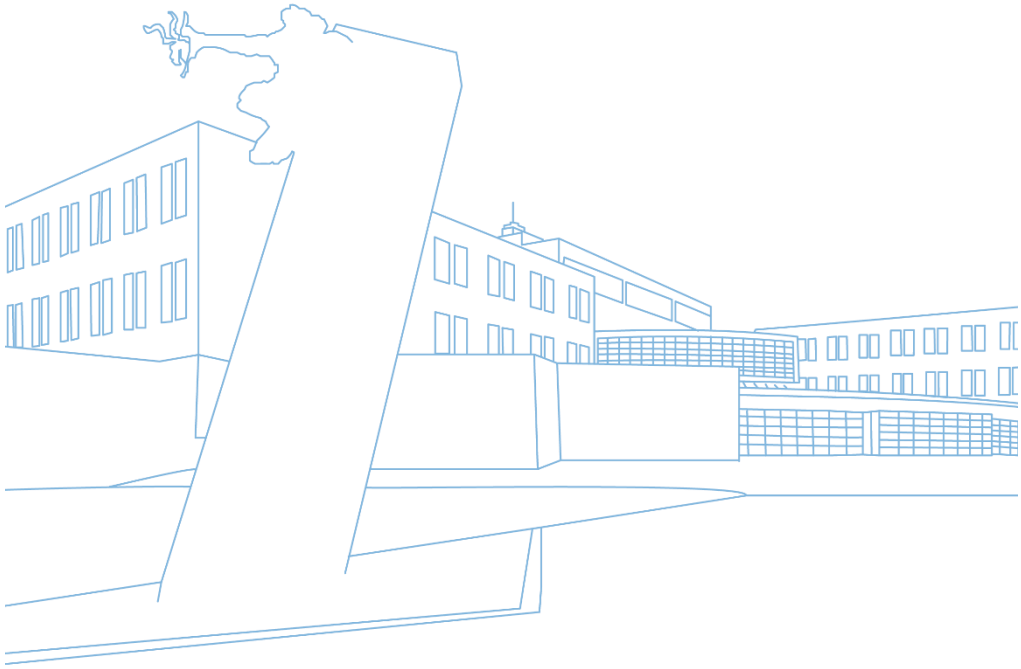
8th ICT CONFERENCE

Abstract book

Braga, 2023



ICT Instituto de Ciências da Terra

Universidade do Minho Escola de Ciências

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ICT CONFERENCE

Abstract book

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University of Minho | Braga

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The abstract book compiles the works presented by masters and doctoral students and ICT researchers. The content of submitted texts is the responsibility of the authors.

TABLE OF CONTENTS

Program ICT Conference

February 2nd

08:30 – 09:00	Reception of participants
09:00 – 09:20	Opening Session of the 1st day of JICT'23
09:20 – 10:50	Oral communication (1st session)
10:50 – 11:30	Coffee break and 1st Poster session
11:30 – 13:00	Oral communication (2nd session)
13:00 – 14:30	**Lunch**
14:30 – 16:00	Oral communication (3rd session)
16:00 – 16:45	Coffee break and 2nd Poster session
16:45 – 17:45	Oral communication (4th session)
15:45 – 19:00	Student and non-teaching researchers group meeting

February 3rd

09:00 – 10:30	Research Groups Meetings
10:30 – 11:00	Coffee break
11:00 – 12:30	ICT's Scientific Council Plenary Meeting
12:30 – 13:00	Closing session and Best communications Awards
13:00 – 15:00	**Convivial Lunch**

|Communications schedule

Oral Communication

1st Session

Moderator: Luís Lima

Schedule	Speaker	Title	Group
9h20 - 9h35	Carolina Purificação	Modelling the atmospheric boundary layer conditions during a wildfire event	G1
9h35 - 9h50	Cátia Campos	Meteorological conditions favouring the development of mega-fires	G1
9h50 - 10h05	Filippe Santos	Vegetation fuel characterization using remote sensing data over Southern Portugal	G1
10h05 - 10h20	Pedro Pereira	Hydrogen geological storage and interactions in porous media of subsurface geology	G2
10h20 - 10h35	Sara Pereira	Progresses in the development of an integrated forecasting model of solar radiation and photovoltaic power output without using onsite measurements	G2
10h35 - 10h50	António Oliveira	Whole-rock and zircon isotopic compositions of subvolcanic dykes from northern Portugal and their petrogenetic significance	G3

2nd Session

Moderator: Ana Carvalho

Schedule	Speaker	Title	Group
11h30 - 11h45	Dina Cabrita	Evidence of Meso- to Neoproterozoic terrane accretion: insights from juvenile mafic magmatism from the southern Ribeira Belt, Brazil	G3
11h45 - 12h00	Guilherme Ínsua-Pereira	Lizardite-to-antigorite transition in serpentinized ultrabasic rocks from the UAT of the Bragança Complex, NE Portugal	G3
12h00 - 12h15	Mariana Costa	Petrographic and mineralogical new data from a burnt coal waste pile, Pejão Mining Complex	G3
12h15 - 12h30	Florencia Sánchez	Geoheritage assessment in the Calbuco volcano, Chile: defining the first stages of a geoconservation strategy.	G4
12h30 - 12h45	Ivaneide Santos	An Object-Oriented Python Application Programming Interface (API) for Geographic Resources Analysis Support System (GRASS) Geographic Information System (GIS): Reclassification of the lithological chart of the National Ecological Reserve (REN), Portugal	G4
12h45 - 13h00	Joana Rodrigues	Science communication theory and practice among geoscientists	G4

|Communications schedule

Oral Communication

3rd Session

Moderator: Florencia Sanchez

Schedule	Speaker	Title	Group
14h30 - 14h45	Noel Moreira	$^{87}Sr/^{86}Sr$ in carbonates: one tool, several applications	G6
14h45 - 15h00	Pedro Teixeira	Advancements in the LouMu Project – Muography for Geological Surveys	G6
15h00 - 15h15	Rui Ernesto Gomes	An instrumentation amplifier with automatic and adaptive gain	G6
15h15 - 15h30	Vítor Martins	Evaluation of potential sources of soil and water contamination in Serra da Estrela	G5
15h30 - 15h45	Carlos Ferreira	Statistical procedures applied to floods in the Douro River Basin	G5
15h45 - 16h00	João Miranda	Hydrogeological characterization of a groundwater municipality reservoir (Guimarães, North of Portugal)	G5

4th Session

Moderator: Joana Rodrigues

Schedule	Speaker	Title	Group
16h45 - 17h00	Mafalda Sousa	Monitoring and remediation of mining effluents - a phytoremediation study	G5
17h00 - 17h15	María Pazo	Development and optimization of decentralized decision models – an application to sustainable mine activities	G5
17h15 - 17h30	Oussama Dhaoui	A new artificial intelligence strategy for predicting the groundwater contamination risk over the Menzel Habib shallow aquifer in south-eastern Tunisia	G5
17h30 - 17h45	Nuno Ribeiro	The importance of biotic and abiotic risks assessment and modelling in the development of frameworks for forest growth models in context of climate change	G5

|Communications schedule

Poster Communication

1st Session (10h50 - 11h30)

Poster	Speaker	Title	Group
1	Ana Ferrão	The Geology of the region between the Sintra mountains and Arrábida: A teaching-oriented approach	G1
2	Beatriz Gomes	Qualitative comparison of aerobiological pollen sampling methods	G1
3	Mariana Marques	The presence of protein and metals in air samples in urban areas	G1
4	Célia Antunes	Evaluation of biochemical air quality: protein and lipid content of air and its potential impacts on respiratory health	G1
5	Ana Galveias	Pollen and fungal spores monitoring activity in ICT	G1
6	Filipa Romão	Assessment of pollen traits variability in the Regoufe mining area: the example of Erica arborea	G1
7	Ediclê Duarte	Fire-Pollutant-Atmosphere Components and Its Impact on Mortality in Portugal During Wildfire Seasons	G1
8	Paulo Canhoto	Renewable Energies Chair- Solar research infrastructures	G2
9	Alexandra Mota	Intrusive granites in the autochthonous of eastern Trás-os-Montes (northern Portugal) and associated mineralizations	G3
10	Ana Teodoro	Secure and Sustainable Supply of Raw Materials for EU Industry (S34I) project	G3
11	Ana Teodoro ou Cátia Almeida	Evolution of the Urban Heat Island effect between 1985 and 2021 in the city of Vitoria-Gasteiz, Spain	G3
12	Sara Costa e Silva	Fluid evolution in tin and tungsten deposits associated with Laza-Rebordelo-Murçós shear zone.	G3
13	Carla Carvalho	The Sn-W deposit of Bejanca (Viseu, Central Portugal): preliminary results	G3
14	Ana Santos	Four-step process to obtain a char concentrate from coal fly ash	G3
15	Óscar Costa	Mineralogical and petrographic characterization of Preguiça and Vila Ruiva mines	G3
16	Alina Yakovenko	P-T-X conditions of formation of scheelites from skarns and quartz veins from “Douro Scheelite Belt” (Northern Portugal)	G3
17	Lia Duarte	INOVMineral - WebGIS-based Visualisation of Geospatial Data	G3
18	Cláudia Cruz	Ongoing study on the surrounding area of the former W-Sn Regoufe mine	G3
19	Marcelo Silva	Multispectral analysis of UAV images from Mostardeira Mine: results from data reduction and unsupervised classification approach	G3
20	Giulia Resta	The Sb-Au Mine Legacy Case: Ribeiro da Serra Mine (Portugal)	G3
21	Luís Lima	Geochemical characterization ofmuscovites from Santa Helena Breccia (Borralha, tungsten deposit)	G3
22	Bruno Valentim	Novel circular economic approaches for efficient extraction of valuables from spend li-ion batteries (NEXT-LIB): Recovery of anode graphite	G3
23	Patrícia Santos	Soil Geochemical Assessment Surrounding a Coal Mine Waste Pile Affected by Self-combustion – Pejão Mining Complex	G3
24	Helena Sant'Ovaia	Combined analysis of U-Pb and Lu-Hf in zircons from Freixo de Numão and Capinha granite intrusions (North and Central Portugal)	G3

|Communications schedule

Poster Communication

2nd Session (16h00 - 16h45)

Poster	Speaker	Title	Group
1	Joana Alexandra Ferreira	Development of Sustainable Materials for Water Splitting: an integrated study from cradle to grave	G3
2	Marcela Rodrigues	Fluid evolution in a quartz crystal from Venturinha pegmatite (Penalva do Castelo, Viseu)	G3
3	Joana Dias	Multidisciplinary study of the Vila Cova iron deposit mineral associations	G3
4	Douglas Santos	Sub-Pixel Classification for Pegmatite Detection in High-Resolution Worldview-3 Data	G3
5	Ricardo Vianez	Multidisciplinary study of mineral associations of the Torre de Moncorvo iron deposit of Cabeço de Mua	G3
6	Sónia Pereira	Characterization of Road Dust in an urban area through cost-efficient methodologies	G3
7	Paulo Pereira	Fostering geoconservation strategies in Patagonia Verde (Chile): sites inventory, assessment and management proposals	G4
8	Margarida Antunes	Groundwater degradation in a semi-arid region - current and future damages under climate change scenarios	G5
9	Bruno Leitão	Agricultural Valorization of Livestock Effluents and Management of Nutrients Based on the Chemical Composition of Effluents	G5
10	Bruno Leitão	Modeling land aptitude for crops: proposals for a more efficient resources management in the North of Portugal	G5
11	Bruno Gomes	Establishment of a vulnerability model in the Sete Fontes aquifer system - land use constraints	G5
12	Bárbara Ribeiro	Reducing the carbon footprint through textile reuse: the case study of a textile valuation company	G5
13	Roberto da Silva	A closer look at two cases of acid mine drainage (AMD) contamination: Canal Caveira (Portugal, NW of the Iberian Pyritic Belt) and Trimpancho (Spain, SE of the Iberian Pyritic Belt)	G5
14	Ana Barroso	Natural attenuation processes in AMD context by mineralogical control: iron oxyhydroxides, oxyhydroxysulfates, and efflorescent sulfates	G5
15	Raquel Fernandes	Acid mine drainage properties in different climate, paragenetic and rehabilitation conditions	G5
16	Joana Araújo	Advances and setbacks in designing the best remediation solution in an abandoned mine highly contaminated with mercury (case study of Canal Caveira mine)	G5
17	Bruno Pereira	Geothermal research in the Cávado basin – preliminary results	G5
18	Natália Silva	Study of the use of geomaterials as an alternative for the remediation of two water systems affected by mining activity: Canal Caveira Mine (Portugal) and Trimpancho Mining System (Spain)	G5
19	Rui Veloso	Analysis and Characterization of Microplastics in Coastal Sediments	G5
20	António Kumoleha	Geological Setting of the Chipindo Mine: a Preliminary Analysis	G5
21	Marina Mendes	Valorization of Caldela´s thermal area (Amares, North of Portugal)	G5
22	Noel Moreira	Can garnets from the high pressure rocks from the Ossa-Morena Zone register the subduction-exhumation processes of the Variscan Orogeny?	G6
23	Ines Hamak	Addition of local and teleseismic events to Arraiolos seismic tomography.	G6
24	João Vieira	Geophysical Data Integration at Lower Tagus Valley: case of Ciborro Fault	G6

