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INTERDISCIPLINARY TOPICS IN MINING, GEOLOGY AND GEOMATICS

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BOOK OF ABSTRACTS

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Predicting of the multi-ply belt joints durability using simulation tools

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Keywords: multi-ply textile conveyor belt, belt joint, joint service life, joint durability

Knowledge about the service life of the joints before they are made is extremely valuable information for the users of belt conveyors, because having additional technical data about the conveyor and the place of its installation, it is possible to forecast the working time of the joint. The results of calculations of service life of joints of multi-ply textile conveyor belts are presented. The calculations were made in a computer program specially created for this purpose, which predicts the service life of the joints before they are made. The program was created as a result of the implementation of research grant No. PBS3/A2/17/2015 financed by the National Center for Research and Development (NCBiR). The results of the simulation were compared with the data showing the working time of the joint in real conditions of its operation in an underground mine. Comparing the results of the simulation of failure-free operation of joints with real data on the operation time of joints in the analyzed mines, it was noticed that the joints could work longer. Depending on the mine, it was from 3 to 8 months. The simulation did not take into account sudden phenomena that could occur during the belt and joint operation. It was assumed that the operation of the belt runs smoothly, the belt does not run off the conveyor, does not rub against the conveyor structure, etc. Each such phenomenon shortens its working time. The simulation results also showed that the joint made by hot vulcanization is characterized by a longer working time compared to the joint made by cold gluing.

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Measurement with PEMS gas analyzer in real underground mine conditions

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Keywords: NOx, Gas PEMS analyzer, underground mine ventilation, gas hazard

Currently, the extraction of minerals in underground mines is becoming increasingly difficult. There are many natural hazards in underground mines. One of the most dangerous is the gas hazard. To ensure safe working conditions for personnel in the face of gas hazards, it is necessary to constantly monitor environmental parameters and analyze the concentrations of harmful gases. One of the most harmful gases is nitrogen oxides (NOx), whose presence in an underground mine is mainly related to the technological process.

The article presents measurements of nitrogen oxide and nitrogen dioxide concentrations using a reference method - the AVL Gas PEMS gas analyzer, using the NDUV measurement method. The research was carried out in one of the Polish ore mines. The results were analyzed in the context of the mine's technological cycle.

Simulation and modelling of a loading process of mineral raw materials

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Keywords: simulation, modelling, loading process, unloading

The mineral resources is an integral part of goods circulation. The loading process is already carried out during the excavation (underground or on the surface), carried out using various types of loaders and into the vehicles. The loading process is then carried out in subsequent stages of the material transportation and processing. Therefore, loading normally represents a part of technological and conveyance systems. Research discussed in the paper is focused on the loading process of mineral resources while applying simulation approach. The simulation has remarkable potential also in terms of further research in the given area. These models are applicable in practice as an auxiliary tool for the planning process of loading of raw materials and other bulk material. The simulation models presented in this paper is only one possible solution.

Preliminary research on Hyperspectral Mineral Mapping as part of the HYPE4EXPLOR Project

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Keywords: mineral mapping, mixture tunned matched filtering, prisma, HYPE4EXPLOR Project, Sierra Gorda, porphyry copper deposits, hyperspectral data

The research contributed to testing the Mixture Tuned Matched Filtering (MTMF) algorithm for mineral mapping purposes. During the study, we confirmed the effectiveness of the method by validation of selected minerals in the Cuprite Nevada area, using spectral characteristics of minerals from USGS spectral libraries and space-borne hyperspectral imagery (PRISMA). As part of the HYPE4EXPLOR Project, we were tasked with creating surface mineralization maps for the Sierra Gorda mining area, as an exemplary site of Porphyry Copper Deposit (PCD) characteristic mineral alterations (fig. 1). Both preliminary results of MTMF (fig. 2) and additional results of mineral indices were put up for discussion. The next step is to apply spectral characteristics obtained during the planned field measurements which may substantially improve the results of the MTMF mineral mapping.

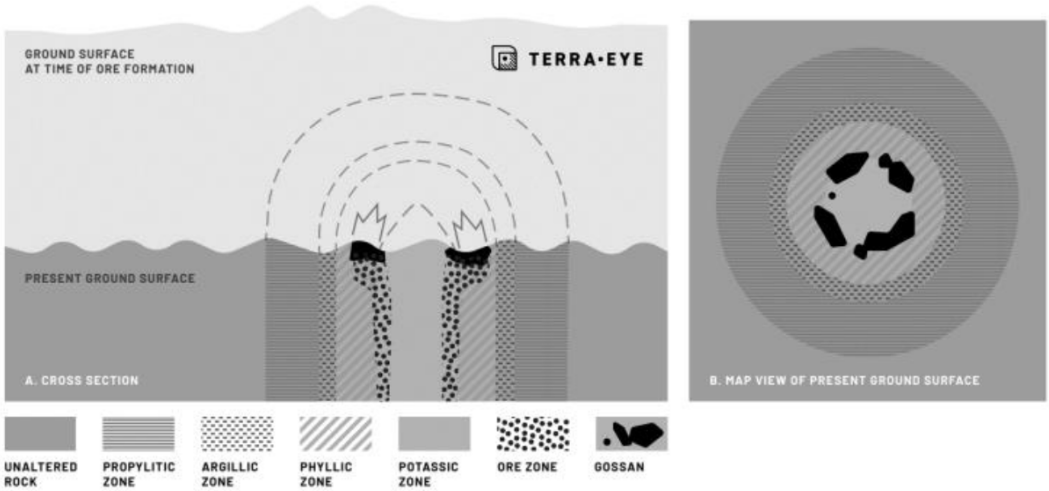

Figure 1: Geological concept of Porphyry Copper alteration zonation and gossans.

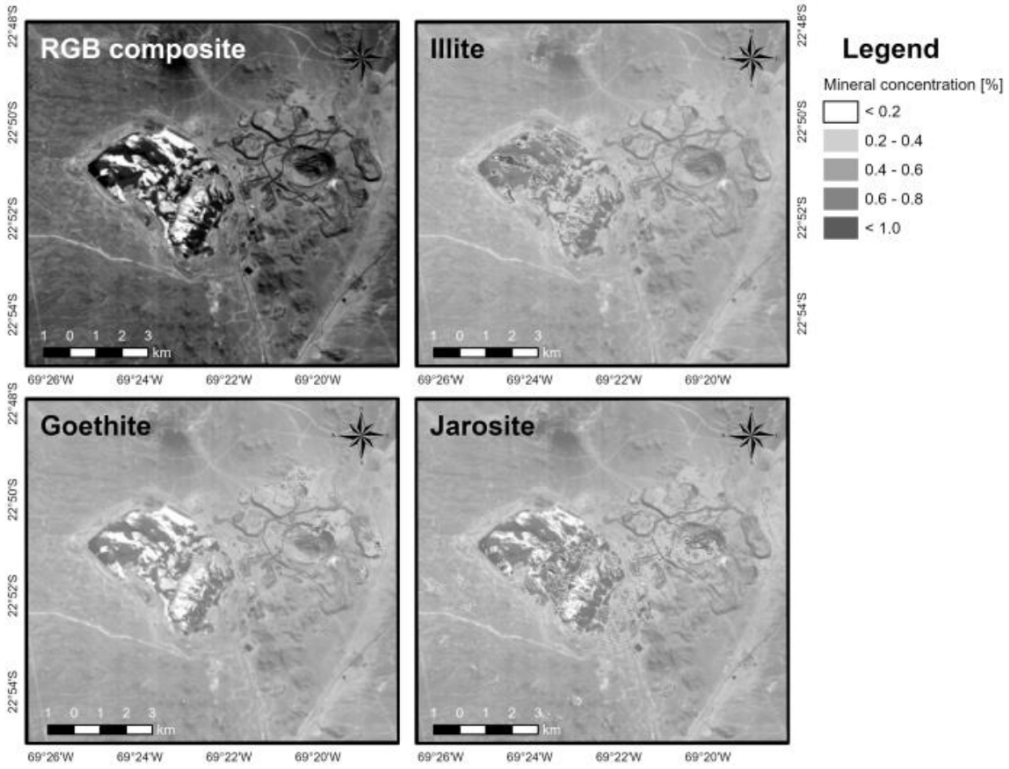

Figure 2: Preliminary results of mineral mapping using MTMF algorithm for the Sierra Gorda mining area.

Identification of the oversized material in hydraulic hammer crushing process based on 3D data analysis

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Keywords: hydraulic hammer crushing, scanning data, point clouds, oversized material

Fragmentation through crushing is a widespread technique in mining, typically utilized to achieve aggregates with the preferred particle size or as an initial step in the fragmentation process prior to grinding to extract valuable minerals from ores. Both crushing and grinding consume significant amounts of energy, the efficiency of which is being increasingly scrutinized.

Crushing is often a multi-stage operation, involving a series of crushers that work in tandem along the technological line to grind the material to the required fraction. During the presented experiments material had to be crushed by the hydraulic hammer to fit through the screen of a 40x40 centimeters square shape, after which it is transported for further processing. The focus of presented research is set on identification of the particles that would be considered as the oversized material as it is a crucial task in the crushing hammer automation process.

Authors propose a method based on the analysis of 3D data obtained from a laser scanner, recorded on one of the crushing sites in KGHM Polkowice-Sieroszowice mine. The difficulties of measurement are multiplied by the necessity of performing the scan from just a single scan station, which was forced by the safety concerns. Segmented but incomplete 3D data was processed by finding the geometric features that prevent the material from going through the screen. Proposed algorithm was able to correctly classify oversized rocks based on the available data.

Life after liquidation – a new reality for the mining communities

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Keywords: social impact, closure of mines, rural commune

Europe has to face many challenges in the perspective of 20230 and 20250 transformation, and the key is to reduce greenhouse gas emissions. Hard coal still plays an important role in the European economy, being present in 12 EU countries and over 120 mines. The coal-energy industry concentrates thousands of people employed directly as well as indirectly related to mining, which is a significant social challenge.

For over 30 years, there has been a gradual reduction in hard coal mining capacity in Poland. In mines where resources have been exhausted, the liquidation process begins: mining operations are stopped, underground excavations and surface infrastructure are liquidated, and land reclamation takes place. At the same time, economic links with other entities are interrupted. These processes also have a very clear impact on local communities and the economy. Cities and their citizens where mining was operating must face a new reality.

Energy transition impact and efforts to limit the hard coal industry has particularly affected local communities where mining companies were the main employer. The paper presents the preliminary research results from a rural commune on the social impact of hard coal mine liquidation. Rural area development based on the operation of the mine and the effects of its closure were analyzed. The voices of the residents – both former employees and their families, as well as people not related to work in the mine. All of them are living in the rural commune in question, were considered. Preliminary research results indicate, inter alia, that citizens perceived a decline in the quality of life in the municipality, a weakening of social ties and the need for post-mining facilities development.

MineCam: Application of Remote Sensing combined with Machine Learning for Mining Areas Monitoring

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Keywords: surface mining, land use, change detection, satellite data, machine learning

Surface mining is a significant activity that results in substantial changes to the land. These changes involve deforestation, infrastructure construction, pits creation, and the disposal of waste, among other activities. Consequently, it is crucial to continuously monitor these transformations in mining areas. Our study addresses this challenge by introducing a novel solution that combines remote sensing and machine learning techniques. We have compiled a dataset consisting of more than 2000 satellite images, each labeled with 10 distinct categories that pertain to various components of mining areas (such as excavations, dumping grounds, or tailing storage facilities). To accomplish the classification task, we evaluated different deep learning algorithms using various combinations of training data, including different image band combinations and truncated datasets focused on specific types of surface mines. The resulting product is readily applicable for assessing the environmental impact of mining operations in terms of land use, identifying illegal mining activities, and tracking the progress of mining operations and subsequent reclamation efforts.

Management and control of underground mine dilution: current trends and the role of machine learning

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Keywords: dilution, dilution management, dilution control, sustainable mining

Dilution is a persistent challenge in underground mining that greatly impacts the economic and operational performance of the projects. The estimation and control of dilution are important aspects required to optimize the ore recovery and minimize the waste extraction, but there are major factors that arise during the mining operation such as geological complexities, lacking mining practices, and operational constraints. Some of the most prominent techniques used to address dilution include careful stope design, drilling and blasting optimization, the use of selective mining approaches, adequate support design, grade control techniques, and the implementation of real-time monitoring and control systems. These techniques can reduce dilution and improve ore recuperation, but the effectiveness can vary greatly depending on specific on-site conditions, and they rely on experience and empirical observations. In recent years the use of machine learning and advanced data analytics have enabled the extraction of major insights from large datasets (geological, production, monitoring, drilling, and blasting data), gaining notoriety for analysing and predicting dilution. Several studies have shown applications of machine learning in estimating dilution, optimizing stope design, and identifying dilution sources, and the current trends in dilution management have seen an increase in the integration of machine learning techniques, offering promising opportunities for addressing some of the major challenges. By using the power of data analytics and advanced algorithms, machine learning can improve the control and management of dilution in underground mining operations, leading to more sustainable mining practices.

Improving accuracy in assessing conveyor belt condition: introducing an innovative diagnostic solution

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Keywords: conveyor belts, condition assessment, wear indicators, diagnostic solution

The assessment of conveyor belt condition is crucial for efficient maintenance and replacement strategies in mining operations. Traditional wear indicators based on calendar age and working time have proven to be inaccurate in assessing the true condition of the belts, leading to inefficiencies and unnecessary energy and time loss. We introduce an innovative diagnostic solution called DiagBelt, which utilizes magnetic field analysis and detection of damage in the steel cord core to provide a more accurate assessment of belt condition. The system scans the belt to detect and measure failures, providing two key parameters: damage density and surface damage density. Damage density represents the average number of failures per meter of belt section, while surface damage density quantifies the average surface area of failures per meter of belt section. These parameters offer a more accurate assessment of the belt's condition compared to traditional indicators. By calculating parameters such as damage density and surface damage density, DiagBelt enables reliable evaluation and monitoring of the belt's technical state. Color-coded maps are used to visually represent the belt's condition, facilitating quick and intuitive assessments. The incorporation of these new metrics improves the accuracy of assessing the belt's technical state and enables more informed decisions regarding maintenance. The proposed solution represents a significant advancement in accurately assessing conveyor belt condition and optimizing maintenance strategies in mining operations.

Advantages of Innovative Safety Management in the Mining Sector:A Case Study

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Keywords: mining sector, occupational health and safety (OHS), safety management, innovation, risk treatment

Mining is a high-risk sector that requires continuous attention to occupational health and safety (OHS) risks. Despite the progress made in reducing accidents and fatalities, the industry still faces challenges in promoting OHS and responding to changes in the sector. The development of technological innovations and new mining equipment has attracted more attention from both academic scholars and industrial practitioners. This review paper discusses the advantages of innovative safety management in the mining sector, emphasizing the need for significant rather than incremental changes in OHS performance. The paper highlights the role of occupational health practitioners in guiding management and employees on OHS legislative obligations and in promoting a holistic approach to risk management. The review recommends sound remedial and monitoring measures to reduce the percentage of injuries and minimize the severity of accidents. The paper concludes that the adoption of innovative safety management practices can lead to a safer and healthier mining sector and enhance the sustainability of the industry.

