, chemical composition and microinclusions, a genetic relationship with primary sources similar to the P. Pinigin deposit was found; for gold grains with medium fineness, formation in gold-ore mineralization characterized for the Mesozoic stage ore development such in deposits of Central-Aldan ore region is assumed.

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## **REGARDING THE CAUSES OF GEOPHAGY AMONG ANIMALS AND HUMANS**

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### **ABSTRACT**

Our investigations of the chemical composition of natural waters, "edible" lands, vegetation, and animal tissues in the two Sikhote-Alin areas, based on the published data of other scientists about Africa, have provided evidence for the "rare-earth" hypothesis of geophagy among humans and animals. It is concluded that geophagy in both animals and humans can develop in landscapes with abnormally high as well as abnormally low concentrations of rare earth elements, but especially in landscapes with the disturbed ratio of rare earth elements of light and heavy subgroups. The main sense of geophagy is the regulation of the concentration and the ratio of rare earth elements in the body.

Corresponding Author: Alexandra Belyanovskaya



## **A BRIEF SURVEY ON THE AVAILABILITY OF SATELLITE AIR POLLUTION DATA**

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### **ABSTRACT**

Satellite air pollution data sources are presented in this article. Satellite missions are listed and described, and corresponding instruments measuring the concentration of greenhouse gases or other parameters that affect air pollution. Main data hubs are enumerated, and other platforms providing access to the data in different formats. Some platforms contain tools and services that have the capabilities to process and store the satellite data further. Most of them also provide the visualisation of the data, and other simplifications for data selection.

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## **THE ROLE OF LAND USE AND MORPHOLOGY REPRESENTATION IN THE SETUP AND CALIBRATION OF THE CONCEPTUAL TUW MODEL**

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### **ABSTRACT**

The processes of the transformation of rainfall to runoff are highly complicated, and the proper characterisation of these processes with conceptual hydrological models is a very challenging task. Morphology and land cover have a significant influence on a river basin's hydrologic response. Thus, catchment characteristics of the topography and land use play an essential role in parametrising the runoff concentration processes in hydrological models. In the study, our goal was to detect which characteristics and their spatial distribution influence the efficiency of a conceptual rainfall-runoff model efficiency most. The spatially lumped and semi-distributed versions of the TUW conceptual rainfall model, which is an HBV type model, were compared. Both models use the concept of lumped storages associated with the surface and subsurface, interconnected by thresholds and links to simulate the runoff transformation. We focused on two land-use characteristics, the percentage cover of the agricultural land and percentage cover of the forests, and the mean slope of the terrain as a topography characteristic. The differences between runoff model efficiencies both in the calibration and validation periods were evaluated. Based on which version of the model was more effective in the simulation of the runoff, it was detected which types of catchment land use, and morphology were better represented by using the lumped or semi-distributed version of the TUW model, respectively. The analysis aimed to improve the understanding of the influence of spatial representation morphology and land cover in conceptual models on model efficiency and may help to improve model setup and calibration.

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## A NEW PYTHON TOOL FOR MAGNETOTELLURIC DATA ANALYSIS, MODELLING AND INVERSION

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### ABSTRACT

The Magnetotelluric (MT) method is one of the most powerful geophysical techniques used for various investigations, including exploration for groundwater, volcanology, geothermal, and tectonics studies. It is used to image resistivity structure of the Earth interior, from near surface down to the upper mantle. Prior to generating subsurface conductivity models, processing and analysis of the MT data are crucial stages in MT projects. However, despite the popularity of the technique, freely available programs for processing, analysis and modelling are few and they are difficult to find as one package. Recently developed packages focused mostly on data analysis and processing parts. In this study, we present a new Python package for MT data analysis, modelling, inversion and visualization of results. The program includes tools for dimensionality analysis, such as estimation of Swift skew, ellipticity, Bahr's parameters, WAL invariants, and phase tensor analysis. Directionality analysis to estimate geoelectric strike and 1D MT modelling (based on *Wait's recursion* formula (1954)) are developed and are available in the package. Inversion for layered earth (1D) is under development to be a part of the program. Post-processing and inversion visualization tools for already existing codes are included as part of the developed program. The developed Python package consist of a collection of codes which will be available freely after completion on *GitHub* and presented as an alternative tool for students and researchers working in MT projects. The Python programming language was chosen for the development of the program as it is flexible, free, easy to use and cross-platform-compatible nature, which therefore makes it popular in the geoscience community.

Corresponding Author: Biruk Abera Cherkose

**MINERALOGICAL CRITERIA FOR GENETIC RELATIONSHIP OF SILICATE IGNEOUS AND  
CARBONATITE ROCKS OF THE TOMTOR MASSIF (SIBERIAN PLATFORM)**

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**ABSTRACT**

The Tomtor massif, located in the north-east of the Siberian Platform, is a polychronous zonal-ring complex of alkaline ultrabasic rocks and carbonatites containing a unique deposit of Nb and REE. A comparative analysis of the typomorphic features of minerals of different types of silicate rocks and carbonatites of the Tomtor massif is given in order to establish their convergent features. In order to exclude the mutual influence of rocks formed at different times on each other, samples were taken from different dispersed independent pipe-like bodies of melteigites, a sheet body of alkaline picrites and a transverse dike of carbonatite located south of the Tomtor massif, as well as from alkaline syenites from the southern margin of the massif. It is shown that interesting convergent features are identified in the rock-forming and accessory minerals, including rare-metal ore minerals of different silicate igneous rocks and carbonatite formations. Rock-forming minerals - pyroxenes, micas, feldspars, feldspathoids, garnets, as well as basic and rare carbonates, oxide ore minerals, including Cr-containing spinelides, and sulfide and other exotic phases have such features. The confirmation of the convergence of a group of obvious high-temperature early magmatic elements-MgO, Cr, and Ni - with a group of CaO, CO<sub>2</sub>, H<sub>2</sub>O, P<sub>2</sub>O<sub>5</sub>, and Y components forming carbonatite derivatives was the most interesting nuance in this regard. Existence of such polychromatic complicated ore-magmatic ring complexes as Tomtor massif indicates occurrence of intraplate deep large magma-generating hearths in lithosphere mantle. Such easily fusible hearths, conserved in lithosphere mantle of residual melts of kimberlite, alkali-picrites, carbonatite compositions, under the subsequent favorable geodynamic settings, are subject to rapid flotation, undergoing decompression melting and forming concentric-zonal platform complexes of alkali ultrabasic rocks with carbonatites.

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## **GEOLOGICAL MAPPING OF RATES AND SÃO FÉLIX OF LAÚNDOS REGION (NORTHERN PORTUGAL)**

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### **ABSTRACT**

The Rates and São Félix of Laúndos region is located in the NW extension of the Valongo Anticline (Northern Portugal), comprising Palaeozoic formations with ages ranging from the Cambrian to the Carboniferous, locally overlaid by Plio-Pleistocene beach deposits and dunes. Detailed geological mapping was developed. The fieldwork allowed distinguishing different lithostratigraphic units, some of them fossiliferous. The study under optical microscope and Scanning Electron Microscope (SEM) allowed noting the presence of volcanic rocks along the Palaeozoic succession. A rhyolite in the Cambrian - Ordovician transition, a likely ignimbrite in the Upper Ordovician, and the existence of a porphyry in the Carboniferous, were for the first time identified in this region. The paleontological study focuses on the samples collected in the field, essentially belonging to the Middle Ordovician (Valongo Formation), but also to Silurian and Carboniferous. The Devonian formations are largely covered by agricultural fields and by urbanization, not allowing the collect of fossils, so the Devonian fossils studied belong to the Stratigraphical and Paleontological Collection of the Department of Geosciences, Environment and Spatial Planning, Faculty of Sciences, University of Porto. The geological mapping previously developed in this region goes back to the XX century. In the present work a detailed geological mapping at a scale of 1:15 000 was developed, with interpretive geological profiles and reinterpretation of the stratigraphic succession.

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**PLANKTONIC FORAMINIFERAL CONTENT AND STABLE ISOTOPE ( $\delta$ -<sup>13</sup>C AND  $\delta$ -<sup>18</sup>O) DATA OF  
PALEOGENE-NEOGENE OLD UNITS IN KORKUTELİ (NW OF ANTALYA) AND ITS SURROUNDING**

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**ABSTRACT**

In this study, the planktonic foraminiferal fauna and stable isotope values of the Paleogene and Neogene deep marine sequence in the western Taurus Mountains near Korkuteli (NW of Antalya) were tried to be revealed. For this purpose, in the study area, Eocene old Küçükköy Formation consisting of sandstone and claystone units and the Karabayır Formation consisting of Miocene old algal limestone units unconformably overlying this formation and Karakuştepe Formation consisting of sandstone, claystone and siltstone units were measured and 267 sample from these sections has been compiled. As a result of detailed micropaleontological studies performed on the collected samples, it was determined that the samples contain very abundant and well-preserved planktonic foraminifera, despite a small number of ostracod fauna. Among the described planktonic foraminifera, 13 genera, 59 species belonging to the Eocene-Oligocene, 11 genera and 29 species in the Miocene were determined. However, for the first time in the study area,  $\delta$ -<sup>18</sup>O and  $\delta$ -<sup>13</sup>C stable isotope analyzes were made on 104 planktonic foraminiferal shells belonging to *Catapsydrax dissimilis*, *Catapsydrax unicavus*, *Dentoglobigerina tripartita*, *Dentoglobigerina galavisi*, *Globigerinatheka index*, *Globigerinatheka mexicana*, *Globigerinatheka semiinvoluta*, *Pseudohastigerina micra*, *Pseudohastigerina nagewichiensis*, *Subbotina linaperta*, *Subbotina crypthomphala*, *Turborotalia ampliapertura*, *Turborotalia cerroazulensis*, *Turborotalia cocoaensis*, *Turborotalia cunialensis* species belonging to Eocene and Oligocene; *Globorotalia bella*, *Globorotalia mayeri*, *Globorotalia semivera*, *Globigerinella obesa*, *Globigerina woodi*, *Globoquadrina dehiscens*, *Globigerinoides triloba*, *Globigerinoides sicanus*, *Neogloboquadrina continosa* species belonging to Miocene, which are important for Paleogene and Neogene, in order to determine paleotemperature and sea level changes.  $\delta$ -<sup>18</sup>O<sub>V-PDB</sub> (‰) stable isotope values of planktonic foraminifera belonging to units in the Eocene-Miocene time interval ranges between -0.33 and -3.17, and the stable isotope values of  $\delta$ -<sup>13</sup>C<sub>V-PDB</sub> (‰) ranges between -0.35 and 2.34.  $\delta$ -<sup>18</sup>O isotope curves were prepared in order to determine the sea level changes in the Cenozoic with the studied region. The fact that the  $\delta$ -<sup>18</sup>O isotope values used in these curves are negative in increasing and decreasing values, shows that the sea level in the region decreases and rises at certain intervals. According to the obtained  $\delta$ -<sup>18</sup>O<sub>V-PDB</sub> (‰) values, it was determined for the first time in the region where the sea water paleotemperature in the Eocene-Miocene time interval ranged between 15.4°C and 28.4°C.

## PLANKTONIC FORAMINIFERAL BIOSTRATIGRAPHY OF THE PALEOGENE SEQUENCE IN THE SOUTHWEST OF ANKARA

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### ABSTRACT

The aim of this study is to determine the planktonic foraminiferal content and age of the Yeşilyurt Formation, which has a wide distribution in the northeast of Haymana district located in the southwest of Ankara. In the study area, Paleocene old Yeşilyurt Formation, which is located harmoniously on Haymana Formation consisting of upper Cretaceous old sandstone, conglomerate and shale units, is laterally transitive with the Kartal Formation consisting of Paleocene old red colored conglomerate, sandstone and marl units and Çaldağ Formation consisting of algal limestone units. The Yeşilyurt Formation, which consists of shale units containing limestone blocks, is harmoniously overlain by limestone, marl and black shale units belonging to the upper Paleocene old Kırıkkavak Formation in the region. In the study area, 171 meters thick stratigraphic section was measured from shale units of Yeşilyurt Formation containing limestone lenses derived from Çaldağ Formation. 45 samples were collected from this measured section. As a result of detailed micropaleontological studies performed on the collected samples, it was determined that the samples contain a small number of ostracod fauna (*Bairdia septentrionalis*, *Cytherella meijeri*, *Krithe* sp., *Paracypris* sp., *Xestoleberis* sp.) and an abundant and well-preserved planktonic foraminifera assemblage. The genera and species of planktonic foraminifera defined in the samples taken from the Yeşilyurt Formation are as follows: *Eoglobigerina edita* (Bolli), *Eoglobigerina eobuloides* (Morozova), *Globanomalina compressa* (Plummer), *Globanomalina ehrenbergi* (Bolli), *Globanomalina planocompressa* (Shutskaya), *Globanomalina imitata* (Subbotina), *Parasubbotina pseudobuloides* (Plummer), *Parasubbotina varianta* (Subbotina), *Praemurica praecursoria* (Morozova), *Praemurica pseudoinconstans* (Blow), *Praemurica inconstans* (Subbotina), *Praemurica tourica* (Morozova), *Praemurica uncinata* (Bolli), *Subbotina cancellata* (Blow), *Subbotina triangularis* (White), *Subbotina triloculinoides* (Plummer). As a result of detailed biostratigraphic studies performed on these planktonic foraminifera, *Subbotina triloculinoides*-*Globanomalina compressa*/*Praemurica inconstans* Interval Subzone (P1b); *Globanomalina compressa*/*Praemurica inconstans*-*Praemurica uncinata* Interval Subzone (P1c) were obtained in the early Paleocene (Danian); *Praemurica uncinata*-*Morozovella angulata* Interval Zone (P2) were obtained in late early Paleocene (late Danian). The determined planktonic foraminifera genera and species indicate that the Yeşilyurt Formation was deposited in Danian (early Paleocene) under deep marine environmental conditions.

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**PLANKTONIC FORAMINIFERAL CONTENT OF THE LOWER MIOCENE UNITS IN THE NORTH OF THE  
WESTERN TAURUS MOUNTAINS (İNCESU, NW OF ISPARTA, TURKEY)**

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**ABSTRACT**

This study was carried out in the vicinity of İncesu Village, which is located in the west of Isparta belt, where the Kırdağları Series belonging to the Beydağları Autochthonous are best exposed. In the study area, the Jura-Cretaceous old neritic limestones belonging to the Kırdağları Series are incompatibly overlain by Paleocene-Eocene neritic and hemipelagic limestones. Middle-upper Eocene (Lutetian-Priabonian) sediments consisting of sandstone, claystone and marls lie harmoniously on neritic and hemipelagic limestones, and lower Miocene old sediments consisting of yellowish sandstone and claystone unconformably overlie these units. As a result of the new micropaleontological studies performed on samples collected from three measured stratigraphic sections taken from the Kırdağları Series in the NW of Isparta, the lower Miocene old yellowish sandstone and claystone sediments and planktonic foraminifera assemblages that are comprised of these sediments are described in detail for the first time in the vicinity of İncesu. The 13 species belonging to 5 genera of planktonic foraminifera defined in these yellowish sandstone and claystone units are as follows; *Catapsydrax dissimilis* (Cushman and Bermúdez), *Catapsydrax unicavus* Bolli, Loeblich and Tappan, *Dentoglobigerina altispira* (Cushman and Jarvis), *Dentoglobigerina altispira globosa* Bolli, *Dentoglobigerina baroemoenensis* (LeRoy), *Dentoglobigerina larmeui* (Akers), *Globigerina (Globigerina) praebuloides* Blow, *Globigerina (Zeaglobigerina) woodi* Jenkins, *Globigerinoides* sp., *Globigerinoides immaturus* LeRoy, *Globigerinoides triloba* (Reuss), *Globoquadrina binaiensis* (Koch), *Globoquadrina venezuelana* (Hedberg), *Globoquadrina praedehiscens* Blow and Banner. Based on the stratigraphic range of the planktonic foraminifera defined in the study area, it was concluded that they belong to the early Miocene (Burdigalian) age. The defined age is thought to make a new contribution to the geology of the region.

## COMPARATIVE STUDY ON DEGRADABILITY CHARACTERISTICS OF EVAPORITIC AND CARBONATE ROCKS FROM AL AIN, UNITED ARAB EMIRATES

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### ABSTRACT

The slake durability index (SDI) test is a well known and extensively used to measure the degradability behaviour of rocks especially for weak rocks like mudstone, shale, evaporites, carbonates, etc. The degradability of rocks plays a critical role in engineering design process either on or in the rock mass for safe and sustainable structures. Evaporitic and carbonate rocks are vulnerable to physical, chemical and mechanical weathering, break down, as result of wetting-drying processes during the SDI test. Evaporites and carbonates are outcropped at the surface and subsurface of the Al Ain city, which is located on the south-eastern of Abu Dhabi, capital city of the United Arab Emirates (UAE) at various level, and it is one of the rapid growing cities in the UAE. However, the detailed data on the slaking behaviour of either evaporites or carbonates are not available presently in the study area. Therefore, this paper provides a comparative study on the degradability characteristics of evaporitic and carbonate rocks in the city of Al Ain as well as comprehensive data filing for the study area. 142 rock blocks ( $\sim 40 \times 40 \times 40$  cm<sup>3</sup> in size), which represent evaporitic (48 blocks) and carbonate (94 blocks) rocks were collected from various accessible either surfaces outcrops or excavated areas from the study area. 48 and 94 slake durability test samples of evaporites and carbonates were prepared and slake durability tests were performed according to the American Society for Testing and Materials (ASTM) standards. Furthermore, their compositional and textural characteristics were examined using polarized-light microscope, X-ray diffractometry (XRD), X-ray fluorescence (XRF) and scanning electron microscope (SEM). The degradability data for evaporite and carbonate rocks designate medium to very low and very high to extremely high values based on the classification (Franklin and Chandra, 1972) after multiple cycling,  $I_{d1}$  to  $I_{d4}$ , processes, respectively. The weight loss values from the first to the fourth cycles ( $I_{d1}$ – $I_{d4}$ ) of evaporite and carbonate samples are approximately 24–95 and 0.68–4.22 wt%. Obviously, evaporites are highly vulnerable compare to carbonates because of their differences in chemical and mineralogical structures and their reactions to the slaking fluid, distilled water. Hydration-dehydration effects on the evaporitic rocks may occur within short time compare to the carbonate rocks due to their natural occurrences. Thus, this study provide comparable and details information for the degradability characteristics of evaporitic and carbonate rocks, and likely improve our understanding of the durability of both rock types in the study area and elsewhere. Especially, such a reliable and inclusive information will compromise a practical guideline for engineers and decision makers to overcome difficulties on durability problems associated with evaporites and carbonates in the study area.

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**LAND SUBSIDENCE MODELING DUE TO MINING DRAINAGE USING MONTE CARLO-MODIFIED  
GEOGRAPHICALLY WEIGHTED REGRESSION**

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Land subsidence due to mining is primarily caused by the removal of a deposit from a rock mass and the formation of a post-mining void. This type of land subsidence damages surface and underground infrastructure and adversely affects the safety of surface users. Underground mining, however, is also associated with the drainage of rock layers, for both technological and safety reasons. When compared to the direct impact of deposit exploitation, mining-induced aquifer drainage typically causes one order of magnitude less land subsidence. However, the spatial extent of the depression cone, and hence the area of land subsidence caused by aquifer drainage frequently extends beyond mining boundaries. Despite this, the environmental impact of the phenomenon remains underestimated. For research on phenomena related to groundwater head variations in aquifer systems, a multidisciplinary approach is necessary. Until far, the methodologies used have mostly relied on models, the application of which required a comprehensive understanding of the properties of the rock mass deformation mechanism. Because of the problem's complexity and scarcity of data, the parametrization of the models utilized thus far, as well as the simulation results, contributed to considerable uncertainty. As a result, the study presented attempted to develop a reliable model of land subsidence caused by mining-induced drainage using minimum input data. The study was carried out in the Bogdanka underground coal mine, Poland. First, land subsidence due to the direct and indirect influence of mining was assessed. The prior research work on the determination of the spatio-temporal drop in groundwater head as a result of mine drainage was then investigated. The outcomes of these efforts were used to develop the Geographically Weighted Regression model (GWR). Using field data and the Monte-Carlo approach, the model was calibrated and validated. This allowed us to statistically determine the quality of the model parameters on a local level. Finally, without requiring a thorough numerical model, the GWR model provided land subsidence patterns based on the relationship between groundwater head variations as well as the spatial distribution and thickness of the drained aquifer. According to the findings, the mining field has the highest land subsidence and decrease in the groundwater head. The calculated subsidence bowl closely resembles the observed depression cone. Its shape, however, is also linked to local geological, hydrogeological, and mining conditions. Furthermore, the greatest values of land surface subsidence caused by mine drainage were less than 0.5 m. Importantly, the spatial extent of mine-induced land subsidence extends several kilometres beyond the boundary of the mining area. The results indicate that the GWR model can be used to successfully estimate the value of land subsidence caused by mining drainage. Furthermore, by implementing the Monte Carlo method in the process of determining the model parameters, it is possible to assess the quality of the prediction performed not only globally, but also locally. Therefore, our findings can pave the way for a more reliable assessment of the environmental impact of the mining-induced drainage considering the spatial variability of the phenomenon and its driving parameters.

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## **TECTONIC SETTING OF THE CENTRAL PART OF THE ADYCHA-TARYN FAULT ZONE (NE RUSSIA)**

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### **ABSTRACT**

The study area is located in the central part of the regional-scale Adycha-Taryn fault zone separating the Adycha-El'gi and Nera anticlinoria in the hinterland of the Verkhoyansk fold-and-thrust belt (central part of the Verkhoyansk-Kolyma orogenic belt). Detailed structural studies were conducted in large quarries in the lower reaches of the El'gi River (Indigirka R. basin). In the Adycha-El'gi anticlinorium, several generations of folds, faults, and cleavage are recorded. The intensity of deformation here is found to gradually increase in NE direction. The NE wall of the Adycha-Taryn fault is thought to be more strongly deformed. The results of our investigations revealed three structural parageneses. The first paragenesis includes thrusts, reverse faults, and intense NW-striking folds of the first generation. The second paragenesis consists of less intense superposed folds of the second generation, with subvertical axes, as well as sinistral strike-slip faults. The previously made assumption is confirmed about manifestation in the study area of at least two deformation stages. We also presuppose the existence of the third deformation stage in which dextral strike-slip faults were formed. A change in the intensity of tectonic deformations both along and across the Adycha-Taryn fault zone is first established. On the southwestern side of the fault zone, the intensity of deformation structures decreases from NW to SE. On the northeastern side, the deformation intensity first increases in that same direction but then tends to diminish. An assumption is made about a growing importance of reverse faults in NW direction, along the Adycha-Taryn fault zone. Orientation of paleostress axes responsible for the formation of tectonic structures in the study area is first determined. Folds and thrusts of the first deformation stage were formed under subhorizontal compression in NE direction. Sinistral strike slips and associated folds of the second deformation stage resulted from WE-oriented subhorizontal compression. The following dextral strike-slip motions occurred in the conditions of NW-directed subhorizontal compression and NE-oriented subhorizontal extension. The studied tectonic deformations were formed in Late Mesozoic time as a result of collision-accretion events in the central part of the Verkhoyansk-Kolyma orogenic belt.