G 1 – ATMOSPHERIC SCIENCES WATER AND CLIMATE

Oral communications

Meteorological conditions favouring the development of mega-fires

Cátia Campos* [1,3]; Flavio T. Couto, [1,2,3,4]; Carolina Purificação [1,2,3]; Rui Salgado [1,2,3,4]; Jean-Baptiste Filippi [5]; Roberta Baggio [5]

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Abstract

In recent years, the development of clouds due to the convection created by the fire has been reported in several wildfires. These clouds can be of 2 types: pyro-cumulus (PyroCu) or pyro-cumulonimbus (PyroCb). In 2017, Portugal recorded 11 mega-fires, of which 8 occurred on October 15, 2017. As a case study of pyro-convection, the Quiaios wildfire was chosen. In this study, two numerical simulations were made using the MesoNH atmospheric model: a simulation coupled with the fire propagation model, ForeFire, with 3 nested domains (2000m, 400m and 80m of horizontal resolution) and 300 × 300 grid points each; and a non-coupled simulation, with a single domain of 15km horizontal resolution of 300 × 250 grid points. From the first simulation, significant pyro-convective activity was confirmed from the moment that some type of hydrometeor was simulated inside the smoke plume. The coupled simulation showed convection created by the fire allowing the vertical transport of water vapor and the development of PyroCu cloud. The large-scale simulation allowed to explore the entire development of the hurricane Ophelia. On October 15th, Ophelia brought to the continent strong southwest winds in lower troposphere, which were essential for increasing the rate of spread of the active fires and mega-fire development. The approach of the hurricane also contributed to the increase of precipitable water over the continent, which may have been an essential factor for the formation of PyroCb clouds. The study revealed the importance of using very high spatial and temporal resolution coupled simulation to study pyro-convective phenomena and how a large-scale system can affect the fire behaviour and the development of strong pyro-convective activity. This study is funded by national funds through FCT - Foundation for Science and Technology, I.P. under the PyroC.pt project (Ref. PCIF/MPG/0175/2019) and ICT project (Refs. UIDB/04683/2020 and UIDP/04683/2020).

Keywords: Fire Weather; Pyro-convection; Numerical Modelling; Hurricane.

Modelling the atmospheric boundary layer conditions during a wildfire event

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Abstract

The atmospheric structure becomes more complex than homogeneous terrain over mountainous terrain in terms of the Atmospheric Boundary Layer (ABL). In the context of interaction between fire and atmosphere, abrupt changes in the ABL wind often lead to erratic and turbulent flow in the fire environment, which can be dangerous for firefighters. The study intends to determine the ABL conditions associated with the largest forest fire that occurred in Portugal in 2019. The present case study is the wildfire that occurred in Vila de Rei county, which is surrounded by hills and valleys with large differences in altitudes. In order to study the regional atmospheric environment between 19 July at 0000 UTC and 25 July 2019 at 0000 UTC, a numerical simulation was performed using the Meso-NH atmospheric model, configured at 2500 m horizontal resolution with 500 × 500 grid points. The simulation involves the Iberian Peninsula scale and coincides with the period when the fire burned more than 9,000 hectares in Vila de Rei. Such a simulation helped to characterise the lower troposphere and the ABL development. In addition to the ABL height, the simulation has allowed exploring the turbulent kinetic energy and its dynamic and thermal production. The ABL height calculated from the Richardson number method depicted a growing in the morning and ranged from 500 to 900 m above the terrain throughout the afternoon and evening during the entire study period. Also, the coastal low-level jet was identified above 500 m altitude, with maximum wind speed at around 600 m altitude at 1800 UTC on 20 July. This study demonstrates the importance of the use of numerical models to explore the ABL evolution over complex terrain, which its development plays an important role during wildfire events.

Keywords: Atmospheric Boundary Layer; orographic effects; fire weather conditions; Meso-NH model.

Acknowledgements: This study was funded by national funds through FCT-Foundation for Science and Technology, I.P. under the PyroC.pt project (Ref. PCIF/MPG/0175/2019) and ICT project (Refs. UIDB/04683/2020 and UIDP/04683/2020).

Vegetation fuel characterization using remote sensing data over Southern Portugal

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Abstract

Portugal will be warmer and drier under future scenario projections linked to climate change, favouring more extreme wildfire events. Fire has a worldwide scale with a critical role in water and carbon cycles. For this reason, it is essential to know better and understand the vegetation dynamic and its role in the Earth system. Remote sensing can be helpful for better comprehension, once it is able to cover large areas with good temporal consistency. In such a context, the study aims to improve the representation of fuel load and moisture content from satellite data for use in fire propagation models. In this study, three above-ground biomass (AGB) datasets are used: first, samples collected by "Instituto da Conservação da Natureza e das Florestas" (ICNF) in 2015 for the Portuguese National Forest Inventory; second, AGB derived from ~3.000 trees in-situ dendrometric variables measurements (total height, tree diameter at 1.30 m above the ground) collected in the Herdade da Mitra at the University of Evora for 2020 and 2021; and third, AGB derived from eucalyptus trees on a field site in Serra de Ossa between 2016 and 2021 provided by the Navigator company. Otherwise, for live fuel moisture content (LFMC), biweekly samples over two field sites (Herdade da Mitra and Serra de Ossa) were collected during the period between April and October 2022, counting almost 250 samples. These samples combined with satellite data information derived from Sentinel-2 (spectral bands and spectral indexes) were used to build a model using a machine learning approach, such as Random Forest (RF) classifier, considering more than 30 variables to predict the AGB and LFMC. Results showed reasonable agreement between predicted and observed values, with r2 and RSME values of 0.56 (0.74) and 17 ton ha-1 (7%) for AGB (LFMC). Finally, the RF model was used to generate wall-to-wall AGB and LFMC maps. The study suggests that remote sensing data combined with a machine learning approach may produce information to characterize vegetation conditions for wildfire risk assessment in Portugal.

Keywords: Above ground biomass; live fuel moisture content; Sentine-2; random forest; wildfire risk.

Acknowledgements: Filippe Santos was supported by Foundation for Science and Technology, I.P (Grant 2022.11960.BD). This research was funded by the European Union through the European Regional Development Fund in the framework of the Interreg V A Spain–Portugal program (POCTEP) through the CILIFO project (Ref.: 0753-CILIFO-5-E), FIREPOCTEP project (0756-FIREPOCTEP-6-E), RH.VITA project (ALT20-05-3559-FSE-000074), and also by national funds through FCT-Foundation for Science and Technology, I.P. under the PyroC.pt project (Refs. PCIF/MPG/0175/2019), ICT project (Refs. UIDB/04683/2020 and UIDP/04683/2020).

G 1 – ATMOSPHERIC SCIENCES WATER AND CLIMATE

Poster communications

The Geology of the region between the Sintra mountains and Arrábida A teaching-oriented approach

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Abstract

The classification of areas of geological interest in the different regions of Portugal may encourage a taste for discovery. Deep down is the taste for geology and all its areas. The systematization of the geological characteristics of each area, as well as their adequacy to the teaching of geology, in Portuguese schools, will allow teachers to make a more assertive choice of the places to be visited, taking into account the objectives of each teacher, in relation to the school year concerned, as well as the resources available in each group of schools. This paper seeks to fill some gaps regarding the reference of different places of geological interest.

The geology and the different characteristics of the area between the Sintra massif and the Serra da Arrábida are known and are described in numerous scientific publications, master's and doctoral theses. The geological charts of the region, as well as their explanatory news are examples of this. On most occasions the information is too technical, not available, nor systematized, with regard to a specific area, making the organization of study visits directed to the levels of education, basic and secondary, an overly complex task, so that its systematization in terms of geological content becomes an added value.

The choice of the different places of geological interest will be made through the analysis of existing documents, having as reference the profile of the student to the exit of compulsory schooling and essential learning. In order to systematize the characteristics of each site of geological interest, a technical data sheet will be elaborated with the different points that can be addressed and analyzed by stakeholders. The level of education to which it is intended is also mentioned in that fact sheet.

The technical data sheet will describe the chosen locations, also using illustrative images of the areas, in order to assist the teacher in choosing the script to be elaborated, for a given field output/study visit. The selection of the sites will be made based on the quality of the observation, possibility of didactic clarity, ease of characterization of the geological process observed, ease of access to the groups concerned.

Keywords: Arrábida, Sintra, Primary and Secondary Education.

Pollen and fungal spores monitoring activity in ICT

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Abstract

Airborne pollen and fungal spores may change from region to region according to geography and climate. Currently, there are ~1500 monitoring stations worldwide, with a greater presence in Europe (Buters et al., 2018) and it tends to extend pushed by the growing burden of respiratory allergies and the public awareness and demands.

This work aims to present a pollen and spore network in Portugal, providing data freely available to the public and particularly relevant for allergy sufferers.

At the moment, three monitoring stations are operating at ICT, located in Évora (38.56°N, 7.90°W), Lisbon - IPMA (38º 46´33´´N, 9º07´32´´W) and Porto (41º 80'58'' N, 8º 36'39' W), representing three different bioclimate regions: Evora (T_{mean}:16.2 ºC; Prec: 585.3mm); Lisbon (T_{mean}:17.4 ºC; Prec: 765.8 mm); Porto (T_{mean}:14.9 ºC; Prec: 1139.5 mm), according to the climatological normal (1981-2010) provide by the Portuguese Institute for Sea and Atmosphere. Pollen Spectra and pollen concentration (updated all year long) for the three cities may be found on the Pólen Alert platform (https://lince.di.uevora.pt/polen/) as well as in the IPMA website (https://www.ipma.pt/pt/saude/polens/). The platform also includes information about the risk levels in three categories (low, moderate, and high) according to the pollen type.

Moreover, other general information about pollen aerosols, namely, plant origin, classification, morphological characteristics, and seasonality, may be found at (https://lince.di.uevora.pt/polen/).

In conclusion, the pollen and fungal spores information and risk level may be freely accessed and followed by the public. This information/knowledge may be relevant for allergic individuals by allowing better planning of daily activities to limit allergen exposure and, thus, extremely helpful in managing allergy symptoms.

Keywords: Pollen; Fungal Spores; Calendars; Monitoring Stations

References:

Buters, J.T.M., Antunes. C., Galveias A., Bergmann K.C., Thibaudon M., Gálan C., Schmidt-Weber.C., Oteros.J (2018). Pollen and spore monitoring in the world. Clin. Trans. Allergy.8:9: doi.org/10.1186/s13601-018-0197-8;

Qualitative comparison of aerobiological pollen sampling methods

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Abstract

Airborne pollen flows temporal variation is determined through atmospheric sampling, which can be done by different types of equipment. In this context, our study aimed to compare three methods of aerobiological pollen sampling: a passive one and two active ones. The passive method, based on the "Cour methodology", contemplates the atmospheric sampling of pollen through vertical filtering units that allow the filtration of air masses. A small sampler prototype, printed in 3D, developed by the Palynology Laboratory, was tested. The active methods were i) the "Hirst type", based on the suction of a continuous air flow (10 L/min) and its impact on a plastic film previously coated with an adherent substance, and ii) a Multi-Vial cyclone sampler, a single reverse airflow miniature cyclone (16 L/min) where samples are collected into Eppendorf vials.

The sampling took place in the city of Porto, during the month of March 2022 (period where the highest annual aeropollinic concentration is recorded). The samplers were located on the roof of FCUP's FC5 building and the samples were processed for daily pollen qualification and quantification. A comparative analysis was carried out, by pollen type captured, among the samplers.

Greater pollen variability was observed in the samples obtained by the passive method compared to the active ones. The most representative belong to *Acer*, Cupressaceae, Pinaceae, *Platanus*, *Populus*, *Quercus* and Urticaceae, with a tendency towards synchronism in capturing their atmospheric flows between the sampling methods.

The results obtained showed that the use of the passive sampler prototype was able to represent the pollen variability existing in the atmosphere, which may become useful for mobile sampling scenarios, in remote locations or in the context of citizen science.

Keywords: Atmospheric sampling, Cour method, Hirst method, Cyclone sampling, pollen grains.

Acknowledgements: This work was supported by the Portuguese Foundation for Science and Technology (FCT), through the project reference UIDB/04683/2020 e UIDP/04683/2020.