Overall, the review paper provides insights into the importance of innovative safety management in the mining sector, and it will be of interest to stakeholders in the mining industry, OHS practitioners, policymakers, and academics.

Figure 1: Mine Safety Management Using Innovative and Technological Strategies

Estimation of cohesion for intact rock materials using regression and soft computing analyses

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Keywords: cohesion, intact rock material, regression, soft computing

Shear strength parameters such as cohesion (c) and internal friction angle (φ) are among the most critical rock properties used in the geotechnical design of most engineering projects. However, the determination of these properties is laboring and requires special equipment. Therefore, this study introduces several predictive models to estimate the c of different rock types based on regression and artificial intelligence methods. For this purpose, a comprehensive literature survey is carried out to collect quantitative data on the shear strength properties of different rock types. Then, regression and soft computing analyses are performed to establish several predictive models based on the collected data. As a result of these analyses, five different predictive models (M1–M5) were established. Based on the performance of the established predictive models, the artificial neural network-based predictive model (model 5, M5) was found to be the most suitable choice for the evaluation of the c for different rock types. In addition, mathematical expressions behind the M5 model are also presented in this study to let users implement it more efficiently. In this regard, the present study can be declared a case study showing the applicability of regression and soft computing analyses to evaluate the c of different rock types. However, the number of datasets employed in this study should be increased to get more comprehensive predictive models in future studies.

Processing of marine minerals: polymetallic nodules, crusts and massive sulphides

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Keywords: marine minerals, mineral processing operations, polymetallic nodules, cobalt-rich manganese crust, seafloor massive sulfides

Polymetallic manganese nodules (PMN), cobalt-rich manganese crusts (CRC) and seafloor massive sulfides (SMS) have been identified as important resources of economically valuable metals and critical raw materials. The currently proposed mineral processing operations are based on metallurgical approaches applied for land resources. Thus far, significant endeavors have been carried out to describe the extraction of metals from PMN; however, to the best of the authors' knowledge, it lacks a thorough review on recent developments in processing of CRC and SMS. This paper begins with an overview of each marine mineral. It is followed by a systematic review of common methods used for extraction of metals from marine mineral deposits. In this review, we update the information published so far in peer-reviewed and technical literature, and briefly provide the future perspectives for processing of marine mineral deposits.

Accuracy and Applicability Evaluation of an Underground Geomonitoring Robot System Using SLAM Methods

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Keywords: geomonitoring, robot, SLAM method, accuracy and precision, applicability

Quantitative and reliable information provided by geomonitoring helps to dentify hazards and to timely adopt appropriate measures. However, doing this job inherently exposes monitoring staff to a dangerous environment, especially in the field of underground geomonitoring. Since 2000, as robots are widely used in various fields, many studies have focused on the establishment of automated robotic systems as well as underground navigation and mapping. Only a few studies have conducted quantitative evaluations of the proposed or used methods, and almost none have provided systematic and comprehensive assessment of suitability of mapping robot for underground geomonitoring areas. In this study, the accuracy and precision of the selected Simultaneous Localization and Mapping (SLAM) method, implemented on the designed robot system, were systematically and quantitatively evaluated using mine surveying methods. In order to assess accuracy, the design of an underground test site, including the configuration of the control points, selection of targets and optimization of the design was conducted. Measurement experiment was performed by a robot equipped with various sensors in conjunction with the selected SLAM method. The obtained result point cloud was compared with the reference point clouds measured by a total station, a handheld scanner, and a terrestrial laser scanner. The accuracy and precision of the selected SLAM methods as well as the verifiability and reliability of the results were evaluated using the German Ordinance on the Survey Work and Observations of the Surface Markscheider Bergverordnung (MarkschBergV) as a regulation.

Education for a sustainable raw materials industry in and for Europe - Raw Materials Value Chain (RaVeN) master engineering programme

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Keywords: master education, raw materials value chain, higher education, mining engineering

Sustainable extraction, processing of raw materials and its use in final products is the key to the development of energy and geopolitical independence of Europe. As Europe, we are at a crucial point for universities educating staff for the mining industry. Therefore, it is necessary to promote entrepreneurial attitudes and arouse curiosity about the aspects of sustainable development in the entire raw materials value chain in the technological, social and economic dimensions. The Raw Materials Value Chain (RaVeN) is the EIT Label double diploma master' program that meets this challenge. Studies are a unique opportunity to acquire extensive knowledge, skills and competencies in the field of sustainable exploitation of raw materials: sourcing, processing, use, recycling and circularity. The whole learning process (including summer schools, winter workshops, student placements and other activities) is carried out with the close cooperation with non-academic partners, which guarantees the gaining of up-to-date, specialised and practical knowledge. Moreover, RaVeN's Master's degree programme promotes creativity, innovation and entrepreneurship, preparing its graduates to incorporate innovative solutions in their workplaces or to set up and run their own businesses successfully. Studies start in October 2023.

Acknowledgements: The RaVeN is implemented within EIT Raw Materials Academy

Evaluation of the work with the rock mass with different properties of selected designs of anchor bolts, on the basis of the results of laboratory and underground tests

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Keywords: rock bolting, expansion anchor bolts, rock bolting selection, laboratory and underground tests

The presentation demonstrates a summary of laboratory and underground testing of anchor lining for 6 types of expanded anchor bolts. The anchor bolts were installed in 7 underground testing grounds featuring different geological-mining conditions in the ZG Lubin mining enterprise that are characterized by various geological and mining conditions.

The underground testing was performed three times: immediately upon the installation of the anchor bolts, one year and two years from their installation in the rock mass. The laboratory testing of load capacity was performed in two series in the cores, which were collected at the underground testing grounds. It was mentioned that the load capacity testing is a part of a larger project, within which the strength tests of the cores collected from the rock mass and of the material of the anchor bolts were performed. The whole presentation was completed with a numerical analysis of cooperation of the bolts with the rock mass.

Preliminary conclusions were presented, which will serve perfecting of the methods of selection of the anchor lining for the prevailing roof conditions.

Comparison of Hexcore and Poly-Hexcore computational grids in the aspect of air flow modeling based on the actual geometry of mining excavations

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Keywords: CFD, scanning data, point clouds, computational mesh

Discrete models are used in industry for many applications. In one of the most frequently used Finite Element Method (FEM) for Computational Fluid Dynamics (CFD) calculations, these models may be two-dimensional or three-dimensional. 2D models are used as a simplification to achieve satisfied results in the shortest computational time. 3D models, on the other hand, are used for more complex calculations. These models use real-world models that have been appropriately simplified to make the calculations accurate and correct. The calculation time of a 3D model is significantly longer compared to a 2D. For this reason, to reduce the calculation time, different types of simplifications and various types of discrete model meshes are used. In this paper, the authors performed a comparison of two types of computational grids: Hexcore and Poly-Hexcore in the aspect of airflow modeling in mining excavations using CFD. The geometry considered in this case came from real-world models captured in Polkowice-Sieroszowice Mine, Poland by laser scanning. Point cloud data was processed through feature extraction which was subsequently utilized to create structured models of mining excavations. The results of the simulations show that taking into account such a diverse and complicated geometry and its significant lengths, reaching tens of kilometers, better results are obtained with the use of Poly-Hexcore mesh. This mesh type allows simulations to be performed with similar accuracy, however, in a shorter computation time. Utilization of a more modern type of mesh makes work more dynamic, which is of particular importance when conducting numerical simulations of air distribution in large and complex computational domains.

Land use change detection using historical satellite images and GIS: a case study of Mai-Nefhi watershed, Eritrea

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Keywords: Landsat 8, ArcGIS, land use changes, land degradation, Mai-Nefhi watershed

Land use and land cover changes significantly impact agricultural land and its productivity. With the increasing demand for urbanization and industrialization, the conversion of land use into other land use types has become a widespread phenomenon. As a result, soil erosion, and land degradation may happen and agricultural productivity may suffer. Moreover, introducing agricultural technologies like irrigation projects is some of the changes. Therefore, understanding the land use changes in different years is crucial in order to analyze its impact. The study aims to investigate the land use and land cover changes in the Mai-Nefhi dam watershed between 1991 and 2021 to analyze land use and land cover changes. In this study, Landsat 8 satellite imagery is utilized from USGS Earth Explorer for data acquisition. The initial step involves image pre-processing, which encompasses various procedures to enhance the quality and usability of the data. Subsequently, supervised data processing techniques are employed to analyze the acquired data. By applying these techniques, a detailed and comprehensive map of land use is generated, showing the distribution and extent of various land use classes within the study area. Furthermore, change detection analysis is conducted to identify and quantify changes using ArcGIS that occurred between 1991 and 2021. The results show significant land use changes and land cover changes over the study period, with the conversion of farmland to water bodies and other land use types. These changes could be because of the country's irrigation projects to introduce irrigation and make the lands irrigable. The result also shows land use changes over the study period, with the conversion of farmland to shrubland and forest land. The study hints at further research to identify the driving forces for land use and land cover changes. The findings will provide insights into the current state of land use and land cover in the watershed and can inform land management decisions for sustainable development in the watershed and can inform land management decisions for sustainable development in the region.

Experimental verification of the mathematical model of transport systems

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Keywords: mathematic model, flexible shaft coupling, resonance, Campbell diagram

This issue deals with the minimization of dangerous vibrations occurring in mechanical systems. The main goal of the work is to create a mathematical model that describes a real mechanical system and then verify it. The work describes the methods for dynamic calculation, namely the method of partial frequencies according to Rivin and the tabular method according to Holzer. Methods were used for mass reduction and calculation of natural frequencies and mode shapes. One of the selected systems was experimentally verified in the Torsional Oscillation Measurement and Tuning Laboratory. The simulation model and the experimental model differ by a small margin. During the development of the work, the MATLAB simulation program was used, and the results were also compared with professional publications. Calculations and analyzes led to conclusions and recommendations for the scientific and practical area of the issue.

Solution of rotating masses f transport system using MATLAB/Simulink

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Keywords: torsional vibration, reduction, conveyor propulsion, dynamic model, block diagram

In the article we give attention to mechanical system and related subject of controlling dangerous vibrations of mechanical systems propulsion. In the center of attention there is namely the mechanical system of conveyor propulsion. In order to specify the intensity of vibrations, dynamic analysis is used and for its realization we have to reduce mechanical system. The article therefore presents also the kinetic differential equations that describe reduced mechanical system with damping. Besides mechanical system there is also a brief description of simulation program MATLAB/Simulink, which is closely related to the topic of controlling torsional vibrations, because this program manages to predict it, to a certain extent. Using this program we are able to solve different kinds of systems and vibrations, in our case it is the three-mass torsionally oscillating mechanical system and this solution is also encompassed in the article. It is important to note that this is only the plan of solution description.

Use of AI to predict the damage to the rubber belt used at coal mine

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Keywords: conveyor belt, wear, artificial neural network, Ishikawa diagram, statistical analysis

The conveyor belt systems are used to transport the heavy and bulk material at mining sites due to their features like continuous operation and proven reliability compared to other means of transport. The rubber belt segments and loops are the core of such systems and various factors contribute in the continuous damage done to it during the material carrying-loading-unloading process. The downtimes are costly at such production sites where mining is carried out.

Timely maintenance and repairs can reduce the emergency breakdowns and extend the service life. The study of governing factors for the wear of the rubber belt can help in better control and implementation of the operating conditions. Ishikawa diagram can be used to identify the parameters which contributes in the damage to the belt during production at mining site. Subsequently, enlisted cause and effect parameters in the Ishikawa diagram can be divide into quantifiable and non-quantifiable categories which can be used into the dataset records which are recorded at mining site. The stored database can be used in the statistical analysis and then in developing the machine learning model which can identify the correlation between the cause and effect variables within the dataset and then predict the damage to the rubber belt.

Assessment of energy efficiency of belt conveyors working in open pit mine

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Keywords: belt conveyors, specific energy consumption, energy efficiency, open pit mining

The mining industry consumes a significant amount of energy, accounting for around 6% of global energy production. Within the industry, transport alone consumes over 20% of this energy. Belt conveyors are widely used for bulk material handling in mining due to their efficiency and cost-effectiveness. However, they still consume substantial amounts of energy. Improving the energy performance of belt conveyors is crucial to address this issue.

Assessing their energy efficiency has been challenging due to their diverse designs. Standardized approaches are necessary to evaluate efficiency for optimization at the technological and management levels. Previous methods relied on comparing conveyors operating under similar conditions, which led to simplified and potentially inaccurate assessments. To overcome these limitations, a Monte Carlo simulation approach was employed to generate energy efficiency classes for belt conveyors based on their operating states. This method provided statistically representative data that would be difficult to obtain in real-world conditions. The specific energy consumption (SEC) indicator was used to assess efficiency by considering the electrical energy consumed to transport materials over a given distance. The results include a classification of real belt conveyors into energy efficiency classes and insights into their operating times within specific energy ranges.

The study focused on belt conveyors used in overburden transportation in an open-pit brown coal mine, where energy consumption is particularly relevant. This classification framework allows differentiation between less and more efficient conveyors, facilitating the identification of factors contributing to lower efficiency in specific cases.

Proposal of belt conveyors energy efficiency classification

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Keywords: belt conveyors, energy efficiency, underground mining, Monte Carlo simulation, energy efficiency labels

Nowadays, the issue of energy efficiency in the mining industry is crucial for reducing operational costs, minimizing environmental impact, and improving sustainability. The key consideration should be put in material handling operation that was recognised as one of the most energy intensive one in the mine site. Many scientific researches indicate that transportation process optimization can lead to significant energy savings. Best practices that enable energy consumption reduction are implemented at equipment, operational and technology level. Nevertheless, there is still a need to develop a new approach to measure and assess the energy efficiency of conveyors.

The study introduces a new approach to belt conveyors' energy performance evaluation that is based on energy consumption labels. Since belt conveyors are considered as mechanical conveying systems, it is barely possible to normalize energy class thresholds directly from measurement data. Therefore, the unique methodology for energy class thresholds with the use of Monte Carlo simulation was established. Moreover, quartile-based classification was used in data analysis and statistical research to understand the distribution of a variable and to group data into meaningful categories named as energy efficiency labels.

The case study of an underground copper ore mine was used to demonstrate the effectiveness and benefits of the proposed method. Its definite advantage is the elimination of the unreliability of directly comparing energy consumption between two conveyors. The proposal for belt conveyors' energy efficiency classification based on Monte Carlo simulations and specific energy consumption indicator has a great potential application in the entire mine and beyond.