Corresponding Author: Dmitry A. Vasiliev

**EVOLVING UNIVERSITY GEOSCIENCE CURRICULA IN THE LIGHT OF BURGEONING LUNAR AND  
MARS SURFACE EXPLORATION PROGRAMS: THE BENEFITS OF EXPANDING PLANETARY  
GEOSCIENCE LITERACY**

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**ABSTRACT**

A flood of photodigital, geophysical, material and chemical data from the terrestrial inner planets and satellites, is being generated by the surging interest in Mars and Lunar explorations missions in recent years. These include the Chinese Tianwen-1 orbiter and Zhurong rover, the US Perseverance rover and Ingenuity robo-copter, and the UAE Hope orbiter Mars missions; and the Chinese Chang'e-4,5, and projected Indian Chandrayaan-3 landers on the surface of the Moon. Proposed further missions in the later 2020's will proceed in partnership with space technology companies, such as SpaceX, Blue Origin, Dynetics and TCT Aerospace, opening the way for private sector involvement in asteroid mining, space tourism, space transport and eventually colonization of our habitable planetary neighbours. These developments will open many opportunities for employment of planetary geoscientists in public and private enterprise activities. In this paper, we explore the level of response of Earth Science departments to these events, in terms of new Planetary Geoscience (PG) Degrees, and courses dedicated to PG topics. To track the current status of PG in US University Geology programs, we have collected and compared data on degree titles, Major titles, undergraduate course titles and the PG content of their curricula for the top 20 US Geoscience departments, and a 100 randomly chosen other US Geology departments. In the top 20-group, we found that even PG-oriented departments typically have only 6-15% of undergraduate and 5-11% graduate courses with specialized PG courses, and up to 6-8% further standard courses with curriculum enhanced by PG course modules. In the elite 20-group, the traditional departments rarely had more than 5% PG-titled courses and extra 2-3% standard courses with minor PG content. A third group were environment-oriented departments with no PG-titled courses, and less than 8% regular courses with PG content. Of the 100 randomly selected Geology departments, 3.8% of BS degrees, 8.6% of MS degrees, and 15.2% of PhD degrees had PG-titles. Unexpectedly, for the top 20-group, 0% of BS degrees, 6.9% of MS degrees, and 12% of PhD degrees had PG-titles, i.e. systematically lower percentages than the random-100 group. These data suggest that the impact of PG on undergraduate and graduate courses is still conservative, and reflect department concerns that traditional employers offering high salaries to geoscientists (petroleum, minerals exploration companies and environmental consultants) are sceptical of job applicants with a degree entitled BS Planetary or Space Geoscience. The eventual growth in private sector PG careers will correct this in due time, however, in the meantime a recommended low-risk approach is to use PG topics to enrich the curriculum of standard courses, whether they are General Education, introductory or advanced. The costs of this policy are nearly zero, as much relevant PG material is presently freely available online. The benefits of this approach are well known in terms of 1) positive student outcomes (increased student motivation, enthusiasm, confidence, problem-solving skills, appreciation of scientific method, and technical competence), 2) timely attraction of students back to STEM careers, and 3) increased general public planetary science literacy.

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**COMPARATIVE PALAEO-ENVIRONMENTAL GEOCHEMICAL INVESTIGATION OF NEOTETHYAN  
MARINE METASEDIMENTS: BANI HAMID COMPLEX, NE UNITED ARAB EMIRATES**

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**ABSTRACT**

Two large but poorly understood low- to very high-grade metamorphic complexes in the Oman Mountains of northeastern UAE, are the Asima Window and the nearby Bani Hamid metamorphic block. These mainly metasedimentary rocks form the sole of an obducted ophiolitic mass (the Semail Ophiolite) that was detached from the NeoTethys Ocean and transported onto the continental margin at the end of the Cretaceous. Previous work has constrained the timing and mechanism of obduction via investigation of the age and grade of metamorphism. However, probably due to the severe shear deformation of these rocks, studies of the palaeo-environments of the metasediments have been lacking, apart from our recent study of the Asima Window. Here we present lithogeochemical data from the Bani Hamid block that attempts to answer the following questions: Were the parent sediments deposited in a continental margin setting (as at Asima)? Were these sediments influenced by seamount activity, especially hydrothermal fluid activity (as at Asima)? What is the tectonic significance of the similarities and differences between the Bani Hamid and Asima metasediments? Both complexes are dominated by quartzites, derived from biogenic chert protoliths, and have subordinate mica schists (originally terrigenous mudstones), and calc-silicate rocks (derived from carbonate sediments). Minor lithologies are meta-exhalites rich in iron and manganese oxides. Intriguing differences between the complexes are that the carbonates at Asima are ferruginous calcite-rich, probably hydrothermal, metasediments, while the Bani Hamid metacarbonates were probably transported biogenic calciturbidites and dolomites. The important minor element, manganese, is quite differently distributed between the two complexes, being mainly present as widespread Mn<sup>3+</sup> and Mn<sup>4+</sup> phases (e.g. piemontite, coronadite) at Asima, but dominantly as Mn<sup>2+</sup> and Mn<sup>3+</sup> phases (e.g. Mn<sup>2+</sup> pyroxenes and Mn<sup>3+</sup> rich andalusite) at Bani Hamid. This has implications for the ocean floor redox conditions at the time of deposition of the protolith sediments. Conditions were mainly oxic at Asima, but generally suboxic at Bani Hamid. Understanding the palaeo-oceanographic significance of the lithological and geochemical differences between these adjacent complexes, will provide new insights into the environment of the sole rock sedimentary protoliths at the time of their attachment to the Semail Ophiolite.

Corresponding Author: Abdel-Rahman Fowler



## **GEOCHEMICAL STUDIES OF THE MINERALIZED ZONE IN DEFTA AREA, WADI HAM, UAE**

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### **ABSTRACT**

The ~96 Ma Semail (Oman) ophiolite includes a relatively intact thrust slice of Tethyan oceanic crust and upper mantle formed above a NE-dipping subduction zone, that was the site of initiation of obduction. In the northern Oman mountains, the Bani Hamid metamorphic block is 1.2 km thick and composed of isoclinally folded granulite facies rocks sandwiched between blocks of mantle peridotite. The metamorphics were exhumed by late-stage out-of-sequence thrusting bringing a slice of lower crust rocks to the surface. The Bani Hamid block comprises two-pyroxene quartzites and amphibolites with localized partial melting, intruded by hornblende pegmatites. Differentiation of mafic and ultramafic magmas deep within the spreading centers led to concentration of chromite and minor sulfides, and these processes are important for the formation of ore deposits within the oceanic crust. There are other massive sulfide deposits that have formed in the ophiolitic volcanic environment. These include chalcopyrite, pyrite and pyrrhotite-mineralized NW-trending shear zones within Bani Hamid paraschists. The sulphide-mineralized shear zones lie near to and parallel with the Wadi Ham Fault Zone, a complex post-obduction shear zone with early mylonitization and later brittle reactivation. The geochemistry of ore rocks shows that the XRD analysis for the mineralization zone consists of two groups of minerals: 1) copper sulfide group, e.g. pyrite, chalcopyrite, pyrrhotite, cosalite, baliczunite, hawleyite, portlandite, kuramite, and mohite; and 2) manganese group such as coronadite, szomolnokite and szmikite, accompanied by sphalerite, magnetite and hematite. AAS analysis for all of the ore samples shows average to high values of Fe (15.6 %), Ti (0.3 %), Cu (0.8 %), S (0.4 %), Cr and Mn (0.1%), Sb (6.5ppm), Mo (30.0 ppm) and Ag (1.6 ppm). ICP analyzed samples have higher values of Cu, Zn, Ag, Ni, Mn, Fe, Au, Hg, Cr, S, Mo, Pb and Co).

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**IMAGE SEGMENTATION TECHNIQUES FOR REFLECTED LIGHT MICROSCOPY: AN OVERVIEW OF SOME ALGORITHMS**

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**ABSTRACT**

Often when we approach the study of stones used for building purpose, but more in general, when we study rocks coming from the urban environment or even from any other environment such as quarries, mines or outcrop of our interest, the first activity that we carry out is the observation in reflected light optical microscopy. Reflected light microscopy requires minimal sample preparation, having to polish a surface and without the need to thin the sample to allow light to pass through. It may be useful, already in the first analysis, to try to produce quantitative data on what we are observing. A further advantage to use reflected light in an urban environment is that of being able to observe and describe the formation or interaction between opaque minerals and the environment. Information that we lose by passing directly to the transmitted light. The qualitative and quantitative data that can be useful to us and that we can obtain are the porosity, texture (when easily recognizable in reflected light), maximum size and shape of the edges of the crystallites of the sample. To all this is added the relationship between the areas of the different crystallites identified and the possible background mass, which cannot be solved on the observation scale. When we are dealing with many samples, we do not always have the time to be able to study individually sample by sample through images, so we resort to the use of image analysis tools for image segmentation and analysis. Among these, the main thresholding methods are the Otsu method, the segmentation with the k averages algorithm and, finally, a neural network of the SOM type. In this work, we will review the main methods of image segmentation, and we will present an innovative method developed by us, highlighting its strengths and weaknesses.

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**MAGNETIC MAPPING AND SEISMOACUSTIC INVESTIGATIONS IN THE ALTINUM SUBMERGED  
ARCHAEOLOGIC SITE**

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**ABSTRACT**

The roman fortress from Măcuca Hill, identified by Romanian archaeologists, until now, as the garrison Altinum, north of Oltina village, northeast of Oltina Lake, has no observable features to be ascribed to late Roman period. On the eastern bank of the lake the team in charge with the archaeological research in Capul Dealului site made land surveys on the northern slopes of Măcuca Hill, looking to the Danube's island Ostrovu Iepurașu (*Rabbit's Island*), some hundreds meters north of the timber and earth playing-card fort described a century ago by Pamfil Polonic. The archaeologists from Constanța found in 2006 survey convincing remains of a monumental stone wall, hidden in the forest. If the remains depend of a fortress, or of a harbor facility, only the seismoacoustic and magnetometric investigation research will answer. In this work we present the results of a multidisciplinary study for characterising the archaeological site of Altinum (Dobruja, Southern Romania). The investigation has been performed by means of the integrated use of two different high resolution and non invasive geophysical techniques: magnetic mapping, and sidescan sonar measurements. The integrated approach allows us to detect submerged archaeological structures. In particular, our results helped to define spatial pattern of the submerged remains, to define the geometry of the anthropogenic settlements and to obtain detailed information about the composition and the manufacturing processes of different building materials. Magnetic prospecting represents one of the widest employed tools in the geophysical research applied to the archaeological studies. This technique provides a great amount of high resolution magnetic data in a very small time: up to ten measurements per second. Moreover, because the magnetic equipment is a portable instrument assembled by the user, it may be used in every configuration for investigation the submerged archaeological site. Sidescan sonar profiling is widely applied to support the magnetometric investigation and archaeological prospection. In particular, three-dimensional modelling of sidescan sonar surveys are increasing in popularity, in fact 3D models are much more valuable for archaeological feature interpretation. However, to obtain a higher horizontal and vertical resolution, a sub-metre line spacing is generally needed, making the 3D acquisition more expensive in time in respect of magnetic measurements. The magnetic survey on the water has been carried out using a caesium vapour marine magnetometer G-882 GEOMETRICS and proton magnetometer G-856 for diurnal variations of the natural magnetic field. The sidescan sonar system (Klein Sonar Pro) has two working frequencies (445 KHz and 900 KHz). The 445 KHz frequency was used to discover submerged walls and other archaeological structure. The integration between these two techniques allowed us to define the geometry and the depth of a buried structures.

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## **TOPOGRAPHY-INDUCED TRACK DYNAMICS OF STRONG CYCLONIC VORTICES OVER IDEAL TERRAIN FEATURES**

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### **ABSTRACT**

When a tropical cyclone encounters terrain features such as the central mountain range (CMR) of Taiwan, the change of motion and structure are complicated and uneasy to predict. Many studies have proposed and attempted to explain the mechanism of track deflection such as track continuity/discontinuity by examining the change of vortex speed and structure. The track deflection mechanism of tropical cyclones before and after landfall has been one of the key topics in operational forecasting in the past decades. The present study proposes a simple model for investigating the track dynamics of strong cyclonic vortices over terrain features on a  $\beta$ -plane. In this model, two predicted velocity components are derived based on the conservation of potential vorticity. One is the meridional adjusting velocity (MAV) arising from the planetary vorticity gradient (the  $\beta$ -effect) and the other is the topographic adjusting velocity (TAV) generating from the induced topographic vorticity gradient by MAV. Detailed track calculations of strong vortices over a bell-shaped mountain and a north-south ridge have revealed a variety of interesting track patterns associated with unsteady motions. The track patterns observed in our calculations show an 'S-shape' pattern consisting of a southward deflection on the windward side and a northward recovery on the lee side of the vortex motion. For different angles of vortex impinging, this meandering S-shape track significantly displays three types of unsteady motions: 'D-A' (type I), 'D-A-D-A' (type II), and 'A-D' (type III) where 'D' represents deceleration and 'A' represents acceleration. The dynamic model results are compared by calculating a modified shallow water model with similar conditions. Both the vortex tracks and motions obtained from these two approaches show a qualitative good agreement. Notably, this dynamic model elaborately predicts the drifting velocity of the vortex motion by assuming a nearly constant strength or vortex circulation over the topography. That is, the calculations are more convincing or can apply under situations where the vortex is strong enough or for limited-extent topographic features. In summary, the proposed dynamic model has provided new insight into the complicated behaviours and the unsteady motions of strong cyclonic vortices over ideal terrains. It also provides promising features on its applications and extensions to incorporate more realistic vortex models or to consider the effect of environmental flows or complex terrain features.

**GRAVITY ANOMALIES AND CRUSTAL STRUCTURE OF THE EASTERN PART OF THE  
VERKHUYANSK FOLD-AND-THRUST BELT, NE RUSSIA: EVIDENCE FROM THE JUNCTION AREA OF  
THE ADYCHA-ELGA AND ALLAKH-YUN TECTONIC ZONES**

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**ABSTRACT**

The results of geophysical studies of the junction area of the Adycha-Elga and Allakh-Yun tectonic zones of the Verkhoyansk fold-and-thrust belt located on the submerged eastern margin of the Siberian craton are presented. Three structural-mineral complexes are recognized: Archean-Paleoproterozoic, Mesoproterozoic-Middle Carboniferous, and Upper Carboniferous-Early Mesozoic. The Early Jurassic plume-related basaltic volcanism and suprasubduction Late Jurassic-Early Cretaceous granitoids, regional Brungadin and Suntar faults are identified. The goal of the research is to identify deep heterogeneities and clarify the structure of the Earth's crust in the junction area of the Adycha-Elga and Allakh-Yun tectonic zones of the Verkhoyansk fold-and-thrust belt. The analysis of gravitational anomalies is carried out, their transformations are performed – distinguishing the medium and low-frequency components, the vertical derivative  $V_{zz}$ , and calculating the equivalent distribution of sources of density masses at depth. It is determined that the hidden granitoids of the Adycha-Elga tectonic zone are located mainly in linear zones of decompaction at a depth of about 3.5 km. In the Allakh-Yun zone, a large gravitational minimum has been identified, where it is assumed that there is a magma granitoid chamber occurring at a depth of about 9 km. The model of the deep structure of the territory is based on the analysis of materials on the reference seismic profile 3-DV with the use of gravimetric data and the regional structure of the territory. According to the results of the wave pattern interpretation, the thickness of the lithosphere varies from 41 to 44 km. The thickness of the Upper Carboniferous-Triassic terrigenous rocks is 8-12 km, Mesoproterozoic - Middle Carboniferous carbonate-terrigenous complex is up to 12 km. The Archean-Paleoproterozoic crystalline basement occurs at a depth of 19-21 km. The Conrad discontinuity is assumed at a depth of about 30 km. Intense deformations of the crystalline basement are recognized, and trans-crust faults are identified.

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**EXPERIMENTAL RESEARCH OF POSSIBILITIES FOR DEVELOPING A BUILDING INFORMATION  
MODEL OF A LASER SCANNED PHYSICAL OBJECT**

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**ABSTRACT**

The methodological approach when using a scanned physical object for the construction of BIM is based on the technology for laser scanning and aims to create technical documentation of existing buildings, most often with the status of historically significant objects. BIM technology can also be used as an integral part of creating documentation in the construction process and new sites, as well as their administrative control in the process of their construction and operation. The essence of the experiment is to model the space in a digital parametric model (BIM) in the ArchiCAD program, using a scanned physical object (point cloud). The point clouds obtained from the scan contain detailed spatial information, which is used in the basis of the creation of a parametric three-dimensional model (BIM) and control during the development of the model. The scanned model contains the same geometric information as the building information model, but with a much smaller amount of data, the file size is visible (point cloud - 118.83 MB, BIM - 9.83 MB). The advantages of BIM over the scanned object is to give the opportunity to edit the model, to study the energy behaviour of the model, to create construction and technical documentation of the scanned object, as well as to reveal the possibility to fill in technical data and parameters based on the map. and cadastral basis. By means of the point cloud density of the scanned object, information with sufficient detail and completeness about the physical data of the real object is used and this is the basis that serves for detailed and comprehensive content of the BIM. Based on the sufficient detail created in the BIM for the physical object, it is possible for its combinability and its actual use in the real environment.

## **GROUNDWATER RESOURCES SUSTAINABILITY IN ARID REGIONS USING GEOPHYSICAL METHODS**

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### **ABSTRACT**

Groundwater management and its sustainability are very important objectives in this study, especially with the limited conventional water resources in this arid region. Groundwater level rising phenomenon is highlighted in Al- Ain area, in the eastern part of the United Arab Emirates (UAE). Monitoring of groundwater level fluctuation has been carried out through acquiring two periodical seismic refraction surveys, which integrated with the field observations obtained from the available boreholes for two successive years. The monitoring of the groundwater through the studied area, that located to the northwest of Jabal Hafit in Al- Ain City aims to detect the groundwater level changes and its distribution in the area. As well as Electrical Resistivity Tomography (ERT) has been acquired to confirm and prove the measurements and to investigate the water level fluctuation. The results indicated a general agreement and similarity between the observed and estimated seismic refraction water levels. Some shallow water depths are detected which may reflect the surface of perched water zone. The processed seismic data in integration with the water level measurements suggest that the deepest and shallowest groundwater levels are up to 20 and 2.5 meters respectively. The average depth is about 10 meters suggesting the accurate water level of the area. This monitoring reveals water level increases at certain locations during two successive years. This study recommends that water level in the study area should be assessed periodically to protect the residential areas from sudden rise in water level and to study any other possibility to manage the water and using the artificial rechargeable wells to enhance the aquifer productivity and to increase the groundwater sustainability.

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## PROCESSABILITY OF GRAPHITE RAW MATERIAL IN THE CZECH REPUBLIC

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### ABSTRACT

Graphite is a raw material that is constantly being used in modern technologies (lubricants, friction materials, batteries, brushes for electrical motors, sealing applications, fire retardants, and pencils; other uses include manufacturing of anodes in batteries and fuel cells for electric vehicles and energy storage systems). However, due to the European Union's dependence on import of this raw material, graphite has been included among the major Critical Raw Materials (CRM). There is a considerable number of graphite deposits in the Czech Republic. The total mineral reserves of graphite-bearing raw material in the Czech Republic as of December 2019 are 13 701 kt (Starý et al. 2020). For a long time, the Czech Republic was one of the world's leading producer of graphite. However, mainly due to the growing demand for cheaper and better-quality graphite from China, the mining in the Czech Republic ended. The last deposits of crystalline graphite were closed in the second half of 2003. One of the reasons for the termination of mining was the difficulty of processing the raw material. The technology of graphite raw material processing has been studied by the Czech Geological Survey since 2014. The attention has been focused on new possibilities of technological processing and modifiability of the raw material. The Czech Geological Survey was granted the patent PV 2018-357, in force as of 31 December 2020, for the graphite raw material processing (Ptíčen et al. 2020). The principle of the patent consists of using ultrasound in the processing of graphite after first being separated by flotation. The process was primarily developed for graphite raw material that is difficult to beneficiate, in particular where the graphite concentrate contained a large amount of inorganic admixtures even after several cycles of flotation separation. Thus, due to this process, some graphite deposits that are being considered as non-prospective because of demanding beneficiation of raw material, can become again economically promising. Further research focusing on the processing of graphite raw material is a part of the Rock Environment and Natural Resources (RENS) project, which is supported by Technology of Agency of the Czech Republic (SS02030023).

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**METHODOLOGY OF DAM MONITORING USING 3D LASER SCANNER. CASE OF KRAMIS'S DAM  
(MOSTAGANEM, ALGERIA)**

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**ABSTRACT**

Monitoring of dams and their behavior requires precise and accurate observations and measurements. With the progress of modern technology, using terrestrial laser scanners (TLS), in the modeling of civil engineering structures and the measurement of their deformations, the lasergrammetry technique offers interesting possibilities compared to conventional topographic techniques (total station, GNSS). The limitations of the latter are overcome, thanks to the potential of lasergrammetry, due to its fast and precise acquisition of huge number of points measurements of objects (dense points clouds) instead of punctual measurements of a few points. The present work consists in establishing a methodology for auscultation of dams based on the technique of lasergrammetry and its application, for the first time, on embankment dam in Algeria, in particular, the Kramis dam in Achaacha (state of Mostaganem). This dam is the subject of an ongoing CTS / ANBT project for geodetic auscultation using the GNSS technique and radar interferometry. Field tests, in February 2020, focused on TLS measurements of the dike and the injection gallery of the Kramis's dam, using two laser scanners: Leica C10 with long range and Faro S150 with short range, respectively. The adopted methodology focused on two main problems: (i) the first is georeferencing (precision and stability) which is fundamental for the junction between successive scans covering the structure and the comparison between scans at different dates (multi-temporal) and (ii) the second is the evaluation of the deformation based on acquired point clouds, using specific software (such as: 3DReshaper). Finally, the results of the application are presented and discussed.

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### **THREE-DIMENSIONAL MODELING OF SPATIAL DATA**

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#### **ABSTRACT**

The content of the research is divided into four points. The first part considers the need of 3D models creation - good practices applied in different countries related to Internet services for urban development and planning, preservation of cultural heritage, as well as scientific research. The second part focuses on the nature of 3D modeling, addressing theoretical issues concerning conceptual modeling, classification of three-dimensional models, geometry and topology. Different data formats are described. The third part focuses on an overview of the different 3D data sources and 3D modeling methods. The fourth part includes the description of a specific software for creating, editing and presenting 3D models - City Engine. The functionality, the specific possibilities for additional analysis and extraction of attribute information from the created models are described, as well as the programming language used in creating three-dimensional models in the software environment. In the fourth part, practical tasks are performed, which aim to make a comparison between the actual state of construction with the set project values in the general development plan for Sofia Municipality. 3D models of buildings in a neighborhood in the Lozenets region were created, after which an additional analysis of the current state of construction was performed. The possibilities of the software for automatic generation of a street network are considered, as well as the functionality related to the modeling of facades.

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## **DEFINITION OF LAND UNITS AT A REGIONAL LEVEL AND THE STUDY OF ITS INFLUENCE IN THE LAND USE MOSAIC**

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### **ABSTRACT**

The concept of land units refers to coherent spatial areas that are characterized by a certain degree of homogeneity concerning certain properties like geology, soils and climate. The Land use mosaic corresponds to a circumstantial layer that represents the present state of the landscape depicting the present factors of resource allocation. Nevertheless, the stable potential layer is related with the stable characteristics of each site and allows the identification of use constraints or potentials. In this study we use a methodology based in the land unit concept to define a stable potential layer at a regional level. Therefore, 26 land units were delimited for the Beira Baixa region. Those units resulted from the combination of geomorphology, soil parent material and bioclimatic influence. For each land unit representative samples were characterized in terms of its land use mosaic attributes. For that purpose, selected landscape metrics were calculated, quantifying the land use mosaic geometrical characteristics, namely: Shannon's Diversity Index, Edge Density, Mean Patch Size and Number of Patches. The existing land use types were also quantified. Finally, a cluster analysis was performed to define groups of samples representing the land units that have the similar land use mosaic types. The validation of the previously defined land units confirmed the reliability of the proposed methodology, with most of the land units strongly influencing the land use mosaic. This relationship is stronger in the land units that occupy a higher extension in the region, mainly soils rich or very rich in silica under the influence of a mesomediterranean subhumid bioclimate.