Fire-Pollutant-Atmosphere Components and Its Impact on Mortality in Portugal During Wildfire Seasons

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Abstract

With climate change, extreme weather events and uncontrolled wildfires tend to become more frequent. Thus, morbidity and mortality tend to increase if mitigation measures are not taken. Portugal is a highly fire-prone region and frequently suffers with intense natural hazards such as droughts, heat waves, and wildfires. Wildfires release great quantities of pollutants to the atmosphere which are a risk factor for adverse cardiovascular outcomes. A shared understanding of the health effects of fire, pollutants, and meteorology can help society and decision makers to be better prepared for extreme weather events and ensure that health services are able to mitigate public health consequences. Wildfires-pollutants-meteorological hazards expose populations to increased morbidity and mortality. In this work, data of burned area, particulate matter with a diameter of 10 and 2.5 micrometers (μm) (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), temperature, relative humidity, wind speed, aerosol optical depth (AOD) and mortality rates due to Circulatory System Disease (CSD), Respiratory System Disease (RSD), Pneumonia (PNEU), Chronic Obstructive Pulmonary Disease (COPD), and Asthma (ASMA), were used. Only the months of 2011-2020 wildfire season (June-July-August-September-October) with a burned area greater than 1000 ha were considered. Principal component analysis was used on fire-pollutant-meteorology variables to create two indices called Pollutant-Burning Interaction (PBI) and Atmospheric-Pollutant Interaction (API). PBI were strongly correlated with the atmospheric pollutants and burned area while API were strongly correlated with temperature and relative humidity, and O_3. Cluster analysis applied to PBI-API divided the data into two Clusters. Cluster 1 included colder and wetter months and high PM_{10}, $PM_{2.5}$, and NO_2 concentrations. Cluster 2 included warmer and dried months, and high AOD, PM_{10}, $PM_{2.5}$, O_3, and CO concentrations. The clusters were subjected to Principal Component Linear Regression analysis to better understand the relationship between mortality and PBI-API indices. The results showed a statistically significant (p-value < 0.05) correlation (r) in Cluster 1 between RSDxPBI (rRSD = 0.539) and PNEUxPBI (rPNEU = 0.644). Cluster 2 showed statistically significant correlations between RSDxPBI (rRSD = 0.464), PNEUxPBI (rPNEU = 0.442), COPDxPBI (rCOPD = 0.456), CSDxAPI (rCSD = 0.705), RSDxAPI (rCSD = 0.716), PNEUxAPI (rPNEU = 0.493), and COPDxAPI (rPNEU = 0.619). Cluster 2 analysis indicates that the warmest, dry, and polluted months of the fire season were significantly associated with cardiorespiratory mortality. Warmer and dried Months with larger wildfires, higher air pollutants concentrations near the surface, were associated with higher cardiorespiratory mortality rates. Colder and wetter months inside the wildfire season and cleaner air, were not associated with increase or decrease of cardiorespiratory mortality rates. The combination of variables related to fire-pollutant-meteorology components through Principal Components Linear Regression efficiently helps to understand how these combined hazards are related with cardio-respiratory mortality.

Keywords: Atmospheric pollutants, Environmental health, Cardio-respiratory mortality, Environmental risks, Multivariate statistical techniques.

Assessment of pollen traits variability in the Regoufe mining area: the example of *Erica arborea*

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Abstract

The old Regoufe W-Sn Mine, located in Arouca, was intensively exploited during World War II, closing its activity in the 70s. As a result of the mine's overall abandonment and lack of treatment, some potentially toxic elements (PTEs) may disperse in soil and be uptake by plants. One important structure is the pollen grains, a microscopic cell that varies in size and shape, corresponding to the male portion of the reproductive process in plants. Thus, if contaminants are present in distinct plant organs, there's a possibility they can also reach the pollen.

The main objective of this study was to evaluate the possible influence of site-specific soil characteristics of the Regoufe mining area in some pollen traits, using *Erica arborea* as an example.

Pollen and soil samples were collected at four different sites within the mining facilities: the tailings area, the drainage area of the processing plant, near a mine entrance and along a drainage water line. In vitro pollen germination, total soluble proteins content and its profile were evaluated. Soil pH, electric conductivity, organic matter and PTEs concentrations measured by ICP-MS were correlated with the pollen results using the Pearson correlation coefficient. A hierarchical cluster analysis was done to ascertain if it was possible to obtain discrimination between sites based on pollen and soil parameters.

There were statistically significant differences in pollen germination between the drainage area of the processing plant, where the lowest germination values were attained, and the other sites. Similarly, the pollen soluble protein content was the lowest at the drainage area, with significant differences between all studied sites. Concerning the proteins profile, the characteristic bands originated showed a similar profile in all sampling sites, although a lower intensity of band staining was observed in the sample corresponding to the processing plant drainage area.

A negative association was observed between the pollen germination rate and soil levels of Ni and Pb, and a positive association between pollen soluble protein content and soil organic matter. After cluster analysis it was observed a clear discrimination between the drainage area of the processing plant from the other sites, corresponding to the place where were found the lower values of the pollen traits and the higher levels of most PTEs.

So, our results point out that pollen from *E. arborea* plants growing at a possibly more contaminated site could be negatively influenced and have some properties compromised.

Keywords: germination, potential toxic elements, soluble protein content, soil.

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Evaluation of biochemical air quality: protein and lipid content of air and its potential impacts on respiratory health

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Abstract

The atmosphere is composed of gases and particulate matter (PM) of biotic natural origin such as pollen and fungal spores, natural abiotic origin, and anthropogenic origin such as black carbon. The PM in the atmosphere is considered as one of the most harmful pollutants for human health and, therefore, exposure to PM by inhalation, depending on its variable composition over the different seasons, can cause several inflammatory responses. Although it is recognized that PM has impacts on human health, there is still little knowledge about the seasonal variation of its composition in the air, and therefore, the real effects on human health are not yet fully understood. With that in mind, the aim of this study is to study the biochemical quality of atmospheric air over 12 months and to assess its potential risks to respiratory health.

For this, the seasonal profile of several aerosols in PM (pollen, fungal spores and BC) was evaluated; to determine the protein and lipid content throughout the year and the relationship of these contents with the common bioaerosols and with BC was investigated. Finally, the impacts on respiratory health were discussed, considering the different chemical and biochemical composition of PM.

The samples to determine the protein and lipid content were collected using a ChemVol 2400 impactor, installed at the top of the Atmospheric Sciences Observatory (EVASO), at the Luís António Verney College, University of Évora. For the determination of protein content, the samples were extracted using bicarbonate ammonium buffer, lyophilized and quantified using the micro-BCA method. For the determination of lipids, the samples were extracted using the Folch method and the lipid composition of the extract was determined by thin layer chromatography. BC data were collected using a MAAP Model 5012 and PM samples for determination of bioaerosol content were collected using a Hirst collector, both installed at EVASO. The determination of the content in bioaerosols followed standardized methodology by the Spanish Aerobiology Network.

It was observed that there is seasonality in the composition of PM, and the content in pollen, fungal spores and BC present their highest concentration in spring, summer, and winter, respectively. The highest concentration of protein and lipids in PM was recorded in the spring, suggesting that pollen is the main source. It was also observed that the highest pollen associated protein was recorded in fraction XL suggesting that they have a greater capacity to be retained at the beginning in the respiratory tree. The concentration in BC was correlated with both fractions, although stronger with the fraction M, suggesting that although it is distributed in particles of varying dimensions, most of them have submicronic dimensions.

In conclusion, these results suggest that there is seasonality in the type and composition of inhalable particles throughout the year, with diverse effects on human health, namely promoting diseases reflecting respiratory conditions of a distinct nature.

Keywords: Bioaerosols; air quality; respiratory health; black carbon.

The presence of protein and metals in air samples in urban areas

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Abstract

Air quality represents one of today's prime environmental, social, and economic challenges; poor air quality is associated with several diseases, environmental problems, and premature deaths. Air quality indicates the level of air pollution, caused by several chemicals in the air, changing the natural composition of the atmosphere. In terms of ambient air quality, several pollutants are evaluated, such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), nitrogen oxides (NOx), benzene (C_6H_6), carbon monoxide (CO), ozone (O_3), particulate matter (PM) and for the pollutants lead (Pb), arsenic (As), cadmium (Cd), nickel (Ni), mercury (Hg), and others. PM originates from various sources (combustion, industrial, natural), and differs in physical and chemical composition, and those posing a higher risk to human health are associated with anthropogenic emissions and specially the aerodynamic fraction below 10 µm (PM10 and below).
This study focused on chemical and biochemical classification of PM10.
The air sampling in an urban area was carried out in the Colégio Luís António Verney, the University of Évora, using a "high volume, Digitel DH77" sampler with constant sampling flow of 500L/min and using quartz fiber filters of Ø150 mm. Twelve samples were obtained between October and December 2022. The sampling duration ranged from 24 h to 168 h. The filters were divided into 4 parts, each one was placed in a properly identified and sealed Petri dish, and these were stored at -20°C for further extraction of the compounds to be analyzed. For protein quantification, the samples were extracted with ammonium bicarbonate buffer in the dark under reverse stirring for 4h, and quantification was performed using the micro BSA method. From the sediments obtained after protein extraction, slides were made and observed under an optical microscope at 400x magnification to evaluate the total fungal spore content. For metals, microwave digestion of the filters with nitric acid and hydrochloric acid was performed, followed by ICP-MS quantification.
The samples presented protein content varying between 0,72 to 2,53 µg/m^3, according to time of the year. Fungal spores were found in all the samples, such as *Copruinus spp, Caldrosporium spp, and Pisolithus spp*. Regarding metal content, chromium, iron, zinc, nickel, lead, cadmium, and arsenic were quantified. In general, the compounds quantified in the highest concentrations were Cr (159 to 8335 µg/m^3) and Fe (2782 to 62580 µg/m^3), and in the lowest were As (3 to 177 µg/m^3) and Cd (0.52 to 37 µg/m^3).
In conclusion, the results suggest seasonality of the chemical/biochemical composition of PM10 and may be influenced by the weather conditions affecting emission, transport, and deposition. Therefore, air quality monitoring is crucial to assess the type of particulate matter in the air and their spreading capacity, as to be used in synergy with physical, chemical, and (eco)toxicological information that can serve as a basis for projecting the effects on the ecosystems' balance and human health.

Keywords: Air quality; Particulate matter; Protein quantification; Metals quantification.

G 2 – ENERGY

Oral communications

Hydrogen geological storage and interactions in porous media of subsurface geology

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Abstract

The national and European hydrogen strategies rely on producing vast amounts of green hydrogen, part of which will have to be stored in geological formations. While storage in salt cavities is a mature technology, the porous media is prone with challenges. Funded by FCT, H2GeoStore project will address impacts on hydrogen storage efficiency and seal integrity in saline aquifer reservoirs. H2GeoStore outcomes aim providing relevant insights for future projects towards the climate and energy goals.

Keywords: hydrogen storage, porous media, saline aquifers, reservoir efficiency, seal integrity.

Progresses in the development of an integrated forecasting model of solar radiation and photovoltaic power output without using onsite measurements

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Abstract

Renewable resources, and consequently the generated energy, are especially variable, which makes finding an accurate balance between electricity generation and consumption at any moment challenging in the absence of reliable large capacity energy storage systems. Thus, having an accurate forecasting of the generated energy allows for a more efficient management of the electric grid comprising various energy sources. This work presents the study of all fundamental models necessary for the forecasting of photovoltaic power output when there is no measuring instrumentation on site, namely: weather forecasting model, direct normal irradiance forecast improvement model, transposition model, photovoltaic module temperature and power output model and inverter model.

The weather forecasting model used in this work is the numerical weather prediction model of the European Centre for Medium-range Weather Forecasts which produces forecasts twice a day with temporal resolution of 1 hour and 0.125° of horizontal resolution in a global grid. Methods for temporal and spatial downscaling are applied to obtain 10-minute values of the forecasted variables for the desired location. The forecasts of direct normal irradiance (DNI) show higher errors (157.16 W/m^2 of mean absolute error - MAE - for forecast day 1) than global horizontal irradiance (GHI, MAE of 63.63 W/m^2) and thus a corrective algorithm based on artificial neural networks (ANN) was developed to improve these forecasts achieving an MAE of 130.94 W/m^2 for forecast day 1.

The transposition model converts DNI and diffuse horizontal irradiance (DIF) into irradiance on the tilted plane (GTI). This is done by using transposition coefficients on the direct, diffuse and reflected component of solar irradiance. In this work some of the most employed analytic models for the determination of the diffuse transposition coefficient are compared, being the modified Bugler model selected. In the case of photovoltaic power plants, which are composed of various rows of panels, there is sometimes obscuring of the sun by the front rows over the second and subsequent rows affecting the beam radiation received by these. There is also obscuring of the sky dome affecting the diffuse radiation and obscuring of the reflected radiation from the ground between rows. In this work a transposition model for rows other than the first based on the works of Varga and Mayer (2021) and Tschopp et al. (2022) was developed and is now being evaluated.

The photovoltaic power output is very dependent not only on the irradiance on the solar panels but also on their temperature. Thus, a model to determine the temperature of the panel is essential when there are no measurements available. Most models used in the literature are steady-state and empirical which means they can be biased towards a specific technology or location. Besides comparing the most commonly used empirical models, a physical transient model for the determination of the photovoltaic panel temperature was developed.

The integration of these models with various non-empirical power output models was evaluated. Finally, the efficiency of the power inverter is considered to obtain the power output supplied to the electric grid.

G 2 – ENERGY

Poster communications

Renewable Energies Chair- Solar research infrastructures

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Abstract

A variety of projects have been implemented in the Renewable Energies Chair (CER-University of Évora) on the premises of the Herdade da Mitra campus, since the beginning of its activity in 2010. With an area of approximately 6ha divided into 2 physical infrastructures, namely Évora Molten Salt Platform (EMSP) and Solar Concentrator Testing Platform (PECS), CER already participated in more than 30 R&D projects with competitive founding. The growth of the research infrastructure has been accentuated since 2018 with the acquisition of the research projects: ALFR-Alentejo, NEWSOL, SOLARTECH, Eres4Water and INIESC Évora Connect.

It has currently the approval of several projects, namely, four integrated into the mobilizing agenda of the Recovery and Resilience Program (PRR) and two H2002 projects, SALTOpower and SolH2O. The CER research infrastructures represents one of the most important assets of INIESC – National infrastructure of concentrated solar energy, led by University of Évora. Also takes part of the integrated asset ESFRI EU-SOLARIS as observer member.