Creating structured meshes of mining excavations based on variability trends of real point clouds from laser scanning

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Keywords: laser scanning; SLAM; point clouds; synthetic models

Accurate modeling of airflows is an ongoing challenge for the scientific community. Various technologies are used to acquire and process 3D data of mining excavations, such as Terrestrial Laser Scanning (TLS), photogrammetry, or Mobile Mapping Systems (MMS) supported by Simultaneous Localization and Mapping (SLAM) algorithms. Due to often difficult measurement conditions, the data obtained is often incomplete or inaccurate. There are holes in the point cloud due to objects obscuring the tunnel. The data processing itself is also time-consuming. The point cloud needs to be cleaned of noise and unnecessary elements. The creation of a mesh model, which could then be subjected to further numerical calculations, is problematic in such a case. This paper proposes to create a synthetic model based on real data. 3D data of underground mining tunnels captured by a LiDAR sensor are processed employing feature extraction. A uniformly-sampled tunnel of given dimensions, point cloud resolution, and cross-section shape is created for which obtained features are applied, e.g. general trajectory of the tunnel, shapes of walls, and additional noise useful for obtaining surfaces of desired roughness. This allows to adjust the parameters like resolution, dimensions, or strengths of features to obtain the best possible representation of a real underground mining excavations geometry. From a perspective of Computational Fluid Dynamics (CFD) simulations of the airflow, this approach has the potential to shorten domains geometry preparation, increase the quality of computational meshes, reduces computational time, and increase the accuracy of results obtained, which is of a particular matter considering airflow modeling of extensive underground ventilation networks.

Comparative Review and Analysis of Coal's Spontaneous Combustion Testing

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Keywords: spontaneous combustion, coal risk management, R_{70}, CPT, SHT_{min}

Spontaneous combustion in underground coal mining remains a persistent hazard for operations and mine personnel into the 21^{st} century. In Australia, small-scale laboratory tests are used to quantify the risk of spontaneous combustion within mining operations allowing mine operators to undertake adequate controls towards prevention of spontaneous combustion.

In Australia, the three most common tests used are: the adiabatic oxidation method (R_{70}), Crossing Point (CPT) and Minimum Self-Heating Temperature (SHT_{min}). In addition, the intrinsic spontaneous combustion propensity classification (ISCP) is used for establishing a risk rating based on the R_{70} laboratory results. This risk ranking provides a guideline to spontaneous combustion severity on a scale from low to extremely high. However, the supporting literature for the currently adopted ISCP is minimal and no literature exists for the correlation between laboratory spontaneous combustion tests nor the creation of a risk matrix for CPT.

This paper presents the results of a correlation study between CPT and R_{70} based on a large historical database (n=285) showing that both CPT and R_{70} can be used to rank spontaneous combustion risk. It was found that CPT is strongly correlated with R_{70} with a coefficient of -0.8042. The hierarchical clustering analysis resulted in a revised risk ranking: Low ($R_{70} < 0.4$ °C/hr, CPT > 151 °C), Medium (0.4 °C/hr $< R_{70} <$ °C/hr, 130 °C $<$ CPT < 151 °C), High (3 °C/hr $< R_{70} < 11$ °C/hr, 102 °C $<$ CPT < 130 °C), Very High ($R_{70} > 11$ °C/hr, CPT < 102 °C).

A GIS Approach for Spatial Prediction and Visualization of Groundwater Pollution by Total Dissolved Solids (TDS) in Asmara, Eritrea

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Keywords: GIS, geostatistics, total dissolved solids (TDS), spatial prediction, Asmara

Groundwater is an essential source of water supply, but its quality is often threatened by pollution. This study aimed to develop a framework to spatially predict and visualize groundwater pollution by Total Dissolved Solids (TDS) in Asmara, the capital city of Eritrea, using GIS and Geostatistics. The framework was tested using 82 TDS concentration samples. The study applied geostatistical tools such as kriging to create a spatial prediction model of TDS concentration, which was classified into three categories based on standard classifications: Excellent ($<$ 500mg/l), Good (500-1000 mg/l), and Poor ($>$ 1000 mg/l). The study found that log transformation of TDS data sets was necessary to ensure normality of the data for creating an accurate prediction model using Ordinary Kriging. The Semi-variogram analysis showed that the Exponential model was the best fit model with moderate spatial dependence of TDS parameter. The cross-validation results indicated unbiased prediction with accurate standard errors. The TDS concentration in the study area ranged from 192 to 1798 mg/L, with an average of 791.71 mg/L and a standard deviation of 369.55 mg/L. Where, the prediction model map revealed that 39.1% of the study area had excellent TDS concentration, while 41.94% and 18.96% of the study area had good and poor ranges of TDS concentration, respectively. The Northeast, Northwest, and Southwest of the study area had very high levels of TDS concentration (Figure 1). This study provides evidence for the utility of GIS and Geostatistics in mapping groundwater pollution, highlighting their effectiveness in helping decision-makers and water resource departments visualize the spatial distribution of contaminants and to make appropriate measures before utilizing to end-users. The framework developed in this study can be applied to other part of the country for groundwater quality assessment and management.

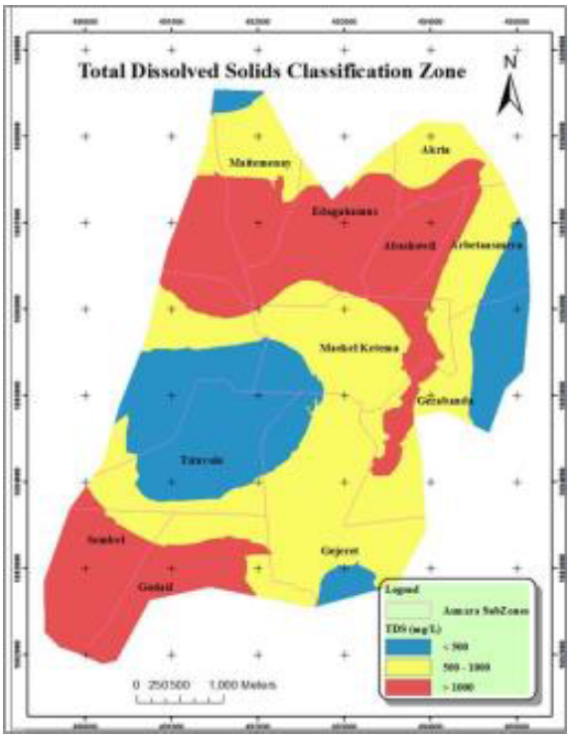

Figure 1: Classification zone map of TDS in the study area

Deformation Pattern Detection in Mining Areas based on Unsupervised Machine Learning and InSAR Data

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Keywords: InSAR, mining induced displacements, time series clustering, self organizing maps

Underground exploitation of mineral resources influences the ground surface in the form of deformation. The Synthetic Aperture Radar Interferometry (InSAR) method is a technique used to remotely measure ground surface displacements, including deformations in mining areas, using satellite SAR imagery. InSAR time series methods in combination with Sentinel-1 open imagery provide extensive collections of data about land surface phenomena. Optimising and automating the extraction of information from the expanding inventory of Earth Observation data is a major challenge for the scientific community. This paper presents a method for unsupervised pattern detection from InSAR displacement time series data.

The study was carried out for the Legnica-Głogów Copper Belt area in south-western Poland. The SBInSAR (Small Baseline InSAR) method was used to measure ground surface displacements (Berardino et al., 2002). Vertical displacements were calculated by fusion of multi-geometry data from ascending and descending sateliite orbits. Vertical displacements of the ground surface from May 2016 to October 2020 were determined.

An unsupervised machine learning method, Self Organising Maps (also called Kohonen's Network), has been used to aggregate time series with similar characteristics and patterns into 10 separate clusters. The research confirmed that the use of unsupervised machine learning methods in displacement time series analysis allows the detection of patterns in unstructured data, facilitating the analysis of the observed phenomena.

Waste sands image analysis for grain size estimation

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Keywords: image analysis, image segmentation, grain size distribution

As the mining industry progresses, the quick and efficient characterization of the excavated soil becomes valuable information to use in mining processes evaluation and planning. Grain size distribution of soil has a great impact on its compressibility, liquefaction potential and many other parameters.

Image analysis techniques come with the advantage of effective and sustainable evaluation of the size of soil particles and its characteristics. Current study aims to investigate the ability of the image analysis to characterise the waste sands for assessment of the sand liquefaction potential and potential damp model evaluation. For this, an image dataset of several waste sand representatives were collected and processed. Results of its analysis consist of soil grains measurements, such as diameter, area and perimeter, and its shape estimations.

Comparison with sieve analysis suggests successful computation of the grain size distribution curve that 89% matches to the one made in the laboratory. Combination of the advanced quckshift segmentation method and image polygon properties calculation makes adequate estimation of grains real size without excessive economical, material and time expenses.

Diagnosis of the Wałbrzych post-mining area: pilot study using public participaton

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Keywords: mine closure, revitalization, post-mining area

Extraction of natural resources is usually carried out until the deposit resources are exhausted or further exploitation becomes unprofitable. Long-term mining activity leads to several changes, both environmental and socio-economic, and the challenges that arise during and after the mine closure depend on the factors that conditioned this decommissioning and, on the actions, taken throughout the life cycle of the mine. The International Council on Mining and Metals (ICMM) distinguishes three types of mine closures, considering the reasons that led to them. In addition to planned liquidation, it distinguishes between temporary and sudden closures. Sudden closures present many challenges and expedited actions that were often only in the conceptual planning phase. Due to the factors that led to this closure, some of these actions may not be partially or even fully applicable [1, 2].

The presented research provides an in-depth analysis of the Wałbrzych case of the sudden mine closure and subsequent socio-economic, infrastructural and environmental changes in the surrounding region [3–6]. The diagnosis of the area was made based on a pilot survey conducted among diverse stakeholder groups. As a result, opinions were identified and assessments of social, infrastructural and environmental changes after the closure of mines were obtained. Information was obtained on the areas and facilities requiring revitalization according to the respondents. The obtained results were compared with the revitalization areas designated by Wałbrzych City Hall.

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The unexplored shallow water – introduction to bathymetry

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Keywords: bathymetry, UAS, airborne bathymetry, SDB

The vast majority of the world's seabed areas remain a mystery. Current estimates suggest that about 75% of the world's water areas remain unknown and unexplored. This stunning number highlights the limited understanding of the diverse ecosystems, geological formations and potential resources that lie beneath the water's surface. What's more, about 50% of coastal areas, which are a key transition zone for land and sea, have not yet been studied in detail. Coastal areas are home to many megacities around the world. They also play a key role in various industrial applications, ensuring the safe navigation of ships and implementing effective coastal protection and management measures. Consequently, continuous monitoring of the coastal area is becoming a necessity.

This presentation focuses on demonstrating existing bathymetric techniques for shallow water mapping. Three different case studies will be discussed: the simulated area (baby pool), the Sardinian coast, and the coast of southern France. Each technique will be critically assessed, shedding light on their strengths and limitations.

Green Red Water Indices – vegetation indices for environmental Geomonitoring

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Keywords: vegetation indices, UAV, remote sensing, geomonitoring

One of the challenges of today's world is the long-term geo-monitoring of phenomena and processes that affect our environment after mining activities have ceased [1–3]. Water resources are one of the elements affected by post-mining processes [1, 2]. Moreover, land subsidence can be observe both during and after mining activities. This phenomenon affects the entire water management of the region. This research present a methodology for using drones to detect water surfaces using a vegetation index. During their research, the authors modified the GRNDVI index [4] to include the Red Edge band in the calculations (Formula 1).

$$GRWI = \frac{NIR - (Green - RedEdge)}{NIR + (Green + RedEdge + Red)} \tag{1}$$

The Red Edge band also influences the presentation of a given pixel in the image (Fig. 1). It can be seen that the spectral profiles of the water, soil and street classes have similar spectral profiles.

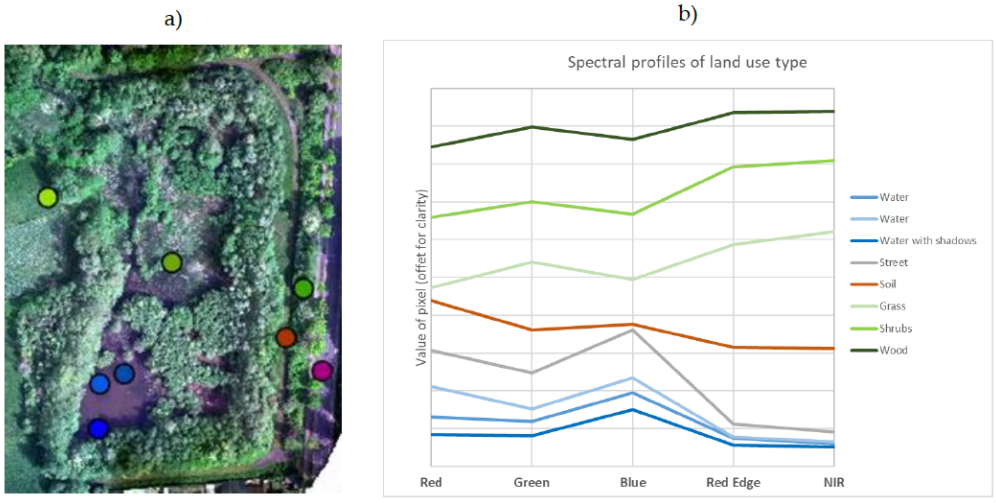

Figure 1: Spectral profiles of various types of land use (a) location; (b) spectral profiles.

The newly developed Green Red Water Index, GRWI, allows the identification of water surfaces (Fig. 2). The authors suggest that the water values for GRWI should be determined between -1 to 0.2.

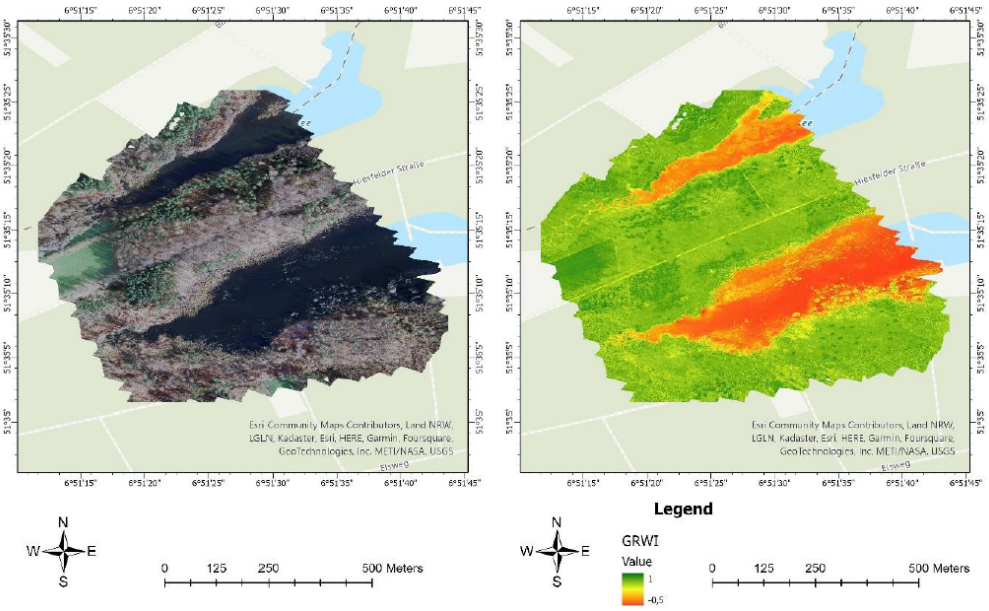

Figure 2: GRWI from 28.03.2023 in the test area Weihnachtsee. Source of Basemap: ESRI.