## THE IMPORTANCE OF SOIL PARAMETERS AS PREDICTORS OF PLANT SPECIES AND COMMUNITIES' DISTRIBUTION AND BIODIVERSITY ALONG ERGES RIVER

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### ABSTRACT

Riparian systems are transitional environments between water bodies and surrounding elevated areas; they form an environment within which the aquatic and terrestrial components of the landscape interact. Riparian zones have been variously defined as very complex ecotones with distinct vegetation and soil characteristics periodically, influenced by flooding and, thus, where vegetation may be influenced by elevated water tables and the ability of the soils to hold water. Soil factors are of well-known importance for plants among other abiotic factors because they constitute the belowground environment from which water and nutrients can be captured. There are important feedbacks between the standing vegetation and fluvial processes, which have a fundamental effect on the character and dynamics of the riparian habitat mosaic. As a result of their complexity and dynamics, naturally functioning riparian systems show high biodiversity and production. Among soil parameters, soil pH is often considered the most proximal for explaining plant distributions and it was shown to be an important predictor of plant species richness. The carbon isotope composition of soil organic matter (OM) is another potentially important parameter used to infer the source of carbon in different ecosystems. This work aimed at evaluating the effect of soil proprieties in plant species and communities' distribution and diversity along the banks of Erges river in the Tejo Internacional Natural Park (PNTI), Portugal. In this riparian area the homogeneous natural vegetation types, the floristic composition and cover of the species were determined in 56 plots floristic inventories and soil samples were collected, following a random-stratified equal sampling design. During the study period, a total of 249 plant species were recorded, and 10 main vegetation communities were identified. The influence of the soil parameters in the explanation of vegetation presence and abundance was assessed using canonical ordination (RDA). Linear regression was used to study the relation between soil parameters and plant richness. The correlation between the pH and plant species richness ( $R = 0.314$ ) and between OM and plant species richness ( $R = 0.397$ ) is moderate and positive. For rock vegetation communities the potassium concentrations in soil are higher than in other plant communities ( $x = 129$  ppm), and the OM content is higher in tall shrubs' communities ( $x = 4.98\%$ ). Concerning the relation between soil parameters and presence of plant species using RDA, with the Monte Carlo permutation test showing that there is a significant correlation ( $P=0.002$ ), and 52.54% of total of the variance explained with the first two axes, we observed that OM, phosphorus, and pH concentrations have a strong influence in species distribution.

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## MODEL-BASED CORRECTION METHOD FOR TEMPERATURE-DEPENDENT MEASUREMENT ERRORS IN EMI SYSTEMS

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### ABSTRACT

Electromagnetic induction (EMI) is a non-invasive and fast geophysical measurement technique that provides information about the uppermost meters of the subsurface with a spatial resolution in the sub-meter range. Frequency domain EMI systems measure the apparent electrical conductivity (ECa) of the soil by inducing a time-varying primary electromagnetic field into the ground using a sender. Since the subsurface is electrically conductive, the primary field produces eddy currents that lead to the generation of secondary electromagnetic fields. The superposition of the secondary and the primary electromagnetic field is measured at a receiver, and the imaginary part of this superposed magnetic field is related to the ECa of the subsurface. Data measured using EMI systems are known to be susceptible to measurement influences associated with time-varying external ambient factors. Temperature variation is one of the most prominent factors causing drift in EMI data, leading to poor predictive performance and non-reproducibility of results. Typical approaches to mitigate drift effects in EMI instruments are performing a temperature drift calibration where the instrument is heated up to specific temperatures in a controlled environment and the observed drifts are collected in a lookup table for a static ECa correction. An enhanced correction method is presented that models the dynamic characteristics of drift and later uses it for correction. The model is tested with a custom-made EMI device equipped with ten temperature sensors that simultaneously measure the internal ambient temperature across the device. The device was used to perform outdoor calibration measurements over a period of 16 days within a wide range of temperatures. In order to reduce the influences of soil variation over time, the instrument measured ECa at a height of 0.7 m with an intercoil spacing of 1.2 m. In contrast to typical approaches involving static thermal ECa error correction based on a look-up table, this new approach models the dynamic thermal characteristics of the drift and actively uses it for correction. The results are showing that modelling the dynamic thermal characteristics of the drift helps to improve accuracy by a factor of five compared to purely static characterization with a look-up table. In addition, the modelling parameters used for drift correction are very stable for all sixteen datasets. For instance, the average temperature-dependent ECa drift of about  $2.45 \text{ mSm}^{-1}\text{K}^{-1}$  fluctuates only by  $0.04 \text{ mSm}^{-1}\text{K}^{-1}$  between measurements for a temperature variation of about  $30^\circ\text{C}$ . These results suggested that our enhanced correction method using the modelling of dynamic thermal characteristics of EMI systems is a relevant method and beneficial for usage to improve drift correction.

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**RE-INVESTIGATION OF THE LOWER PALEOGENE RUS FORMATION PALEOENVIRONMENT, SE  
UNITED ARAB EMIRATES: NEW LITHOFACIES AND BIOFACIES DATA**

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**ABSTRACT**

The partial closure of the NeoTethys Ocean at the NE margin of Gondwana, at the end of the Cretaceous, resulted in the raising of an ophiolitic mountain range with a flanking foreland basin filled by molasse. The leveling of the mountain range and post-obduction tension, resulted in a new basin (the Pabdeh Basin) that received ophiolitic debris (the Qahlah conglomerate formation) followed by shallow marine carbonates (the Simsima Formation) and the Paleocene Muthaymimah mudstone formation. By the Early Eocene a regionally widespread carbonate and evaporite formation (the Rus Formation) was deposited over most of the Arabian Peninsula, Iraq and the Levant, in a shallow marine platform environment. In the UAE, the Rus Formation, and the overlying Dammam and Asmari Formations were deposited in a deeper environment, the Muthaymimah trough. The UAE sequence is consequently the thickest representative Paleogene section (1000 m) in the Arabian Peninsula. The Muthaymimah trough passed through the Jabal Hafit area of Al-Ain, UAE, where the Rus Formation forms the core of the Hafit Anticline. In this presentation the Rus Formation of the Hafit area, is divided into two units – a white limestone unit (Tarabat Member) and a grey nodular limestone unit (Hili Member). No detailed paleontological data exists to date the Tarabat Member precisely, whereas the Hili Member has yielded late Early Eocene planktonic and benthonic foraminifera. The Hili Member is thought to lie unconformably upon the Tarabat Member, however, our reconnaissance investigations show interbedding of the two units. The facies of the two units are compared and used to build a paleogeography for the Lower Eocene in the SE Arabian Peninsula.

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## STUDY OF AR<sup>+</sup> AND HE<sup>+</sup> IMPLANTED SOS-STRUCTURES

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### ABSTRACT

In the work SOS-nanostructures after implantation by various doses of ions 4He<sup>+</sup> and 40Ar<sup>+</sup> are investigated. irradiated with helium (4He<sup>+</sup>), the energy of 40 keV (doses D=1.1014-1.1016 cm<sup>-2</sup>), at a temperature T = 220C; irradiated with argon (40Ar<sup>+</sup>), the energy of 400 keV (doses D = 1.1013-1.1014 cm<sup>-2</sup>), at a temperature of T = 220C; irradiated with argon (40Ar<sup>+</sup>), the energy of 400 keV (doses D = 1.1013-1.1015 cm<sup>-2</sup>), at a temperature of T = 2200C. The irradiating ions, energies and doses were selected in such a way that the energy transferred by the ions fell mainly on the thin surface layer of silicon up to the boundary with the hidden dielectric. Researches were carried out by measurement of optical reflection spectrum and magnitude of work function of an electron. It is shown that ions 40Ar<sup>+</sup> in SOS-nanostructures, providing high efficiency of gettering influence, incorporate the neutral divacancy responsible for an observable minimum in ranges of reflection 0.73-0.75eV. As a result of implanted by ions 4He<sup>+</sup> the gettering doesn't occur and the entered defects are divacancies with one negative charge, responsible for an observable maximum in reflection ranges 0.73-0.75eV. The received results indicate possibility of purposeful updating of SOS-nanostructures for improvement of their optical characteristics.

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## **CHARACTERISING NITRATE DYNAMIC IN A RURAL CATCHMENT USING CONCENTRATION-DISCHARGE RELATIONSHIPS**

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### **ABSTRACT**

Understanding processes controlling stream nutrient dynamics over time is crucial for implement effective water-quality management strategies. In this sense, the study of relationship between nutrient concentration and discharge during individual runoff events can be a valuable tool for inferring likely source area and flow pathways contributing to nutrient transport. The objective of this study was to investigate the nitrate dynamic during a set of contrasted runoff events by means of the analysis and interpretation of the nitrate concentration-discharge relationship over a 6-year period in a small Atlantic (NW Spain) catchment. To this end, nitrate concentrations were monitored at high temporal resolution during 102 runoff events. For each of the selected runoff events, concentration-discharge response was examined visually for the presence and direction of hysteresis loop and classified into three types of responses: clockwise, anticlockwise and no hysteresis. Different hysteresis types were observed. The most frequent hysteretic response was enrichment with anticlockwise rotation, indicating proximal sources and delay in the nitrate transport to the stream. However, dilution with anticlockwise rotation was observed in runoff events recorded shortly after another event, i.e., under high antecedent moisture conditions.

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**WATER QUALITY LINKED TO AGRICULTURAL AND LIVESTOCK ACTIVITIES OF LOW INTENSITY: A  
CASE STUDY IN A SMALL HUMID TEMPERATE CATCHMENT**

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**ABSTRACT**

Knowledge of water quality in rural ecosystems is key to defining agricultural management practices that will effectively reduce potential nutrients losses. This study focuses on assessing the water quality linked to agricultural and livestock activities of low intensity of a headwater stream draining an agroforestry catchment in northwest of Spain. Water samples were collected at the catchment outlet during intervals of approximately 2 weeks over a 3-years period, under low flow conditions, with a few exceptions during rainfall-runoff events. The analysis was performed on the following physicochemical parameters: pH, electrical conductivity, dissolved oxygen, chemical oxygen demand, major cations, anions, nutrients (dissolved organic carbon, dissolved and total phosphorus, nitrites, nitrates and total nitrogen) and suspended solids. The mean levels of the parameters used as major indicators of the water quality were lower than those typically documented for rural catchments under temperate climate, consistent with the low population density and characteristics of the non-intensive agricultural practices that have been developing in the area.

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**PROBABILISTIC ANALYSIS OF THE OBSTRUCTION OF WATER SOURCES DUE TO THE  
OCCURRENCE OF RAIN-TRIGGERED MASS MOVEMENTS**

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**ABSTRACT**

This paper presents a methodology for the probabilistic estimation of the obstruction of water streams generated by shallow landslides triggered by rainfall. The study focuses on the Ovejas River, a tributary stream of the Medellín River, in the jurisdiction of the municipality of San Vicente in the department of Antioquia (Colombia). The occurrence of a mass movements was evaluated by deterministic and probabilistic methods based on the automation of processes of Geographic Information Systems (GIS) and spatial modeling. The spatial distribution of the mass movement hazard was estimated in terms of Factor of Safety (FOS) values by the deterministic method with physical basis SLIDE (Slope - Infiltration - Distributed Equilibrium), which consists of the zoning of the hazard by calculating a FOS for mass movements induced by rainfall with different return periods. The precipitation regimes of the area were estimated by means of a simple scaling Log Normal Model. On the other hand, the Probability of Failure (PF) analysis was performed under Rosenblueth's point estimation methodology, which allowed incorporating the uncertainty of the soil parameters. Subsequently, the resulting zones with high hazard that could detach and reach the Ovejas River channel were identified as sources for runout modeling by means of the Flow R model, thus estimating the extent of mass movement in probabilistic terms. In all the scenarios analyzed, the sliding material from the critical stability zones has a high probability of spreading to the riverbed of the main river. This analysis made it possible to identify those areas of the riverbed that should be analyzed with more detail and require possible intervention for the protection of the riverbed.

Corresponding Author: Laura Ortiz Giraldo

**MULTISTAGES MINERALIZATION AND TRANSFORMATION OF CLASTIC ROCKS IN THE VYUN ORE FIELD, YANA-KOLYMA METALLOGENIC BELT, NORTHEAST ASIA: CONSTRAINTS FROM THE SEDIMENTARY, DIAGENETIC AND HYDROTHERMAL SULFIDES AND GEOCHEMISTRY OF ORE-HOSTING ROCKS**

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**ABSTRACT**

The Yana-Kolyma metallogenic province is characterized by zones of dispersed sulfidization, which are developed in clastic rocks of the Triassic and Jurassic and are often confined to trans-crust deep faults. The zones occur both within the orogenic gold deposits (Natalka, Malo-Tarynskoe, Khangalas, etc.) and away from them. A wide band of sulfidized rocks is confined to the Charky–Indigirka thrust, which separates the Kular-Nera terrane from the Polousno-Debin terrane of the Yana–Kolyma orogenic belt. We have studied the zone of sulfidization of the Charky–Indigirka thrust in the lower reaches of the Burgandzha (right tributary of the Elgandzha river) creek within the Vyun ore field. Mineralization is represented by hydrothermal veins and veinlets of quartz, carbonate-quartz, and chlorite-carbonate-quartz composition confined to crushing zones, dikes, and sandstone layers. The host rocks are characterized by disseminated sulfide mineralization. The content of sulfides usually does not exceed 1%, in some local areas it increases to 10%. The article presents the results of studying the distribution of major and trace elements in terrigenous rocks of the Upper Triassic and Middle Jurassic, and in distal metasomatites in the territory of the Vyun ore field. The petrochemical features of slightly altered terrigenous rocks, conditions of their formation and changes in their composition as a result of epigenetic processes are analyzed. Typomorphic impurity elements in sedimentary Py1, diagenetic Py2 and hydrothermal Py3 pyrites were determined and their distribution variations were characterized. **Py2 and Py3 are characterized by zoning and sectoral structure. Py3 - increased impurity As (up to 2.8%).** Analysis of the compositions of slightly altered sedimentary rocks of the Upper Triassic and Middle Jurassic allowed us to conclude, that changes of oxygen conditions to disoxic and anoxic, as well as the enrichment of the terrigenous material with ore elements contributed to the formation of authigenic sulfide mineralization at the early stages of the formation of sedimentary strata. **The subsequent multi-stage evolution of the territory involved an active migration of chemical elements, their supply and redistribution.** The major sulfide mineral of the host rocks of the Vyun ore field is pyrite, which is represented by two pre-ore generations and metasomatic pyrite, which is characterized by an increased impurity of As. Py2 and Py3 are characterized by zoning and sectoral structure

Corresponding Author: Polufuntikova Lena

## **IRON OXIDE TRACE ELEMENTS GEOCHEMISTRY AS A TOOL IN MINERAL EXPLORATION: A CASE STUDY IN NW SPAIN**

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### **ABSTRACT**

Asturias (NW Spain) is a region with three gold belts (alignments of small-scale gold occurrences), which are described in the scientific literature. The Río Narcea gold belt has been intensively explored and exploited during the last two decades; conversely, the Navelgas and Ibias-Oscos gold belts are infra-explored and they have not yet been object of modern metallic mining works. These latter gold belts are included in the so-called “West-Asturian Leonese Zone”, a part of the Iberian Massif, which extends over the westernmost one-third of the Asturian region. This area is mainly constituted by thick metasedimentary sequences of slates and quartzites with only a thin (~150 m) limestone level of Lower Palaeozoic age. Igneous bodies are, in general, granitic masses of little significance. Some geological evidences (such as the presence of alluvial gold and other heavy minerals) support the existence of unknown metallic mineralizations within the watersheds of the Rivers Eo, Navia and Esva. In order to deepen the knowledge of the economic geology of these areas and to prioritize prospective areas in future mineral resources exploration works, fluvial sands were taken in the Eo, Navia and Esva river mouths. Heavy minerals ( $\rho \geq 3 \text{ g cm}^{-3}$ ) were separated by gravimetric concentration methods and the heavy fraction was then divided in three sub-samples of ferromagnetic, diamagnetic and paramagnetic behaviour. Iron oxides (magnetite and hematite) that appear in the heavy ferromagnetic sub-sample were mounted in polished sections and their content in 12 selected elements (Ca, K, Mg, Mn, Ti, Cu, Ni, Al, Si, V, Cr and Zn) was determined by electron-probe microanalysis (EPMA), following the procedure described in Dupuis and Beaudoin (2011). Trace elements geochemistry in iron oxides led to the construction of discriminant diagrams for mineral deposits types, as it was proposed by the above-cited authors. Iron oxides geochemistry reveals quite high Al, Ca, Mg and Ti contents in almost all particles (also for Mn in the Navia river sands) and low Cr, Ni and V concentrations. Presenting the EPMA results in the form of discriminant diagrams allows to infer that the most probable origin of iron oxides is linked to hydrothermal and skarn type mineral deposits, which constitutes a useful criterion in subsequent prospecting stages. In addition to the use of Fe oxides geochemistry as a geochemical tracer, showings of other heavy minerals of economic interest, such as scheelite or monacite, have also been found.

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## **INFLUENCE OF THE DROPLET VELOCITY ON THE ATTENUATION OF OVERPRESSURES IN A WATER MIST**

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### **ABSTRACT**

Mist generator is a basic element of systems designed for protection from explosions, as it is responsible for forming a suppression barrier between the place of explosion and the zone to be protected. The effectiveness of the system is determined by the capacity of the mist to suppress blast overpressure and impulse. The attenuation capacity, on its turn, depends on mist properties, such as droplet size, water concentration in mist and droplet velocity. The paper examines droplet velocity influence on overpressure and impulse attenuation in mist when the properties of the latter were in the following ranges: droplet size - 15-345  $\mu\text{m}$ ; droplet velocity - 5.5-35 m/s; shock wave velocity – 515-718 m/s, droplet impact angle -  $90^\circ$ . The influence of drop velocity on blast attenuation has been assessed according to overpressure and impulse reduction factors.

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## **EXPERIMENTAL INVESTIGATION OF INFLUENCES OF TRAFFIC LOAD ON HISTORICAL BUILDINGS**

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### **ABSTRACT**

Long-term dynamic loads represent a serious factor which compromise the safety and durability of historical buildings. Continued exposure to these types of loads contributes to the degradation of materials and joints, causing the initiation of cracks or the growth of existing ones, such that they may endanger the structure. Loads, which an undamaged structure could safely resist, can be critical if repeated numerous times. This risk is present in various types of historical buildings, and is influenced by changes in vibration magnitude, by the distance from their source, and by the quality of the building's maintenance. Good maintenance, which includes regular inspections, affords early detection of many emerging damage and its subsequent repair. This article describes the methods and results of the measurement of dynamic response to road traffic and other types of technical seismicity in four historic buildings.

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## QUALITY OF THE SURFACE WATER IN THE RATKA SMALL WATER RESERVOIR

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### ABSTRACT

The aim of the contribution is to evaluate the state of the quality of the surface water in the Ratka small water reservoir and its surroundings. The Ratka small water reservoir is included in fishing grounds; it is therefore necessary to know the quality of the surface water. The work is focused on an evaluation of the surface water quality indicators, i.e., the water temperature, pH reaction, content of the nitrate nitrogen, nitrite nitrogen, and the ammonia nitrogen, the chemical oxygen demands, and the total organic carbon. The analysis was divided into field measurements and laboratory measurements. Three sampling points were identified, from which samples were regularly taken. For water temperature and pH reaction, the field measurements were performed every month during 2019 and for other selected indicators of water quality, the field measurements were performed during April – September 2019. The laboratory analyses were realized in 2019 (summer, winter) and were focused only on samples from the Ratka small water reservoir. To evaluate the results, they were compared with the recommended values found in the valid Regulation of the Government of the Slovak Republic No. 269/2010 Coll. After evaluating the results of the study, increased values indicators of quality of the surface water were found water temperature, pH reaction,  $N - NO_2$ , chemical oxygen demands and total organic carbon. Phosphate contents are also present in the water. The results showed that the Ratka small water reservoir, due to the increased values of the mentioned indicators of the quality of the surface water, does not meet the set conditions of the Government of the Slovak Republic. The significance of this study can be seen not only in the importance of water quality assessment from the practical point of view, but also in the need to perform these analyses, especially in areas where no water quality assessments have been performed so far, an example of which is the Ratka small water reservoir assessed in this study.

## THE IMPROVEMENT OF PICRIC ACID SYNTHESIS METHODOLOGY

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### ABSTRACT

Explosives have the greatest importance in human practical activities, not only at time of war, but at tranquility as well. Nowadays, huge amount different type of explosives is synthesized, and fabricated for military and civilian applications. Nevertheless, this fact doesn't exclude necessity of synthesis of new explosives for optimization of their characteristics, such as prime cost, power, safety during production, storage, transfer and etc. Picric acid is a fairly strong and energetic explosive, same time, beside to its explosive properties, it is characterized with antibacterial nature and it is the best yellow dye, especially for dyeing animal and plant tissues. The synthesis of **picric acid structural analogues**, is the main purpose of the research. One of the reasons of synthesis picric acid and further preparation of its structural analogues, is safe nature of substances of this group, which makes them safe to various manipulations. On the other hand, it is well known that the synthesis and production of explosives is classified as high risk and costly technology. Therefore, even a small increase of their production productivity, is interesting from the economic effect point of view. During an investigation, changing of reaction conditions (temperature, concentrations and dosage of reagents) the improved method for syntheses of picric acid was developed. As result the **significant increase of practical yield of picric acid**, from 46% to 86% was archived. Synthesized picric acid was placed in steel tube and tested on initiation of detonation in explosive chamber. The description of modified method, comparisons to conventional technology, as well as explosion testing results are described in the paper.

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## **POSSIBILITIES OF WATER STORAGE IN DRAINAGE CHANNEL SYSTEM OF UPPER RYE ISLAND**

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### **ABSTRACT**

Consequently, to the construction and operation at water power plant Gabčíkovo came to changes in water regime in adjacent area. The power canal of the Gabčíkovo power plant cut the upper parts of the drainage system in Danube Lowlands. Groundwater level changes have occurred in the vicinity of the Hrušov reservoir what caused changes in discharge and water level regime of the drainage channels. Presented contribution deals with theoretical and practical background of the water management in agriculturally exploited regions, especially with the possibility to create and store enough water for irrigation in the channels of one part of the Rye Island. Therefore, it was necessary to measure and calculate the capacity of given channels as well as the volume of water stored by means of improved operation on hydraulic structures or by construction of new structures. Rye Island belongs to an area where agriculture in the growing season, especially due to the irregular distribution of precipitation, very often suffers from drought. The probability of ensuring at least 10 mm of precipitation in one decade of the growing season is only 50% and the probability of 30 mm of precipitation is only 20%. It follows that without irrigation the moisture for vegetation cover is not ensured. But there can be years with heavy rainfall and then there is no need to irrigate. Rye Island is the warmest area of the Slovakia where the vegetation period is also the longest. Most of it belongs to the area of corn production type. The irrigation economy is therefore profitable. However, the technology of implementation and the effort to introduce large-scale irrigation as soon as possible led to the conclusion that this issue should be considered from several points of view.