The infrastructure currently allows the following type of tests:

- Testing of new thermodynamic cycles for solar thermal generation (namely making use of the infrastructure that will be installed within the scope of Solarsco2ol project);
- Testing of new solar concentrators to high temperature thermal conversion (e.g.:ALFR-Alentejo, MS trough proposal);
- Testing of a Carnot battery to electrical storage (e.g. PRR-ATE);
- PV/CSP hybridization in large solar plants (e.g. PS CIMAA);
- Integration and production of new renewable gases in high temperature thermal storage systems (e.g. SALTOpower, SOLIVE and FLEXREGAS proposals)

Future prospects for infrastructure expansion

Under a strategical point of view CER intends to approach concepts such as **(1) AgriPV** with the installation of a pilot to demonstrate agriphotovoltaic activities, **(2) hybridization of CSP/PV** through the demonstration of the concept to produce dispatchable solar electricity, **(3) solar fuels** trough the production of syngas/ liquid solar fuels through pyrolysis or gasification of biomass

The current pipeline of actual projects in progress, it is foreseen in short term to have:

(1) The installation of a new supercritical CO2 thermodynamic cycle in the scope of project AURORA;
(2) The installation of a PV system in the scope of project AURORA;
(3) The installation of equipment foreseen in the scope of proposals under evaluation (PURAGRAF, SOLIVE, FLKEXREGAS);

Keywords: Évora Molten Salt Platform, Solar Concentrator Testing Platform, Solar R&D projects,

G 3 – GEORESOURCES AND GEOMATERIALS

Oral communications

Whole-rock and zircon isotopic compositions of subvolcanic dykes from northern Portugal and their petrogenetic significance

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Abstract

During the late to post-tectonic stages of the Variscan orogeny, several melts of variable composition were produced throughout the Central Iberian Zone (CIZ), generating a plethora of hypabyssal lithologies such as granite porphyries, lamprophyres, and dolerites. Even though these rocks are abundant in northern Portugal, not much is known about them due to the scarcity of fresh outcrops. In this work, we report the isotopic compositions of selected subvolcanic dykes from three regions of northern Portugal (Vila Pouca de Aguiar (VPA), Lamas de Olo (LO), and Vila Nova de Foz Côa (VNFC)) and interpret these results to provide insights into their petrogenesis.

The granite porphyries of the VPA region, named the Loivos and Póvoa de Agrações (PA) dykes, respectively exhibit $(^{87}Sr/^{86}Sr)_i$ = 0.7113–0.7160 and 0.7231–0.7274, as well as εNd_i = -4.21 to -4.08 and -4.37 to -3.78, while the VNFC porphyry reveals $(^{87}Sr/^{86}Sr)_i$ = 0.7044–0.7151 and εNd_i = -4.40 to -4.18. Furthermore, oxygen isotope measurements on zircon crystals of the PA and VNFC specimens yield the following signatures: $\delta^{18}O$ = 6.27 ± 0.24‰ to 9.66 ± 0.39‰ (PA); $\delta^{18}O$ = 7.83 ± 0.17‰ to 11.58 ± 0.32‰ (VNFC). Based on the Rb-Sr and Sm-Nd isotopic compositions, the VPA and VNFC porphyries are, most likely, unrelated to the regional granites, having presumably derived from different sources. The VNFC dyke is isotopically similar to felsic metaigneous granulites of the lower crust, the PA porphyry resembles metagreywackes, phyllites, and micaschists of Late Proterozoic to Cambrian age, and the Loivos specimen carries an intermediate composition regarding these two groups of metasedimentary/metaigneous protoliths of the CIZ. Moreover, the influence of magma mixing on the petrogenesis of the porphyries cannot be completely ruled out, taking into account the coexistence of mantled and non-mantled feldspars, as well as the information withdrawn from mineral chemistry analyses. On the other hand, the T_{DM2} ages (Loivos: 1.84–2.17 Ga; PA: 1.66–2.13 Ga; VNFC: 1.27–1.44 Ga) are comparable to those registered in late to post-tectonic Variscan granites and metasediments of the Schist-Greywacke Complex, suggesting that the sources are Precambrian. The prior observation is broadly consistent with the presence of Paleoproterozoic to Neoproterozoic inherited cores.

The LO lamprophyre yields $(^{87}Sr/^{86}Sr)_i$ = 0.7056, εNd_i = -0.05, and $\delta^{18}O$ (in zircon) = 4.36 ± 0.36‰ to 7.87 ± 0.17‰, whereas the isotopic signatures of the VNFC microgabbro are $(^{87}Sr/^{86}Sr)_i$ = 0.7049 and εNd_i = +2.83. Such compositions corroborate the interpretations derived from the bulk-rock geochemistry, in the sense that both studies imply that the lamprophyre possibly resulted from partial melting of a subduction-modified lithospheric source, metasomatically enriched by crustal sediments, while the microgabbro is OIB-like and was probably generated from a slightly enriched, asthenospheric mantle source. Also, the corresponding T_{DM2} ages (1.02 and 0.79 Ga) implicate that partial melting of the lamprophyre source took place shortly after the metasomatic enrichment, and that the tectonic evolution of the CIZ in the post-Variscan setting progressed rapidly, considering the contemporaneous emplacement of distinct mafic melts generated from both lithospheric and asthenospheric sources.

Keywords: Subvolcanic dykes, Northern Portugal, Variscan orogeny, Isotopes, Petrogenesis

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Evidence of Meso- to Neoproterozoic terrane accretion: insights from juvenile mafic magmatism from the southern Ribeira Belt, Brazil

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Abstract

Terranes of the Neoproterozoic Ribeira Belt provide a record of processes related to West Gondwana assembly. However, the evolutionary history of the belt in the preceding Rodinia supercontinent and its role in the transition to West Gondwana assembly is poorly known. New geochemical and geochronological data of mafic magmatism from Meso- to early Neoproterozoic rock units (1500-900 Ma) integrated with published data provides new constrains to unravel the tectonic setting of the Ribeira Belt. Data from the Votuverava Group and Embu Complex from the southern Ribeira Belt record three distinct periods of juvenile magmatism. The mafic rocks from the Votuverava Group define the oldest magmatism at Calymmian (1490-1475 Ma) and Ectasian (1300-1260 Ma). Both age groups display Th/Yb ratios above N-MORB, low Ta/Yb and Nb/La ratios, low Nb and Zr concentrations, negative Nb anomaly, $\varepsilon Nd_{(T)}$ of +2.25 to +4.01 an Nd two-stage TDM model age spanning 1629-1471 Ma which are characteristic of juvenile mantle source arc-related magmatism. The third event occurred in the early Tonian (900 Ma) and is recorded in the mafic rocks from the Embu Complex. Geochemical data indicate that the mafic rocks belong to the tholeiitic series with low LREE enrichment, negative Nb and Ta anomalies, low Nb and Zr contents and low Nb/La and Zr/Y ratios, consistent with arc-related basalts. Whole-rock Sm–Nd isotopic data yield $\varepsilon Nd_{(T)}$ of +0.72 and Nd two-stage TDM model age of 1921 Ma, with Hf isotopes indicating juvenile mantle sources to the mafic magmatism with εHf_T between + 4.5 and + 17.2. Thus, mafic rocks from the southern Ribeira Belt record multiple periods of accretion and convergence settings associated with assembly of Rodinia and Gondwana.

Keywords: Geochemistry; U-Pb-Hf isotopes; Arc basalts; Brasiliano-Pan-African Orogen; Rodinia and West Gondwana assembly.

Lizardite-to-antigorite transition in serpentinized ultrabasic rocks from the UAT of the Bragança Complex, NE Portugal

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Abstract

The Upper Allochthonous Terrane (UAT) exposed in the Bragança Complex (NE Portugal) encompasses a set of ultrabasic igneous rocks (e.g. gabbro, peridotite, dunite, pyroxenite and hornblendite), which supported fragile deformation where cracking and fracturing enabled the percolation of metamorphic fluids, triggering its serpentinization.

A collection of mineralogical data obtained on serpentine minerals from altered-ultrabasic rocks (from West to East: Vinhais, Ousilhão, Conlelas–Alimonde–Carrazedo, and Bragança sectors of the Bragança Complex) is presented in this work. X-ray diffraction (XRD) data points to a lizardite to antigorite transition. Lizardite corresponds to the 1*T* symmetry expressed by a set of d_{hkl} peaks identified at 7.20 Å, 4.50 Å, 3.65 Å, 2.44 Å, 2.08 Å, 1.74 Å, and 1.53 Å. Structural alterations were observed in the XRD patterns in the range 33-38 º2θ and 58-63 º2θ during lizardite to antigorite transformation expressed by a triplet of the d_{hkl} reflections.

The samples were also analysed by Infrared spectroscopy (IR) where several changes of molecular vibrations (stretching and bending) were identified during lizardite to antigorite transformations. Changes occur in the OH- and Si-O stretching regions and Mg-OH bending regions.

Electron probe microanalysis (EPMA) data obtained for serpentine minerals also point to a lizardite to antigorite transformation expressed by Al^{3+} increases and Si^{4+} decreases in lizardite and Si^{4+} increases and Al^{3+} decreases in antigorite.

This allows us to hypothesize the occurrence of a metamorphic front during serpentinization in the Bragança Complex from East to West, since most data points from the easternmost sector of the complex (Bragança) approximate to the lizardite field, while most data points from the westernmost sector (Vinhais) plot near the antigorite field.

Keywords: UAT, Bragança, serpentinization, lizardite, antigorite.

Acknowledgements: This work is supported by a PhD scholarship (reference SFRH/BD/149312/2019) through National funds and European Social Funds though the Regional Operation Programme NORTE 2020, and the project UIDB/04683/2020 – ICT (Institute of Earth Sciences), financed by the Portuguese Foundation for Science and Technology (FCT).

Petrographic and mineralogical new data from a burnt coal waste pile, Pejão Mining Complex

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Abstract

The Pejão Mining Complex, located in Castelo de Paiva, was one of the major coal mines in the Douro Carboniferous Basin. This mine extracted anthracite for over a century being the mining rejects deposited in waste piles nearby, and in 2017 a forest wildfire caused the ignition of some of them. The waste pile under study burnt between 2017 and 2019 and the fire extinguishing process included the remobilization of the coal mining material using water mixed with a cooling accelerator agent. It is well known that coalfires release hazardous elements into the surrounding ecosystems, thus, it is important the study of these materials by petrographic, mineralogical and geochemical methodologies.

For this study 21 samples were collected, in which 10 samples were taken from the area affected by the coalfire, 5 from the unaffected area, and 6 with mixed materials (burnt and unburnt) resulting from the intervention of the fire extinction.

These coals are classified as anthracite A. Petrographic analysis showed that the samples were composed mainly by mineral matter, iron oxides of greyish blue or reddish color which is indicative of high temperatures reached during combustion. Concerning the organic fraction, the most abundant maceral was vitrinite, with a minor percentage of inertinite. In burnt samples and mixed material, the signs of thermal effects were represented by cracks, devolatilization vacuoles, dark reaction rims, plasticized edges, and oxidation of framboidal pyrite. Occasionally pyrolytic carbon was identified.

The darker reaction rims of thermally affected particles occur when the high rank coals are exposed to high combustion temperatures, while lighter reaction rims are related with low combustion temperatures. In the studied samples a few particles with a higher reflectance rim were identified, which can be associated with the drop of the temperature and fast cooling promoted by the cooling accelerator agent used to extinguish the coalfire. To compare the thermal effects in the organic particles, the maximum reflectance of vitrinite was measured in unaffected particles, and in the thermally affected was measured the reflectance in the center of the particle and in the rim. The results showed that the mean maximum reflectance of the unburnt particles and the center of the burnt particles is very similar, while the mean maximum reflectance of the rim showed lower values. In some cases, the decrease in reflectance is about 3%. However, the lighter reaction rims show about 2% higher reflectance values than the center.

To characterize the inorganic fraction, namely the modes of occurrence of trace elements, some samples were observed in SEM-EDS. In all of them, minerals such as zircon, rutile, pyrite, iron oxides, xenotime (Y phosphate) and monazite (Ce phosphate) with La and Nd, sometimes with Th and U were identified. Concerning the burnt samples, cinnabar (Hg sulfide) and galena were observed. In the unburnt samples florencite (Ce, Al phosphate), arsenopyrite and an Ag sulfide were identified. In one of the unburnt samples it was observed what it seems to be cinnabar that evaporated when heated by the beam, leaving vacuoles in the zircon.

Keywords: Coal mining waste; combustion; reaction rims; reflectance;

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G 3 – GEORESOURCES AND GEOMATERIALS

Poster communications

Intrusive granites in the autochthonous of eastern Trás-os-Montes (northern Portugal) and associated mineralizations

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Abstract

The area in study is located SE of Trás-os-Montes, near Freixo-de-Espada-à-Cinta village, on the border with Spain, marked by the Douro River, and includes the former Fonte Santa Mine (or Lagoaça Mine) which was exploited to produce scheelite concentrates between 1942 and 1982 (Triede, 2002).

This area is characterized by the occurrence of schists and quartzites from the Lower to Middle Ordovician, which overlap rocks from the "Complexo Xisto-Grauváquico" (CXG), Douro Group, on the N flank of the Carviçais anticlinorium.