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Special thanks go to Prof. Michael Hegemann and Prof. Peter Goerke-Mallet for their commitment and sharing their knowledge of the research area.
In particular, thanks are going to the RAG Foundation for funding the project – "Digital Twin – Integrated Geomonitoring" (No. 20-0013).

The use of UAV data to observe post-mining processes and the formation of subsidence lakes in the former mining area of Prosper-Haniel mine

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Keywords: vegetation indices, UAV, remote sensing, geomonitoring

The utilization of drone flights for geo-monitoring post-mining processes is experiencing a rapid surge in popularity. Modern unmanned aerial vehicles (UAVs) are becoming increasingly accessible to a wide range of users. This paper focuses on the application of drone flights. Our proposed solution involves employing various sensors, including multispectral cameras and thermal cameras, to monitor the mining areas environment.

The former Prosper-Haniel mine is located in the north-western part of the Ruhr area (Germany) (Fig.1). The main mining exploitation in the research area started in the 1990s and lasted until 2014 [1–3].

The data captured by multispectral UAVs can be utilized, for instance, to generate orthophotos and calculate remote sensing indicators (Fig. 2), thereby enabling environmental monitoring. Moreover, the use of a thermal camera facilitates observation of soil and water temperatures (Fig. 3).

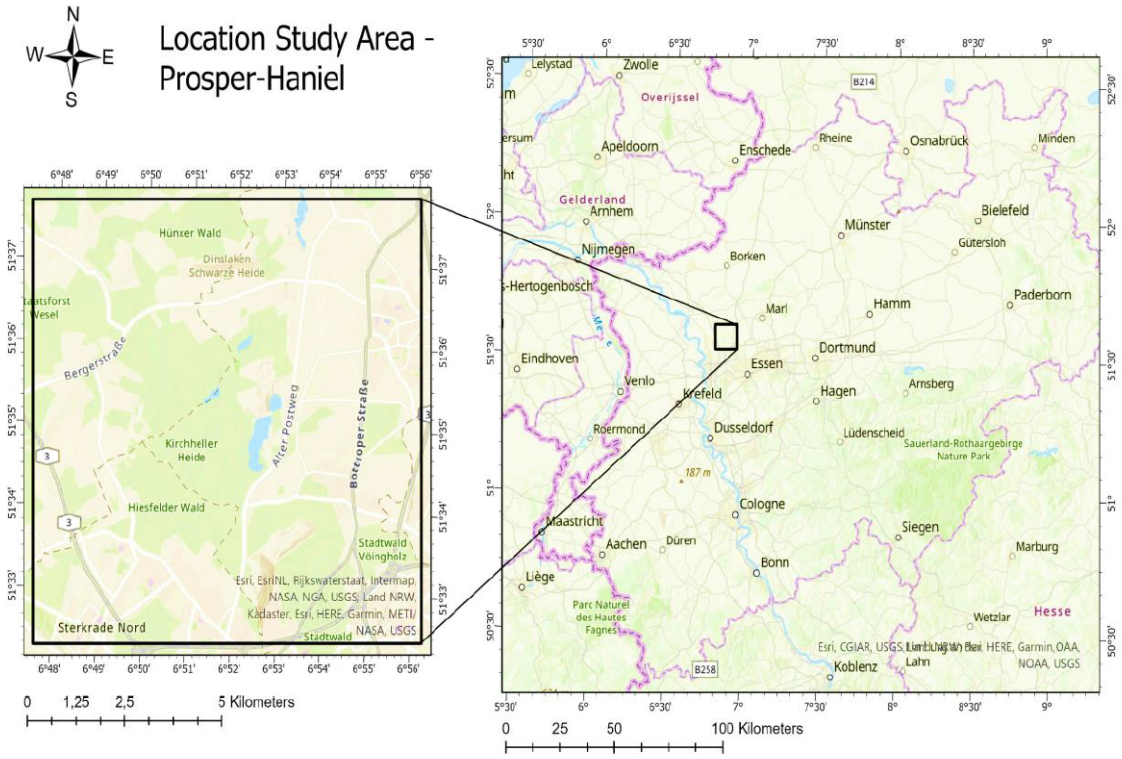

Figure 1: Location of the study area in the north-western Ruhr area in Germany [4].

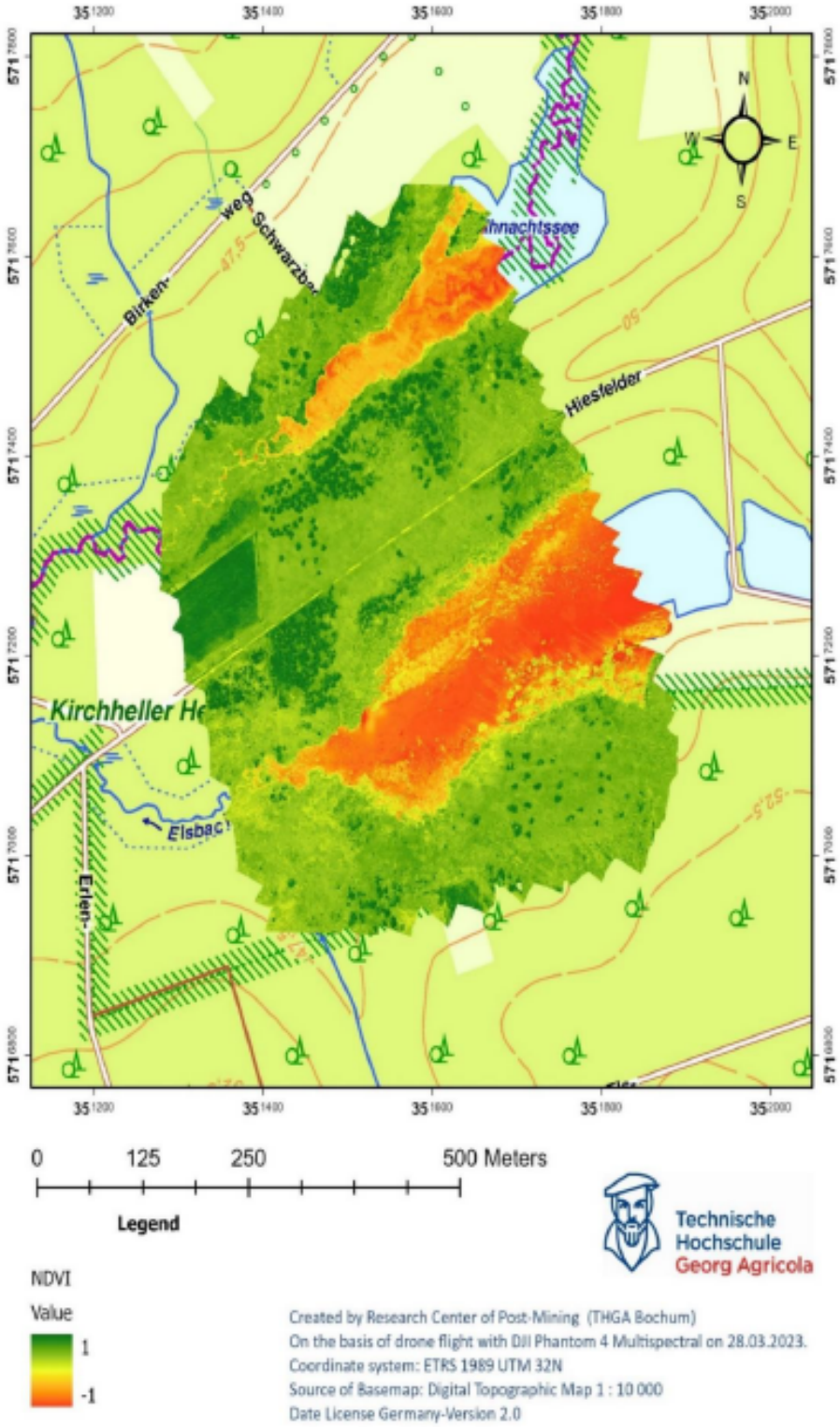

Figure 2: Normalized Difference Vegetation Index (NDVI) derived from the multispectral data.

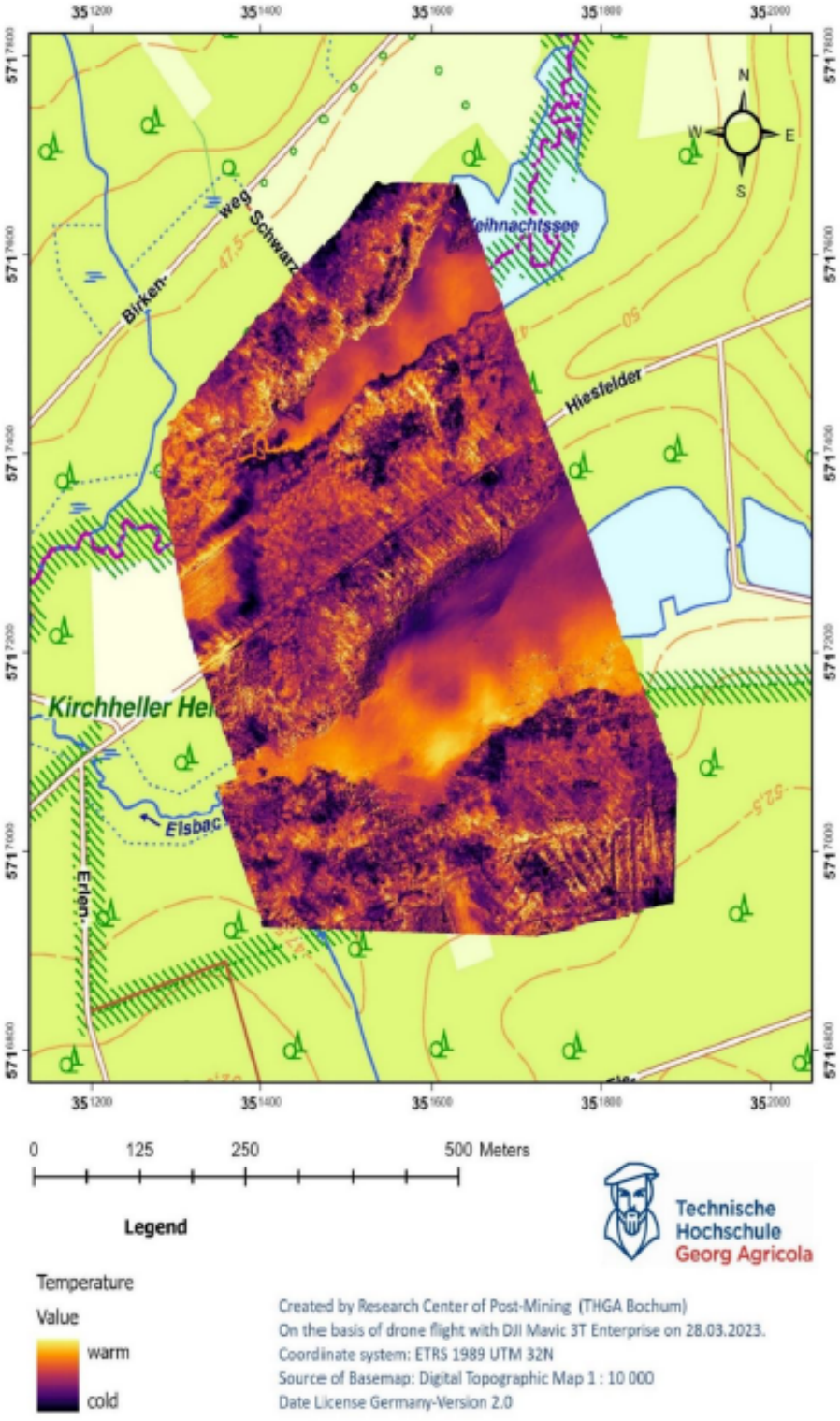

Figure 3: Thermal orthophoto calculated from the captured thermal infrared data.

By integrating and fusing data from different drone flights with high precision georeferencing, we can achieve improved visualization and, most importantly, a deeper understanding of the ongoing processes in the environment.

The use of a multispectral camera during drone flights allows for the creation of high resolution, multispectral orthophotos, enabling detailed vegetation analysis. Derived remote-sensing indices (Fig. 2) from the captured spectral channels provide accurate assessment of vegetation conditions and cover changes.

Drone flights equipped with a thermal camera can identify water currents in bodies of water (Fig. 3). The results represent a preliminary phase for further long-term geo-monitoring of the post-mining processes at the closed Prosper-Haniel mine.

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The authors would like to thank the Geological Survey NRW for their good cooperation in the "Digital Twin – Integrated Geomonitoring" project.
In particular, thanks are going to the RAG Foundation for funding the project – "Digital Twin – Integrated Geomonitoring" (No. 20-0013).
The authors would also like to thank the team from the city of Bottrop for their good cooperation in planning drone flights in the Kirchheller Heide nature conservation area.

Comparison of land use forms based on historical cartographic data and databases - Case study of the Strzelin quarry

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Keywords: land cover, mining area, historical maps, database, spatial data

The topic focuses on comparing different forms of land use using historical cartographic data and digital databases, with a particular focus on the areas affected by the Strzelin quarries. Historical cartographic data refers to maps, plans and other documents that provide information about past land use patterns in the region. These historical records can reveal details about the extent of quarrying activities, land structure, boundaries and distribution of settlements. Historical maps are a valuable source of information to complement the spatial data currently available. It also highlights the benefits of integrating historical cartographic data with modern digital databases to more fully understand land use dynamics. Both historical data and modern databases or measurement technologies are used to analyse and understand land cover changes, identify changes and forecast future scenarios. They are key in many areas such as land use planning, natural resource management, environmental monitoring.

An evaluation and exploration of the applicability of open data: the BrineRIS case study

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Keywords: BrineRIS, lithium extraction, open data

The "Brines of RIS countries as a source of CRM and energy supply" project (2022-2024) aims to extract lithium from geothermal brines to foster sustainable mining practices. This multinational effort involves mapping brine resources by gathering extensive data from diverse sources like archives, databases, research findings, and governmental offices, focusing on site locations, environmental aspects, exploitation parameters, and legal frameworks [1]. Open research data is integral to this process, including geological, hydrogeological, and legal information. Geospatial and environmental data are sourced from Polish and European agencies and the World Database on Protected Areas. Findings from this project will significantly contribute to the future exploration of geothermal brine resources [**?**].