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## **ASSESSMENT OF GROUND WATER DRAWDOWN IN INDUSTRIAL PARK OF NITRA**

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### **ABSTRACT**

The main objective of this paper is to inform about the results of proposal, design, realisation and optimization of the groundwater extraction system to control excessive rise in groundwater table during last three years. Its theoretical background is intended to be used for Nitra Industrial Park where the Land Rover Jaguar motor car company is nowadays already completed at northern part of the town of Nitra. For proper construction and operation of the industrial park, there was already proposed 38 groundwater extraction well system from which optimum pumping rate is required to keep the groundwater level at required elevation for the investor without causing any depletion to water resources in the adjacent area. To address this challenge, we applied numerical groundwater modelling system using TRIWACO simulation package. The modelling package utilises finite element method (FEM) that can handle complex aquifer parameters for running quasi three-dimensional groundwater flow model. Based on available hydrological, geological and hydro-geological data numerous simulations were carried out for both - steady state and transient flow conditions. Integral part of these input data was the realisation of three proposed pumping tests by INGENIO, Ltd. Company as well as measured ground water level data from boreholes of the basic observation network of Slovak Hydro-meteorological Institute (SHMI). In order to implement the transient simulation system, a 1000-year instantaneous flood wave ( $Q_{1000}$ ) was considered. This research paper will present numerical modelling results on design of groundwater extraction system to maintain the groundwater level to required elevation as well as parameters and uncertainties for design purposes. Furthermore, the system was optimised in situ for proper operation of the groundwater extraction system and for minimisation of operation costs.

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## **RUSSIAN APPROACHES TO THE FOREST TYPE CLASSIFICATION**

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### **ABSTRACT**

The results of researches characterizing the geographical distribution of forest-ecological, phytocoenotic, and genetic classifications of forest types in the Russian Federation nowadays are presented in the thesis. A comparative analysis was carried out for the following items: the inclusive concept of a classification unit (a type of habitat conditions; a type of forest); features of distinguishing the border of the classification units; classification features used to determine the type of habitat conditions; features of the classification of phytocoenoses used to determine the forest type; the degree to which the successional dynamics of forest stands are taken into consideration; the degree to which the influence of anthropogenic factors are taken into consideration; the level of implementation in forest management and forestry practice; regions of implementation. In the process of development of forest typologies, the concept of a forest type changed from understanding it as a forest area homogeneous by composition, structure, and appearance (homogeneity in space) in natural classifications to the concepts of a forest type, in which priority is given to homogeneity in origin (genesis), as well as developmental processes and dynamics (homogeneity in time) in genetic and dynamic typologies. Currently, there is the following forest type classification in the Russian Federation: forest-ecological, phytocoenotic, genetic, and dynamic. When classifying forest areas within the forest-ecological direction provided by E.V. Alekseyev – P.S. Pogrebnnyak, the priority is given to the characteristics of the habitat conditions. Within the phytocoenotic direction provided by V.N. Sukachev, the priority is given to the phytocoenosis characteristics. Within the genetic approach provided by B.A. Ivashkevich – B.P. Kolesnikov, a forest type is considered as a series of alternating phases – types of phytocoenosis within the same type of habitat conditions. In this case, phytocoenotic classifications can be a part of the genetic classifications for the climax forest phytocoenosis. And the dynamic approach provided by I.S. Melekhov is very close to the genetic one and is a superstructure over the classical phytocoenotic forest typology provided by V.N. Sukachev. The current use of forest typological classifications by forest inventory management enterprises in the Russian Federation was studied. A map of the geographical distribution of forest typologies of the above-listed directions of forest typology researches was created. Forest-ecological classifications are used mainly in the southern regions of the European part of Russia and the North Caucasus. Forest typologies created based on a genetic approach to the forest type classification are used in Western Siberia, in the south of the Far East and Eastern Siberia, and in some regions of the Urals. Phytocoenotic classifications of forest types are used in other regions of the Russian Federation.

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Corresponding Author: Valery Fomin

**APPLICATION OF PB, CU AND ZN ISOTOPES IN THE DISCRIMINATION OF POLLUTION SOURCES IN  
LARGE INDUSTRIAL CITY (EKATERINBURG, RUSSIA)**

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**ABSTRACT**

The ecological condition of the urban environment has an impact on public health. Pollution can occur due to the release of metals into the urban environment. The identification of anthropogenic sources will reduce their impact on the environment. Copper, zinc and lead are contained in various artificial materials, and their geochemical cycles are influenced by anthropogenic activities. The using of lead, copper and zinc isotopes can help in pollution discrimination. The aim of our work is to discriminate the sources of environmental pollution in the large industrial city of Ekaterinburg, Russia. We have analyzed the samples of urban deposits in local depressions of the microrelief in Ekaterinburg during the field seasons in 2007-2009. The isotopic studies were conducted in the cleanroom facilities (class 6, 7 ISO) of the Zavaritsky Institute of Geology and Geochemistry UB RAS, Ekaterinburg. Analytical procedure consisted of sample decomposition, chromatographic separation and isotope measurements on a Neptune Plus MC-ICP-MS spectrometer (Thermo Fisher). The accuracy and long-term reproducibility of the measurement procedure was estimated using the NIST SRM 976, JMC-Lyon and NIST SRM-981. To control the entire analytical procedure and isotope ratio measurement accuracy, an USGS AGV-2 andesite reference material was used. Based on the obtained multi-isotope diagrams ( $^{206}\text{Pb}/^{207}\text{Pb}$  vs  $\delta^{66}\text{Zn}$ ,  $\delta^{65}\text{Cu}$  vs  $\delta^{66}\text{Zn}$ ) the following preliminary conclusions can be made. The dominant pollutants in the city of Ekaterinburg are sources associated with the automotive infrastructure. The southern and western part of the city is dominated by vehicular traffic. In the northern part of the city, the main pollution can be associated with road dust. Road paint and furniture are the main contributors to the pollution of the eastern part of the city. In the course of further work, we plan to conduct an additional analysis of isotope ratios of Cu, Zn, Pb in technogenic particulate matter in order to clarify and quantify the contribution of various sources of anthropogenic pollution.

*The work was carried out at the UB RAS "Geoanalitik" Center for Collective Use and supported by the Russian Foundation for Basic Research (RFBR), grant No. 19-35-60011.*

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## **GROUNDWATER CONTAMINATION RISK ASSESSMENT BASED ON ADVECTION DISPERSION EQUATION**

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### **ABSTRACT**

It is common knowledge that there is an immense amount of water in aquifers below the earth's surface. However, groundwater challenges and opportunities are often overlooked in national and international strategies for sustainable development. Good water quality was, is, and always will be a high priority. Groundwater contamination is seen as a significant problem because this is a real threat to the water supply. Different human activities, industrial discharges, mining, waste disposal, agriculture, and various chemicals can affect groundwater quality and cause significant contaminations. The consequences of contaminated groundwater can seriously affect sustainable development; present and future generations being seriously affected by inadequate drinking water quality, loss of water supply, degraded surface water systems, high remediation costs, more expenses for other water supplies, and likely health issues. Therefore, an effective way to protect groundwater resources is by assessing the risk of groundwater contamination. An assessment of groundwater pollution should be performed to determine the level of risk posed by soil and groundwater contamination and establish if remediation strategies are required to protect controlled waters from site-derived contamination. Furthermore, if remediation is deemed necessary, site-specific remedial targets should be derived. A case study is presented in the paper, where a Conceptual Site Model was derived based on a "Source-Pathway-Receptor" exposure mechanism using historical information. Primary sources of contamination at the site are residual contamination within the soil and groundwater, and samples were collected from the site and tested in the laboratory; the concentration of water samples was compared to Romanian Drinking Water Standards. The following potential migration pathways have been identified: a. Leaching from soil; b. Migration of contaminated groundwater. The Detailed Quantitative Risk Assessment (DQRA) has modelled the leaching of contaminants from the site via infiltration and vertical migration to the groundwater and subsequent lateral groundwater migration, with dilution and attenuation process active, to the compliance point, using Ogata-Banks equation. The results of this assessment indicate that the concentration of contaminants does not represent a significant risk to controlled waters.

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## CORELA DEVICE FOR DRILLING CORE ACTIVITY MEASUREMENT

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### ABSTRACT

KUTH radiometric analysis gives useful knowledge about rock formations. Radiometric measurements may be performed in a borehole or the drilled core can be measured. The disadvantage of the drill core measurement is the natural background at the site (laboratory) but it is counterbalanced with the possibility to measure with more sophisticated device compared to the in-borehole measurement. Another advantage is improved measurement of cores from existing archives. Due to such challenges, the modular system Corela is being developed. The keypoint of the Corela system are small detectors of GAGG+ scintillator with SiPM silicone photomultipliers and a novel software for the spectra evaluation. The software works with whole isotope spectra and performs the measured spectrum decomposition with respect to the KUTH. The small detectors employed can be placed around the measured core with minimum gap between them and the sample. So, they can be shielded together with the sample with relatively weaker shielding of lead and tungsten. The advantage of the GAGG+ is either high density of 6.6 g.cm<sup>-3</sup> or high proton number 64 of Gadolinium. So, despite small size of the scintillators, each detector is equivalent to the NaI:TI 1x1" (diameter x length). The Corela is a modular system consisting of rings placed coaxially to make a tunnel for the sample to be moved in. The rings are of three types: shielding and collimating rings, detector ring and end-cap rings. It is considered that customer can arrange different patterns of the rings to optimize it according to his needs (sensitivity, velocity of measurement etc.) The modularity is advantage in case the Corela should be transported – the rings can be transported separately so weight considerations can be obeyed. The shielding rings suppress the background 5 times in the window 250 – 700 keV and almost 20 times in the window 100 – 250 keV. Now, the basic simple setup has been tested and evaluated. It consists of one detector ring with three detectors around the sample and of shielding and end-cap rings on both sides to prevent background radiation leaking towards detectors. The sample must be moved manually at this first setup although automatic movement synchronized with the measurement procedure is planned for near-future upgrade. We have performed first technical tests to evaluate the system parameters. Spatial resolution has been tested with point-like radioactive source hidden in a model core of concrete. The count-rate was plotted against depths of sample insertion and peak FWHM (Full Width at Half Maximum) was evaluated as spatial resolution. With <sup>137</sup>Cs @ 662 keV (250 kBq) we got resolution of 8.1 cm. This value is comparable with the diameter of the central sample hole.

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## MARBLES FROM CASTAGNETO CARDUCCI AREA (TUSCANY, ITALY)

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### ABSTRACT

Marble is a building and ornamental material that has been widely used over the centuries for its valuable aesthetic features and workability. In Italy, the wide availability of marbles and their excellent quality favored a very wide structural and ornamental use. In fact, Italian marbles have been used to build churches, cathedrals, temples and so on, as well as masterpieces of sculpture made by important artists such as Michelangelo Buonarroti, who used marbles extracted from the quarries of the Apuan Alps in Tuscany to create his works. It is not a coincidence that Carrara has been an important quarrying district since Roman times. However, there are many other quarries in Italy, from which valuable marbles are extracted, albeit with different macroscopic and microscopic characteristics from the materials extracted from the Apuan Alps. In this work, we examined the marbles from Castagneto Carducci (Livorno province, Tuscany), which originated by contact metamorphism of the *Calcare Massiccio Fm.*, an Early Jurassic limestone belonging to the Tuscan Sequence. Examination of the bibliography, conducted in the initial phase of the work, has shown that the data on these marbles are rather scarce. The purpose of this work was to determine the chemical, mineralogical and petrographic characteristics and especially the main physical and mechanical properties. Overall, forty marble samples were studied, coming from two inactive quarries, open on the NW and NE slopes of the Mt. Romitorio, and from natural outcrops near these quarries. The analyzed rocks are pure or almost pure marbles, with a calcite content > 98% by weight. Optical microscopy observations have shown that Castagneto Carducci marbles generally have a heteroblastic granoblastic texture with crystal boundaries from right to lobate. The maximum grain size ranges from 0.2 mm to 1.4 mm. The determination of the main physical properties of the analyzed marbles showed that these rocks have low porosity and, in general, good physical and mechanical properties. Compared to the marbles outcropping to the south, near Campiglia Marittima, the Castagneto Carducci marbles have a fine grain size, although they belong to the same formation. This is due to the location of the Campiglia Marittima marbles close to the neogenic magmatic intrusion of *Botro ai Marmi*. Consequently, the latter have undergone a more thorough metamorphism and, therefore, a greater recrystallization of the calcite crystals. From a commercial point of view, the Castagneto Carducci marbles are valuable materials, however the intense fracturing behavior that affects the outcrops limits the possibility of extraction.

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## **ÁLVARO SIZA – UNEASINESS AROUND THE RIGHT ANGLE**

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### **ABSTRACT**

Álvaro Siza's methodological and strategic implications have an importance that goes beyond the particular circumstances and experiences of each of his works. In refusing to make his principles absolute, and in methodically avoiding moral solutions to architectural problems, Siza does not avoid the uncertainty of the historical contingency present in each site. Tradition is a challenge to innovation and Siza is both a conservative and a traditionalist, i.e., he transitions between conflicts, compromises, and hybrid transformations. Even when advocating the preservation of a particular element, he always remains selective, drawing a precise dividing line between contextualism and sentimentalism. The basis of this relationship lies in a somewhat contradictory double position, or, at least, in a dichotomy between urban composition and architectural language. By analysing Siza's architecture, we can see the search for an architectural language that contrasts with the absolutely canonical and traditional compositions of the city's pre-existences. His work allows us to understand the way in which his architecture presents itself through a pure creative freedom that reconciles a progressive vision while establishing a resonance and plasticity with the place: it produces and integrates the echoes of certain fragments of the spatial geometry of the site in which it is inserted. This paper aims to analyse and relate some of Álvaro Siza's works in which 'gesture' takes on a primary importance, as the link between architecture and its context. This 'gesture' explored by Álvaro Siza seeks to respond to the inactive forces of the environment and generates urban intensity through distortion and diversification.

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**DETERMINATION OF THE REQUIRED PARAMETERS OF THE MAIN FANS ON THE EXHAUST SHAFT  
FOR THE TARGET MODEL OF THE HARD COAL MINE Y IN CONNECTION WITH ITS  
DECOMMISSIONING**

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**ABSTRACT**

The article presents the results of the analysis and calculations of the ventilation network of the decommissioned hard coal mine Y for the model of its target operation. After the end of hard coal mining and the liquidation of most of the mining excavations, the former Y hard coal mine will become an element of the drainage system and a protection for other mining plants still active. In order for the Y excavation to be transformed into underground water pumping stations, its ventilation system should be rebuilt and new parameters of the main fan should be determined for a smaller network of mining excavations. For this purpose, the AERO-2016D program by the company POK "West" limited liability company was carried out. simulation of the parameters of the ventilation network in the target model of mine Y after the liquidation of the "Southern" shaft and mine workings at the levels of 530m and 660m. The results of the simulation made it possible to select the optimal main fans for the target model of the transformed mine Y.

**CONCEPTUAL CONSIDERATIONS OF THE MODERNIZATION OF THE MAIN FAN STATIONS OF MINE  
Y AND THEIR ECONOMIC ASPECT**

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**ABSTRACT**

In connection with the liquidation of the rock mine Y and the change in the nature of its operation, it is necessary to modernize the main fan station installed at the "Northern" shaft of mine Y. The article presents concepts of changing the efficiency of WPK 5.0 fans installed in the "Northern" shaft and air access systems for the commercial model mines with a reduced network of mining excavations. It discusses four alternative black-tech options. The most effective of them is illustrated with a preliminary economic analysis, the results of which enable the introduction of an investment decision

**ARTIFICIAL THERMAL DECAY: INFLUENCE OF MINERALOGY AND MICROSTRUCTURE OF  
SANDSTONE, CALCARENITE AND MARBLE**

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**ABSTRACT**

In a major framework of studies around artificial weathering and its effects on different lithotypes, in this work we study the effects of thermal stresses after artificial thermal decay on different types of stones used in historical buildings: a sandstone, a calcarenite and a marble. The sandstone belongs to the so called “Macigno” Formation and mainly outcrops along the northern Apennine (North Western Tuscany) and it has been widely used around Tuscany for building purposes (e.g., in Florence, Lucca, Pisa, Pistoia, etc.); the analysed calcarenite (Gravina) comes from the surrounding of Matera Town and has been deeply used for the construction of the ancient buildings of the town itself; and the marble comes from the Carrara marble district (Northern Tuscany), a highly used stone throughout the centuries as ornamental stone. All these types of stone for their physical and mechanical properties, and aesthetic appearance, have been extensively used as both ornamental stones and as construction materials. To reproduce a plausible effect of natural thermal decay of the stones due to day-to-night and season-to-season fluctuations, we subjected the samples to artificial thermal decay. We carried out different thermal cycles on the samples by using an oven at 150°C and a muffle furnace at 300°C and 450°C. We analysed the physical and mechanical properties before and after each cycle to compare and evaluate the effects of thermal stresses on the stones. Among the different analyses: mass and volume measurements, water absorption tests, mercury intrusion porosimetry, thin-section observations and determination of chromatic alterations through image analysis and Munsell charts method. It was then possible to evaluate the influence of both mineralogy and microstructures on thermal decay of the studied stones (variations in fabric and modifications on physical and mechanical properties).

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## REMOVAL OF SPECIFIC PHARMACEUTICALS FROM WATER USING ACTIVATED CARBON

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### ABSTRACT

Many types of pharmaceutical substances have been detected with significant concentrations through various advanced instrumental techniques in surface water, ground water, partially treated water (with concentration typically less than 0,1 µg/L), drinking water (concentration below 0,05 µg/L) domestic wastewater, municipal wastewater and industrial effluents (concentration approximately 1 µg/L). Pharmaceutical compounds are found at much lower concentrations in drinking water sources than the normally prescribed doses, but there is concern that chronic exposure to numerous compounds could cause serious health problems and that compounds can act synergistically to cause adverse health effects. The effectiveness of removal the specific pharmaceuticals (paracetamol, carbamazepine, warfarin, metronidazole and caffeine) from drinking water with adsorption using two types of granular activated carbon (Filtrisorb 400 and WG12) was monitored. Paracetamol is a medication used to treat fever and mild to moderate pain. Paracetamol significantly relieves pain in acute migraine and headache. Carbamazepine is an anticonvulsant medication used primarily in the treatment of epilepsy and neuropathic pain. It is used in schizophrenia along with other medications and as a second-line agent in bipolar disorder. Warfarin is a medication that is used as an anticoagulant. It is commonly used to treat blood clots such as deep vein thrombosis and pulmonary embolism, Metronidazole is an antibiotic and antiprotozoal medication. It is used either alone or with other antibiotics to treat inflammatory disease. Caffeine is a central nervous system (CNS) stimulant of the methylxanthine class. It is the world's most widely consumed psychoactive drug. The concentrations of caffeine in surface waters were detected in the range 0.1 - 6.9 µg/L. The experiments were performed in laboratory conditions with varying values of pH (7,6 or 6,5), stable temperature, and dose of adsorbent. The experiments were performed in the glass bottles with the volume of 200 mL stock pharmaceuticals solution with concentration approximately 0.05 µg/L. On the analytical scales weighed out 200 mg GAC was used and then it was added to the bottles. Subsequently these bottles were regularly stirred at 200 rpm. Samples were taken at 30, 60, 120 and 240 minutes, after which they were analyzed. EPA Method 1694 was used to determine pharmaceuticals in water samples by high performance liquid chromatography combined with tandem mass spectrometry (HPLC/MS/MS) using isotope dilution and internal standard quantitation techniques. The efficiency of pharmaceutical removal and the adsorption capacity of granular activated carbon depends on the time of contact of water with the material. Adsorption efficiency for two types of granular activated carbon varies from 40 to more than 90%.

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## **IMPACT OF DATA PROCESSING AND DTM RESOLUTION ON DETERMINING OF SMALL EROSIONAL LANDFORMS**

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### **ABSTRACT**

Small erosional landforms are characterized by a dynamics closely related to the occurrence and changes in precipitation and water flowing down the slopes. Triggered by water, the erosion processes are controlled by the other environmental conditions like slope gradient, lithology, land cover and land use. Studying the changes in the topography gives information about the spatiotemporal dynamics of erosion and can contribute to more effective assessment of erosion susceptibility and mitigation measures at the earliest stage of the process development. Usually in the initial stages the changes in the topography are hardly noticeable and using high resolution DTMs (digital terrain models) is of high importance. In this relation the aim of the current research is to determine to what extent the resolution of the models influences the results of delineating the flow lines, rills and gullies. For this purpose a terrain survey was carried out and data was acquired by UAS (uncrewed aerial system) DJI Phantom 4RTK. DTMs in horizontal resolution of 0.05, 0.1, 0.2, 0.5 and 1 m are created and analysed. Special attention is given to the analysis of surface curvature as an indicator for flow convergence and divergence. The research is done on a slope area covered mainly by grass and some rare bushes and trees. Despite the observed variations, the results show a general trend of decrease in the flow length with decreasing DTMs resolution. Considering the plan curvature and concave areas the differences are smallest between the models with cell size 0.1 and 0.2 m.

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## HYDROGEOCHEMISTRY AND QUALITY OF SURFACE WATER IN PARTS OF MIDDLE BENUE TROUGH, NIGERIA

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### ABSTRACT

Statistical analyses, Gibbs plots, Piper diagram, Chadha's plot, correlations, principal component analysis (PCA), Cl/Br ratios, U.S. salinity diagram and Wilcox diagram of chemical parameters were used to reveal the hydrogeochemistry and quality of thirteen surface water samples in parts of Middle Benue Trough. Inductively Coupled Plasma Mass Spectrophotometer (ICP-MS) was used to analyse for the major cations and trace elements while titration method was used for bicarbonate ( $\text{HCO}_3$ ), sulphate ( $\text{SO}_4$ ) and chloride (Cl) and bromine (Br) were analyzed using the Ion Chromatographic Method (IC). The Gibbs plots indicated that the hydrogeochemistry of majority of surface water in the study area are mainly influenced by the rock weathering process. Temperature and pH classified the water into sub-thermal and thermal/slightly acidic to slightly alkaline. Total dissolved solid (TDS) and Sr indicate that all the surface water are fresh water. Electrical conductivity (EC) showed that 85% of the surface water in the study area are fresh while 15% are slightly brackish while total hardness (TH) gives three types of water based on TH < 75 mg/l (62%) as soft; 75–150 mg/l (15%) as moderately hard; 150–300 mg/l (23%). Plotting the thirteen (13) surface water samples of the study area on the Piper Trilinear Diagram give three (3) water facies: NaCl,  $\text{NaHCO}_3$ , and  $\text{CaHCO}_3$  while Chadha's plot identified four distinct facies ( $\text{CaMg-HCO}_3$ , 46.15%,  $\text{Na-HCO}_3$ , 38.46%, Ca-Mg-Cl and Na-Cl water types constitute 7.69%) each. Strong positive correlation between Na and Cl in the surface water of the study area is an indication of salinity. The PCA of surface water in the study area also generated three PCs accounting to 82.87% of the variance. Using Cl/Br ratio plot, about 84% of the surface water are from marine origin. All the surface water in the study area is suitable for domestic, livestock and irrigation and industrial purposes.

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## **NEW TECHNOLOGIES FOR REAL ESTATE MARKET ANALYSIS**

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### **ABSTRACT**

LiDAR technology makes it possible to obtain spatial characteristics of undeveloped land parcels which were the subject of the real property sales contract. Advances in modern measurement techniques made it possible to collect spatial data in a fast, systematic and, above all, reliable manner. This allowed for the dissemination of spatial data in various sectors of the economy and fields of science. One of the most popular types of spatial data are data collected using LiDAR technology (Light Detection and Ranging). LiDAR data allow to gather information about terrain and land cover characteristics. They offer an opportunity to obtain information that can radically change the way specific processes or phenomena are perceived. Digital terrain models obtained from airborne laser scanning (ALS) are currently seen as one of the basic sources of elevation data. It allows for obtaining elevation data directly from the models. This study attempted to use spatial data for real estate market analysis. A method for integrating spatial data with real estate information was developed. The vector map and LiDAR data were processed in ArcGIS Software. The analysis was carried using LiDAR data, land registry and transaction data. The point cloud was obtained from the Central Office for Geodetic and Cartographic Documentation. The Land and Buildings Register database containing vector layer of the borders of cadastral parcels was obtained from the County Office for Geodetic and Cartographic Documentation. The ArcGIS software was used for integration of various types of data. The data refers to spatial characteristics of undeveloped land parcels.