These formations belong to the autochthonous of Central Iberian Zone (CIZ) and were affected by the C1 and C3 compressive Variscan phases and low-grade regional metamorphism (Ribeiro, 1974, Hildenbrand et al. 2021).

Intruding the metamorphic formations, several two-mica peraluminous Variscan granite massifs are represented: Fonte Santa, Bruçó (belonging to the cross-border Bruço-Aldeadavilla de la Ribera massif (MBAR), Fornos and Carviçais (Conde et al., 1971; Ribeiro and Rebelo, 1971; Schermerhorn, 1982; Pereira et al., 2014). Spatially associated with granites there are different types of mineralizations. Quartz veins and intragranitic pegmatites associated with the porphyroid muscovite-biotite granite from Bruçó and stockworks with cassiterite-wolframite-scheelite associated with the Fonte Santa medium to fine grain muscovite granite. Skarns with scheelite occur in the contact between the Fonte Santa granite and carbonate levels interspersed in the schists (Bussink, 1984).

More recently, in the 2000s, several studies were carried out in Fonte Santa area: petrographic, mineralogical and geochemical studies on the granites and stockworks that occur spatially associated with highly evolved and tin rich (Sn > 44ppm) Fonte Santa muscovite granite; studies of stream sediments and soils from the abandoned mine of Fonte Santa (Silva, 2000; Silva et al., 2001; Antunes et al., 2008; Gomes et al., 2008a, 2008b).

It is worth noting the potential of the "Douro Scheelite Belt" (DSB), located north and south of the Douro River between Régua and Freixo-de-Espada-à-Cinta and which includes a set of scheelite deposits located in the contact of CXG formations with Variscan granites in which the study area is located (Martins, 2012).

With this study we intend to: i) evaluate the genetic connection of the mineralizations with the regional granites, evaluating their sources through isotopic studies and differentiating processes; (ii)also study the structure of the massifs through petrophysics and geochemistry for evaluate the shape of the massifs and the degree of deformation; iii) assess whether the intrusive granites in the area were the source of W and mineralizing fluids and/or source of heat necessary for activating the circulation of flids fluids involved in mineralizing processes.

Keywords: scheelite, granites, skarns,

P-T-X conditions of formation of scheelites from skarns and quartz veins from “Douro Scheelite Belt” (Northern Portugal)

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Abstract

The North and Central Portugal, due to the granite-metasediments binary is especially enriched in tungsten (W) mineralization and is an important producer of W concentrates. Tungsten is identified as a critical element due to its high supply risk and high economic importance, with very important current applications. The present study will be developed in the context of mineral resources and will have as its main focus the study of the fluids and P-T-X conditions of formation of tungsten deposits of the “Douro Scheelite Belt” (DSB). This area could be studied in the light of new methodological advances and its study could thus contribute to better understanding not only of the metallogenesis of scheelite ($CaWO_4$) but also for the evaluation of its metallogenic potential in terms of scheelite deposits.

Different mineralized structures will be studied combining field observation, petrography, information from mineral assemblages and trace element geochemistry of minerals, microthermometric and Raman microspectrometry studies of fluid inclusions in quartz and scheelite, stable isotope and dating.

The study of fluid inclusions in scheelite and quartz will be carried out in skarns and quartz veins from the most promising areas for new W resources such as Tabuaço, Freixo de Numão and Lagoaça located in the Central Iberian Zone (CIZ) and which have the particularity of being hosted in metasediments of the Douro Group of the "Complexo Xisto - Grauváquico". The main objective is to investigate and characterize the chemical composition of the fluids and determine the P-T-X conditions of deposition of the scheelite in different types of deposits, namely skarns and quartz veins and to challenge the question about the origin of the mineralizing fluids: “Magmatic fluids, metamorphic fluids or modified fluids resulting from interaction with host rocks?”.

It is verified that the scheelite mineralization, in the highlighted deposits, are close to variscan granites intrusive in metasediments and that nearby there are host rocks with carbonates. The macroscopic analysis of scheelite mineralization in these deposits will allow verifying if they have different characteristics, which may indicate possible differences in the mineralizing fluids that can be: (i) magmatic-hydrothermal, (ii) metamorphic or (iii) modified by interaction with the host rocks and/or have different ages of deposition.

The origin, P-T-X conditions and fluid flow evolution for the different types of scheelite deposits from DSB will be reconstructed and will contribute to better understanding the formation of $CaWO_4$ in DSB.

Keywords: Scheelite mineralizations, Fluid inclusions, Microthermometry, Magmatic-hydrothermal fluids, Metamorphic fluids

Acknowledgements: The present work was supported by the Portuguese Foundation for Science and Technology (FCT) grant 2022.10799.BD and project UIDB/04683/2020 - ICT (Institute of Earth Sciences).

Four-step process to obtain a char concentrate from coal fly ash

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Abstract

The presence of carbon in coal fly ash (CFA) can limit its utilization in the production of concrete, which is one of their main applications. Hence, the removal of carbon could prevent the CFA landfilling that, in addition to representing high costs for companies, can lead to severe environmental problems. Furthermore, the carbonaceous solid residue (char) present in CFA can be reclaimed and used in a wide range of value-added applications, e.g., as substitute of graphite in oxygen reduction reaction.

Considering this, the current research was looking forward for a process to recover the char from CFA without resorting to techniques using liquids that could remain adsorbed in the char (e.g., dense liquids) and affect its properties. For this purpose, it was used a CFA sample from a pulverized-coal power plant (Pego, Portugal) burning low-sulfur commercial coals from Colombia.

In previous works, it was verified that that char is largely concentrated above 75 microns of CFA and for this reason this was the target granulometric fraction. The sequential application of dry sieving, vibration-induced segregation, wet sieving, and elutriation allowed to obtain a char concentrate with approximately 70 wt. %, db, fixed carbon (FC) from a CFA initially containing less than 6 wt. %, db, FC. The carbon recovery was over 30 % and the process was proven to be reproducible for this sample.

Keywords: sieving, vibration-induced segregation, elutriation.

Acknowledgments: The work was supported through the projects UIDB/50006/2020, UIDB/04683/2020, UIDP/04683/2020, DRI-India/0315/2020 (Insub), and EXPL/CTM-CTM/0790/2021 (PhotoBioTrans). ACS for PhD scholarship SFRH/BD/131713/2017 and COVID/BD/151941/2021. Pego power plant (Portugal) for the CFA sample.

Secure and sustainable supply of raw materials for EU industry (S34I) project

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Abstract

The SECURE AND SUSTAINABLE SUPPLY OF RAW MATERIALS FOR EU INDUSTRY (S34I) is a Horizon Europe (HORIZON) project that began on the 1st of January, 2023. It involves 19 partners from 12 countries and is coordinated by Ana Teodoro from the Faculty of Sciences of the University of Porto (FCUP). This project will investigate and innovate new data-driven methods to analyse Earth Observation (EO) data, supporting systematic mineral exploration and continuous monitoring of (i) Exploration; (ii) Extraction and; (iii) Closure and post-closure activities to increase European autonomy regarding raw materials (RM) resources, and to use EO data/techniques not only for the management of technical and environmental issues for a green transition but also to support public awareness, mining's social acceptance, and better legislation.

The S34I project will be based on satellite data, airborne, unmanned aerial vehicle (UAV), ground-based conventional in-situ techniques/methods and fieldwork.

Promising remote sensing methods will be prototyped to contribute to the secure and sustainable supply of RM in Europe while promoting its resilience and independence from non-EU sources.

S34I results will be validated at six different sites as industrial relevant environments and at different phases of the mining life-cycle in order to holistically address the challenges of topic: (i) Land exploration in Spain, to gain knowledge on cobalt (Co) deposits (and associate other critical metals) by effective exploration methods including on old mine waste dumps and tailings; (ii) Shallow waters / coastal exploration at the Iberian Peninsula Atlantic coast, to update the knowledge on coastal metallic placers including critical metals such as Ti, Sn, Li, rare earth elements (REEs) and Au; (iii) Extraction phase in Austria, to address questions associated with construction and chemical materials quarries which are widely spread geographically and; (iv) Closure/post-closure phase in Finland (2 sites) and Germany, to tackle environmental and health impact challenges, critical for modern mining acceptance by the general public, paving the way for independent pollution monitoring tools or early warning of risks.

S34I will exploit Copernicus, Contributing Missions (CCM) and other EU satellite sensors such as PRISMA, TerraSAR-X and COSMO-SkyMED. Different Artificial Intelligence (AI) techniques will promote advances and innovative methods that mining stakeholders can use to address the challenges faced in different phases of the mining life-cycle, each represented by at least one study site.

It is anticipated that the project will be finished by July 2025. However, research and distribution will continue even after it is finished to promote communication and knowledge of the creative outcomes.

Keywords: Earth Observation, mining life-cycle, Copernicus, raw materials, land, coastal areas

Combined analysis of U-Pb and Lu-Hf in zircons from Freixo de Numão and Capinha granite intrusions (North and Central Portugal)

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Abstract

Freixo de Numão and Capinha granites are located in Central Iberian Zone. Both granite intrusions occur in small, circumscribed outcrops discordantly intruding thick metasedimentary sequences belonging to "Schist Graywacke Complex" (SGC) and, in the case of Capinha, also intrusive in biotite-rich granites (Pêro Viseu-Seia late-D_3 granite). Concerning to SGC metasedimentary rocks, Freixo de Numão (FNG) and Capinha (CG) granites intrude metasediments from "Upper Unit" from SGC ("Douro Group") and "Lower Unit" from SGC (Beiras Group) (Neoproterozoic). respectively. The CG is a muscovite-rich granite considered as late to post-D_3 and FNG a biotite-muscovite granite classified as post-D_3. Petrography allowed to observe that zircon grains exhibited four distinct morphologies: prismatic-shape (most common), lamellar-shape, rounded-shape (usually the older ones), and acicular-shape. Magmatic and inherited zircon cores from both granites were dated by LA-MC-ICPMS. Lu-Hf isotope data were obtained using the same method to constrain possible magma sources. $\varepsilon Hf_{(t)}$ values were measured in 51 zircons of FNG, and the values range between -16.8 and + 8.4 (mean of -2.7). However, 13.7% of the analyzed zircons (n = 7) display positive and 86.3% (n = 44) show negative $\varepsilon Hf_{(t)}$ values. Considering, the εHf(t) data obtained for FNG, mantle-derived magmas contaminated with crustal material is suggested. Zircons from CG displayed a larger range of $\varepsilon Hf_{(t)}$ from -19.4 to +10.1, proposing magma crystallization from mildly contaminated mantle-derived magmas or from a lower crustal source. It must be noticed, that U-Pb isotope data showed that positive $\varepsilon Hf_{(t)}$ values were mostly obtained in inherited zircons of both granites. Inherited zircons from FNG display very heterogeneous ages distribution, yielding ages between and 1992 ± 61 Ma and 423 ± 11, including Neoproterozoic (64 %, 925 ± 40 Ma to 546 ± 18), Upper Cambrian (18%, to 495 ± 19 Ma to 489± 12), Paleoproterozoic (9%, 1992± 61 Ma) and Upper Silurian (9%, 423 ± 11 Ma). Inherited zircons from CG are roughly clustered only in two groups, with ages ranging from to 1146 ± 67 Ma to 544 ± 18, containing Neoproterozoic (93 %, to 779 ± 27 Ma to 544 ± 18) and Upper Mesoproterozoic (7 %, 1146 ± 67 Ma) ages. Thus, the ages obtained for inherited zircons from CG are compatible with ages found for Lower Unit from SGC metasediments (Beiras Group); in contrast, inherited zircons from FNG are more compatible with Upper Unit from SGC metasediments (Douro Group). Concerning the U-Pb ages of representative magmatic zircons from FNG and CG, crystallization ages of 306 ± 2 Ma and 301 ± 3 Ma were respectively found, within the level of 2σ errors. The ages obtained for CG and FNG are consistent with field observations pointing out that both are late to post-kinematic granites, being CG the most evolved facies.

Keywords: zircon, isotopes, age, emplacement, source.

Novel circular economic approaches for efficient extraction of valuables from spend li-ion batteries (NEXT-LIB): Recovery of anode graphite

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Abstract

Spent lithium-ion batteries contain a host of critical raw materials and other valuable metals such as lithium, cobalt, nickel, manganese, copper, aluminium, and graphite. Currently, the Umicore process is implemented in Europe to recover some of these materials and metals. However, lithium, graphite, and electrolyte are lost during processing, and the shredding of batteries proof to be a slow and unstable process. The NEXT-LIB project is an international consortium from Sweden, France, Italy, Finland, and Portugal and aims to develop new technologies to address the mentioned concerns. The authors of this paper are involved with the graphite recovery component of the NEXT-LIB project.

The methodology followed involved the usage of a combination of different physical and hydrometallurgical separation technologies. These technologies include size separation, acid leaching, density separation, communition, and electrostatic separation. Size separation yielded a coarse aluminium-, copper-, and polymer-rich fraction with graphite and lithium metal oxide residues and a fine fraction enriched in lithium metal oxides and graphite with polymer residues. The polymers were removed through density separation while electrostatic separation can be implemented to further separate copper and aluminium. Acid leaching removed the lithium metal oxides. Communition through sonication and attrition acted as refinement stages to deliver three products rich in graphite. These products are a <75 µm product with a 74 wt. % carbon grade, a <45 µm product with an 88 wt. % carbon grade, and a <25 µm product with an 85 wt. % carbon grade. The graphite recovery is above 60 %.