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon Europe, the EU Framework Programme for Research and Innovation. This work is supported by EIT RawMaterials GmbH under Framework Partnership Agreement No 21005 (BrineRIS). The project is co-financed by the Polish Ministry of Education and Science within the programme entitled "International Co-Financed Projects".

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Comparison of accuracy of TLS and SLAM technologies for 3D reconstruction of objects with different geometries

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Keywords: SLAM, TLS, 3D reconstruction, point cloud

Current technologies have greatly simplified the 3D mapping process, but despite these advancements, there are still aspects that require further improvements. Efficient 3D data collection and reconstruction of objects with high accuracy remain a challenge for the scientific community. One of the most widely used methods is Terrestrial Laser Scanning (TLS). It provides data collection with high accuracy and precision, making it a preferred choice for many researchers and professionals. In comparison, mobile scanning technology, while less accurate, remains an effective alternative. Its portability and ability to capture data in real-time make it a practical option for a variety of scenarios where mobility and rapid data acquisition are the most important. This study aims to compare SLAM (Simultaneous Localization and Mapping) and TLS technologies in terms of accuracy evaluation and 3D reconstruction. Selected objects with varying geometries were utilized as examples for this evaluation. The analysis of distances measured between corresponding elements in the two point clouds uncovered a root mean square error (RMSE) of 5 cm. SLAM technology demonstrates its capability to effectively model objects that demand accuracy at the centimeter level.

MIN3D dataset: MultI-seNsor 3D mapping with an unmanned ground vehicle for mining applications

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Keywords: robotics, photogrammetry, SLAM, underground mine, open dataset

The research potential in the field of mobile mapping technologies, particularly for specific applications, is hindered by several constraints. These include the need for costly hardware to collect data (possibly with automation using mobile platforms such as robots or drones), limited access to target sites with specific environmental conditions, and the establishment of a ground truth model for evaluating developed solutions. To address these challenges, the utilization of open datasets presents a viable solution. However, the availability of datasets that encompass truly demanding mixed indoor-outdoor and subterranean conditions is currently limited within the research community. In response to these requirements, we propose the MIN3D dataset: MultI-seNsor 3D mapping with an unmanned ground vehicle for mining applications. This dataset was gathered using a wheeled mobile robot in two distinct locations: predominantly textureless or dark corridors within a university campus and tunnels of an inactive underground site in Walim. The dataset comprises over 150 GB of raw data, including images captured by multiple co-calibrated monocular and stereo cameras, a thermal camera, 2 LiDARs, and 3 inertial measurement units. Furthermore, reliable ground truth point clouds were obtained using a survey-grade terrestrial laser scanner. By openly sharing this dataset, we aim to support and expedite the efforts of the scientific community in developing robust methods for navigation and mapping in challenging conditions of mining applications. The MIN3D dataset provides an invaluable resource for researchers to test and refine their algorithms, ultimately advancing the field of mobile mapping in demanding environments.

Classification of urban areas using Gaofen-3 SAR data by LightGBM

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Keywords: remote sensing, image classification, ensemble learning

This study investigates the effectiveness of PauliRGB decomposition of Gaofen-3 data for the classification of urban areas using LightGBM (light gradient boosting machines) and Random Forest (RF). The new generation ensemble learning algorithms such as LightGBM and XGBoost gained great attention in remote sensing due to their higher performance compared to state-of-art algorithms (RF, support vector machines etc.) in terms of accuracy and computation time. In this study, classification of the urban areas using Gaofen-3 SAR data (PauliRGB decomposition) for the study area of San Francisco was assessed using LightGBM and RF classification. There are six land cover classes in the study area: mountain, water, vegetation, high-density urban, low-density urban and developed urban. The classification performance of algorithms was compared in terms of overall accuracy and computation time. The experimental results show that LightGBM received higher accuracy (72.64%) than RF (69.29%) in terms of overall accuracy. The result also indicates the faster training speed and lower memory usage of LightGBM compared to RF.

Analysis the quality of mesh representinh the underground excavation

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Keywords: MESH quality, point clouds, 3D modeling, quality metrics, underground excavation

Advancements in 3D laser scanning technologies have revolutionized the way we visualize and model underground excavations [**?**]. The quality of these 3D models, known as MESH, is paramount in geodesy and mining applications, where data reliability and accuracy are crucial [2]. This study presents an analytical comparison of MESH quality derived from three distinct scanning devices: Riegl VZ-400i, Velodyne VLP-16, and GeoSLAM ZEB-Horizon. Quality parameters examined include Signed Inverse Condition Number (SICN) [3], Gamma (inscribed radius / circumscribed radius) [4], and Signed Inverse Gradient Error (SIGE) [5]. The quality assessment was conducted using Gmsh, a freely available and widely accepted 3D finite element mesh generator. The empirical study focused on a section of the Gontowa drift, a component of the Riese Project, located in the Góry Sowie, Poland. Point clouds acquired from scanning devices were transformed into MESH and analyzed. Upon visual inspection, the MESH models showed no significant differences, thus quality parameters were statistically analyzed to allow a more objective comparison. Results revealed minor differences in MESH quality among the three scanning technologies. Specifically, Riegl VZ-400i consistently yielded the highest quality MESH based on all three parameters.

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Remote monitoring of our hazardous planet with Sentinel-1 SAR

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Keywords: SAR, Monitoring, geohazards, earthquakes, volcanoes, Sentinel-1, earth observation

The devastating earthquakes that struck Türkiye-Syria in February 2023 were a tragic reminder of the power of our planet. Since the year 2000, there have now been 8 earthquakes in which we have lost more than 10,000 people, with 2 of these (2004 Sumatra, 2010 Haiti) resulting in losses of greater than 100,000 lives. At the same time, volcanic activity has resulted in evacuation of hundreds of thousands or people and events like the 2010 Eyjafjallajökull eruption have caused major economic disruption through airspace closures. On a smaller spatial scale, but occurring much more frequently, landslides are a major geohazard that have widespread impact – from 2004 to 2016, around 55,997 people lost their lives in 4862 non-seismic landslides. All of these hazards are associated with ground movement. Tectonic faults slowly accumulate strain, volcanoes deform as magma approaches the surface, and catastrophic landslides are typically preceded by a period of accelerated ground movement.

Over the last decade, a new generation of SAR satellites has transformed our ability to monitor how our hazardous planet deforms at increasingly high spatial and temporal resolution. The European Commission's Copernicus Sentinel-1 satellite constellation has been particularly important. It is an operational mission that has been acquiring data systematically over the entire planet since 2014. Importantly, the data a fully free and open. This has allowed scientists and commercial operators to develop a large number of services that use the data. Sentinel-1 results include the mapping of ground movement over very large areas, rapid response to earthquakes, detailed automatic analysis of volcanoes globally, and numerous studies of active landslides. In this presentation I will highlight some of the results to date from Sentinel-1, focusing on some of the work we have been doing in COMET, the UK Natural Environment Research Council's Centre for the Observation and Modelling of Earthquakes, Volcanoes and Tectonics. I will end by discussing the future for SAR monitoring of our hazardous planet.

Reconstructing LoD3 building models using ray casting and semantic segmentation

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Keywords: semantic 3D building reconstruction, LoD3 reconstruction, 3D point clouds, semantic segmentation

Semantic 3D building models are ubiquitous and are automatically reconstructed up to a level of detail (LoD)2. While LoD2 building models display detailed roof geometries, they lack facade elements such as windows, doors, and underpasses. Such building features become pivotal for numerous applications, such as autonomous driving simulations and enhanced energy demand estimations.

Detailed facade elements can be acquired by vehicle-mounted mobile laser scanners (MLS) that yield dense, street-level point clouds, which, however, do not provide any semantic information; thus their semantic 3D reconstruction poses a challenge.

We propose a strategy to refine existing semantic 3D building models using MLS point clouds by detecting and modeling absent façade elements. To identify missing façade elements, we employ ray casting of laser scanner points and analyze them with a semantic 3D building model using Bayesian reasoning. Three states are identified in the process: conflicted (ray penetrates building surface), confirmed (a hit point is on a surface), and unknown (unmeasured space).

The conflicts serve as geometric cues for localizing missing façade elements. To infer the underlying semantic information of conflicts, we employ a modified Point Transformer neural network on 3D point clouds and Mask R-CNN on textures.

The experiments corroborate the effectiveness(91% detection rate) and robustness (3% false alarm rate) of our method of detecting façade openings. Such refinement strategy also achieved up to 54% higher reconstruction accuracy when compared to standard mesh-based methods (Poisson).

A case study of petrophysical prediction using machine learning integrated with interval inversion in a tight sand reservoir in Egypt

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Keywords: robust cluster technique, borehole logging interpretation, inverse problem, petrophysical prediction

Machine learning and artificial intelligence have become popular due to their ability to analyze massive amounts of data and make precise predictions in various industries. With the increasing availability of data, these technologies are expected to continue playing a significant role in shaping our world. This study discusses a new algorithm for reservoir characterization using borehole logging data. The proposed algorithm integrates unsupervised machine learning techniques and interval inversion to determine the layers' boundaries, zone parameters, and petrophysical parameters automatically. The research aims to reduce the time and manual input required for borehole inversion to estimate petrophysical parameters. The integration of the new cluster technique and interval inversion can also enhance the automatic detection of both the geometrical and petrophysical parameters. The study evaluates the suggested algorithm using synthetic and field data and demonstrates its effectiveness in distinguishing between various forms and providing a preliminary estimate for layer thicknesses. The algorithm was used to predict the shale parameters such as cementation exponent, density of shale , and neutron of shale. Field well logging measurements were obtained from an oil and gas field situated in the northeastern region of Egypt. Based on the geological characteristics of the area, the main reservoir being sought after is the Jurassic reservoir. This particular reservoir is composed of a dense sandstone layer that exhibits a significant level of heterogeneity due to diagenesis, which is the process responsible for converting kaolinite into illite. The algorithm has been used for predicting the cementaion exponent as well as the petrophysical parameters. This transformation leads to a decrease in both porosity and permeability. The data collected from this well includes gamma-ray, neutron, density, shallow resistivity, and deep resistivity logs. The field data reveals that the reservoir is made up of sandstone that varies in quality, impacting both the storage capacity and the saturation of hydrocarbons. The two algorithms demonstrate consistent convergence of the distance of the data at 7.5%.

To sum up, The integration between the new cluster technique and the interval inversion can help with the automatic detection of both the geometrical and petrophysical parameters, thus improving the time-intensive and laborious process of borehole inversion to estimate petrophysical parameters.

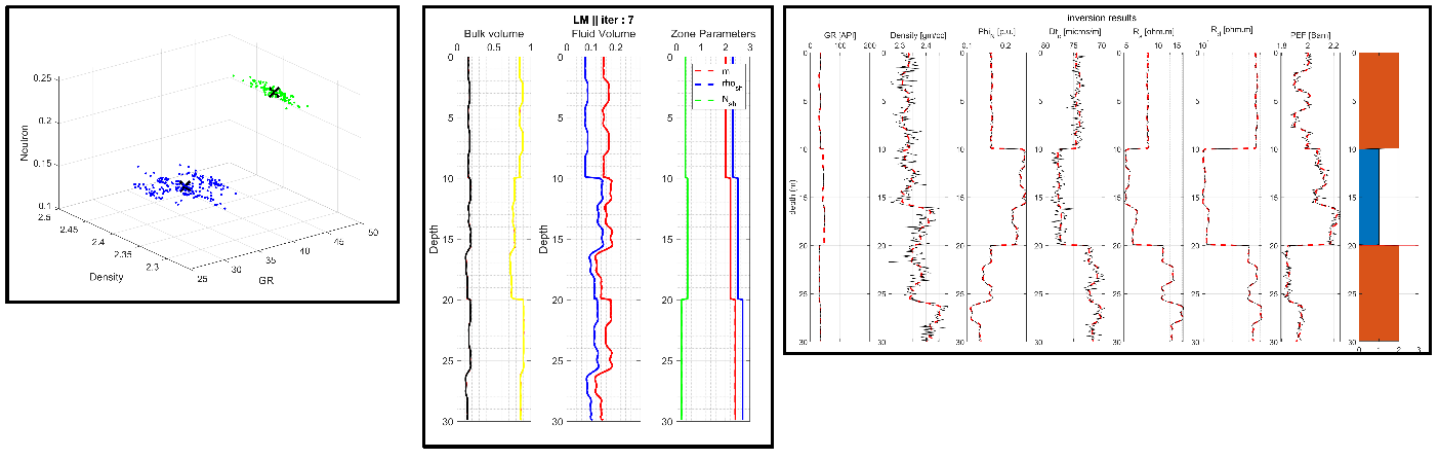

Figure 1: Automatic detection of the layers' boundaries and reservoir parameters.

Study of shear activity criteria and their indications on a regional-scale tectonic framework: a case study from the Um Nar area, Central Eastern Desert, Egypt

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Keywords: Najd Fault System, microstructures, strike slip faults

The Central Eastern Desert of Egypt comprises a variety of lithologies that were formed during the Pan-African Orogeny, a prolonged deformational regime. The NW-SE Najd Fault System (NFS) is primarily responsible for the evolution of the tectonic fabrics exposed in the area. The anastomosing shear zones of this system are identified with local names at several localities in the Central Eastern Desert (e.g., Atalla, Nugrus, and Um Nar Shear Zones). Despite the widely held belief that shear sense of motion along the NFS is sinistral, our field investigation revealed dextral shear activity along the Um Nar Zone, especially at shallow crustal level. At thirty field stations, we explored the macro- and microstructures (e.g., S-C fabric, asymmetric pleats, rotated porphyroclasts) associated with the shear activity of Um Nar Zone. These features reveal two major shortening events that occur roughly in the ENE-WSW and NW-SE directions as a result of the initiation of the Um Nar sinistral master shear, which refers to late-stage reactivation at the shallow crustal level with a dextral shear sense of motion. These outcomes would raise quarries for re-evaluation of the NFS at other localities and, consequently, re-modeling of the tectonic framework of the NFS.