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## **UTILIZATION OF RISK ANALYSIS OF HYDRAULIC STRUCTURES FOR EFFICIENT ALLOCATION OF MEANS**

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### **ABSTRACT**

Efficient allocation of available means presuppose detailed knowledge about risks, costs and benefits within the area of interest. The societal demand for increased safety of hydraulic structures, as components of the critical infrastructure, requires considerable investment. To evaluate the effectiveness of potential measures in an environment influenced by epistemic and aleatory uncertainties, risk analysis and cost-benefit analysis are used in practice. The above described approach is now fully implemented when considering natural floods and structural flood protection measures, and also presented in the paper. For potential failures of dams and other important hydraulic structures however the procedure becomes rather more complex to comprehend the effect of designed measures on different failure modes. After introducing governing theoretical principles used for the natural flood vs structural measures analysis, the paper presents examples of application of combination of cost-benefit and risk analysis in the framework of the authors' work as Strategic Expert of the Ministry of Agriculture of the Czech Republic for the different stages of the flood prevention program. The last part of the paper focuses on dam safety and the application of risk analysis as a support tool for decision making processes. It describes the practice applied in the Czech Republic and comments on the advantages and disadvantages of the current approach while suggesting further possible improvement.

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## MICROBIOLOGICAL, HIDRODINAMICAL AND GEOCHEMICAL SURVEY OF SULFIDE-RICH MINERAL WATERS OF CALDAS DA RAINHA, CENTRAL PORTUGAL

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### ABSTRACT

Natural mineral waters are complex ecosystems with a wide range of autochthonous microorganisms. Characterizing the microbial variety present in groundwater is critical not just for biodiversity but also for understanding its involvement in biogeochemical cycles. In the case of thermal mineral waters, this new knowledge could lead to a re-evaluation of their therapeutic indications for thermalism, as well as their bioactive potential for cosmetic and pharmaceutical applications. The hydromineral springs located inside the Thermal Hospital in Caldas da Rainha (the oldest Thermal Hospital in the world), central Portugal, were used since 1485 to treat the illness and bathe the poor. The water is sulphurous, rich in Chloride and Sodium, with a total mineralization of approximately 3000mg/L, a temperature of 32°C and a pH of 6,9. The springs are located near an oblique fault, with N-S direction, on the contact between Jurassic carbonate rocks and Hetangian-Retian marls, on a geological setting dominated by a syncline with diapiric origins. The mineral water circulates in Jurassic limestones. In addition to these traditional springs there are 2 drilled wells and 2 piezometers. Investigations were undertaken to characterize quantitatively, chemically, and microbiologically the hydromineral resource, as well as the hydrodynamical connectivity between the several springs and the mineral water wells. Prokaryotic communities were characterized through environmental DNA barcoding by long-read nanopore sequencing of 16S rRNA region. There is no hydraulic connection between the drilled wells and the springs. High levels of diversity were observed at all sampled sites and statistical differences were found between the microbial diversity of all samples. Representatives of both Archaea and Bacteria were found, and *Sulfurimonas*, a chemoautotrophic bacterial genus responsible for reducing nitrate and oxidizing both sulfur and hydrogen, was the prevailing group. Another relevant genus were *Sulfurovum*, *Sulfuricurvum* (bacteria) and *Aeropyrum* and *Desulfurococcus* (Archea). These microorganisms are putatively involved in the sulfur cycle, as they are capable of oxidizing and reducing sulfur. This study confirms that groundwater environments host highly adapted and diverse microbial communities.

Corresponding Author: Rita Carvalho

## **REVIEW OF PHYSICAL BASED MODELS FOR DEBRIS FLOW ASSESSMENT IN TROPICAL MOUNTAINOUS REGIONS**

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### **ABSTRACT**

Debris flow is a very destructive mass movement which behavior and occurrence are heavily influenced by the environment. South America for example, is known for being full of rainforest, mountain ranges and high annual rates, all conducive characteristics to debris flow development. However, there is still a lack of comprehension and analysis about triggering mechanisms, soil behavior and the environment influence on its occurrence. Physical based models (PBM) allow zoning and definition of debris flow scenarios through simulations that reproduce the behavior of each landslide event. For calibration effects, parametric information is obtained by the recorded past events and high-resolution topographic information available nowadays. These PBM, also called routing models, implemented in software package like RAMMS, FLO 2D, LS RAPID, Debris 2D, Flow R, among others are usually based in continuum mechanical equations, one or two dimensional. Generally, simple rheological relationships are assumed by these models to make approximations about the behavior of large-scale mixtures without considering the physical relationships involved. Bingham fluid rheological formulation, Savage and Hutter equations and the Voellmy rheology are the main formulations on which these models are based. They have proven their usefulness into describing debris flows in several dimensions. However, their suitability depends on each case, since they all need detailed information regarding topography, volume, and rheological parameters, that in most of the cases are difficult to obtain. This study aims to analyze and compare the PBM mentioned. Their applicability in mountainous regions environments is the focus of interest. Different aspects like input and output parameters, workspace, calibration, and results are considered and compared between aforementioned PBM.

Corresponding Author: María Isabel Hurtado

**USE OF GEOTECHNOLOGIES IN MINING PLANNING IN QUARRIES CARBONATED ROCKS -  
CONTRIBUTION TO THE DIGITAL TRANSITION (INDUSTRY 4.0)**João Duarte <sup>1</sup>, Francisco Sousa <sup>2</sup>, Bruno Valente <sup>3</sup><sup>1</sup> IQGeo - Serviços, Lda e Geosciences Center of the University of Coimbra, Portugal<sup>2</sup> Portugal<sup>3</sup> StillMoving, Portugal**ABSTRACT**

As part of the strategy for Industry 4.0, this work was developed to outline a methodology that is an important contribution to improve the efficiency and productivity of processes in the ornamental stone extraction industry. Since this sector is important for the Portuguese economy, it is imperative to optimize processes to improve their efficiency in the use of resources, economic valuation, and economic viability. Knowing that one of the main factors to take into account in the feasibility of an exploration of ornamental rocks is the density, persistence and attitude of the discontinuities present in the rock mass, a methodology is proposed that aims to map and characterize the existing discontinuities in the using the latest digital technologies and whenever possible open access (CloudCompare, Stereonet, 3D Block Expert). To this end, work was initially carried out on an active exploration front, identifying and characterizing, through the traditional method (compass and clinometer) and photogrammetry, existing discontinuities and statistically analysing their occurrence. The data analysis shows a variation in the attitude of the discontinuities in a range of  $-17.72^{\circ}$  to  $14.7^{\circ}$ , this variation corresponding to the strike. As a percentage, there is also a variation in the range of values, from  $-5.30\%$  to  $4.91\%$ , with the reference value being the value obtained by the photogrammetric method. This step was also used to compare the acquired data and verify the variations between them depending on the method used. Photogrammetry was used with another complementary purpose, but very important for the proposed methodology, which is related to the 3D modelling of the fronts and the subsequent projection or extraction of the existing discontinuity plans. The determination of the attitude of the discontinuities was obtained through the manipulation of the point clouds obtained by the photogrammetric modelling, based on the technique of Structure for Motion [SfM] and application of the RANSAC Shape Detection algorithm of the CloudCompare® program, which allows the determination of the attitude of the discontinuities. The characterization of the discontinuities by the photogrammetric method provided the data that was used in the present study to calculate the blocometry in that sector. This was calculated using the 3D BlockExpert software, based on the exploration sequences. The program calculated the predicted volumes in each one, based on a standard dimension for the block of  $2.7 \times 3.0 \times 2.0$  meters. As a result, it was possible to compare a number of blocks the value predicted by the 449 modellings and the number of blocks produced 490. This difference of approximately 10% for this order of magnitude is acceptable and confirms the reliability of the proposed methodology. This evaluation using Geotechnologies allows data modelling to be effectively an important process in the planning of the extractive process, and with the development of this approach, it may introduce in a second phase the decision automation of the extractive process, based on economic and commercial criteria and last and third stage, the automation of the extractive process.

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**THE SCALING OF  $PGA$  WITH  $IV2_p$  AND ITS POTENTIAL FOR EARTHQUAKE EARLY WARNING IN  
SELECTED SEISMOGENIC ZONES IN GREECE**

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**ABSTRACT**

The main goal of an Earthquake Early Warning System (EEWS) is to estimate the magnitude of an underway rupture from the first few seconds, thus becoming an important operational tool for real-time seismic risk management on a short timescale. EEWSs are based on the use of scaling relations between parameters measured on the initial portion of seismic signal after the arrival of the first wave. To optimize magnitude estimation for an EEWS in selected seismogenic zones in Greece, amplitude- and frequency-based parameters, as that of peak displacement ( $P_d$ ), the integral of squared velocity ( $I_v^2$ ) and the characteristic period ( $\tau_c$ ), were analyzed. All parameters were estimated directly from the initial 3s, 4s and 5s signal windows ( $t_w$ ) after the P arrival. While further study needs to be done on the behavior of the initial P-wave based EEWS parameters, we propose that the  $I_v^2$  parameter and the peak amplitudes of the first seconds of the P waves present remarkable stability and could be used in future single-station earthquake early warning operations for areas affected by earthquakes located in the seismogenic zones investigated. Scaling laws are extrapolated for both individual and across sites (i.e. between a near-source reference instrument and a station located close to a target). Furthermore theoretical justification of the proposed expressions is given based on the relations between the estimated parameters in the early part of P waves with stress drop, seismic moment and hypocentral distance. Considering that further study on the behavior of  $IV2_p$  is necessary, there are indications that the parameter could be used in future on-site single-station earthquake early warning operations for areas affected by earthquakes located in the seismogenic zones in Greece, as it presents significant stability.

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Corresponding Author: Filippos Vallianatos

**ECOLOGICAL PROCESS OF A NANO GOLD OBTAINING FROM THE SLOVAK CONCENTRATE**Jana Ficeriová<sup>1</sup>, Erika Dutková<sup>1</sup>, Jarmila Harvanová<sup>2</sup><sup>1</sup>Institute of Geotechnics, Slovak Academy of Sciences, Watsonova 45, 04001 Košice, Slovakia.<sup>2</sup>University of Veterinary Medicine and Pharmacy in Košice, Komenského 73, 04181 Košice, Slovakia.**ABSTRACT**

Due to the negative aspects of the cyanide process (high toxicity, low leaching kinetics, unsuitability for refractory ores/concentrates, and difficulties in storage of cyanide solutions) in the recovery of gold, nowadays modern research studies have a focus on environmentally friendly and more efficient methods. On the basis of the prohibition of the use of the cyanide method in Slovakia and the above-mentioned reasons, this work is focused on gold obtaining from the sulphidic concentrate (Hodruša-Hámre, Slovakia) with the application mechanochemico-biological process, which is environmentally friendly. In this concentrate, the gold occurs physically enclosed in the intercrystalline space of sulphide minerals, and is also isomorphic and fills structure defects in sulphides. The innovative mechanochemico-biological process enables obtaining gold using a thiourea solution, which is a convenient alternative opposite to the toxic cyanidation method. The thiourea compared to cyanide represents an ecologically acceptable reagent with excellent kinetics and selectivity. Mechanochemical processes utilize high-energy milling at which occurs the formation of surface and volume defects in solids. The most significant privilege of mechanochemical processes is the formation of nanostructures. The utilization of the biological process with the application of algae has shown that algae with siliceous structures make it possible to obtain gold from the concentrate (Hodruša-Hámre, Slovakia) with dimension in the nano range. These algae are part of aquatic ecosystems, have unique properties, and produce relatively large biomass from all plants on Earth. The mechanochemico-biological process is a method that enables to obtain the gold nanoparticles (100 nm) from the refractory concentrate (Hodruša-Hámre, Slovakia). Mechanochemical activation of this sulphide concentrate and silica shells of the limnetic algae of tribes (*Dinobryon bavaricum*, *Surirella elegans*) in thiourea solution caused changes in physico-chemical properties of the minerals of gold as well as in the constituents of the algae minerals. These structural changes had a decisive influence on the exclusion of gold nanoparticles to the thiourea solution under specific conditions. The gold nanoparticles were subsequently fixed in the cellular matrix on mechanochemically activated algae shells. The reason for the fixation of gold nanoparticles was the action of biomolecules that algal cells during activation secreted while they defend again the chemical effect of metal ions present in the solution. Nanoparticles of gold were obtained from the concentrate after 30 minutes by the described mechanochemico-biological process. In the case of the mechanochemical activation of the concentrate, but without the activation of defined algae, the exclusion of gold nanoparticles was not confirmed even after three hours. From the above knowledge, it turned out that algae must be activated, i.e. it is necessary to follow the complete mechanochemical-biological process. The nanoparticles of gold obtained by the described way may have different usage (applications) in practice, such as accelerating the decomposition of hazardous substances or eliminating pollutants in contaminated water, soil and air. The acquirement of gold nanoparticles through this process would also lead to the elimination of algae from aquatic sources.

Corresponding Author: Jana Ficeriová

## **A HYBRID MODEL COUPLING EXTREME GRADIENT BOOSTING MODEL WITH GAUSSIAN MIXTURE MODEL FOR STREAMFLOW FORECASTING**

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### **ABSTRACT**

With the increasing water requirements and weather extremes, effective planning and management for water issues has been of great concern over the past decades. Accurate and reliable streamflow forecasting is a critical step for water resources supply and prevention of natural disasters. In this study, we developed a hybrid model (namely GMM-XGBoost), coupling extreme gradient boosting (XGBoost) with Gaussian mixture model (GMM), for monthly streamflow forecasting. The proposed model is based on the principle of modular model, where a complex problem is divided into several simple ones. GMM was applied to cluster streamflow into several groups, using the features selected by a tree-based method. Then, each group was used to fit several single XGBoosts. And the prediction is a weighted average of the single models. Two streamflow datasets were used to evaluate the performance of the proposed model. The prediction accuracy of GMM-XGBoost was compared with that of support vector machine (SVM) and standalone XGBoost. The results indicated that although all three models yielded quite good performance on one-month ahead forecasting with high Nash-Sutcliffe efficiency coefficient (NSE) and low root mean squared error (RMSE), GMM-XGBoost provided the best accuracy with significant improvement of forecasting accuracy. It can be inferred from the results that (1) XGBoost is applicable for streamflow forecasting, and in general, performs better than SVM; (2) the cluster analysis-based modular model is helpful in improving accuracy; (3) the proposed GMM-XGBoost model is a superior alternative, which can provide accurate and reliable predictions for optimal water resources management.

Corresponding Author: Dong Wang

## **STREAMFLOW FORECASTING BY TWO LONG SHORT-TERM MEMORY-BASED MODELS**

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### **ABSTRACT**

Prediction of streamflow is important for water resources planning and management. In this study, we developed two hybrid models, based on long short-term memory network (LSTM), for monthly streamflow forecasting. One model, wavelet-LSTM (namely, WLSTM), applied a trous algorithm of wavelet transform to do series decomposition, and the other, convolutional LSTM (namely, CLSTM), coupled convolutional neural network to extract temporal features. Two streamflow datasets were used to evaluate the proposed models. The prediction accuracy of WLSTM and CLSTM was compared with that of multi-layer perceptron (MLP) and LSTM. The results indicated that although all four models yielded quite good performance on one-month ahead forecasting with high Nash-Sutcliffe efficiency coefficient (NSE) and low root mean squared error (RMSE), LSTM-based models provided the best accuracy with significant improvement of multi-step forecasting accuracy. It can be inferred from the results that (1) LSTM is applicable for streamflow forecasting, and in general, performs better than MLP; (2) the data pre-processing method is helpful in improving accuracy; (3) the proposed WLSTM, CLSTM model are superior alternatives.

Corresponding Author: Dong Wang

## **HYDROLOGICAL SIMULATION AND PREDICTION OF TYPICAL MINING AREA UNDER CHANGING ENVIRONMENT**

Along Zhang, Dong Wang

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### **ABSTRACT**

More frequent extreme weather resulting from climate change (e.g., higher temperatures) and human activity (e.g., mining and smelting) have been cited as two major reasons for exacerbating runoff reduction and environmental degradation. The non-stationary meteorological fluctuation and complex human activities cause significant changes in hydrological factors such as runoff and sediment. Mining and smelting not only affect the underlying surface conditions of the basin, but also disturb the local meteorology of the basin. Runoff and sediment are not only affected by hydrological factors (such as precipitation intensity, precipitation duration and precipitation, etc.), but also affected by soil characteristics. Disturbance of changes in land use and hydrogeological conditions. However, the physical mechanisms of the disturbance of runoff and sediment by mining has not been well understood and documented. The objectives of this study were to: 1) To develop a practical method to simulate and predict runoff and sediment in mining. 2) Considering the local economic population data, historical remote sensing image data and historical hydrological data, combined with hydrogeological conditions and other factors, the hydrological model was established. 3) The hydrological model was designed and constructed to simulate the runoff and sediment transport process with different rainfall intensity. Different land use schemes and different mining scale are predicted, and simulation scenarios are established. This presentation will introduce constructed of hydrological model method, experiment apparatus, and simulation results.

Corresponding Authors: Dong Wang

**ANALYSIS OF PRECIPITATION DISTRIBUTION CHARACTERISTICS BASED ON SPATIAL  
INTERPOLATION PREDICTION EXPERIMENT**

Along Zhang, Dong Wang

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**ABSTRACT**

In this paper, the spatial sampling of terrain in Guangxi Province of China is carried out by using five scale grid method. The Kriging model, RBF model and IDW model are used for evaluation and comparative analysis. The digital elevation DEM is used as the evaluation benchmark. The results are used to analyze the spatial distribution characteristics of precipitation in Guangxi. The results are as follows; With the increase of sampling points, the proportion of areas with prediction error less than 40% increases significantly. When the distribution scale is  $2^{\circ} \times 2^{\circ}$ , Kriging model is better than other models; From the prediction error values of different models, it is found that the proportion of positive error area is significantly larger than that of negative error area; The range of prediction error is mainly affected by interpolation method; The maximum error always appears in the flat low-lying, valley or Intermountain basin in the south of the study area; The mean value calculated by the interpolation model is closer to the real situation than the mean value calculated by the measured arithmetic mean method; The advantages and disadvantages of the interpolation model are mainly shown in the case of large scale of distribution points. With the increase of the number of distribution points, the prediction results of various spatial interpolation models are similar, and their advantages and disadvantages can not be distinguished significantly; Different spatial interpolation prediction models are reliable for the analysis of regional precipitation spatial distribution trend, but the prediction accuracy of each point needs to be further explored.

Corresponding Authors: Dong Wang

## **STABLE LEAD ISOTOPIC RATIOS AS INDICATOR OF URBAN GEOCHEMICAL PROCESSES**

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### **ABSTRACT**

The study is aimed to apply the Pb isotope fingerprinting technique for tracing pollution of urban surface deposited sediment (USDS). USDS reflect changes in the geochemical conditions occurring in the environment. USDS samples were collected in residential areas with multistorey buildings in Russian cities: Magnitogorsk, Nizhny Tagil, Tyumen, Ufa, and Chelyabinsk. Element's concentrations and stable Pb isotopic ratios were measured in the samples. The reconstruction of the initial geochemical baseline (IGB) relationship between potentially harmful element (PHE) Pb and conservative lithogenic element (CE) Fe was carried out for USDS sample populations in the cities. The IGB reconstruction divided USDS sample populations into the groups of 'polluted' and 'unpolluted' with Pb samples. Analysis of elements concentrations and Pb isotope ratios in the groups of USDS samples showed different trends in altering geochemical conditions for metals in the surveyed cities. The USDS is characterized by a decrease in the isotope ratios of  $^{206}\text{Pb}/^{204}\text{Pb}$  and  $^{208}\text{Pb}/^{204}\text{Pb}$  as a result of soil pollution by vehicles during the period of using leaded gasoline.

Corresponding Author: Andrian Seleznev



## **ANALYSIS ON COMPLEXITY OF WATER TEMPERATURE AND ITS FACTORS IN THE MIDDLE REACH OF THE YANGTZE RIVER**

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### **ABSTRACT**

Based on the sample entropy, the study analyzed the characteristics of complexity of water temperature series at Yichang and Cuntan hydrological stations in the main stream of the Yangtze River. The generalized regression neural network model (GRNN) was used to reconstruct natural water temperature in the absence of Three Gorges Reservoir (TGR). To quantify the impacts of TGR on complexity of water temperature in the middle reach of the Yangtze River, the sample entropy values of observed water temperature series were compared with those of natural water temperature series at Yichang station. The results revealed that the complexity of water temperature showed obvious spatial differences in the main stream of the Yangtze River, which is probably attributed to regulated reservoirs, underlying surface conditions and so on. The sample entropy values at Cuntan station firstly decreased and then increased from 1993 to 2015. At Yichang station, sample entropy values from 1983 to 2015 followed a trend of increase-decrease-increase. The impoundment of TGR reduced the complexity of water temperature in the middle reach of the Yangtze River, while natural factors significantly added the complexity. The study can help guide operation of Three Gorges Reservoir to enhance biological conservation.

Corresponding Authors: Yuankun Wang; Dong Wang

**GEOLOGY OF ZAGROS METAMORPHOSED VOLCANICLASTIC SANDSTONES: A KEY FOR  
CHANGING THE MAWAT OPHIOLITE COMPLEX TO A METAMORPHIC CORE COMPLEX, KURDISTAN  
REGION, NE-IRAQ**

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**ABSTRACT**

Mawat Ophiolite Complex located about 36 km to the northeast of Sulaimani city and directly to the east-northeast of Mawat town near the border of Iran in the northeastern Iraq. The complex has about 600 km<sup>2</sup> surface and consist of high mountain terrains which subjected to intense geological investigations from the fiftieth of previous century till now. According to previous studies, the complex contains tens of igneous rocks such as basalt, metabasalt, tuff, diabase, metadiabase, diorite, periodotite, serpentinite, serpentinite-matrix mélange, gabbro, metagabbro, pyroxenite, plagiogranite, pegmatite, granitoid rocks and dunite. They added that the volcanic and subvolcanic rocks occur as dykes or basaltic flows. The present study changed the petrology and tectonics of whole complex from Ophiolite Complex to Metamorphic Core Complex. The revision includes refusal of all the above igneous rocks, instead they considered as medium grade regional metamorphism of different types of volcaniclastic sandstones (volcanic wackes), arenites and greywackes (impure sandstones) which are derived predominantly from remote volcanic source area inside Iran. The revision depended on several conjugate field and laboratory evidences inside the complex. These evidences such as absence of pillow basalt, volcanic flows, glass shards, volcanic cones, dykes, sills, contact metamorphism, dilatational structures and flow structures. Other evidences are presence of cross beddings, erosional surfaces, lensoidal channel fills, metamorphosed conglomerate, exposures of thousands of laminated planar beds and transition from fresh volcaniclastic sandstones to its medium grade metamorphosed counterparts which previously considered as igneous rocks of ophiolites. In contrast to ophiolite section, the basalt located at the base of the claimed ophiolite section while plutonic (dunite and peridotite) rocks located at its top. Accordingly, the present study changed the geological map of the whole Mawat area from igneous outcrops to metamorphosed volcaniclastic sandstones, arenites and greywackes that belong to Walash-Naoperdan Series. The parent rocks of the series transformed to different types of regionally metamorphosed rocks by deep burial during Eocene. During the burial, diageneses and metamorphisms enhanced by complex mixture of materials from different source areas and sea water environments. Later, they uplifted, unroofed and exhumed during Pliocene as a core complex.