Keywords: lithium-ion batteries; circular economy; anode graphite recovery.

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Evolution of the Urban Heat Island effect between 1985 and 2021 in the city of Vitoria-Gasteiz, Spain

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Abstract

The Urban Heat Island (UHI) effect results from anthropic activities, which change the characteristics of land use and occupation and culminates in higher temperatures in urban areas compared to the surrounding vegetated areas. The effect is more intense after sunset and until sunrise, and can impact the well-being and health of local inhabitants. This work analyses the evolution of the UHI between 1985 and 2021 in the Spanish town of Vitoria-Gasteiz, European Green Capital in 2012 and winner of the Global Green City Award in 2019. Since 1990, Vitoria-Gasteiz is the scenario of several environmental remediation actions, such as the creation of a ring of parks that connects the surroundings of the city, a sustainable mobility plan and urban green structure strategies. Landsat 5, 7 and 8 satellite data were used to compute the Land Surface Temperature (LST), using Google Earth Engine (GEE) platform. The criterion was to use images that presented cloud concentrations below 20%, resulting in 218 images for the period. Additionally, Air Temperature (T_{air}) data from five meteorological stations installed in the municipality since 2003 were used as local data validation points. The existing correlations between T_{air} and LST at each of the five points were analysed using Excel and SPSS software, resulting in a correlation of 0.883. The LST was computed for each of these stations and the other 25 points in the study area. The selection of these points was made using Google Earth Pro, and two variables were considered: i) spatial location, to represent the different Local Climate Zones (LCZ) proposed by Stewart & Oke, 2012[1]; and ii) temporal changes, to identify points that have belonged to the same LCZ during the 36 years of study and others that have been transformed into other LCZs. The UHI effect was obtained by calculating the temperature difference between two LCZs. The analysis associates the characteristics of each LCZ with its climatic behaviour and, consequently, its impact on the intensity of the UHI. The data were analysed considering the 36 years of study and three sub-periods, which coincide with the most relevant environmental interventions in the town: 1985-2000, 2001-2013, and 2014-2021. The analysis was also done by distinguishing the different climatic seasons: spring, summer, autumn, and winter. The results show that in the period 1985-2021, the intensity of the UHI incresed, and analysing the sub-periods, the effect decreased between 2001-2013 and 2014-2021. The point with the highest average temperature was identified in the city centre, and the lowest was found in the forest located on the periphery. It was also identified that the effect is more intense in summer than in winter. Although the time of the satellite pass is not the most convenient for studies of UHI (10:45 UTC), the RS data proved to be a valuable resource for the analysis of the local thermal behaviour.

Keywords: Urban Heat Island, Land Surface Temperature, Remote Sensing; Google Earth Engine; Local Climate Zones.

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The Sn-W deposit of Bejanca (Viseu, Central Portugal): preliminary results

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Abstract

The Bejanca Sn-W deposit (Viseu, Central Portugal) was mined during a vast portion of the 20th century and has promising potential for future mineral exploration. Three distinct types of primary Sn-W mineralizations can be found in Bejanca: (i) intragranitic quartz veins; (ii) stockwork composed of a network of quartz veinlets hosted by greisens; and (iii) disseminated mineralization in greisens. The mineralizations are spatially associated with the syn- to late-D_3 Abraveses granite. Granitic samples show strongly peraluminous signatures (A/CNK = 1.25 - 1.44; CIPW corundum = 4.0 - 5.4%), suggesting an origin by partial melting of a metasedimentary protolith in mid crustal levels (S-type granite). Trace elements normalized patterns display a marked depletion in LIL (Ba and Sr) and HFS elements (Nb and Ti). Strongly positive anomalies in U, Ta and P were also observed. A remarkable enrichment in Sn and W (up to 90 ppm and 14 ppm, respectively) confirms its high metallogenic potential. REE normalized spectra show an enrichment in LREE (La_N/Yb_N = 10.02 - 10.20) and a prominent negative Eu anomaly (Eu/Eu* = 0.36 - 0.38).

Wolframite collected from the intragranitic quartz veins displays a hipidio- to allotriomorphic habit and a chemical composition more enriched in Mn. Cassiterite occurs in subordinate amounts and exhibits an idiomorphic habit. Besides these ore minerals, the hypogenic paragenesis of the mineralized quartz veins also comprises muscovite, fluorapatite, pyrite, arsenopyrite, sphalerite, chalcopyrite, stannite, pyrrhotite, bismuthinite, galena, native bismuth, Bi-Ag sulfosalts and enargite. The oxidation of sulfide mineral phases resulted in the formation of covellite, scorodite, turquoise, greenockite and Fe-oxyhydroxides.

Keywords: Bejanca, Sn-W mineralizations, Variscan metallogenesis

Ongoing study on the surrounding area of the former W-Sn Regoufe mine

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Abstract

The Regoufe mine is an old mine that exploited quartz veins mineralized with wolframite, having its exploitation peak during World War II due to the interest for tungsten in the war industry. The mineralized veins are hosted in post-orogenic granites (280 ± 8 Ma) which constitute the Regoufe pluton. This pluton is represented by a small intrusive body with an outcrop extension of approximately 6 km^2 with a slightly elongated circular geometry in an NW-SE direction. Three granitic facies can be described: (i) a medium-grained muscovite-albite granite (in the northern and eastern parts of the pluton), (ii) a tourmaline-bearing porphyritic two-mica granite (particularly in the western sector), and (iii) a non-uniform mineralogical transition zone in the middle of the pluton. These granites intrude the Neoproterozoic-Cambrian Beira Group Metasediments, which comprise a sequence of phyllites and graywackes, commonly known as the Schist Graywacke Complex (CXG). In the mining area, significant works were already carried out, such as petrography, metallography, geochemistry, hydropedology, and, recently, some geophysical methodologies (i.e., electrical resistivity, electromagnetic, seismic reflection, and multichannel analysis of surface waves), aimed at the understanding of the contamination of the mining area. Although in outcrop, the Regoufe pluton is not very large, its thermal metamorphic aureole (between ca. 1 and 4 km beyond the pluton outcrop) suggests a large extent of continuity in depth. Since the mineralization of the Regoufe mine is spatially associated with the granitic pluton, the study of its emplacement model and three-dimensional shape is being carried out, using magnetic susceptibility (K_m), and gravimetric measurements. Up to now, 95 and 82 sampling stations have been performed for K_m and gravimetric studies, respectively. The first results of K_m, give, respectively, mean values of 38 μSI (typical of a leucogranite), and 125 μSI (characteristics of CXG formations). For Regoufe pluton and metasedimentary host rocks the gravity survey, including gravimetric reductions, Bouguer, Regional and Residual anomalies through the Oasis Montaj software are ongoing but already pointing out an extension of the pluton at the subsurface.

Keywords: magnetic susceptibility, gravimetric survey, granite emplacement, W-Sn Regoufe mine.

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Sub-pixel classification for pegmatite detection in high-resolution worldview-3 data

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Abstract

Remote Sensing has been effectively employed in the identification of pegmatitic exploration worldwide (Cardoso-Fernandes et al., 2020; Santos et al., 2022). Despite this success, a common problem in identifying target minerals is the spatial resolution of the satellites, which can be much higher than the mineral being studied. This creates a situation of sub-pixel occurrence where a mixed spectrum can make classification difficult. The sub-pixel occurrence has been a restrictive factor to the potential of the classification in previous studies. This research tests a sub-pixel classification method based on spectral unmixing in high spatial resolution images from the WorldView-3 (WV3) satellite, aiming to identify Niobium–yttrium–fluorine (NYF) pegmatites in Tysfjord, Norway.

Located in the northern region of Nordland in the Tysfjord district (Norway), the study area has two main open pit mines (Jennyhaugen and Håkonhals). The pegmatite bodies are classified as NYF type and 157 distinct minerals can be identified. As the eastern part of the image, which covers Jennyhaugen, is affected by haze, it was decided to divide the study area into area 1 (A1) and area 2 (A2). In this way, the integrity of the results is prioritized.

The Hourglass Spectral Wizard (HSW) is a Workflow to find, select and extract endmembers that are then used for image classification. First, a set of methods were applied to perform data reduction minimum noise fraction (MNF) transform, Data dimensionality, and Pixel Purity Index. Next, two methods were applied to select and derive endmembers from the image (n-D Visualizer and Spectral Analyst) and, finally, the Mixture Tuned Matched Filtering (MTMF), was used to classify the image using the endmembers obtained before.

The results obtained permitted us to understand the potential of WV3 satellite images for the pegmatite exploration field. The results obtained have fewer false positives than previous results obtained from conventional satellites such as Sentinel 2, Landsat 8, and ASTER. This may be due to the higher spatial resolution of the WV3 images that allow for a more detailed classification of objects that are on its surface. These results can be used in synergy with other data, such as Light Detection and Ranging (LiDAR) data, to map new points of interest for pegmatite exploration in the future.

Keywords: Hourglass Spectral Wizard, Tysfjord, NYF pegmatites, spectral unmixing.

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The Sb-Au Mine Legacy Case: Ribeiro da Serra Mine (Portugal)

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Abstract

Mining activity between 19th and 20th centuries did not consider the environmental dimension in mining residues management. Considering this, the present work intends to verify the extent of the environmental legacy of a contemporary antimony mine: the Ribeiro da Serra Mine.

The study area includes the former mining concession of Ribeiro da Serra (RS), in the Gondomar municipality, more precisely at Flores Sierra, north of Medas' locality. RS belongs to the Sb-Au Dúrico-Beirão mining district. This mine produced ~1 200 t of antimony and 2 t of gold, partially recovered.

This work proposes to characterise the potentially toxic elements (PTEs) present in the soils surrounding the former Sb-Au mine and evaluate how these elements are associated with the mining activity. To better understand the distribution of the PTEs in the area, spatial distribution of the ICP-MS analysis results from geo-referenced soil samples of Ribeiro da Serra was combined with a multivariate statistical analysis. Spatial interpolations of the soil elemental concentrations were created using kriging methodologies for modelling parametric data and kernel density estimation for the non-parametric data.

The Principal Components Analysis highlights an association between arsenic (As), antimony (Sb), lead (Pb), silver (Ag) and among most samples from the mining area. The spatial distribution of As, Sb, and Pb from the interpolation based on the ICP-MS, corroborate this association, as the results shows higher concentrations for these elements along the NNW-SSE trend, crossing the mine and extending though the drainage valley.

The local geochemical background was determined based on soil samples collected over the same geologic units from uphill, without the mine influence, and present a clear enrichment when compared with elementary concentrations present in world soils. It is important to have in mind the higher natural enrichment of these PTEs due to local mineralizing events.

The contamination factor (CF) that is expressed by the metal concentration per sample divided by its respectively local background, revealed that 22% of the sample presents very high contamination ($CF > 6$) in Sb, 17% in As, 11% in Pb. The samples with $CF > 6$ follow the same path as the already described spatial distribution for As and Sb, suggesting an anthropogenic influence.

Keywords: geochemical mapping; geochemical background; antimony; contamination factor; abandoned mine.

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Development of Sustainable Materials for Water Splitting: an integrated study from cradle to grave

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Abstract

The sustainability of Smart Cities and their contribution for the goal of Neutral Climate Impact requires the development of greener energy sources with reduced climate impact. Hydrogen is envisaged by Portugal and the European Union as one step forward in the direction of Neutral Climate Impact. To achieve this, a scientific and technological effort is still required in the development of new materials that can improve the energetic efficiency of hydrogen generation and use.

This project aims to evaluate the available national mineral resources, to develop national competences for fabrication of water splitting materials, and to assess the environmental safety of the fabricated materials, in that way contributing to the neutral climate impact of Smart Cities and to the national hydrogen strategy (EN-H2).

Therefore, the Water Splitting project gathered researchers from four Porto University research units (CIQUP, GreenUPorto, ICT and IFIMUT) to contribute to the assessment and harmonization of the existing data on national relevant mineral resources, to develop new oxide nanomaterials that can be used in the electrochemical and photoelectrochemical water splitting for hydrogen production, to issue recommendations on the safe environmental production and management of the raw materials and final products and to disseminate for the community the findings generated in the project.

The project targets are structured in five tasks/working packages aiming at the development of:

i) updated evaluation of the available mineral resources of non-precious metals that can be used in the fabrication of water splitting materials;
ii) new metal oxide materials for improved water splitting;
iii) new metal oxide nanomaterial devices with improved water splitting properties;
iv) recommendations on the safe environmental use of the metal oxide nanomaterial devices;
v) a prototype to demonstrate the achievements of the project.

The ICT team included in the project is responsible for the execution of the first working package (WP1) which consists in the re-assessment and harmonization of the available data, sampling, and ore characterization. As the materials of interest for the water splitting devices are metals like W, Fe and Zn, the WP1 target is the characterization of tungsten, iron and zinc ores (e.g., wolframite, magnetite, hematite and sphalerite).

Since the tungsten and zinc ores from the Panasqueira and Neves Corvo deposits, respectively, are very well studied and characterized, the ongoing work is focused on the characterization of the iron ores from the Moncorvo and Marão deposits. For instance, the last studies which concerns the Marão iron ore characterization are from the fifties. Therefore, the research line is the characterization of the iron ores using modern techniques such as Scanning Electron Microscopy, Magnetic Susceptibility, Raman Spectroscopy, X-ray Diffraction, Mössbauer Spectroscopy, and Inductively Coupled Plasma-Mass Spectroscopy.