PAN POLSKA AKADEMIA NAUK ODDZIAŁ WE WROCŁAWIU KOMISJA NAUK GÓRNICZYCH
PAN POLSKA AKADEMIA NAUK SEKCJA GÓRNICTWA PODZIEMNEGO RUD MIEDZI KOMITETU GÓRNICTWA POLSKIEJ AKADEMII NAUK

Analysis of coseismic surface deformations after the 2022 M6.2 Afghanistan earthquake

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Keywords: InSAR, coseismic deformation, fine-fault source inversion, phase gradient, M6.2 Afghanistan earthquake

Integration of satellite radar interferometry (InSAR) methods with geophysical information is a powerful tool for detecting seismic effects on the surface and better understanding the phenomenon of both natural and induced tremors. Interferometric data provide information about pre-seismic, coseismic and post-seismic changes taking place on the ground surface in the area of the tremors. This enables the process of source inversion for a finite rectangular fault plane and to examine the occurrence of discontinuous deformations related to the movement of rock masses along the fault. This research was about the Afghanistan M6.2 earthquake occurred on June 21, 2022 at 20:54:34 (UTC) with its range covering both the eastern area of Afghanistan and western and northern Pakistan. According to the USGS, the main shock was characterized as strike-slip faulting, either left-lateral slip on a northeast-striking fault or right-lateral slip on a northwest-striking fault. Following the main shock, a sequence of 16 aftershocks took place between June 21 and August 22, 2022. The computational work provided a multifaceted analysis of the Afghanistan June 21, 2022 earthquake, which was divided into several stages:

1. Determination of one-dimensional coseismic displacements along the radar line of sight (LOS) for two paths (ascending and descending) using the GMTSAR.
2. Decomposition of displacements into horizontal (east-west) and vertical components.
3. Performing an earthquake source inversion to define the parameters of the fault surface in the GROND package.
4. Generation of phase gradient maps for coseismic and post-seismic displacements to detect small-scale discontinuous deformations as a consequence of the main tremor.

Ore prospecting on the Moon, Mars, and asteroids

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Keywords: planetary geology, ore deposits, extraterrestrial mining

Ore prospecting for extraterrestrial mining has a different scope on Mars, the Moon, and asteroids. All of the recovered resources on Mars will be used to develop local bases, likewise, on the Moon, but except for helium-3, feasible to bring it to Earth. Asteroids can be brought to Earth, but probably also to Mars and the Moon to supply bases there. Different is also timescales with lunar mining possible to start yet in this decade, Martian mining in the first half of this century, and asteroid mining until the end of this century. Despite those different timescales, early ore prospecting efforts should focus on remote sensing activities, including spectroscopy (e.g., IR, XRF) and geophysics (e.g., radar, magnetometry). Polish Lunar Mission based on the far-IR MIRORES spectrometer envisaged for 2028–2032 fits well into this strategy.

Chemometric analysis as a tool for confirmation of join meteorites fall- case study

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Keywords: low-background gamma spectrometry; ordinary chondrites; radionuclide; radioactive isotopes; chemometric analysis; HaH 346

Ten specimens of ordinary chondrites from two different campaigns were investigated. An analysis was carried out using a unique gamma spectrometry system to obtain the optimal measurement conditions for the quantitative identification of the radioactive isotopes. Short-lived radionuclide concentrations can be considered, as a specific fingerprint of the chondrite terrestrial age, to confirm whether meteorites originate from a single fall.

Chondrite radiometric studies enabled a detailed analysis of the activities of radioactive isotopes—the short-lived ^{22}Na, ^{54}Mn, ^{60}Co, and long-lived ^{26}Al, ^{40}K. The HaH 346 group of chondrites was classified in February 2021. The data sets have been analyzed based on multivariate chemometric techniques, including K-means, PCA, and clustering analysis, to derive essential information and confirm similarities or significant differences between the studied specimens. In this study, low-background gamma spectrometry was used to confirm the identity of a set of ordinary chondrites found in 2018 and 2019, by different expeditions, in a part of the Al-Hamada al-Hamra desert, in the region of Al-Dzabal al-Gharbi, in Libya.

Short-lived radionuclides are sensitive tools to estimate the terrestrial age of chondrites, even if the fall took place in a relatively short time interval. 54Mn is the most representative for a comparison of specimens originating from different falls. Radioactivity levels of 54Mn in HaH 346-163 and HaH 346-198, is on average, twice lower than in the case of other specimens and are equal to 13.3 and 22.5 Bq/kg, while the average value for other specimens is equal to 35.9 $\pm$ 7.2 Bq/kg.

Identification of treated Baltic amber by FTIR and FT-Raman (a feasibility study)

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Keywords: baltic amber, modified amber, natural resin, FTIR, FT-Raman

Heat-treated succinite modified under air, oxygen or inert gas atmosphere to improve its colour and clarity, was studied with Fourier-Transform Infrared and Raman spectroscopy, and referenced to variously altered untreated samples. For treated amber, the macroscopic observations revealed diagnostic features such as (1) the presence of discoidal " sun sparkles" inside the crumbs; (2) unusual colours (e.g. dark red) for transparent specimens; (3) mottled colour patches in "beeswax" and "dragon's blood" amber; (4) luminescence quenching; and (5) significant reduction of pine-tree resinous smell. On FTIR spectra the heat treatment of succinite is mainly marked by: (1) the intensity decrease of 2932 cm^{-1} band (>CH_2 and -CH_3), followed by the intensity increase of line at 1732 cm^{-1}; (2) the shifts of the band from ν(C=O) towards lower wavenumbers (from 1735 cm^{-1} to 1714 cm^{-1}); (3) the decrease of intensity of the band at 888 cm^{-1} (=CH_2 or -CH=CH-); (4) some slight distortion of "Baltic shoulder" in the region 1100-1300 cm^{-1}. The Principal Component Analysis applied to FTIR spectra enabled to distinguish not only untreated amber from treated one, but also recognize the modifications made under oxygen conditions from the ones in an inert gas. On RS spectra of the treated Baltic amber, the heat modifications are indicated by: (1) slight value increase of the relative intensity ratio I1650/1445 compared to untreated succinite; (2) the shift of bands near 1650 (C=C) and 1445 cm^{-1} (CH_2, CH_3) towards higher wavenumbers.

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Assessment of a geothermal project in a petroleum reservoir using Volumetric and Monte Carlo Methods. Study Case

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Keywords: geothermal energy, Monte Carlo, geothermal gradient, temperature, Volumetric method

The petroleum industry's heavy reliance in Ecuador has hindered the development of geothermal resources. Early studies focused on potential geothermal sites that could generate electricity and identified reservoirs with high temperatures. As the majority of petroleum reserves are concentrated in the east basin of Ecuador and contribute significantly to the country's economic income, the potential for geothermal energy projects has never been considered. This research evaluates the possibility of a geothermal energy project in the Sacha field. The key factors for evaluating such a project include reservoir temperature, geothermal gradient, reservoir pressure, and a conceptual reservoir model that explains the heat sources, recharge zones, and reservoir size. To analyze the potential for geothermal energy generation, data from 19 wells around the Sacha field were used to develop a numerical geological model (see Fig. 1). By employing the T-Navigator software, a conceptual 3D model was created to understand the water source and the underground caprock layers of the Sacha field. The Monte Carlo Volumetric methodology was utilized to calculate the volume and energy capacity in the geothermal reservoir (as shown in Equation 2). The Kozeny-Carmen method was applied to estimate the permeability in some wells where data was not available. Additionally, the heat capacity and thermal conductivity were determined using the Hashin-Shtrickman model. The initial analysis indicated a reservoir temperature of 93.63°C at a depth of 3 km, with a moderate geothermal gradient averaging 30.76°C/km. Two shale layers, Napo-Basal and Napo-Superior, could be used as caprock shale. An aquifer located in the central east part of the reservoir provides water for the reservoir. However, preliminary results suggest that the geothermal energy generated would not be sufficient for electricity generation but could be used for other purposes. The potential geothermal energy available in the project is 7.0924e+12 KJ.

$$Q = \int_{z0}^{z1} C(z)\,[T(z) - To]\,\partial z \tag{2}$$

A: is the surface area(m^2); Q: is the heat energy(J); Zo and $z1$ are the upper and lower depth limits of the reservoir system (m); $C(z)$: is the heat capacity of the reservoir system changing with depth (KJ/Kg°C); To: Is the cut-off temperature for the planned utilization (°C); and $T(z)$: is the temperature changing with the depth.

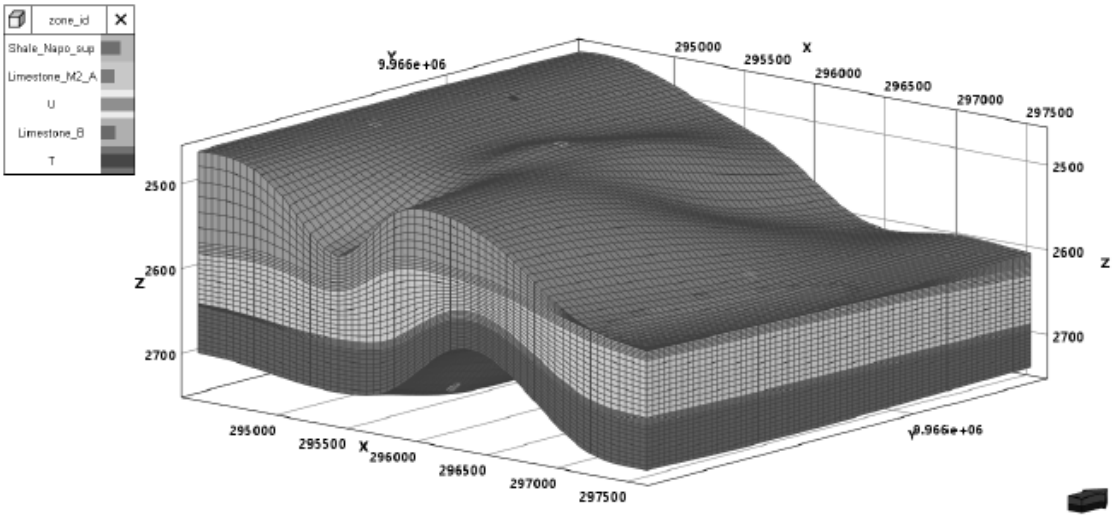

Figure 1: Numerical geological model of the center-east of the Sacha field with the different layers.

Efects of light pollution on the environment

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Keywords: light pollution, socioeconomic aspects, ecological aspects, physiological aspects

The invention of artificial lighting 150 years ago changed people's lives as they became independent of daylight, which brought many conveniences to their daily lives. That influenced people's behavioural patterns, and now we are dealing with a 24-hour society.

With population growth, urbanisation and technological development, the amount of artificial light in the environment is increasing. The result is a loss of natural and open spaces and a decrease in the "dark sky". The ubiquity of lighting at night and the glare extending far beyond city limits have led to light pollution. Scientists classify excessive artificial lighting as an element of anthropopression, as it disrupts human processes. It also causes negative impacts on the environment and living organisms and is therefore classified as pollution.

Urban lighting systems are designed in a way that does not ensure the reduction of light beam dispersion. Scientific studies show that light pollution is increasing by more than 2% per year. There is a strong need to reduce this pollution by reducing artificial lighting while maintaining a comparable effect.

It is a relatively new phenomenon, so research and monitoring methods are still being sought and improved. Among these are low-altitude nighttime aerial photogrammetry or analysis of satellite images of the areas under study.

Light pollution is a complex interdisciplinary problem requiring the cooperation of researchers from many scientific fields. The results of their work should be used to develop appropriate regulations to reduce light pollution and introduce new technical solutions and approaches to planning sustainable urban lighting.

The BrineRIS Project – to discover hidden lithium resources in groundwater of Poland

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Keywords: lithium, geothermal brines, BrineRIS, critical raw materials, extraction

The topics related to extracting critical raw materials (mainly lithium) using geothermal energy as a zero-emission energy source are crucial for developing the high-tech market. One of the objectives of the international project "BrineRIS – Brines of RIS countries as a source of CRM and energy supply" is to find geothermal lithium in the RIS countries. In Poland, a study of lithium content in geothermal brine was conducted as part of a project co-funded by EIT RawMaterials. The sites potentially containing elevated lithium concentrations in brines were selected in Garki, Polanica Zdrój, and Duszniki Zdrój. The research is an opportunity to find valuable lithium resources and meet market needs for this raw material. The project also makes it possible to identify new test sites that could become attractive for further lithium exploration. This document summarizes key information on the tests conducted in Garki, Duszniki Zdrój, and Polanica Zdrój under the BrineRIS project.

The activity of the Geoscience Research Group exemplified by the study using ground penetrating radar (GPR) method for the Slup water dam investigation in the Męcinka

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Keywords: GPR, echograms, case study

The Geoscience Research Group at the Wroclaw University of Technology conducted a comprehensive geophysical study on May 4, 2023, to locate the reinforcement in the concrete structure of a hydraulic dam at the Slup reservoir. The study deployed various tools, including the Mala ProEx ground-penetrating radar (GPR) with 800 MHz and 1.6 GHz antennas, along with GPS equipment for marking the start and end points of the profiles. The echograms were processed using the GPRPy software. A total of 84 profiles were investigated, selected due to visible structural damage and based on preliminary estimations of reinforcement depth in the concrete structure. The results were consistent across both longitudinal and transverse profiles, with the detected reinforcement depth varying from approximately 9 to 15 cm. While acknowledging the potential error due to the experimental nature of the measurements, this study provides vital preliminary insights into the depth of the reinforcement in the dam structure, laying a foundation for detailed further analysis.

Capacity building of RIS countries professionals in geothermal lithium – the BrineRIS project

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Keywords: geothermal water, expert knowledge, critical raw materials, extraction, training

The topics related to extracting critical raw materials (mainly lithium) using geothermal energy as a zero-emission energy source are crucial for developing the high-tech market. One of the objectives of the international project "BrineRIS – Brines of RIS countries as a source of CRM and energy supply" is to exchange expertise and build the capacity in innovative mining. Within the framework of the EIT RawMaterials co-funded project, various workshops and the Geothermal Lithium Networking Event have been organized. The BrineRIS consortium members continuously increase their knowledge from general information on recovering critical raw materials and extracting geothermal water to more specific ones. Meetings on these topics accelerate knowledge exchange and collaboration between different stakeholders, which can contribute to even greater achievements within and outside the RIS region. This paper is a collection of crucial information on the organized meetings of the BrineRIS project.