## **SUPPORTING ACTIONS TO INCREASE SEISMIC RESPONSE IN AREAS WITH POTENTIAL FOR DISASTER**

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### **ABSTRACT**

Seismic resilience of urban community is ensured also through organization and preparation of technical activities in order to build a post-seismic investigation capacity. Thus, some elements are necessary: responsible structures, competencies and specific legislative references for the management of post-earthquake response measures, at central and local level; information resources; collection and storage of information related on the existing built fund; computerized databases - creation, maintenance and management of information; organizing the keeping of the primary documents of the investigations; training of inspectors and technical staff; material resources; stocks of materials strictly necessary in the event of an earthquake for the implementation of emergency response measures; buffer spaces for sheltering persons evacuated from unsafe damaged area etc. The paper presents in this context the role of the building instrumentation before and after the incidence of severe earthquakes. An interdisciplinary investigation system in-situ and with advanced techniques of the effects on buildings with different functions, in emergencies produced by powerful earthquakes is also defined. The level reached by the research studies within INCDC URBAN-INCERC and the future premises for development in this direction will be reviewed, as a safety necessity and as a European requirement.

Corresponding Author: Claudiu-Sorin Dragomir

## **SIMULATION OF SOIL COMPACTION BY A TRACTOR PASSING**

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### **ABSTRACT**

Several methods for agricultural soil compaction evaluation are known. However, there is a lack of knowledge about a soil elasticity, which could be an important factor for final level of compaction. The paper deals with a possibility of evaluation of soil elasticity using automatic computerized oedometer. A simulation of tractor passing was performed as a part of research focused on the monitoring of soil conditions in vineyards. Cyclic loading test of five loading cycles (loading 300 kPa and un-loading 5 kPa) was performed and vertical deflection was observed, which changed in dependency on change of vertical stress. Course of vertical deformation indicates the ability of soil to relax when the load subsides. The paper presents pilot results, that show good potential of using oedometer for soil elasticity evaluating. Information on the elastic behaviour of soil will make it possible to design and apply means for improving soil elasticity and thus help to mitigate the effects of soil compaction.

Corresponding Author: Pavla Bukovská

## **METHANE AND COAL DUST HYBRID MIXTURE EXPLOSION PROPERTIES STUDY IN SHOCK TUBE**

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### **ABSTRACT**

The explosions of methane and coal dust in the coal mines presents an important problem of the coal industry since its development till now. Notwithstanding the worked-out methods and applied measures to prevent the explosion of methane and coal dust in coal mines, annually several hundreds of miners die or acquire serious trauma from the explosions. During of recent decade, more, than 50 serious accidents were occurred in the different countries of the world, which were caused by explosion of methane and coal dust. The explosions constitute a serious issue for the active mines operating in Tkibuli - Shaori (Georgia) coal field. Here, as a result of two explosions during 2018-year, 10 people died and 9 was seriously injured. The paper presents G. Tsulukidze Mining Institute research defines the coal dust fraction's influence on the explosion ability of the mixture with methane composition. The experiments were performed in a shock tube of the Mining Institute. The shock tube consists of explosion chamber, sectional pipes, the system of metered supply of methane and solid particles, overpressure and flame sensors and computer module managing the processes. The mixture's deflagration was studied via high-speed video camera. The explosive ability of the mixture of coal dust and methane into the shock tube were defined according to International standards. Based on the analysis of the experimental results, the conditions determining the flammability, deflagration and detonation processes at various concentrations of methane and dust were established.

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Corresponding Author: Nika Bochorishvili

## **ANALYSIS ON ROLE OF NiCl<sub>2</sub> IN SOLIDIFICATION OF YELLOW SILTY SAND BY BIO-STIMULATION APPROACH**

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### **ABSTRACT**

Abstract. Microbiologically induced calcite precipitation (MICP) is now widely tried to improve the quality of mostly sandy soil due to its application prospect to sustainability, environment-friendly and cost-efficiency. The present study is aiming to evaluate the feasibility of bio-stimulation, one of MICP techniques, for strengthening the engineering quality of Shanghai silty sand soil, a special type of soil located in low hillside of west Shanghai, as well as the influence of two factors: CaCl<sub>2</sub> as a cementing material and NiCl<sub>2</sub> as a co-factor, which was rarely researched before and can be viewed as the influence of urease activity on bio-stimulation result. The direct shear test, unconfined compressive test, supersonic wave test and calcite mass test have been carried out to evaluate engineering performance of yellow silty sand soil enhanced by bio-stimulation method as well as their relationship with concentration of CaCl<sub>2</sub> and NiCl<sub>2</sub> solutions. The result shows that bio-stimulation method can significantly promote the characteristics of Shanghai yellow silty sand soil and there seems to be extreme point for concentration of CaCl<sub>2</sub> and NiCl<sub>2</sub> solution in improving the quality of Shanghai yellow silty sand. Microstructure and composition of treated soil by bio-stimulation method have also been analyzed by Scanning Electron Microscope (SEM) and Energy dispersive Spectrometer (EDS), with giving the corresponding micro-mechanism of bio-cementation among soil particles.

Corresponding Author: Jili Qu

**SELECTED PROBLEMS OF POLAND'S ENERGY TRANSFORMATION IN THE LIGHT OF THE  
REQUIREMENTS OF THE EUROPEAN GREEN DEAL**

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**ABSTRACT**

The article presents the issues of legal and socio-economic conditions concerning the adopted European Green Deal, i.e. a strategy whose ambitious goal is to achieve climate neutrality by the EU by 2050. The article presents the conditions of the climate package in the European Union. The main obligations of the member states to reduce greenhouse gas emissions were indicated and the challenges for the transformation of mining regions in Poland were indicated. The results of the analysis of the diversity of the member states in terms of energy balances are presented. On this basis, it has been shown that changes in the energy systems of the Member States are very complex issues. The state of advancement of selected countries in implementing modern energy technologies, including the use of renewable energy sources, was presented. It was indicated that the level of economic growth is a factor determining the pace of changes in energy systems, and an analysis of the conditions in Poland was carried out in comparison with other Member States. The specificity of Poland compared to other countries was demonstrated, consisting in the highest share of hard and brown coal (over 80%) in the country's energy balance, which is a unique case among the European Union countries. Therefore, the course of the transformation process should be adapted to the financial potential of each country and should lead to a fair transformation in order to enable the achievement of the assumed goals, i.e. reduction of the emission to zero in the strategic assumptions of 2040 and 2050 and green economy.

Corresponding Author: Anna Bluszcz



**THE EFFECT OF A RUBBER SHEET ON THE DYNAMIC RESPONSE OF A MACHINE  
FOUNDATION LOCATED OVER A SMALL THICKNESS OF SOIL LAYER**

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**ABSTRACT**

Placing a machine footing over a small thickness of soil layer, which is located over a bedrock, could have many challenges due to the bed's notable stiffness in comparison to the soil. The advantages of using rubbers to protect facilities (structures, machine foundations, nearby footings and equipment, etc.) from vibration and control its consequences are well known nowadays. In this study, the benefits of employing a small thickness of rubber sheet (12 mm) on the dynamic response of a machine foundation which is located over four thicknesses of soil (210, 420, 630, and 840 mm) has been investigated. The soil layer is located over an artificial bedrock that is consisted of a thick concrete layer. The tests have been conducted in a vast test pit of size 2500×2500 mm and a depth of 840 mm by using a semi large-scale machine foundation model with a square concrete foundation of width 400×400×100 mm. It was observed that, by increasing the soil layer thickness, the resonant frequency and amplitude of the vibrating system decreases. Moreover, by employing a rubber sheet beneath the machine footing, the resonant frequency of the vibrating system significantly decreases especially for a small thickness of the soil layer. Although, using a rubber sheet could slightly increase the resonant amplitude, but the benefit of the resonant frequency-changing capability of the rubber sheet is too impressive by taking the resonant frequency of the system far enough from the unchangeable working frequency of the machine and preventing the resonant phenomenon to happen.

Corresponding Author: Omid Khalaj

## **THE EXPERIMENTAL INVESTIGATION OF THE REPEATED-LOADING BEHAVIOUR OF THE SAND-RUBBER-MIXTURE (SRM)**

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### **ABSTRACT**

Nowadays the waste rubber problems are concerned due to the environmental issues, storage, and recycling difficulty. However, the rubber base equipment has been widely used to protect structures for vibrations - that has been generated by the structure or induced from the vicinity area or the bedrock into the structure - due to the notable capability of absorbing energy. In this study, the repeated-loading behavior of the Sand Rubber Mixture (SRM) has been investigated and the remarkable energy absorption properties of the mixture have been illustrated. The test soil material that has been used in this study was a well-graded sand (SW) with a mean grain size of 2 mm. The test martial rubber that has been used was grain particles with a uniform size of 4.76 mm. The sand rubber mixture (SRM) was prepared by using 7.5% rubber inclusion because it was found as the optimum rubber content. A series of the force and displacement control repeated-loading CBR tests have been arranged. The effect of the SRM layer thickness of 1, 1.5, 2.0 , 3.0, and 11.6 cm (all SRM) over the well-graded sand (SW test material) was investigated. This study has been shown the remarkable energy absorption capability of Sand Rubber Mixture (SRM) to protect the bed of a machine's footing that is generating a repeated load. The SRM usage could be extended to be employed as a part of an energy absorption unit and dampers facilities beneath a machine footing or structures that are sensitive to the vibration to prevent destructive deformation and resonance phenomenon.

Corresponding Author: Omid Khalaj

**INNOVATIVE TECHNOLOGIES FOR THE PRODUCTION OF CERAMIC BUILDING MATERIALS FROM  
WASTE OF NATURAL (EXOGENOUS) PROCESSES**

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**ABSTRACT**

The main material for the modern construction business is cement/concrete, the production of which is associated with high energy and material costs and, most importantly, high CO<sub>2</sub> emissions into the atmosphere. Based on this, the development of technologies for new energy-efficient building materials - substitutes for Portland cement is of great importance. One of the ways to solve this problem could be the wider use of ceramic building materials, the production of which requires less energy and is not associated with high CO<sub>2</sub> emissions compared to the production of Portland cement. The subject of this article is the development of innovative technologies for the production of ceramic building materials in Georgia (ordinary building bricks and clinker bricks) by using unconventional raw material - clay shale aluvium which is a waste of natural (exogenous) processes. As the main component of the ceramic mass, we used clay shale aluvium from the Duruji river bed near the town of Kvareli, which made it possible to reduce the firing temperature and improve the quality of the finished product. X-ray phase, petrographic and electronic microscopic studies have shown that ceramic products, both building and clinker bricks, made with the use of Kvareli shale, under the same firing conditions, have been obtained with a denser structure ensuring higher physical and mechanical features as compared to clay Metekhi, which is currently used by the brick factory in Georgia. The use of shale accumulated in the region of Kvareli in various areas of the economy (including production of ceramic building materials) will make it possible to clear the adjacent territory from risky deposits of natural alluvium, which threatens to flood the city and provide companies engaged in production of ceramic building materials with low-cost and environmentally friendly raw materials.

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## ADSORPTION OF H<sub>2</sub>S FROM THERMAL WATER USING CLINOPTILOLITE

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### ABSTRACT

Thermal waters are the cheapest, environmentally friendly, stable and inexhaustible sources of energy. Their use plays an essential role in the fight against climate change and the improvement of atmospheric air, since using underground hot water and heating systems will save million tons of organic fuel, electricity, drinking water and gas. Georgia is a rich country with natural sources of underground hot waters, known from ancient times. But widespread use of geothermal water is limiting due to the presence of toxic H<sub>2</sub>S+HS<sup>-</sup>. Consequently, the problem of purification the water from H<sub>2</sub>S has obtained big topicality that is confirmed by the large number of research works on this issue. The goal of current research was to study and develop the composite adsorbents to uptake H<sub>2</sub>S from thermal water on the base of natural zeolite clinoptilolite (CL) from deposit of Georgia and activated carbon (AC). Cation-modified forms of CL were prepared by wet-milling method. Crystalline structure of the adsorbents were analyzed by X-ray diffraction (XRD) technique using DRON-2 diffractometer with CuK $\alpha$  radiation. The amount of adsorbed H<sub>2</sub>S was detected by back titration with iodometric method before and after filtration; the content of exchanged ions were determined using AAS method on AAnalyst-200 of “Perkin-Elmer”. Adsorption of H<sub>2</sub>S was been studied at ambient temperature and normal pressure by stirring samples with thermal water, varying the ratio zeolite : AC, composite : solution, duration of contact, granulation degree. The results showed that modification of CL by ion-exchanging with metal ions (Zn<sup>2+</sup>, Fe<sup>3+</sup>, Mn<sup>2+</sup>, Cu<sup>2+</sup>) has improved the adsorption capacity, including initial and decationated samples (DeCL). XRD patterns of these samples indicated that introduction of cation made more changes in CL crystalline cell. Adsorption equilibrium has been reached in seven-fifteen minutes, and adsorption activity grows in a row:

DeCL<CL<CuDeCL<MnDeCL<FeDeCL<ZnDeCL<AC/CL. The sorption capacity ranged from 0.68 mg/g to 28.17 mg/g. pH of thermal water before sorption was 8.97 and in filtrates changed in very wide ranges – from 10.44 till 3.55 depending on type of modification. According to water analysis results before and after filtration simultaneously with H<sub>2</sub>S the ions of Fe, Mn, Ca and Mg were adsorbed. The hardness, alkalinity, permanganate oxidizability, smell, water colour and colony count decreased too. It is known that at adsorption of H<sub>2</sub>S the determining factor is the size of the entrance windows into large channels of zeolite. An increase in the availability of latter upon replacement of Na<sup>+</sup> with divalent cations by 30-40% leads to the fact that exchanged forms adsorb hydrogen sulfide in a dynamic mode more than initial form. So, presence of multivalent cations of metals in the zeolite was confirmed to be an essential factor determined the adsorption activity relation to H<sub>2</sub>S, adsorption occurs via both physical sorption and chemisorption. Most active was composite AC/CL with ratio AC:CL, equal 3:2. The difference in the amount of adsorbed H<sub>2</sub>S between decationated and cation-exchanged forms of CL may be explained by the change of surface potential. Polarity of zeolites depends on Si/Al ratio, which by-turn depends on conditions of acid treatment.

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## **GEOCHEMICAL DIFFERENTIATION OF ATMOSPHERIC AEROSOLS IN NATURAL ZONES OF EUROPEAN RUSSIA**

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### **ABSTRACT**

Climate and environmental changes on Earth have become modern challenges to humanity. The main factor affecting the landscapes of Russia is an increase in air temperature and a decrease in precipitation. As a result of these processes, the amount of aerosols in the near-ground atmosphere of the landscapes of the ETR (European territory of Russia) increases. The aim of the study is to determine the atmogeophysical and atmogeochemical indicators that reveal the interaction of the atmosphere and the diversity of natural landscapes in European Russia. Landscape-geochemical research methods make it possible to study geosystems with the participation of all landscape components and actual migration processes, especially the atmospheric migration of chemical elements. To determine the modern atmogeochemical existence, field comprehensive studies of the potential emission of matter in all natural zones of the ETR were carried out submeridionally - in the landscapes of the steppe, forest-steppe, forest and tundra zones of the ETR. The research results show that in the submeridional profile, the mass concentration of aerosols decreases regularly from south to north, the minimum concentrations of atmospheric aerosols are observed in the forest zone, in the tundra there was a slight increase due to anthropogenic landscapes and the influence of the sea. Analysis of the chemical composition of aerosols revealed that, among the elements of global importance, aluminosilicates naturally increase to the south of the ETR as elements of clay minerals that are widespread in the Russian Plain. The maximum phosphorus content occurs in the residential area with agricultural landscapes. Sulfur concentrations are confined to the semiarid zone of the ETR, then decrease in the forest zone and increase again in the technogenic regions and the tundra belt of the Kola Peninsula, surrounded by the sea. The concentrations of chemical elements of regional and local distribution in atmospheric aerosols are more differentiated on the ETR and depend on the natural and technogenic features of each region. Thus, heavy metals are more common in the Plain territories of the forest-steppe and forest zones of the ETR and are confined to the bedrock and technogenic sources. High concentrations of calcium and strontium are associated with areas of weathering of carbonate rocks. In general, increased concentrations of atmospheric aerosols with an increased content of anthropogenic elements are observed during the western and southern transport of air masses. At the same time, the amount of rainstorm precipitation increases when these aerosols act as condensation nuclei. To assess the current state of the atmosphere at the ETR, it is necessary to continue field measurements and organize European annual and seasonal geochemical monitoring at stationary observation points.

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**PALYNOFLORAL AND PALYNOFACIES STUDIES OF GANGAPUR FORMATION IN CHINTALAPUDI  
SUB-BASIN, SOUTH INDIA: ITS IMPLICATIONS TO BIOSTRATIGRAPHY, PALAEOVEGETATION,  
PALAEOECOLOGY AND ENVIRONMENT OF DEPOSITION**

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**ABSTRACT**

The integrated detailed investigation includes palynological and palynofacies studies played a vital role to establish the age, reconstruction the palaeoecology and inferring the environment of deposition. It also provides significant information regarding the processes responsible for sedimentary deposits along with their lithological counterparts. The rigorous palynological investigations indicated the presence of six palynofloral zones comprised of lower most *Murospora florida* zone corresponds to fine grain sandstone in the section, and successively upper *Retitriteles watherooensis* zone shows siltstone, shale and intercalation of shale and sandstone; *Ruffordiaspora australiensis* zone exhibits intercalation of shale and sandstone, sandstone and shale; *Foraminisporis wonthaggiensis* zone belongs to shale, sandstone, intercalation of shale and sandstone and streaks of siltstone; further above *Cyclosporites hughesii* zone occurred in grey shale, sandstone and streaks of siltstone, while top extremity of borehole sediments represents *crybelosporites striatus* zone lithologically corresponds to grey shale. Comparison and correlation of these zones with various palynozonation schemes proposed by different palynologists invariably assigned Kimmeridgian-Early Albian age. The predominance (average 77%) of conifers, chiefly araucareaceae and podocarpaceae members along with well diversified pteridophytes (filicophytes-highly diversified; lycophytes-less diversified) and bryophytes prominently suggested the presence of thick canopy coniferous forest and prevalence of cool and humid palaeoclimate in terrestrial source area. Sum total four palynofacies have been recovered, characterized by the abundance of palynomorphs, terrestrial structured, terrestrial degraded, opaque phytoclasts and AOM. Palynofacies studies along with lithofacies indicated low energy settings and dysoxic-anoxic conditions in the basin. APP analysis and Marine influx index reveals a change from marginal dysoxic-anoxic basin to heterolithic proximal shelf deposition.

## **NORTH ALGERIAN GEOTHERMAL RESERVOIRS TEMPERATURE ESTIMATION BY GEOLOGY AND HYDROGEOCHEMISTRY METHODS**

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### **ABSTRACT**

The study zone is one of the significant geothermal provinces in North Algeria. It is characterized by a Mediterranean climate with medium rain fall 600 mm and low evaporation rates. The geothermal reservoirs are encountered in Triassic sandstones, Liassic Carbonates and lower Cretaceous formations. The thermal waters chemical characteristics of highly mineralized Na-Cl water type representing the deep thermal waters. The study of geothermal reservoirs characteristic, a multidisciplinary approach was approved, including geology, hydrogeochemistry and geothermometry (i.e. the Na-K, Na-Li, Li-Mg, Na-K-Ca-Mg, quartz, chalcedony and 18O (SO<sub>4</sub>-H<sub>2</sub>O)). More than sixty samples collected recently in 2019 with an average between 24 and 94°C. Chemical analysis of those thermal waters displays a certain degree of salinity with sodium-chloride type waters domination. The maximal geothermal reservoir temperature estimated using geothermometers is about 120°C.

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**EROSIONAL THICKNESS IDENTIFICATION USING MULTIPLE METHODS AND ITS IMPLICATION ON  
HYDROCARBON GENERATION: CASE STUDY ON CENTRAL ARJUNA DEEP, NORTH WEST JAVA  
BASIN, INDONESIA**

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**ABSTRACT**

Central Arjuna Deep is a part of North West Java Basin which is one of the potential hydrocarbon-producing basins in Western Indonesia. In terms of regional geology, tectonic evolution in this area during Cambrian to present allows for a very significant erosion due to uplift. However, several previous publications did not mention the existence of a significant erosion thickness, even though that affected the hydrocarbon generation process. This is due to the lack of evidence of erosion when only a single method (i.e. seismic) is used for identification. Therefore, in this study the calculation and erosion analysis are performed by combining well data consisting of vitrinite reflectance, sonic log, and biostratigraphy, and then seismic to be able to identify the presence of unconformity and erosional thickness during the basin formation in more detail. Then a burial history analysis will be carried out to determine the maturity level of the source rock in this basin. Based on data integration, identified three times of erosional period with a sediment thickness of 540 – 2,280 feet were loss. Burial history analysis by considering the loss of eroded sedimentary rocks during three tectonic phases shows hydrocarbon generation time just occurred 7.4 million years ago. Meanwhile, if we compare with using the erosion absence assumption, the hydrocarbon generation starting from around 23 million years ago. So, it can be concluded that in the study area the erosion of the sedimentary rocks causes the maturation process delayed more than 15 million years.

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**PETROLOGY AND DIAGENESIS ANALYSIS OF EOCENE TO OLIGOCENE SANDSTONE IN CENTRAL ARJUNA SUB-BASIN, INDONESIA: IMPLICATION TO RESERVOIR QUALITY**

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**ABSTRACT**

The Late Eocene to Early Oligocene clastic sediments (known as Talang Akar Formations) is syn-rift deposits of the arjuna sub-basin. This sequence is interesting because currently, it is a deeper future reservoir target. By identifying the provenance and diagenesis of this sequence, it is hoped that it can understand sediment supply, tectonic settings, and geological factors that affect reservoir quality. This study was built by integrating petrographic data, XRD, and core analysis from 9 wells. Based on the sandstone petrography data, overall, the sandstone is typically poorly to moderately sorted, fine to medium-grained, with angular to subrounded grains of monocrystalline quartz, lithic fragment, feldspar, mica, organic matter, and heavy minerals. The lithics are most commonly polycrystalline quartz, phyllite, schist, devitrified volcanic glass, and chert. The QFL ternary diagrams indicate that the sandstones were derived from recycled or quartzose source rocks reflecting a craton interior or transitional continental setting, which probably came from a multi-source sediment supply. The rock fragment found indicates the sediment supply came from Schwaner Mountain and Tin-Belt Granite. The diagenetic history of clastic sediments has involved the early pyritization, compaction, quartz overgrowth and cementation, leaching, kaolinite precipitation, to late-stage minor phases of ferroan dolomite cementation. Based on the integrated data, the reservoir quality of sandstone in this study is mainly influenced by the abundance of quartz, the leaching and degradation of unstable grain, and the precipitation of the authigenic kaolinite. The more dominant quartz and the presence of leaching will increase the porosity of sandstone value. In contrast, the presence of authigenic kaolinite causes a decrease in the porosity of sandstone value.

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**ENHANCING THE ENVIRONMENTAL PERFORMANCE OF BIOTRICKLING FILTERS TREATING  
VOLATILE ORGANIC COMPOUNDS IN AIR**

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**ABSTRACT**

The actual biotrickling filtration technology addresses volatile organic compounds (VOCs) removal from air, by their conversion into less harmful gaseous compounds (e.g. carbon dioxide). The actual study extends this capability towards not only VOCs removal, but also removal of carbon dioxide issued from biodegradation, in the same biotrickling filter (BTF). This upgrade results in higher C-capture and the reduction of greenhouse gases associated with this process, thus increasing the environmental performance of such BTFs. The model pollutant used in this study is ethanol, while a co-immobilised microalgae and compost-derived microorganisms is used for the first time accomplishing the above mentioned desiderate (simultaneously removal of VOC and carbon dioxide in the same BTF), under continuous regime and illumination provided by an array of light-emitting diodes (LED)). Very promising performances are obtained, revealing new competitive alternatives with high potential for further development, in the light of atmospheric protection and climate change issues.