Keywords: Hydrogen; Water Splitting; Mineral; Resources

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Multidisciplinary study of the Vila Cova iron deposit mineral associations

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Abstract

Vila Cova is a non-active iron mine located in the Marão mountain, in the North of Portugal. This mine is framed in the Central-Iberian Zone and the iron ore host rock consists of quartzites and schists from the Marão Formation, lower Ordovician in age.

The focus of this research is to characterize the iron ore from the Vila Cova deposit through several techniques, such as X-ray fluorescence (XRF), using portable equipment, and magnetic susceptibility (χ) with the use of a KLY-4S Kappabridge susceptometer Agico model (Czech Republic) and with a Bartington MS2 System for the frequency-dependent susceptibility (χfD%) study.

For the XRF analysis, three modes were used on two fraction sizes of the iron ore, <90 µm and >125 µm, after crushing and sieving the ore: LIGHT ELEMENTS mode (LE), MINING mode (MM) and SOIL TO CONDITION mode (S2C). The first mode was used to analyse the lighter elements that were not detected by the other two modes, which had very similar results comparatively. As for the obtained results, the focus was the iron contents and the remaining enriched elements. Therefore, with portable XRF equipment, it was possible to determine the presence and the respective relative contents of: Al, Si and P through the LE; Y detected by the MM; Cr, Cu, and Pb with the MM and the S2C; and K, Ca, Ti, V, Mn, Fe, Zn, Rb, Sr, Zr, Co and Ba through the three modes. Consequently, these results indicate in which fraction sizes were the specific elements concentrated. To this extent, it was possible to observe that elements such as K, Ti, Sr, Zn, Zr, Al, Si, Rb, Ca, Y and Mn show higher concentrations in the <90 µm fraction, even in lower quantities, while elements such as V, Co and Fe show higher concentrations in the coarser fraction, >125 µm. The other elements displayed similar concentrations in both fractions.

The variation of Fe content between the two fractions of the ore is corroborated by the magnetic susceptibility, since it is lower for the <90 µm fraction ($\chi = 26747.4 \times 10^{-8}$ m^3 kg^{-1}) than it is for the >125 µm fraction ($\chi = 32471.4 \times 10^{-8}$ m^3 kg^{-1}). Such values of χ indicate a high percentage of a soft coercivity mineral, magnetite in the ore, which was to be expected. The χfD% values preclude the existence of fine superparamagnetic grains, pointing out the presence of multidomain grains.

As aforementioned, this study will use the two fraction sizes of iron ore, along with some polished and thin sections to complete the characterization of the mineral associations of the Vila Cova iron deposit. This will be achieved by relying on other traditional and advanced techniques, which include: 1) Petrography; 2) Metallography; 3) Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM/EDS); 4) Raman microspectroscopy; 5) Mössbauer spectroscopy; 6) Inductively Coupled Plasma Mass Spectrometry (ICP-MS); 7) Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS); 8) $\delta^{18}O$ isotope analysis; 9) X-ray diffraction (XRD); and 10) Isothermal Remanent Magnetization (IRM).

Keywords: iron ore, magnetite, X-ray fluorescence, magnetic susceptibility.

INOVMineral - WebGIS-based Visualisation of Geospatial Data

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Abstract

The INOVMINERAL 4.0 project is funded by Portugal2020, Compete2020, Lisbon2020 and the European Regional Development Fund, with the general objective of reorienting innovative industrial models for the Mineral Resources Industry through the development of advanced technologies, new products and software that respond to all the value chain: upstream, enhancement of Mineral Resources and Market Place (client/market connection). In general terms and, in the specific case of Lithium (Li), the joint use of remote sensing, geophysical, geochemical, and Geographic Information System (GIS) techniques contribute to improving the knowledge of potential areas, reducing possible local impacts and allowing the establishment of priorities with implications: (i) on investment to be carried out in the stages before the start of exploration; (ii) in the selection of the most eco-efficient technologies for blasting and ore treatment, preferably with no waste production; (iii) in the life cycle of the mining operation; (iv) in the value chain of extracted raw materials, respecting the CP (Cleaner Production) principles; and (v) in the selection of methodologies to be used either in the monitoring of environmental impacts, or in their mitigation or remediation. The research area is located in the Ribeira de Pena region, in an area known as Aldeia where Li-bearing pegmatite resources are under study. The large amount of data required the development of a GIS framework to spatially present all the information collected in the project. In the last decades, webGIS applications have been widely developed to dynamically represent variables. Therefore, the main objective of this work was to present a preliminary webGIS implementation under the INOVMineral project, to spatially represent the data acquired in the project. The webGIS is composed of five tabs: i) the “webGIS” tab where the geospatial information is presented under a base map; ii) the “About the project” tab which presents some information about the project; iii) the “Team” tab composed by information about the researchers of the project; iv) the “Publications” tab with a list of publications (and respective links) produced under the project and; v) the “Contacts” tab with a formulary to contact the researchers. The webGIS was developed using HyperText Markup Language (HTML), Cascading Style Sheets (CSS) and Javascript languages and through open source Javascript libraries such as Bootstrap and Leaflet. The development of a user-friendly webGIS allows users to dynamically visualize and analyze the data related to i) processed satellite images for Lithium-Cesium-Tantalum (LCT) pegmatite exploration; ii) reflectance spectroscopy data of the Aldeia pegmatite and host-rocks; iii) gamma-ray spectrometry maps, and iv) LiDAR (light detection and ranging)-derived digital elevation model (DEM) of the area. The data can be disseminated to any user, with tools that can help to analyze the information provided. The webGIS provide free access to any user and can help with management decision-making.

Keywords: remote sensing; mineral resources; GIS technologies; photogrammetry; LCT pegmatite.

Geochemical characterization ofmuscovites from Santa Helena Breccia (Borralha, tungsten deposit)

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Abstract

The Santa Helena Breccia (SHB) is in the Vila Real district in NE Portugal and occurs in the contact between the Central Iberian Zone and the Galiza-Trás-os-Montes Zone. This breccia is a pipe corresponding to a sub-vertical structure, with an ellipsoidal shape with N-S major axis revealing at least 575 m in length, over 150 m in width, and at least 200 m in depth. SHB occurs in the contact between synorogenic Variscan granites and metasedimentary rocks (Silurian in age). SHB is collapse breccia cemented by quartz that was then injected by an injection breccia. The lithological composition of the collapse breccia fragments, which may be metric in size, is identical to that of the surrounding rocks. The injection breccia is composed of small elements (centimetric) aggregated by a fine leucocratic matrix composed of muscovite, quartz and wolframite. The main objective of this study was to geochemically characterize the muscovites, in order to better characterize and understand the injection episode. The ore petrography revealed that the fine wolframite is intrinsically connected with a fine muscovite. A more detailed EMPA study of these muscovites revealed a composition enriched in K (9.5%), Si (22.9%), Al (18.6%), and depleted in Ca (0.008%), Fe (1.8%), Na (0.35%) and Mg (0.59%) when compared with the average values from muscovites resulting of sub-solidus alteration of Borralha Granite elements belonging to the SHB.

These results suggest that the muscovites associated with the injection breccia matrix did not result from the same process that gave rise to the alteration of the granitic elements of the collapse breccia because they have different geochemical signatures.

Keywords: White Mica, Geochemistry, Tungsten Mineralization, Santa Helena Breccia .

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Fluid evolution in a quartz crystal from Venturinha pegmatite (Penalva do Castelo, Viseu)

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Abstract

The Venturinha pegmatite outcrops in a Variscan late-tectonic, coarse-grained, porphyritic, biotite granite in an area NE of Penalva do Castelo (Viseu), specifically between Silvã de Cima and Sezures (Gonçalves et al., 1990). This pegmatite was mined for its beryllium mineralization during the second half of the last century and in the subsequent years for feldspar and quartz. An extensive research by Correia Neves (1962) allowed for the recognition of the following structure and mineralogy: the border zone, that establishes a continuous transition between the granite and the graphic pegmatite, is characterized by the presence of milky quartz, potassium feldspar, muscovite, and biotite; the wall zone presents quartz and microcline-microperthite intergrowth (graphic pegmatite); the intermediate zone is mainly composed of quartz, potassium feldspar and albite, with accessory beryl and tantalite-columbite, followed by a quartz core. During sampling, several quartz crystals were collected, including a 6 cm crystal that consisted of two single-terminated prisms in parallel intergrowth, still presenting on its base part of the matrix composed of muscovite and potassium feldspar. The quartz crystals are milkier at the base than on its termination. A study of fluid inclusions, using microtermometry and Raman microspectrometry, intended to provide some insights into the characterization and conditions that prevailed during the formation of a quartz crystal. The primary fluid inclusions in this sample generally have a negative-crystal shape and range usually from 20 to 60 μm in size. They can exhibit two or three phases at room temperature, with a degree of filling (flw) between 0.60 and 0.95. Fluid inclusions are mainly of the Lc-w, Lw-c and Lw types. Thermometry analyses provided global homogenization temperatures (Th) between +273 and +332 °C for Lc-w fluid inclusions, between +228 and +310 °C for Lw-c fluid inclusions and between +212 and +235 °C for Lw fluid inclusions. Overall, the microthermometric and Raman microspectrometry analyses revealed the existence of: (i) aqueous-carbonic H_2O-CO_2-N_2-(CH_4)-NaCl fluids, with 89.4 to 95.5 mol% H_2O, 3.0 to 5.8 mol% CO_2, 0.6 to 5.3 mol% NaCl, 0 to 0.2 mol% N_2, and traces of CH_4, and an overall density between 0.69 and 0.93 g/cm^3 and (ii) aqueous H_2O-NaCl fluids, with low salinity (between 0.9 and 1.1 mol% NaCl) and with only traces of CO_2, CH_4 and N_2 in some cases, with an overall density between 0.76 and 0.97 g/cm^3. Petrographic, microthermometric and Raman results indicate that this crystal started to crystallize in the presence of aqueous-carbonic fluids that evolved to aqueous fluids with lower salinity at the end of crystallization.

Keywords: beryl pegmatite, microthermometry, microspectrometry, Raman, fluid inclusions

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Multispectral analysis of UAV images from Mostardeira Mine: results from data reduction and unsupervised classification approach

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Abstract

Mostardeira is an abandoned copper mine located in the vicinity of Estremoz city. It is considered as an epithermal quartz vein type with chalcopyrite as the main ore and with associated sulphides, carbonates, and oxides. The quartz vein has a variable width between 1.9 m to 2.4m and crosscuts rocks from Siluriam to Devonian ages in the SW flank of the Terena anticline.

This work was conducted to demonstrate the aptitude of using Unmanned Aerial Vehicles (UAV) to map the different soil and geological units present in the area. A Mavic 2 Pro equipped with a RGB camera and a multispectral NDVI Sentera sensor was used. The flight was done at an altitude of 100 meters covering an area of 37.44 ha with 438 photos. This flight conditions allowed to create orthorectified images with a pixel size of 3.1 cm for RGB image and 12.4 cm for NDVI image. The images were resampled to a 10 cm pixel size and the results were processed in QGIS using the Semi-Automatic Classification plugin and resampling algorithms from SAGA API package.

For image classification the k-means and Isodata methods were applied, and the results were interpreted according to a classification of 2, 4 and 6 classes that include mine waste, barren soil, grassland, trees, among others. For data reduction PCA analysis was carried out reducing the information from 5 to 3 components. The NDVI index was calculated according to Sentera sensor specifications.

The results obtained suggest that NDVI is useful to separate vegetation (NDVI> 0.58) from grassland (NDVI between 0.42 and 0.58), soil (NDVI between 0.33 and 0.42) and raw soil (NDVI <0.33). with kmeans and isodata algorithms showing similar results. Kmeans with 2 clusters separates vegetation and shades from soil. The 4 clusters image allow the distinction between Tress and shadows, Grassland, Soils, and Raw Soils.

The PCA results can be used to separate the previously identified elements, that is, PC1 displays Trees, its shadows, and Grassland in the positive part of the axis and Soils and in the negative part.

As an overall result one can state that the results are promising and the combination of the UAV information, with machine learning techniques will provide new insights to the automatic identification of soil types and lithologies.

Keywords: unmaned aerial vehices, soil classification, k-means, principal component analysis.