The role and place of spatial analysis in earth and space science informatics, including the context of technology and new definitions of the terms geoinformatics and geomatics

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Keywords: Earth Science, Geomatics, Geoinformatics,

Earth and space systems science encompasses the application of formal and computational methods, spatial and temporal analyses and all aspects of computer applications to acquire, store, process, exchange and visualise data and information about materials, properties, processes, features and phenomena that occur at all scales and locations in the five components of the Earth system. Terms such as geomatics and geoinformatics are used in the Earth Sciences. This paper attempts to redefine these names, i.e. the use of information systems to analyse and manage spatial data. In order to address the issue of naming, a study of the evolution of the structure of spatial data was carried out, a review of GIS acronyms was conducted, and another study was carried out by means of terminological analogies, comparing definitions of similar, in terms of vocabulary, names relating to other research areas. As a result of the research, 7 terminological postulates were developed to formulate limitations and rules for giving new definitions. The new author's definitions of geomatics and geoinformatics terms are presented at the end of the paper

Hydrochemical background of ^{222}Rn of three geological units of lower silesia

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Keywords: radon, ^{222}Rn, surface water, hydrochemical background, Lower Silesia

The aim of the research was to create the first Polish database on the concentration of ^{222}Rn activity in surface (river) waters for one of the 16 Polish voivodeships. For this purpose, the research area within the administrative borders of the Lower Silesian Voivodeship was chosen. Geologically, this area can be divided into three different parts: Sudetes, Fore-Sudetic Block, and Fore-Sudetic Monocline. The authors used the liquid scintillation method to measure the concentration of ^{222}Rn activity. The range of measured values in individual areas was 0.21–24.44 Bq/dm^3, respectively for the Sudetes, the Fore-Sudetic Block 0.08–4.27 Bq/dm^3, and the Fore-Sudetic Monocline 0.09–3.37 Bq/dm^3. Based on the obtained result, the authors determined the hydrochemical background which amounted respectively: 0.26–1.33 Bq/dm^3 for the Sudetes, 0.18–0.92 Bq/dm^3 for the Fore-Sudetic Block, and 0.12–0.48 Bq/dm^3 for the Fore-Sudetic Monocline. Both the background and ranges of measured values for surface waters are consistent with the decreasing share of crystalline rocks in the surface structure. In addition, it can be stated that river waters in the Lower Silesian Voivodeship meet the radiological requirements that should be met by water intended for human consumption in terms of ^{222}Rn activity concentration.

Biofiltration of odorous gases emitted from high-temperature processing of animal by-products

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Keywords: rendering, animal by-products processing, odorous gases, biofiltration

A rendering process is defined as a process using high temperature and pressure to convert whole animal and poultry carcasses or their by-products with no or very low value to safe, nutritional, and economically valuable products. Remaining odorous gases (direct-fired meal dryers and workshops) can then be transferred to a biofilter bed constructed of materials such as concrete and layered products such as compost, coarse gravel, pinebark, and woodchips.

In the present study, the functional stratification of an experimental semi-industrial biofilter fed with an industrial gaseous effluent was thoroughly investigated by assessing the relative abundances of waste gas compounds using gas chromatography–mass spectrometry (GC-MS) and by quantifying sulphured compound concentrations (H2S, methylmercaptan, dimethysulphide, dimethyldisulphide (DMDS)) using gas chromatography. The study focuse on sulphured compounds since these volatiles have been identified as predominant odorants in the emission of a wide range of activities in bio-industry such as rendering plants.

To improve process design and scale-up of gas biofilters, a thorough understanding of compounds degradation mechanisms within model engineering biofilters is needed. The aim of this study is then to investigate the spatial distribution of pollutants removal within an experimental semi-industrial biofilter fed with industrial emissions from a rendering plant.

Characteristics of Bauxite Ore in Toba Area, Sanggau District, West Kalimantan, Indonesia.

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Keywords: Gibbsite, Concretion Texture, Low-Fe Bauxite, Desilication, and Bauxitization

Indonesia's largest bauxite reserves are in the province of West Kalimantan, which is 703 million tons of bauxite is formed from rocks with a high relative aluminium content, low iron content, and a small amount of quartz. The mineralogy and characteristics of lateritic bauxite deposits are closely related to several factors, including the texture and composition of the bedrock. This study discusses the genetic type of bauxite deposits based on the result from petrography analysis, XRD, and XRF methods. The primary data from bauxite ore samples were collected from the stockpile of PT. Dinamika Sejahtera located in Toba area. The bauxite ore appears in concretion texture while the petrographic appearance of the ore shows the traces of gibbsite have been altered from kaolinite. Mineralogically, XRD analysis provides the quantitative composition of the ore are gibbsite (70,4 wt.%) as the major mineral while dickite (23,8 wt.%), hematite (5,8 wt.%), and other minerals (3,9 wt.%) are the accessory minerals. The quantitative result of the geochemical analysis indicates a higher amount of aluminum oxide observed using the XRF method. The deposit is recognized as a Low-Fe bauxite due to comparing Al_2O_3, Fe_2O_3, and Si_2O_3 concentrations. The weathering process has altered the primary texture, remaining resistant and secondary minerals. Based on the Al_2O_3 – $CaO + Na_2O + K_2O + MgO$ – Fe_2O_3 (A–L–F) plot, the deposit experienced the desilication process in the early stage followed by the bauxitization process due to the higher amount of Al_2O_3 comparing with Fe_2O_3.

Quantifying seismic activity in the Makran subduction zone: analysis of instrument data for events of magnitude 4.5 and greater

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Keywords: Makran, subduction zone, seismicity, instrumental earthquakes

The Makran subduction zone is one of the largest accretionary prisms on Earth. It extends for about 1000 km along the boundary where the oceanic part of the Arabian Plate is subducted beneath the Eurasian Plate. Subduction and accretionary growth began in the Paleocene and Eocene, respectively. However, the final collision of the two plates has not yet occurred. To investigate seismic activity in this region, a comprehensive analysis of instrumental earthquake data was conducted. The study examined earthquakes with magnitudes greater than 4.5 that occurred between January 1900 and May 2023. The distribution of earthquakes from west to east for each longitude (57 to 67) and latitude (24 to 26) was considered using the Iranian earthquake catalog revised by the International Institute of Earthquake Engineering and Seismology Iran (IIEES). The analysis revealed a seismic gap in the western part of the Makran and seismic migration from west to east. The results of this study support Byrne et al. (1992) and suggest that two factors-asymmetric convergence rate and differential dip angle of subduction-significantly affect the seismicity of the Makran and confirm the extent of the eastern boundary of the Lut block in the Makran. These results are important for geohazard assessment in this area and contribute to a better risk assessment for future earthquakes in this region.

Unsupervised classification of lithological units using Aster satellite data by machine learning algorithms, case study in a region in the Makran subduction zone in southern Iran

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Keywords: machine learning algorithms, geological maps, unsupervised classification, K-means method

Over the past decade, Machine Learning Algorithms (MLAs) have achieved great success in accurately detecting and mapping geological targets compared to traditional methods. MLAs use artificial intelligence derived from input data by analyzing their features and patterns with minimal human intervention. In this study, MLAs were used to classify geological units in a selected area in southern Iran. After preprocessing the ASTER satellite data and performing the K-Means method, an unsupervised classification was performed to find out how efficient the result of the K-Means method is in the complicated geological zones with marine sediments up to 10 km thick compared to previous geological maps. In this study, nine clusters were used for classification. The analysis and results of this comparative study demonstrate the potential of K-means clustering for developing classified geological units that are prominent in the study area, particularly when adequate surveys such as litho-stratigraphic and structural studies are not available. It can also be used for quality control of geological maps. This method can help us save costs before preparing a geological map.

The paleo-relief influence on sedimentation and diagenesis and the significance of this process for prediction of geohazard potential in the excavations of the KGHM mines

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Keywords: non-uniform compaction, paleo-relief, hydrogen sulfide mining hazard

Paleo-relief after eolian sedimentation influenced distribution of transgressional muds, which accumulated in depressions between sandy elevations. Constantly increasing volume of carbonate deposits privileged its rapid lithification in contrast to muds which still preserved high compaction potential. Direct indicators of differentiated mechanical parameters of described rocks are clastic dikes.

Early diagenesis resulted in a set of lithified carbonate plates overlaying muds or supported directly on sandstone paleo-elevations tops. Such a suite of layers indicates that deformations of the carbonate plate during early diagenetic stage should be taken into account and consequently we may expect a retarded influence of sandstone paleo-relief on sedimentation of even younger rocks - evaporitic sulfates and chlorides.

There is negative correlation of lower anhydrite and copper bearing shales thicknesses, as mud compaction probably had controlled location of evaporitic paleo-environments - the salt pans and separating them anhydrite elevations. In the top part of the lower anhydrite, in the pan areas, bituminous, laminated anhydrite was distinguished. Hydrosulfide in these parts were recognized.

In the KGHM copper mines hydrogen sulfide hazard occur. H2S derives from the overlaying evaporates and carbonates (Main Dolomite). Migration paths are created mostly by reopening of formerly existed or by newly created cracks due to rock mass relaxation above the mining excavations.

As indicated above occurrence of bituminous rich parts of lower anhydrite can be predicted, by recognizing location of sandstone paleo-elevations and depressions between them, mainly by measuring the shale thickness in the forecasting profiles.

The first ton of the Moon on Earth

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Keywords: the Moon, lunar meteorite, basalt, anorthosite, feldspathic breccia

In December 2022, the authors highlighted the classification of over one ton of lunar meteorites that have fallen to Earth. These meteorites have been discovered since the 1960s, but they were officially classified as lunar meteorites in 1982. The classification became possible due to advancements in geochemical research, allowing for comparisons with samples brought back by the Soviet Luna and American Apollo missions. With access to over 1.4 tons of lunar rocks on Earth, multidisciplinary studies of lunar geology have become feasible. These studies are crucial for the development of human settlements or lunar bases and for further exploration of the solar system.

The physical properties, chemical composition, and mineralogy of lunar rocks are of particular importance in understanding the presence of various mineral resources and building a knowledge base for lunar exploration. Notably, the collection of meteoritic material from the Moon has been rapidly growing since 2015, primarily through exploration efforts in Antarctica, Africa, the Arabian Peninsula, and Australia.

Among the lunar meteorites identified on Earth, the most abundant types are feldspar breccias (impact metamorphic rocks), anorthosites (plutonic igneous rocks found in the highlands), and basalts (extrusive igneous rocks forming the lunar maria). Additionally, there are other mafic rocks such as gabbro, norite, troctolite, and more. The lunar crust's surface is covered with regolith, which consists of fragments of the aforementioned igneous rocks and breccias that have undergone fragmentation due to meteorite and micrometeorite impacts and solar wind particles (space weathering). This process forms a loose sedimentary layer with a thickness ranging from a few to several meters. In some areas, regolith may become compact clastic sedimentary rock if rock fragments are fused together with glaze produced during collisions with micrometeorites.

The authors also briefly discussed the genesis, evolution, geological structure, and the latest research findings on the Moon's geophysics, geochemistry, mineralogy, and petrology. They mentioned the synestia model, which proposes that the Moon formed from a synestia (a donut-shaped structure) resulting from the collision between the proto-Earth and a hypothetical planetary embryo named Theia. This model effectively explains the chemical and isotopic similarities between the Earth and the Moon. It was noted that lunar meteorites are classified and named similarly to terrestrial rocks due to their common origin, distinguishing them from other meteorites. Martian and HED meteorites are exceptions, as they are classified similarly to terrestrial rocks, but their names often lack equivalents in terrestrial rock classification (e.g., SNC meteorites).

Based on tracking data of officially classified lunar meteorites, the authors found that by December 2022, the total mass of meteoritic material considered to be from the Moon exceeded one ton. Lunar meteorites currently represent the largest source of information about the geology of the Moon, accounting for approximately two-thirds of the mass of lunar material available for study on Earth.

Geoscience Research Group

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Keywords: scientific circle, geosciences, GPR

The poster presents an activity overview of the Geoscience Research Group, a dynamic scientific group established at the Faculty of Geoengineering, Mining, and Geology (Wrocław University of Science and Technology). Founded in 2020, the group serves as a platform for passionate geoscience enthusiasts, particularly focusing on geophysics, geoinformatics, and geothermal studies. Using advanced field equipment such as ground-penetrating radar, magnetometers, gravimeters, and drones, the group conducts theoretical and field research.

The Geoscience Research Group places significant emphasis on programming training, recognizing its vital importance in Earth Sciences. Furthermore, the group organizes field expeditions to enhance the practical skills of its members, who aspire to become accomplished researchers. Notable projects undertaken by the group include The Development of a Basalt Deposit Model in Sulików Mine and The Search for the Foundations of a Historic Chapel in Krzeszów.

Composed of both undergraduate and postgraduate students, as well as doctoral candidates, the Geoscience Research Group unites individuals who firmly believe in the transformative power of innovative ideas and proactive engagement. By fostering collaboration and a stimulating environment, the group aims to contribute to a better world through a firm commitment to the exploration of earth sciences.

Analyzing tensile strength and deformability as a function of anisotropy

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Keywords: tensile strength, laboratory test, anisotropy, rock mechanics, deformability

Anisotropy is a very common condition in rock mass; it can be due to different factors and directly affects the failure mechanisms affecting the rock mass. For example, metamorphic rocks that are foliated, sedimentary rocks that are stratified or volcanic formations with alternating layers. Despite the existence of several studies related to anisotropy those specifically addressing the tensile strength of anisotropic rocks are quite limited.

The present study is focused on the determination of the deformability, compressive and tensile strength of anisotropic rocks. Being remarkable that the mechanical behavior of the anisotropic rock mass is dependent on the inclination of the foliation planes. Considering a parallel plane of weakness, suppose that the two extremes of tensile strength are 0°(horizontal) and 90°(vertical).

A series of laboratory tests has been done in anisotropic sandstone (lithic arkose), from Burgos, Spain, including uniaxial compressive strength tests, direct tensile strength tests, and diametric compression (Brazilian tests). The tests were carried out with strain gauges that allowed estimating the elastic modulus. To determine the anisotropic direction, ultrasonic pulse wave velocity tests were also performed.

The variation of strength and deformability as a function of anisotropy is analyzed, as well as the variation of elastic behavior in tensile and compressive.

The influence of the void shape in the bearing capacity of rock mass with a superficial void

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Keywords: finite difference method, rock mass, bearing capacity, shallow foundation, void

In this study is proposed a chart that allow estimating the reduction of bearing capacity due to the existence of a superficial void in a rock mass. It is contemplated the influence of different shapes and size of the void in relation to the foundation.

The reduction of the bearing capacity is analyzed through the Finite Difference Method. In the numerical model, six possible cavity shapes are considered, with three different sizes and depths. Calculations are made considering eighteen types of rock masses, modelled by the H&B failure criterion.

The results demonstrate that the critical depth where the cavity no longer influences the bearing capacity varies considerably depending on the geometric variables (size, shape and location of the void). In addition, it is observed that the relation between the bearing capacity obtained considering the rock mass with and without void is not affected by the geotechnical parameters of the H&B failure criterion.

According to the results analyzed and graphic output, the variation in the stress distribution in the rock mass and the change of the failure mechanism under the different hypotheses studied can be observed. The results are presented in chart that facilitate to directly estimate the reduction of the bearing capacity of a rock mass with void based on geometric parameters.

Tectonic stresses as the cause of asymmetry and shape deviation of subsidence profiles: a numerical study

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Keywords: ground subsidence prediction, stress conditions, numerical simulation, asymmetrical subsidence profiles

The accurate prediction of ground movement resulting from mining activities is of utmost importance to prevent damage to civilian properties and ensure fair compensation. However, current methods for predicting subsidence often suffer from uncertainties. Existing literature indicates that these methods overlook the significant influence of the stress field, a crucial characteristic of rock masses. Through numerical experiments using FLAC 3D 7.0 and the advanced Hoek-Brown constitutive model, this study examines the asymmetry effect of tectonic stress on subsidence profiles, considering a range of rock mass properties. The findings shed light on the complex nature of subsidence behavior, encompassing magnitude, shape, and the impact of stress conditions and rock mass properties. Notably, the explicit analysis of asymmetry resulting from higher horizontal stress underscores the necessity of carefully accounting for stress conditions in subsidence prediction. Furthermore, the study offers an estimation of the influence angle based on rock mass properties, contributing to a deeper understanding and prediction of subsidence behavior in practical scenarios.