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**GEO-HYDROLOGICAL RISK AWARENESS AND DISASTER PREPAREDNESS IN A MOUNTAINOUS  
AREA OF SOUTHERN PERU VULNERABLE TO DISASTER**

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**ABSTRACT**

Disaster risk management involves reducing disaster damage to homes, critical infrastructure and the interruption of basic services and developing their resilience. This work analyzes the perception of geohydrological risk by the population living or working in the town of Cuyocuyo (southern Peru), which was affected in previous years by events of landslides, debris flow and floods. In order to see the effect of the social perception of geohydrological risk on disaster preparedness in areas under threat from landslides and debris flow, a survey was applied to 65 adult heads of household. The method for estimating results was logit regression. The results show the following: First, the preparation through the acquisition of items necessary to avoid the impact of the disaster is related to indicators of perception of disaster risk and the age of the population. Second, the knowledge and prevention of disaster mitigation significantly depends on indicators of dependency of the place and the affection of the place. Third, the participation of households in trainings and drills to prevent disasters organized by the government depends significantly on the indicators of the perception of probability of the disaster, threat of disaster risk and the identity of the place and Fourth, the modification and reinforcement of the buildings of the settlers depends positively on the dependence of the place.

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## **HYDROGEOCHEMISTRY OF THE THERMAL SPRINGS OF POJQPOQUELLA AND PHUTINA, PUNO, PERU**

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### **ABSTRACT**

This paper deals with the results of a hydrogeochemical study of two thermal springs that originate from in very high altitudes in southwestern Peru with outflow temperatures of maximal 38,4 °C and flow rates of 1,08 - 2,02 l/s. Water samples from the Pojqpoquilla and Phutina geothermal wells, were collected during the period between September 2018 and January 2019 in the main area of Puno. Chemical types of the thermal spring are Na<sup>+</sup>, Ca<sup>2+</sup>, Cl<sup>-</sup> and CO<sub>3</sub><sup>2-</sup> in Ayaviri and Putina. According to the Piper and Schoeller diagrams for the Pojqpoquilla thermal spring water is classified as Na<sup>++</sup> K<sup>+</sup> (75 %) and Cl<sup>-</sup> (60 %) type water while that of the Phutina thermal spring is classified as Na<sup>++</sup> K<sup>+</sup> (76 %) and Cl<sup>-</sup> (72 %) type water. The electrical conductivity (EC) values for the Pojqpoquilla and Phutina thermal spring waters is 2160 – 3142 μS/cm and 3160 – 3184 μS/cm, respectively, the thermal spring waters have a high electrical conductivity which shows that it has interacted with the host rock for a long time. The reservoir rocks of the Pojqpoquilla thermal system consist of a red sandstones and conglomerate rocks while the reservoir rocks of the Phutina thermal system consist of a thick sequence of cretaceous rocks.

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**FORECASTING OF THE SHARE OF RENEWABLE SOURCES IN THE TOTAL FINAL ENERGY  
CONSUMPTION FOR SELECTED EUROPEAN UNION COUNTRIES**

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**ABSTRACT**

The development of society requires stable access to electricity at an acceptable price. In order to meet the growing demand in the European Union countries, we are observing a dynamic development of the use of renewable sources in the energy balances of the Member States. The article presents the legal framework resulting from the newly adopted climate strategy, New Green Deal, and the conditions for the development of renewable sources in the process of transforming energy systems. The characteristics of selected energy balances of countries are also presented, which may constitute a knowledge base on the diversity of the Member States in terms of energy resources used, levels of independence and self-sufficiency of raw materials, as well as the levels of current electricity prices. Based on the available statistical data, the Eurostat database presents forecasts of the levels of renewable energy consumption in the 2030 time horizon for selected countries and according to the main types of renewable energy such as wind, solar energy, biofuels, geothermal energy, and hydropower. The statistical analyzes presented in the article are important tools for building a development strategy for the process of integrating energy markets within the European Union. The obtained results of the analyzes constitute a new approach to the study of the diversified energy market in the EU and present potential development scenarios for the surveyed countries.

## **THE EFFECT OF SURFACE FINISHES ON RISING DAMP IN ORIENTED STRAND BOARD**

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### **ABSTRACT**

It is known that oriented strand board (OSB) is prone to water absorption. This characteristic of OSB is undesirable, it can have a negative impact on the physical and mechanical properties of the material and it can also make it prone to attack from wood-destroying insects, rot or mould. The research follows previous work of the authors related to optimisation of surface finishes for OSB in order to increase its moisture resistance. The aim of the research is to compare the rise of dampness in test specimens with different types of coating, spray, primer and waterproofing under predefined conditions. The paper contains a definition of the basic material, test specimens and test methods, and covers 8 different types of surface finish materials selected for application to the test specimens. The results include graphs showing rise of dampness in the test specimens for each day of observation. The results are also discussed and in the conclusion the results are evaluated. The results of the experiments confirm the assumption that the choice of surface finish has a significant effect on slowing down the rise of dampness in OSB.

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## **MINING WASTE COMPLEX RESEARCH AND DEVELOPMENT OF TECHNOLOGIES FOR THEIR USE IN GEORGIA**

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### **ABSTRACT**

In 1996, Georgian mining and extractive industry moved to a new stage as a result of the adoption of a new law on subsoil, which prepared grounds for the development of a legislative framework regarding the use of country's subsoil and created new economic settings for the industry. Mining and extractive industry play a significant role in Georgia's sustainable economic development. From 1999 through 2020, the output value of the industry (excluding non-renewable energy resources: coal, natural gas and oil products) is estimated at of 5,6 billion Lari (GEL). The majority of deposits of mineral resources in Georgia are mainly small and medium in size. Considering the current rate of their exploitation, within 15- 20 years their majority will be exhausted. Over time, the country's economy will face a serious problem as it will need to import raw materials. It is therefore important to look for feasible technologies for the application of unconventional raw materials, namely secondary raw materials that come with essential mineral resources. This will allow to maintain the potential of mineral resources of the country. The work presents the outcomes of the Mining Institute's current studies on qualitative, quantitative and assimilative technologies and possibilities of the application of mining waste as secondary natural resources. Research methodology is based on the principles of Green Economy that implies linking mining and extractive industry to circular economy, aiming at rational assimilation of natural resources by applying the 3R (reduce, reuse and recycle) approach. Within the frames of the study, technologies were developed for obtaining construction, glass and porcelain raw materials (from spoiled rock layers stored and extracted from operating open pit mines of the Chiatura manganese and Bolnisi ore deposits/queries), along with those for manufacturing products with such materials.

Corresponding Author: Davit Khomeriki

## **GEODIVERSITY AND GEOCONSERVATION IN YUANMOU BASIN, YUNNAN PROVINCE, CHINA**

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### **ABSTRACT**

Geodiversity is considered as abiotic diversity, and it is the foundation of geopark, geotourism and geoconservation. Yunnan Province is the typical area abundant in geodiversity in China. Geodiversity of Yuanmou Basin, which is located in North Yunnan, possesses scientific, cultural, aesthetical, ecological values. However, there are some problems, such as underexploitation, inadequate protection, even destruction in the area. Research of geodiversity will provide a new idea for sustainable development in Yuanmou Basin.

Corresponding Author: Xianfeng Cheng

**ORE FEATURES AND GOLD OCCURRENCE OF THE MANLONGGOU GOLD DEPOSIT, SOUTHEAST YUNNAN PROVINCE, CHINA**

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**ABSTRACT**

The Yunnan-Guizhou-Guangxi “Golden Triangle” is one of the famous Carlin-type gold deposits in China and even in the world. Manlonggou gold deposit is a newly discovered gold deposit in this area. The host rocks are mainly lithic quartz sandstone, siltstone and silty mudstone above Caledonian unconformity. The main minerals in ores are natural gold, limonite, hematite, pyrite and so on. The occurrence state of gold is fine exposed and semi-exposed natural gold, as well as gold encased by limonite, carbonate, quartz and silicate minerals. The deposit can be a fine grain hydrothermal altered gold deposit with the origin of tectonic-medium-low temperature hydrothermal percolation.

Corresponding Author: Wufu Qi

**STUDY ON DEBRIS FLOW RISK MONITORING AND EARLY WARNING IN NUJIANG PREFECTURE,  
YUNNAN PROVINCE, CHINA**

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**ABSTRACT**

Debris flow is the mainly the geological disasters in Nujiang Prefecture, while precipitation is the trigger of it, how to implement debris flow forecast based on precipitation monitoring data or forecast data is a hot issue in current debris flow disaster research field. Because of the special geomorphology in Nujiang Prefecture, due to the influence of human activities, geological disasters occur frequently, severely affect the local economic development. As a demonstration area of geological disaster monitoring and early warning in Yunnan Province, to build a well-developed geological disaster warning system, it is very important to spread it to other parts of Yunnan province. Based on the analysis of the current situation of geological disasters in Nujiang Prefecture, adopt appropriate monitoring method and calculation method to select the primary sites for debris flow monitoring and early warning in the Nu River basin for research.

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## **THE APPLICATION OF DIGITAL INFORMATION TECHNOLOGY IN INTANGIBLE CULTURAL HERITAGE**

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### **ABSTRACT**

The rapid development of digital information technology has become one of the important channels for the protection of intangible cultural heritage. This paper analyzes the current situation of the application of digital information technology in China's intangible cultural heritage and summarizes the strategies of the application of digital information technology in the protection and development of intangible cultural heritage. It provides ideas for digital information technology to further promote the protection of intangible cultural heritage.

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## **QUALITY OF SURFACE GEOSTATISTICAL PARAMETER REPRODUCTION FOR LASER PROFILOMETERS**

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### **ABSTRACT**

The description of the surface topography of building structures is important for contact tasks, bond strength and rheological processes monitoring. The determination of surface parameters is carried out using increasingly sophisticated methods and techniques, such as laser profilometer, laser scanner, confocal microscope or short range photogrammetry. The research is aimed at evaluating the mobile surface test device for quality control and failure prevention, also the authors have addressed the possibility of using inexpensive profile measuring laser equipment to obtain a geostatistical description of the surface parametrics. It is the support of creation of new measurement apparatus that is the impetus for this work for the selection of optimal laser device. It is possible to deduce from the paper how the density of measurements taken and the accuracy of height estimation in the profile affect the parameters of the semivariogram model. With the proper choice of device it is easier correctly estimate the strength parameters of the joint of concrete or soil-concrete structures. The relevance of the correctly performed measurement is proved by the link between the strength parameters of the contact surfaces and its geostatistical description. In order to assess the quality of the mapping, a spherical theoretical model with a corresponding generated surface was used as a reference. The measuring laser devices with various mapping accuracy and depth measurement precision were tested, also for description fractal dimension of results. The measurement accuracy of the depth parameter has the greatest influence for determination of the remaining parameters of the surface roughness.

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## **MONITORING OF SOIL STRUCTURE**

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### **ABSTRACT**

Based on data from the Central Office of Construction Supervision, there were 5455 construction disasters in Poland between 2008 and 2019. Four thousand twenty-three disasters were caused by random events, of which 110 were caused by landslides. Most of these events took place in 2010, when there were up to 94 disaster-related landslides. Landslides have been occurring with different intensity, significantly influencing the current structure of the Earth surface. In natural conditions, without human intrusion, these phenomena have a character of long-term processes that activate depending on the changes of natural external conditions such as ground saturation with water, area deforestation, high degradation or slopes erosion. Everyone who had contact with landslides knows that it is not a sudden phenomenon, but a process - chain of events occurring one after another and developing with time. This phenomenon forces constant necessity of getting more detailed knowledge of the processes mechanism and character and phenomena occurring inside the slopes. That is why slope monitoring plays such an important role in understanding the mechanism of landslides. In Poland, most structures of this type belong to the second or third geotechnical category in accordance with the Regulation of the Minister of Transport, Construction and Maritime Economy (2012). The law obliges the owner of the land on which this type of structure is located to perform inspections and monitoring of its condition. The monitoring of the slope protecting the liquid waste landfill facility located at the food processing plant was analysed in the article. In 1997, the slope was subject to a construction disaster in consequence of washout by the Oder River and too high irrigation of the ground structure. Following the disaster, the slope with the waste reservoirs slid into the river polluting it. Since the reconstruction, the slope is subject to constant monitoring of the external geometry and checking the condition of the ground building the dam. The paper discusses the applied monitoring methods and shows the methodology of conducting the measurements. The results of slope settlement were analysed and compared with model calculations. In conclusion, modern monitoring techniques were shown, which could be applied to this type of structures.

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## THE MODEL IDENTIFICATION OF BUILDINGS HORIZONTAL DISPLACEMENTS WITH THE USE OF A FREE GEODETIC NETWORK

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### ABSTRACT

The geodetic monitoring of engineering structures, their displacements, and deformations, carried out permanently or periodically, allows obtaining information on the technical condition of facilities. The achieved information enables determining the necessary changes in using objects and minimizing future errors in the similar object's design. The measurement results are subject to geometric interpretation based on the determined displacement parameters of the object's shape and the approximation of the vector displacement field. Due to the influence of random factors characterized by a change in time and varying intensity, the deformation measurements performed during the operation of the facilities are of great importance for the safety of structures and engineering structures. In actual tasks of determining the object's deformation and building a geometric model of displacements, the dominant method is the differential method, the advantage of eliminating systematic errors in measurement results while maintaining the geometric structure of the measurement and control network. The displacement's geometric model, built based on measurements and calculations, can build a dynamic model of a building object, additionally considering such causes of deformation as, for example, own and usable weight, wind pressure, changes in ambient temperature, or ground vibrations. The article proposes approaches using the free alignment of linear and angular observations made in a geodetic network to determine horizontal displacements of an engineering object. This method may be necessary to study displacements of various parts of the object, thus analyzing its deformation. Free alignment allows for an optimal fit of the equalized network into the approximate network by imposing additional conditions (compared to the classic least squares method) on the vector of estimates of increments to approximate coordinates and the value of the covariance matrix. As an example of applying the proposed approach, the actual data received from the geodetic monitoring of the building structure was used. The structure was a road viaduct located along Wojska Polskiego Street in Bydgoszcz. The object of measurements and analyses was represented by finite sets of fixed points, subject to periodic observations over two years. The authors tested the effectiveness of the proposed algorithm and compared the obtained results with the values of horizontal displacements, which were calculated based on the classic study of geodetic monitoring results using the least-squares method. The accuracy analysis of the obtained values of the geodetic network horizontal displacements using free alignment and the least-squares method was also performed. The results indicate the possibility of using the presented approach to identify the geometric model of horizontal displacements without losing the accuracy of their determination.

Corresponding Author: Maria Mrówczyńska

## **STABILITY OF THE BEDROCK OF CASTLE BUILDING FOR GEOTOURISM PURPOSES**

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### **ABSTRACT**

The geological structure of the Slovak Republic is very complex and varied. This fact in the course of centuries has had an impact on the castle buildings built here. The subsoil of these structures has different petrographic composition, tectonic disturbances and other geological complexities that threaten the stability of these structures and endanger the objects in their surroundings. In recent years, these structures have begun to receive deserved attention. In the past, the problems of severely disturbed blocks in the subsoil were mainly addressed and had to be rehabilitated for these reasons. These were mainly buildings whose subsoil is built with carbonate rocks. A perfect example of a long-term solution to these complex problems is also the Strečno Castle. A lot of effort and money has already been devoted to solving the stability of the bedrock, which also adversely affects the stability of the castle. However, the extensive set of works that have been carried out here over a long period of time have not brought a complete solution to the problems that occur here. For this reason, continuous work is being carried out here under the guidance of experts to eliminate the effects of erosion of the bedrock in particular. In the present work, the activities and measures that have been implemented here in stages up to the present are briefly described chronologically.

Corresponding Author: Miloš Duraj

**GEOTOURISM INTERESTING LOCALITY WITH REMEDIATION OF THE BEDROCK AND  
RESTORATION OF SPIŠ CASTLE - UNESCO HERITAGE SITE**

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**ABSTRACT**

Understanding the structure of the geological subsoil should be the first stage in the construction of any major building. Therefore, if the problem of rescue and restoration of various historical buildings is currently being addressed, it is necessary to study their subsoil in detail. Among the important historical buildings that have been preserved in Slovakia are numerous castles and chateaux. Nowadays, many of these buildings need to be extensively restored to prevent their gradual devastation. The issue of rehabilitation of some buildings has been addressed for several decades. The reasons for the rehabilitation of these buildings have varied. In the case of the ruins of Strečňan Castle and its subsoil, it was primarily the safety of traffic on the adjacent important road. In the case of Spiš Castle, it is a monument of world importance. It is one of the largest castle complexes in Europe. The beginnings of the construction of this complex date back to the 11th century. Its current state is due, among other factors, to the instability of its geological subsoil. For this reason, the stabilisation of the travertine body, which has been severely damaged, particularly by tectonics and karst processes, has already been addressed in the past. The solution of this problem in the past has already produced positive results, but due to exogenous processes and, hypothetically and certainly, seismicity, the bedrock may move again in the future. For this reason it is necessary to pay attention to continuous monitoring of the movement of its rock blocks. As far as the castle itself is concerned, its current state is mainly due to the fire at the end of the 18th century, followed by its rapid devastation. In view of the world importance of the castle, the restoration of the site may therefore also take other directions. One possibility is, for example, its reconstruction according to contemporary records, which would bring its final appearance even closer to its original grandeur.

Corresponding Author: Miloš Duraj

## **POSSIBILITY OF MONITORING OF MOVEMENT ON CRACKS FOR SOLID ROCKS**

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### **ABSTRACT**

The main goal of this article is to analyze the possibility of measuring on cracks. For measuring the distance between points, e.g. crackmeters are used. When measuring cracks in rock masses, very precise instruments are used, which are referred to as dilatometers. These dilatometers are based on a mechanical or electrical principle and measure directly inside the fracture, as opposed to a crackmeter where we measure on both outer sides of the fracture. Measuring on cracks is one of the methods of evaluating the development of slope deformation on the surface. If cracks appear on the slope, we can use the crackmeter to start more frequent and accurate control of the slump movement by measuring the relative changes in position using appropriately selected stabilized points on opposite sides of the crack. If we know the direction of movement, we can use only two points to check debonding cracks. If we are measuring marginal cracks, a three-point system is appropriate. Two points are placed outside the landslide and one is placed directly on the landslide. The principle of the measurement consists in evaluating the change in distance of two points (short anchors) firmly connected to the surrounding environment and located in the simplest case on opposite sides of the crack. Crackmeters are also used to measure movements across open tension cracks and scarps delimiting the boundary of the potential slide mass.

Corresponding Author: David Neuman

## **USING OF THE TAPE EXTENSOMETER FOR POSSIBILITIES OF LANDSLIDE MONITORING OR ANOTHER PURPOSES**

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### **ABSTRACT**

The main goal of this article is to analyze the possibility of using tape extensometry. It is one of the methods of evaluating the development of slope deformation. Tape extensometry is used to monitor the movement of the slope on the surface. Tape extensometry is used for fast and accurate measurement of relative distances between pairs of reference points on the surface of structures, including radial movements and convergence of tunnels, linings, shafts and caves. Then deformations of excavations in underground caves and displacements of retaining walls, bridge piers and arches. The digital tape extensometer is a portable device used to measure the displacement between pairs of eye bolts. The principle of measuring on a slope consists in directly measuring the distance between the stabilized measuring points. The measuring points are located in both stable and unstable parts. The measuring points are concreted into boreholes drilled to a non-freezing depth, which in the Czech Republic is about 0.8 m below the ground. The direction of movement can be determined by measuring the change in distance between several points located in the stable part and points in the unstable part. If we also measure in time intervals, we can also find out the approximate speed of movement. The tape extensometry method is performed using a tape extensometer. It is a specially adapted zone in which emphasis is placed on the material from which the meter is made, because it is important that the material has a low thermal expansion, for example nickel steel is suitable.

Corresponding Author: Barbara Matuszková

## PRINCIPLES OF USING PRECISE INCLINOMETRY FOR LANDSLIDES

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### ABSTRACT

The main goal of this article is to analyze the possibility of using precise inclinometry for landslides. Inclinometric measurements are widely used to monitor landslides, retaining walls, piles and in places where it is necessary to measure deep ground deformations. The value of deep-seated ground deformations is calculated indirectly by using the difference of the inclination of an inclinometer casing installed on a borehole. Inclinometers are used to measure horizontal movements at various levels, usually within earth fills. Inclinometers are used to monitor slopes, indicating movement on a slope before it is visible on the surface of the slope. Inclinometers have often proved very successful in recognizing movement zones and the size, speed and direction of movement not only on slopes, but also on embankments, etc. There are a number of different types of inclinometers, and within each type there are variations produced by different manufacturers. However, the basic principle of precise inclinometry is the same. A guide tube is installed in the borehole and the inclination of the guide tube from the vertical is measured at predetermined intervals. It is measured using a pendulum which is enclosed in a watertight probe. The probe is lowered through the tube. The inclination of the pendulum is measured using electronic devices that are very accurate. The measurement results are determined by pulling out the measuring instrument (inclinometric probe). After assessing the measured values, the course of the profile is determined, if we compare the profiles from different measurements, we can evaluate the direction and size of the shift for the monitored period.

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## DEVELOPMENT OF LOW-COST INCLINATION SENSOR BASED ON MEMS ACCELEROMETERS

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### ABSTRACT

Rapid development of Micro Electro Mechanical Systems (MEMS) and the minimization of sensor cost, size and energy consumption in the last two decades leads to an effort to replace traditional sensors with their MEMS alternatives. The power consumption is one of the key problems, due to necessity to provide long term device power supply. Therefore a newly developed device was designed with the accent to low power consumption, to be able to operate with one small internal battery at range several months to years. The main goal was to develop a wireless monitoring system capable of continuous stability monitoring of various building structures. The sensor is designed to measure slow inclination variations or changes and in combination with variant designed for high frequency monitoring should represent complete solution of real time structure health monitoring. The STATOTEST compact measurement system is mainly composed of triaxial MEMS accelerometer as a sensing unit, motherboard containing IOT modules and battery, all placed in single waterproof box. The raw signal measured by MEMS accelerometer is preprocessed inside the unit and the data are sent to the cloud via LoRaWan, NBloT or satellite. The results can be displayed, managed and exported through the web application. This paper presents current state of sensor development, refer to number of problems, which were solved during the process and deals with estimation of its accuracy characteristics in the laboratory conditions. During the laboratory experiment, small defined changes of inclination were performed and compared with values registered by the inclination sensor. The testing was performed before and after calibration procedures. After eliminating of accelerometers production errors, the accuracy of the unit measurement RMSE is less than  $0.002^\circ$  for the step change of  $0.09^\circ$ , tested in six different orientations of the sensor. One measurement is mean of 1000 measurements and its residual random error for one measurement is  $2^\circ \times 10^{-5}$ . Series of laboratory tests proved high short-term device accuracy in stable conditions. It is well known, that MEMS accelerometers strongly depend on the sensor temperature. To perform temperature compensation, we built own climate chamber, which is able to change automatically temperature of the several devices at once in specified ranges. Temperature compensation was then performed by using of polynomial approximation to obtain the field measurement accuracy close to laboratory conditions. This task is challenging because it is necessary to improve the proper material composition between the MEMS and the monitored structure and the device fixing methods.

Corresponding Author: Jan Balek

## **EUROPEAN GNSS TROPOSPHERE MONITORING FOR METEOROLOGICAL APPLICATIONS**

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### **ABSTRACT**

Near real-time GNSS double-difference network processing is a traditional method still used within the EUMETNET EIG GNSS Water Vapour Programme (E-GVAP) for the atmosphere water vapour content monitoring in support of Numerical Weather Prediction. The standard production relies on estimating zenith tropospheric path delays (ZTDs) for GNSS ground stations with a 1-hour time resolution and a latency of 90 minutes. The Precise Point Positioning (PPP) method in real-time mode has reached the reliability and the accuracy comparable to the near real-time solution. The effectiveness of the PPP method relies on exploiting undifferenced observations from individual receivers, thus optimal use of all tracked systems, observations and signal bands, possible in-situ processing, high temporal resolution of estimated parameters and almost without any latency. The solution may implicitly include horizontal tropospheric gradients and slant tropospheric path delays for enabling the monitoring of a local asymmetry of the troposphere around each individual site. We have been estimating ZTD and gradients in real-time continuously since 2015 with a limited number of stations. Recently, the solution has been extended to a pan-European and global production consisting of approximately 200 stations. The real-time product has been assessed cross-comparing ZTDs and horizontal gradients at 11 collocated stations and by validating real-time ZTDs with respect to the final post-processing products.

Corresponding Author: Jan Douša



## **MAPPING OF SPATIO-TEMPORAL CHANGES OF SURFACE WATER USING SENTINEL-1 SAR IMAGES**

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### **ABSTRACT**

Exploration of surface water bodies and their spatial definition has great importance in water resources management and helps understand hydrological processes in the country. Fast, regular, and effective ways of mapping watercourses and their surroundings through remote sensing methods are crucial tools for capturing change and predicting hazards. The last decades have brought new data products, open-source software, and evaluation procedures that allow low-cost mapping of surface water objects. A widespread and sought-after option for this type of mapping is the use of SAR (Synthetic Aperture Radar) image products. Just through SAR technology that it is possible to identify changes in water in a relatively short time and at the same time under any meteorological conditions thanks to backscattered microwave radiation. This paper presents the possibilities of using SAR technology and its data for long-term temporal mapping of meteorological-hydrological changes in surface water using satellite images of Sentinel-1 product level GRD. As regards surface water extraction, this process is performing by segmenting the threshold values according to the Otsu principle. The water surfaces are then interpreted into the form of water masks of objects by the binarization of the final image. These values are subsequently compared with the supervised classification RFC (Random Forest Classifier) method results. Suitable processing and evaluation procedures conclude that the more suitable polarization configuration for mapping water bodies is VV (vertical-vertical) polarization. As for speckle filter tools to eliminate radar noise, the most suitable option seems to be using a Lee filter. To achieve more accurate results of the extracted water bodies, it is then appropriate to implement quantitative statistical indicators of accuracy and their numerical interpretation of the reliability of results. This paper aims to demonstrate the advantages of using satellite SAR images for spatiotemporal mapping of surface water in the landscape to observe hydrological processes due to inundation, ecological and meteorological changes, and anthropogenic activity.

Corresponding Author: Lubomír Kseňák

**NEW MEASUREMENT METHODS FOR STRUCTURE DEFORMATION AND OBJECTS EXACT  
DIMENSION DETERMINATION**

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**ABSTRACT**

The current rapid development of technologies enables new procedures for deformation and the detecting of construction defects and their modelling and monitoring in BIM. New instruments were developed for fast and sufficiently accurate mapping like personal mobile laser scanners (PLS). In the world of photography, the size of camera sensors is bigger, and the photographs are sharper. The rapid development of computer performance enables automatic and complex calculations, which lead to large sets of detailed 3D data and a high degree of automation. This influences photogrammetry and its methods. The results are more detailed and more accurate. Deformation, defects and exact dimensions (metrology) of different structures or objects can be currently measured by digital close-range photogrammetry. Cracks and cavities are monitored for structure status detection. This is important for planning reconstruction and for financial reasons. For structures like cooling towers, chimneys, or bridges can be created on a 3D model with a high texture resolution for finding and monitoring cracks and cavities. Deformations or defects that were found must be in scale, and measurable for the calculation of the scope of repair work and its price. The generated 3D object model can then be used for further measurements, for the price estimation of renovation, and for the creation of a BIM, in which all processes can be modelled and watched. Deformation can be monitored over time by creating additional models after a defined period. Captured 3D models from different periods can be compared in software like CloudCompare to determine the progress of degradational changes. The trend of the aging of the structure can be traced, which will be helpful for the reasonable planning of reconstruction. Based on the rapid development and miniaturization of measuring devices, new, smaller, easier to use, and more perfect devices are constructed. This also applies to the new group of laser scanners constructed for basic measurement and structure modeling for BIM. Conventional laser scanners can be accurate, but they are relatively large and heavy, difficult to transport and measuring with them is relatively slow (stop and go type). If the project goal is the classic construction, documentation of the object, data transfer to BIM or basic documentation of objects, PLS is the ideal device. Thanks to the development of accurate IMU (inertial measurement unit) and SLAM (simultaneous localization and mapping) technologies, these devices are on the rise. The forthcoming article will inform about the methods of accurate close-range photogrammetry and mobile laser scanning and will show their advantages with specific examples.

Corresponding Author: Karel Pavelka

## EXPERIMENTAL DYNAMIC ANALYSIS OF THE ARCH ROAD BRIDGE

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### ABSTRACT

The paper presents an experimental dynamic analysis of the existing road bridge across the Labe river at Valy village in the Czech Republic. The observed structure is a bridge with 6 spans 23.1 m, 31.5 m, 84.0 m, 31.5 m and 23.1 m long. The horizontal load-bearing structure is a composite structure with two main steel girders and a lower reinforced concrete deck. The load-bearing structure is reinforced in the main span by the arch, this structural system is also called the Langer beam. The experiment was realized in three stages. The first one was performed in May 2020 before its opening, the second stage of the described experiment was realized in August 2020 and the third one was carried out in April 2021. The main purpose of the first stage was to determine in detail the natural frequencies and mode shapes of the whole bridge horizontal load-bearing structure also including the arch. The electrodynamic shaker, that was located on the bridge deck in the quarter of the main bridge span, was used for excitation of the bridge vibration. The measured characteristics of the natural vibration were compared with the calculated ones. Based on this comparison, the theoretical bridge model was verified. Basic objective of the second experiment stage was to verify new approach to dynamic response measurement – radar interferometry realized by two synchronized radars. The vibrations of the bridge caused by the standard road traffic and also by pedestrians were observed concurrently by both radar interferometry and classical approach realized by high sensitive piezoelectric accelerometers. The experiment was focused on the main span of the bridge only and the levels of forced vibration were observed primarily. However, the fundamental natural frequencies were also evaluated. The third stage was carried out by classical approach only. Again, the bridge vibration caused by the usual road traffic and pedestrians were measured in the main bridge span only because this section of the bridge was the most dynamically sensitive. Again, the levels of forced vibration were observed and the fundamental natural frequencies were determined. The evaluated natural frequencies from all three experiment stages were consequently compared.

Corresponding Author: Tomáš Plachý

## **TERRESTRIAL PHOTOGRAMMETRY AT THE QUARRY AND VALIDATING THE ACCURACY OF SLOPE MODELS FOR MONITORING THEIR STABILITY**

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### **ABSTRACT**

The paper is devoted to the application of photogrammetry in surveying and geomechanical studies of the state of stability of slopes in a quarry. For deep quarries a particularly important task is to ensure the stability of the slopes of the benches. The purpose of this study is to improve the survey techniques of the slopes using terrestrial photogrammetry, the establishment of the values of the basic errors in the positioning of cameras in local geodetic network. The results of photogrammetric measuring data processing, which are the coordinates of the slope points and its elements, point cloud, surface model, volume and area data, improve the quality of geomechanical monitoring at mining enterprises and provide increase safety of mining operations. The proposed method of survey consists in positioning images (projection centres) in the system of the geodetic reference network by measuring with an electronic total station. Established during the study was dependence of the accuracy of the coordinates of the three-dimensional model of the slopes on the distance between the camera and the total station, between the camera positions in a pair of images. The article contains the results of the practical implementation of the proposed survey method, the results of experiments performed for the purpose of comparison with an alternative measurement method, which was a survey by a total station, graphs of dependencies describing the effect of measurement parameters on the accuracy of work performed. The article is also supplemented by a theoretical analysis of the use of UAVs in the use of work to determine of stability of slopes in a quarry, which is based on the authors' experience with the use of UAVs in open pit mines. In this theoretical comparison, the emphasis is mainly on the operability of the use of UAV, which in the case of open pit mines creating a practically stable wind vortex with a speed higher than the allowed speed of operation rotors UAVs.

Corresponding Author: Václav Šafář

## **EXPERIMENTAL DETERMINING OF HORIZONTAL MOVEMENTS OF THE WATER TOWER RESERVOIRS BY GB-RAR**

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### **ABSTRACT**

Ground-based radar interferometry (GBRI) with ground-based real aperture radar (GB-RAR) is most often used for monitoring vertical deflections of bridge structures caused by vehicle passages. This paper presents an experimental determining of the horizontal dynamic movements of water tower reservoirs by GB-RAR. Determining the dynamic movements of water tower reservoirs is more complicated precisely because the movement of the reservoir is influenced not only by external influences, such as wind, but also by the movement of water mass in the reservoir. The resulting oscillation is then a composite oscillation of multiple frequencies. Next, in the case of routine determination of vertical deflections of bridge structures, it is reasonable to assume a predominant deflection of the structure in this one particular direction. But in the case of tower structures such as reservoirs, it is necessary to assume their movements (oscillations) in the entire horizontal plane. The movements can be circular, elliptical, straight, spiral, or even completely irregular. This means using at least two radars to simultaneously determine 2D movements (in both perpendicular directions of the horizontal plane). In the optimal case, the radars aim at the monitored object in approximately perpendicular directions to each other, and the resulting motion vectors in the horizontal plane are calculated from LOS measurements. The processing of measurements from both radars raises other problems, namely accurate time synchronization of radar measurements. In case of tower structures, time synchronization cannot be solved by coincidence of oscillation amplitude peaks, since the peaks from different radar views may not occur simultaneously. Therefore, alternative solution is offered in this contribution. Purpose of this contribution is to design and verify a procedure for accurate determination of horizontal movements of tower reservoirs with sufficiently accurate oscillation characteristics. The procedure was experimentally verified in practice on a real water reservoir in central Bohemia. The results of the experiment confirm the expected benefits of simultaneous measurements by two radars for determining horizontal dynamic movements of water tower reservoirs by GB-RAR.

Corresponding Author: Milan Talich

**EXPERIMENTAL INVESTIGATION OF INFLUENCES OF TRAFFIC LOAD ON THE CHURCH OF THE  
ASSUMPTION OF THE VIRGIN MARY IN STARÁ BOLESLAV**

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**ABSTRACT**

Long-term dynamic loads represent a serious factor which compromise the safety and durability of historical buildings. Though the daily traffic may cause only low level vibrations, which an undamaged structure could safely resist, extreme values of traffic loads over longer periods can be critical having as a consequence the initiation of cracks or the growth of existing ones, such that they may endanger the structure. Good maintenance including control measurements or monitoring can aid in early damage detection and timely planning of remedial actions. The preceding statements are supported by an investigation of the effects of ambient vibrations mainly due to traffic loads on the Basilica of the Assumption of the Virgin Mary in Stará Boleslav. Attention is aimed at a structural fault, its rehabilitation and prognosis for the future.

Corresponding Author: Jan Bayer

**THE INTEGRATION BETWEEN 3D STRUCTURAL MODELLING, GROUND-BASED AND SATELLITE  
SAR: CREATING A LINK BETWEEN SHORT AND LONG - TERM SLOPE STABILITY HAZARD  
MANAGEMENT IN TITANIA MINE**

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**ABSTRACT**

Geohazards can impose a threat to the sustainable continuation of the production both in short and long term. Mining is a high risk business and the main aim of its open pit design is to create walls that will be stable for the life of the open pit, which in some cases may extend beyond the closure. As a result, any kind of instability should be manageable and if possible, it should not develop to instabilities. This paper focuses on an instability that began in 2008 and continues until today in Titania. The hazard associated with this instability was a constant threat for the continuation of the production and the safety of people and machinery. In order to manage the hazard in short- and long-term, it was evident that data from different sources should be combined and analyzed. Data from ground-based and satellite SAR were used to delineate the unstable area through a period of 10 years. At the same time advanced implicit modelling techniques were used to integrate borehole and surface structural data in a 3D structural model. This 2 stage workflow, led to a set of preventive and remedial measures that allowed the continuation of the production the last ten years and will ensure the continuation of the production for, at least, other ten years.

Corresponding Author: N. Boldrini

## **FLOOD HAZARD CALCULATION BY USING A DIGITAL TERRAIN MODEL**

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### **ABSTRACT**

Due to the global warming and the high environmental burden to the country, the risk of flood hazards increases hand in hand with the climate changes. It is not the only hazard, but parts of this hazard may be eliminated by using flood barriers, flood defences, etc. There are anthropogenic possibilities of the flood barriers' application, such as dams, bags, regulated riverbeds. There are also protections with natural elements that can be used, namely water gardens, water stages, balanced vegetation planting. The strength, dimension and position may be calculated from the proper terrain data.

Corresponding Author: Juraj Muzik



## REMOTE SENSING DATA ANALYSIS FOR THE ECOLOGICAL STABILITY PURPOSES

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### ABSTRACT

The remote sensing offers the opportunity of miscellaneous data acquisition with various ways of their consequent analysis and application. The processed remote sensing data in the form of georeferenced orthophotoimages or orthophotomaps enable the study of the examined locality from the chosen observed feature point of view. According to periodical data acquisition, it is possible to monitor the ongoing and emerging actions in time and then prevent and predict the upcoming actions. With the increasing interest in environmental issues and nature protection, the natural environment monitoring, preservation, protection and remediation present the number one priority. From the ecological point of view, the analysis of orthophotos/orthophotomaps present the up-to-date way of ecological stability calculation and monitoring.

Corresponding Author: Jakub Chromcak

## **INTERPRETATION OF REMOTE SENSING IMAGERY**

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### **ABSTRACT**

The process of interpretation and analysis of remote sensing data is based on extracting meaningful information from satellite imagery. The quality of visual interpretation depends on the resolvability and recognisability of the main visual characteristics of each photo or images. The current process of image analysis is based on digital processing limited by used satellite or airborne sensors.

Corresponding Author: Anna Seidlova

## **ACTUAL SATELLITE IMAGERY SOURCES**

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### **ABSTRACT**

The huge benefit of the Internet is that it not only connects people from all over the world but also provides information that would otherwise be unavailable. Anyone who needs access to the latest satellite imagery can take it via many platforms provided remote sensing data, either for free from the websites belonging to national research and space centers or for a fee charged by commercial companies. The article offers an overview of the most used services, whose data are available and suitable for processing using EarthExplorer – a platform of the U.S. Geological Survey agency.

Corresponding Author: Jana Izvoltova

## **DIGITAL TERRAIN MODEL GEOSPATIAL MODELLING**

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### **ABSTRACT**

The modelling means the world object cognition based on the analogy. This analogy presents an idea and material imitation of some properties of the existing world. It is processed by various anthropogenic objects, in which the chosen properties are presented, defined and characterised as shapes and relations of original objects. The simplified objects are created. These objects are specially created only for world study. These types of objects are called models. To edit the digital terrain model correctly, it is necessary to understand the geospatial modelling.

Corresponding Author: Robert Sasik

## **COSMIC GEODESY CONTRIBUTION TO GEODYNAMICS MONITORING**

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### **ABSTRACT**

The cosmic geodesy provides methods and ways of various data acquisition. The collected data may be used for research, calculations and analysis in different fields of interest. According to the reliability and redundancy of data provided by cosmic geodesy methods, it is possible to contribute to the geodynamics monitoring. The geodynamics monitoring enables the tectonic plates movement tracking and predicts the movements which may result in disasters. Applying data provided by cosmic geodesy methods in the form of permanent observation station positions and their changes in time, in calculations, whose physical nature is based on the continuum mechanics, makes possible to monitor the direction, locality and size of visualised deformation tensors.

Corresponding Author: Dasa Bacova

## **QUANTITATIVE AND QUALITATIVE TERRAIN ANALYSIS BASED ON DIGITAL TERRAIN MODEL**

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### **ABSTRACT**

Within the Digital Terrain Models (DTM) processing and consequently qualitative and quantitative analysis, it is possible to gain a credible imagination of real terrain shape. In order to obtain an appropriate DTM, it is necessary to decrease the influence of the gross errors that have negative effects on the final DTM. These gross errors may degrade and in the worst case also ruin the calculations and the final outputs. The gross errors have a greater impact and are harder to define in complicated terrain and pointing out these types of errors depends on the editor's experiences and terrain knowledge.

Corresponding Author: Dana Sitanyiova

## **VISUAL ORTHOPHOTO CLASSIFICATION APPLICATION**

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### **ABSTRACT**

Data acquisition using remote sensing has opened up new possibilities of their analysis and application. For the ecological stability calculations, it is needed to divide the observed area into subsections based on the land character. The selection may be done by various kinds of processing. For example, it may be done manually, but to increase the post-processing effectivity, it is necessary to find faster, automatic ways of the post-processing. Many software environments are able to solve this problematic by using spectral analyses and appropriate tools.

Corresponding Author: Vilma Kriauciunaite-Neklejonoviene

## **SOME REMARKS ON REGISTRATION TECHNIQUES OF POINT CLOUDS OBTAINED FROM TERRESTRIAL LASER SCANNING**

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### **ABSTRACT**

Terrestrial laser scanning (TLS) is a measurement technique used for many geodetic applications (such as determination of displacement and deformation of building objects or monitoring of engineering structures) as well as for non-geodetic applications (for example in forestry, archeology or geotechnics). Despite the high level of automation, the measurement with a laser scanner and the processing of the results consist of many stages and depend on many factors. The most important factors are: the features of measurement object (size, material, availability), required accuracy, speed of scanning, required scan density, type of reference frame, registration method, planned visualization, and 3D modelling method. In this article, the authors focused on the type of registration technique of point clouds obtained from TLS. The most popular strategies of registration were discussed. The practical application of the selected technique was presented on the example of measurement of the railway gauge of the viaduct. Due to the characteristic object (narrow and long railway line) and considering the local reference frame of point clouds as well as the need of minimization of the measurement time, the hybrid registration method in the nested variant was selected.

Corresponding Author: Zbigniew Muszyński



## **COMPARISON OF DIGITAL TERRAIN AND SURFACE MODELS FOR NEXT USAGE IN A CHOSEN LOCALITY**

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### **ABSTRACT**

There are many possibilities for applications of digital terrain model and digital surface model due to their georeferenced character. The informational system of georeferenced data of Slovakia called ZBGIS gives new opportunities of downloading digital data in various formats. It is possible to download ortophotomosaics, ZBGIS raster at various scales, point cloud but digital terrain models and digital surface models with great possibilities of their application in GIS calculations as well.

Corresponding Author: Alessandro Valetta

## **TRENDS IN INERTIAL NAVIGATION TECHNOLOGIES**

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### **ABSTRACT**

The inertial measurement unit is an electronic device built-in practically in any controlled or autonomous technology used for land mapping. It is based on a combination of accelerometers and gyroscopes and sometimes magnetometers used for relative orientation and navigation. The paper is focused on functions and trends of an inertial measurement unit, which is a part of inertial navigation indicator of position and velocity of moving devices on the ground, above and below ground in real-time.

Corresponding Author: Stanislav Hodas

## **ACTIVITIES OF A MINE SURVEYOR AND A GEOLOGIST AT DESIGN BASES IN A LIMESTONE QUARRY**

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### **ABSTRACT**

At the beginning of this article, the main historical milestones of Povážská cementáreň (cement plant) Ladce, a.s. (PCLA) are presented. The main parameters of the Butkov quarry are also specified (sources of the mineral resources) such as the size of the protected deposit area, the mining area, etc. Another part of the article is devoted to proposals for future mining process. There are two projects in connection with the basic investment plan for PCLA modernization. The first one is the preparation of the survey area for limestone - the stages above the current E15 and the other one is the preparation of the survey area for marl - the Moškové locality. Both of these projects were realized in association with Považská cementáreň, a.s., Ladce and VŠB - Technical University of Ostrava. An integral part of this article based on the project are also simulation of graphic models and diagrams. The last part of the article documents ways of the cooperation of Butkov Quarry and Považská cementáreň, a.s., Ladce with the public. The management of the Butkov Quarry and Považská cementáreň, a.s. have come to realize that their cooperation with the public on cultural and social activities helps both, the public and the quarry (include cement plant).

Corresponding Author: Milan Mikolas

## **ON THE APPLICABILITY OF LASER SCANNING FOR EVALUATION OF THE PAVEMENT SERVICEABILITY PARAMETERS**

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### **ABSTRACT**

Pavement performance is influenced by external factors such as climate and environmental conditions, traffic and operational conditions and type of pavement. These factors cause a pavement deterioration which eventually leads to the restriction of the pavement serviceability or pavement efficiency. The pavement serviceability is the ability of the pavement to fulfil the service function represented by the actual values of variable parameters such as pavement surface roughness, surface evenness, pavement surface condition. The state of the pavement is assessed using different performance indicators with International Roughness Index (IRI) being the most used one. This approach allows to classify the state of the pavement in the pavement management system as a most used indexing, generalizes the pavement surface to the response of the testing car tire and the pavement. Laser scanning presented in this paper is able to provide data about the real pavement surface considering the accuracy of the method and equipment. Realized laser scanning proved the applicability of this method for the measurement of the pavement surface. Because of the complex knowledge of the pavement surface morphology, we can evaluate the pavement serviceability in terms of roughness, surface evenness or even pavement surface condition (rutting or cracks).

Corresponding Author: Veronika Valaskova

## **USE OF LASER SCANNERS IN PAVEMENT MANAGEMENT**

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### **ABSTRACT**

The presented article introduces the utilization of laser scanning technology in the field of pavement management (PM) systems. Thanks its many advantages that allow objectification of road surface characteristics in a more holistic and sophisticated way, right decision-making within the PM, both at the network and project level. Specifically, outputs from the installed road scanners, such as SRS, Trimble CX and Lynx SG1 Mobile Mapper, have been combined to improve the accuracy. There has been found data correlation dependence of the development of rut depth for non-rigid pavements by evaluation of data from measurements at the public transport stop Hurbanova in Žilina during the years 1994 to 2018.

Corresponding Author: Martin Decky

### **3D MODEL OF CASTLE ENHANCED BY REAL TEXTURES**

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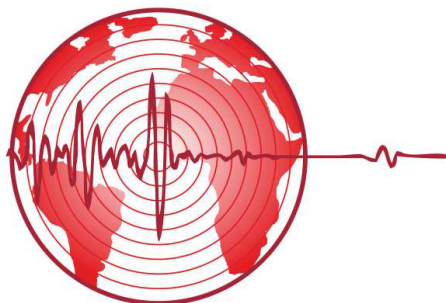
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### **ABSTRACT**

The authors present the outputs of an interesting case study, more specifically the creation of a 3D model with real textures of Hričov Castle, which was developed in 2019 with additional improvements done in 2020. For model creation, devices obtained within the project of Broker centre of air transport for transfer of technology and knowledge into transport and transport infrastructure were used. The 3D model of Hričov Castle created by team leader Tomas Cesnek currently presents one of the most realistic Slovak digital 3D models created by laser scanning technology. This model will be a part of the permanent exhibition of Hričov Castle in the historical toll building from 1556 in Dolný Hričov, Slovakia. Model creation methodology and use of special textures should be used to produce more realistic laser scan 3D models.

Corresponding Author: Tomas Cesnek



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