Evaluating the Performance of an Oil Reservoir Under Water-Drive: a Case Study

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Keywords: water drive, Aquifer, MBAL, original oil in place, prediction

Reservoir engineers play a vital role in evaluating the performance of hydrocarbon reservoirs, including estimating reserves and understanding driving mechanisms over time. This responsibility becomes more complex for water-drive reservoirs due to the difficulties in comprehending their characteristics, given the uncertainty related to aquifer properties such as rock properties and aquifer geometry.

This study evaluated the aquifer models of X reservoir in SABA field using MBAL software, and identified the best model based on material balance concepts. It also investigated possible conductivity between the X, Y, and Z reservoirs, estimated the original oil in-place using MBE and Monte Carlo concepts, and predicted reservoir performance from 2021 to 2031.

The study concluded that the small pot aquifer model had the lowest RMSE of 2.306568. The MBE and Monte Carlo P50 methods estimated OOIP to be 23.371 MM Sm3 and 23.4051 MM Sm3, respectively, while the volumetric method's estimate was 22.199 MM Sm3. The XY and YZ faults were impermeable due to low transmissibility values, and could be neglected. Figure 1 shows the results of OOIP statistical distributions from Monta Carlo technique in MBAL software.

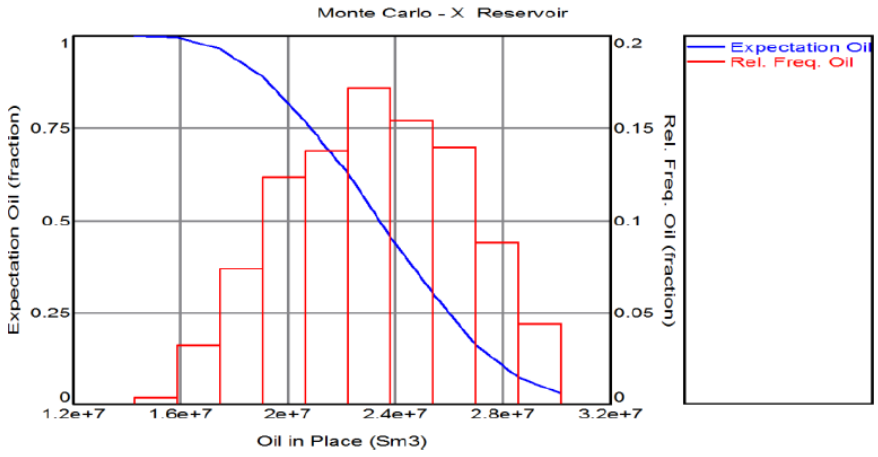

Figure 1: Monte Carlo Volumetric Reserve Probability Distribution

Based on the results of this work, the commutative oil production for the next ten years (2021-2031) was predicted to be 0.119 MM Sm3. Figure 2 shows Cumulative oil production and reservoir pressure versus date.

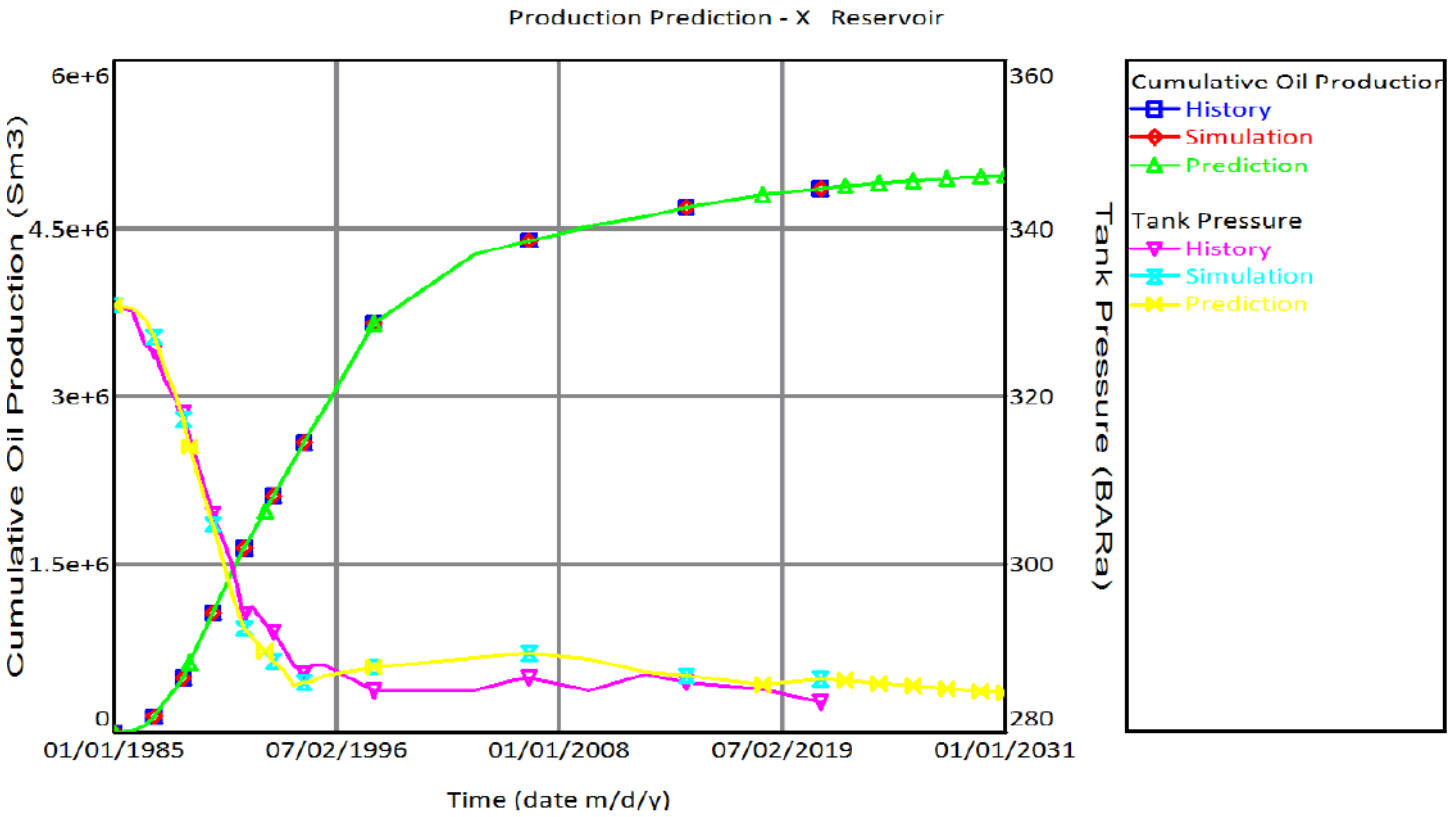

Figure 2: Monte Carlo Volumetric Reserve Probability Distribution

Preliminary assessment of Badajo Cave (Segovia, Spain) stability using empirical, numerical and remote techniques

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Keywords: cave, stability analysis, cave geomechanical index (CGI), Q index, rock mass classification, numerical modelling, photogrammetry

Badajo cave is a shallow cavity (hemispherical rock shelter) located in the valley of Clamores River, Segovia city, Central Spain. This small canyon carved in Cretaceous dolostones has numerous geosites, as well as a rich archaeological and historical heritage. There are dozens of rock outcrops in the valley's cliffs and slopes, on both banks, where various types of sedimentary rocks can be easily recognized and differentiated, especially carbonates (dolostones and limestones), and mixed carbonate-detrital (dolomitic sandstones, calcareous silts, marls). The cave was formed by karstic and gravitational processes within a mixed dolomitic sandstones and limestones, and it has an important archaeological interest.

This study proposes a preliminary stability analyses of the cave applying: (i) empirical approaches based on geomechanical classifications using Barton's Q Index, Rock mass rating (RMR) and the recently created Cave Geomechanical Index (CGI); (ii) numerical modeling using a 2D model based on the generalized Hoek and Brown failure criterion and also a 3D model for wedge analysis; and, (iii) three-dimensional model performed with the remote photogrammetric technique Structure from Motion (SfM) to allow acquisition of data to complete the parameters established in the geomechanical classifications, and to create the numerical calculation sections of the different critical parts of the cave.

The results of the analysis show that the cave is generally stable, although it presents some places with small problems (falls of slabs and some blocks) that deserve monitoring. Furthermore, the evaluation by the geomechanical classification Q and the corresponding abacus of cave stability indicates that it is located in the "transition" zone, therefore, it requires attention. In addition, SfM photogrammetric technique makes possible to generate a geometric 3D model that allowed the acquisition of data that were difficult to take in situ. The geotechnical parameters obtained from the different methods complement each other, resulting in a more realistic engineering representation of the subsurface environment. As a conclusion, a graph showing the two empirical methodologies (Barton's Q Index and CGI), and some recommendation for a future analysis are given.

Towards an unified theory of rock foundations

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Keywords: rock foundations, characteristic lines, ultimate bearing capacity, analytical solution

Soil mechanics presents a generally accepted formulation of bearing capacity of foundations, known as the Brinch-Hansen equation. This formulation has been completed empirically incorporating the influence of the foundation dimension and density of the soil, as well as different correction factors that allow the analytical formulation to be generalized.

In rock mechanics, the presence of discontinuities gives the rock mass with a structure that complicates the analysis of bearing capacity. In particular, a non-linear failure criterion should be considered with the possibility that the behavior of the medium is controlled by the anisotropy of the discontinuities. Thus, the study of rock foundations requires the identification of different potential failure mechanisms. Furthermore, numerous empirical formulas offering solutions that depend mainly on the uniaxial compressive strength of the rock have appeared.

This keynote article presents how the advances of the last years allow the general formulation of a bearing capacity theory in rock masses, considering: (1) non-linear failure criteria; (2) the different failure mechanisms associated with anisotropy; (3) influence of high confining loads; (4) possibility of mechanical collapse; (4) generalization correction factors; (5) influence of embedment in rock to generalize the formulation to piles.

Ensemble methods applied for NOx prediction in deep underground mine

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Keywords: machine learning, ensemble learning, NOx emission, prediction, deep underground mine

Mining industry is facing hazardous gas emissions problem all the time. During the work shift crews are using wheeled vehicles powered by diesel engines, which are considered as the main source of nitrogen oxides (NOx) in underground mines. Although the diesel engine manufacturers provides information on how many gas is generated, the mining company needs to predict NOx emissions from many LHDs working in dynamical regimes. Research was focused on 2 ensemble methods – Bootstrap Aggregation (Bagging) and Least-Square Boosting (Boosting). Both proposed approaches combine multiple weak models into single, strong result. Acquired information could be used as input data for ventilation system, what will result in better management of the mining and reduce the air pollution in the workplace resulting in better planning the work and increase safety.

The Impact of Urbanization and Migration on the Protection of Agricultural and Forested Lands in the Context of Spatial Planning

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Keywords: conversation to other purposes, migration, farmland, forests, spatial planning

Socio-economic development, urbanization, and migration are integral components of the modern world. Based on the projected trends for 2030, there is an expected increase in built-up and urbanized areas, a slight increase in agricultural land, a decline in forest land, and a decrease in migration to cities while migration to rural areas is expected to rise. The increase in built-up and urbanized areas poses a risk to the availability of agricultural and forest lands. However, the slight increase in agricultural land provides some relief in mitigating the negative effects of urbanization. On the other hand, the decline in forest land raises concerns for biodiversity and forest ecosystems. The expansion of urban areas and changes in land use for other purposes contribute to this decline.The projected increase in migration to rural areas requires appropriate actions in spatial planning to ensure sustainable development, protection of agricultural and forest lands, and the provision of necessary infrastructure and services for the rural population.

In the context of spatial planning, it is important to consider these projections and develop strategies that aim to protect agricultural and forest lands. Sustainable urbanization, the provision of green spaces in cities, and the promotion of environmentally friendly practices are crucial for safeguarding the natural environment. Collaboration among the public, private, and civil society sectors is essential to achieve the goals of protecting agricultural and forest lands in the face of changing migration and urbanization trends.

A method for the prediction of ground movements on open pit mine dumps including spatio-temporally dense monitoring data

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Keywords: settlement, post-mining, satellite-data, prediction

In the course of the coal phase-out in Germany, numerous opencast lignite mines will have to be closed prematurely. The remaining dump areas pose a significant problem for post-mining use, since settlement processes can hardly be estimated so far and last for several decades. In the course of the European project Trim4Post-Mining, a model was developed that can predict ground movements based on various input data, both in terms of magnitude and time span. The work is initially based on a large amount of geological data, which could be overlaid and evaluated with an existing dump model. This makes it possible to estimate settlement-relevant parameters at almost every point of the dump and, based on this, to calculate the maximum settlement to be expected.

A time series of satellite-based vertical terrain measurements serves as a comparative parameter, providing millimetre-accurate elevation changes on the dump every three to four days over a period of four years. By knowing the original height of the dump immediately after dumping and the terrain height during the measurements, the time series can be extrapolated to the maximum expected settlement. A comparison with the previously calculated values shows that both systems provide similar prediction values. Via inverse modelling, the parameters used for the calculation can be adjusted so that calculated and extrapolated settlement match. On the basis of this, a reduction factor can be determined, which gives an indication of the extent to which the soil-specific parameters change during transport from extraction site to the dump.

Urban heat island – What does the data show and how do we perceive it?

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Keywords: UHI, urban heat island, temperature

Urban Heat Island has become a very popular phenomenon since urbanisation has rapidly accelerated. To map the urban heat island, the NDVI (normalised differential vegetation index) is calculated, which quantifies green vegetation. It is derived from near-infrared and red channels, such as Landsat 8 band 5 and band 4, or Sentinel 2 channels B8A and B4, respectively. NDVI values range from -1 to 1, indicating biomass and chlorophyll content. Healthy vegetation absorbs blue and red radiation for photosynthesis. Calculating NDVI is the first step in determining Land Surface Temperature (LST), requiring radiation temperature and emissivity coefficient components.

The radiation temperature (T) is obtained using specific formulas incorporating thermal conversion constants (K1 and K2) stored in metadata, dependent on the sensor type and spectral channel. Next, the emission factor (ε) is determined. This involves calculating the Proportion of Vegetation based on the previous NDVI values and their minimum and maximum values.

By following this process, the urban heat island's impact can be mapped using NDVI, leading to the computation of LST. This provides valuable insights into the heat patterns of urban environments.

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