Mineralogical and petrographic characterization of Preguiça and Vila Ruiva mines

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Abstract

This study was performed on the Preguiça and Vila Ruiva mines and aimed at petrographic and mineralogical characterization of various geological media. The Preguiça and Vila Ruiva mines are two examples of the different types of Zn-Pb(-Ag-Sb-Au) deposits that occur in the Ossa Morena Zone, more specifically in the Moura-Ficalho region. Both deposits are in Serra da Preguiça, Beja district, and were explored for Fe-Zn-Pb in the early 20th century and between 1960 and 1966. In Preguiça and Vila Ruiva mines, the old exploration mainly targeted supergene enrichment areas, and information available on the primary mineralisation is scarce. The geology of the Preguiça-Vila Ruiva mining area consists of carbonate rocks that are affected by significant hydrothermal alteration (dolomitization and chertification), essentially composed of dolomite, calcite, and minor ankerite. Recent studies suggest that the Preguiça and Vila Ruiva deposits correspond to very rich secondary Zn-ores located in metadolostones of Lower Cambrian age due to strong in situ oxidation and supergene enrichment processes on previous sulphide mineralisation. Rock samples were collected from the gossans and the host rocks in the spring of 2022. In addition, local soil was sampled from the first 15cm of the soil profile. All rock and soil samples collected from Preguiça and Vila Ruiva were analysed by x-ray diffraction (XRD) and the host rock specimens were further studied using a petrographic microscope. The study of the Preguiça and Vila Ruiva thin sections suggests that the host rocks correspond to dolomitic meta-limestones manly with granoblastic texture, composed of dolomite, calcite, quartz, and opaque minerals. For the Preguiça mine, XRD shows that the dolomitic meta-limestone has average dolomite contents of ~30%, while Vila Ruiva shows significantly higher contents (~80%) of this mineral. The Preguiça gossan is characterized by significant amounts of willemite (~52%), quartz (~40%), and iron oxides (goethite, hematite, and minor magnetite). Accessory minerals include chalcophanite and anglesite. At Vila Ruiva, the gossan is dominated by iron oxides, manly magnetite (~33%) and minor hematite (~17%) and goethite (~12%). In this mine, mineral phases such as willemite, chalcophanite and anglesite were not identified. The soils of Vila Ruiva present slightly higher amounts of quartz and lower contents of carbonate minerals than Preguiça soils. However, smithsonite (~12%) was only identified for Vila Ruiva, while cerussite (~3%) was identified only for Preguiça. Hematite is the most abundant iron oxide in the soils of both mines. Although the results suggest some differences in the gossans mineralogy of both mines, the small number of samples analysed largely justify further investigation.

Keywords: x-ray diffraction, petrography, host rock, gossan, soil.

Soil Geochemical Assessment Surrounding a Coal Mine Waste Pile Affected by Self-combustion – Pejão Mining Complex

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Abstract

The Pejão Mining Complex, located in Castelo de Paiva, operated over a century until its closure in 1994, exploiting anthracite A (ISO 11760, 2005) from the Douro Coalfield to be used in power generation. In 2017, after ignition caused by forest fires, Fojo waste pile started self-combustion obliging to a technical intervention in 2019 by a Portuguese company responsible for environmental monitoring and rehabilitation of degraded mining areas (EDM - Empresa de Desenvolvimento Mineiro).

Coal waste piles affected by coal-fires can represent a potential source of contamination to surrounding soils. In the scope of SHS Project, aiming the geochemical characterization of the soils surrounding the Fojo waste pile, a total of 40 samples of deposited coal mining waste were collected, as well as the soils located uphill and downstream. Samples were dried, pulverized and analysed by inductively coupled plasma emission spectrometry/mass spectrometry (ICP-ES/MS). The samples were characterized geochemically, and elemental spatial distribution accessed, values were compared with national and international reference values and allowed the characterization of both the residues deposited in the waste pile as well as surrounding soils.

Lead, Sb and As concentrations in the waste pile are high, with the majority of the samples presenting concentrations above soil reference values for agricultural usage, proposed by the Portuguese Environmental Agency - APA. In the soils sampled downstream the mine waste piles, only As overcomes the Portuguese reference, nonetheless the soils located downstream the waste pile show an enrichment in Mo, Cu, Pb, Zn, Ni, As, Sb, Cd and Cr comparing with soils located uphill. The spatial distribution of these elements combined with environmental assessment indexes reveal an increase of these potentially toxic elements (PTEs) in the waste pile, whose remobilization might be the source of the enrichment identified in the soils distributed along the drainage basin.

Keywords: Coal exploitation, mining waste materials, soils, PTEs

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Multidisciplinary study of mineral associations of the Torre de Moncorvo iron deposit of Cabeço de Mua

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Abstract

The Cabeço de Mua iron ore deposit is located in the Torre de Moncorvo mining district, a northeastern region of Portugal, in the Bragança district, where iron has been explored since the Iron Age. Cabeço de Mua's iron deposit has an unquestionable value as a source of resources and thus, the characterization of its ore in the light of new methodological advances is important. As the first step in the characterization of the iron ore, an X-ray Fluorescence (XRF) portable equipment was used on crushed iron ore samples. This equipment is important as an initial approach since it quickly analyses the elements' concentrations present in the ore. Petrographic microscopy, Scanning Electron Microscope with Energy Dispersive Spectroscopy (SEM/EDS) and Raman Microspectroscopy were used to characterize the iron ore occurrences, as well as the mineralogical assemblages. Preliminary results show that the ore minerals are dominated by hematite and later goethite and rare magnetite. The gangue is mainly constituted of quartz and some phyllosilicates, such as muscovite and chlorite. Regarding the XRF results, these allow us to do a comparison with iron ores from other deposits and to have a general idea of the iron and other elemental contents so that the subsequent analysis could be appropriately prepared and carried out. The elemental results were not far from what is described in the literature for most of the elements in this deposit.

The XRF analysis were conducted on the same samples by testing three different analytical modes: Light Elements (LE) mode, Mining mode and Soil to Condition mode. The results obtained through Mining Mode and Soil to Condition mode were very similar, while there was a clear distinction with the results from the Light Elements mode. The first two modes were the only ones that detected Cr and Cu, elements that did not appear in the LE mode, which can detect lighter elements such as Al, Si and P. The three modes were able to detect K, Ca, Ti, V, Mn, Fe, Zn, Rb, Sr, Zr, Co and Ba. The most interesting and important value is the Fe one, showing that the samples have an average of 37% Fe. In the near future, these values will be compared to Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) analysis, to ascertain whether it is beneficial or not to use XRF methodologies in this type of deposit and research.

Regarding magnetism, the analysis was also conducted on crushed samples, which displayed an average magnetic susceptibility of χ = 838.1 x 10^{-8} m^3 kg^{-1}, hence supporting the presence of both high and low coercivity magnetic minerals. The Frequency-dependent Susceptibility (χfD%) values preclude the existence of fine superparamagnetic grains.

To complement the characterization other techniques will be resorted upon such as: X-ray Diffraction (XRD), ICP-MS, Laser Ablation Inductively Coupled Plasma Mass Spectroscopy (LA-ICP-MS), $\delta^{18}O$ isotope analysis, Isothermal Residual Magnetism (IRM) and Mössbauer spectroscopy.

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Fluid evolution in tin and tungsten deposits associated with Laza-Rebordelo-Murçós shear zone.

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Abstract

The Laza-Rebordelo-Murçós shear zone (LRMSZ) is located in the eastern of the Galicia-Trás-os-Montes Zone (GTMZ), not far of its limits with the Central Iberian Zone (CIZ). Along this structure, several tin (Sn) and tungsten (W) mineralized quartz veins occur, distributed in the axial zone of the Chaves-Miranda do Douro antiform, hosted by the Silurian metasediments of the Parautochtonous Domain and spatially associated to a great variety of variscan granitic rocks. This study will focus on a set of deposits that occur along the LRMSZ and the main examples are Ervedosa (Sn) and Murçós (W) deposits, both corresponding to old productive mines. One of the most notable characteristics of these deposits is the differential expression of metallic ores, with the occurrence of veins with dominant mineralization of cassiterite, in Ervedosa, and of scheelite, in Murcós, spatially related to two-mica granites and biotitic granites, respectively. This project aims to investigate the importance of the fluids in the current distribution of Sn and W in quartz veins and therefore contributing to better understand the metallogenesis of Sn and W deposits. A comparative study of the fluid evolution in the different types of quartz veins, cassiterite-rich and scheelite-rich, and with both ore minerals will be carried to evaluate the magmatic and hydrothermal contribution and study the importance of magmatic-hydrothermal transition in the mineralizing processes. This study will combine field observation, information from mineral assemblages and trace element geochemistry of minerals, microthermometric and Raman studies of fluid inclusions in quartz, cassiterite and scheelite, ion analyses on solutions using the conservative tracers such as Br and Cl, stable isotope (D, O) and dating. The origin, P–T–X conditions and fluid flow evolution for the different studied veins will be reconstructed and will contribute to better understanding the formation of Sn and W quartz veins associated with LRMSZ. It is relevant to evaluate the existence of genetic affinities between the Sn and W mineralizations, that is, if they are independent in space and time and therefore related to different granites or if, on the contrary, they correspond to a continuous process and their difference is only due to the existence of a peribatolitic zoning.

Keywords: Fluid inclusions; Microthermometry; Stable isotopes; Raman Microspectroscopy.

Characterization of Road Dust in an urban area through cost-efficient methodologies

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Abstract

Road dust can be a valuable means to characterize environmental quality in urban areas since it reflects the accumulation of solid particles, organic and inorganic compounds, with various natural and anthropogenic sources (e.g. surface erosion, atmospheric deposition related to road traffic). A detailed characterization of these dust, according to the location, particle size distribution, chemical composition, origin and potential ecotoxicological and human risks, can be a very useful proxy of an urban environment air pollution degree. The main goal of our study was to characterize the road dust from a major sideroad near the Faculty of Sciences of the University of Porto in two seasons of the year in October 2021 (autumn) and January 2022 (winter). Biweekly road dust samples were collected, sub-sampled and analyzed for particle size distribution. In each size fraction, it was determined the magnetic susceptibility (SM) using a suscetibilimeter, colour parameters corresponding to the CIELAB system (L*a*b*) using a spectrophotometer and chemical composition determined by X-ray fluorescence using a portable X-ray spectrometer.

Our results reveal that the coarser fractions are the dominant ones (500 μm<Ø<1 mm and 250 μm<Ø<500 μm). However, the finer fractions, especially Ø<25 μm, although less representative in mass, are the most relevant concerning human health protection, whose elemental analysis results may be of greater interest. The chemical elements with the highest concentration were calcium, iron, potassium and titanium, but potentially toxic elements such as chromium, copper, manganese, nickel, lead and zinc were also present. These elements presented an increasing trend in concentration at the finer granulometric fractions, with maximum concentration at the fraction < 25 μm, which correspond to potentially inhalable particles when resuspended in air. The magnetic susceptibility values (SM) follow a similar trend as the elemental analyses, increasing as the particle size decreases. Concerning the spectrophotometric analysis, the colour parameters (L*a*b*), showed similar values for the different sampling months and with low inter-sample variability.

From the two sampling moths it's possible to observe some differences between sampling periods (Autumn – Winter), in particular for chemical composition. Some seasonal changes may affect the composition and hazard of road dust, it would be interesting to verify whether this characteristic would remain seasonally stable for in a second year sampling.

Keywords: Road Dust, Magnetic susceptibility, X-ray fluorescence, Particle size distribution, spectrophotometry.

G 4 – GEOCONSERVATION AND GEOSCIENCE EDUCATION

Oral communications

An Object-Oriented Python Application Programming Interface (API) for Geographic Resources Analysis Support System (GRASS) Geographic Information System (GIS): Reclassification of the lithological chart of the National Ecological Reserve (REN), Portugal.

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Abstract

The National Ecological Reserve (REN) is a public utility restriction of national scope, included in the territorial management instruments, subject to a special territorial regime established by decree-laws. It is a biophysical structure that integrates the set of typologies that, due to their ecological value and sensitivity or to their exposure and susceptibility to natural risks, are subject to a special protection regime - the National Ecological Reserve Legal Regime (RJREN).

Among the set of actions necessary for compliance with the legislation is the territorial delimitation of these areas. Thus, the aim of this work is to highlight the importance of the tools provided by geographic information systems and information systems, more specifically with regard to the Quantum GIS program and the Python programming language and Python GIS technologies, respectively.

Geographic Information Systems (GIS) have the ability to integrate heterogeneous digital data, give public administration, industry and research the opportunity to provide basic and advanced data analysis and modelling services for a wide range of topics. The Geographic Resources Analysis Support System (GRASS) supports the creation, modification and processing of 2D and 3D raster and vector layers. It provides a topological vector model and true three-dimensional coordinates for feature vectors.

The GRASS developers chose Python to replace POSIX for scripting modules. For this purpose, a Python scripting library was implemented, providing a Python API for GRASS modules. However, the Python API was implemented, the current Python scripting API provides the additional improvement to the POSIX approach of managing process chains using the standard Python library and a larger community of programmers and open source material.

The methodology used, consists of implementing the PyGRASS library, which is written in Python and makes use of modules from the standard of their respective libraries. From the implementation of the libraries mentioned above and the definition of the classification methods, it was possible to outline the functions which subsidized the construction of an interface which allows the automatic execution of the operations of calculation and reclassification of the variable corresponding to the lithology of the Geological Map of on a city-wide scale.

As a result, it was produced a plugin that "renders" an interface that requires inputs (layers) for the calculation and reclassification of variables corresponding to lithology, slopes in degrees, hydrography, vegetation cover, topography, areas threatened by floods, the areas of instability from the Geological Map of the municipality of interest and the break values pre-determined in the classification methods: *Processing tools > GDAL > Vector conversion > Rasterize (vector to raster), Processing tools > GRASS > r.recode, Processing tools > GDAL > Raster calculator, Processing tools > Raster analysis > Raster layer statistics, Processing tools > GDAL > Raster conversion > Transform to polygons (raster to vector)*, respectively.

This work demonstrates the importance of the development and use, in an enterprise environment, of open-source plugins to automate and reduce costs and errors in the processing and analysis of georeferenced data.

Keywords: Object Oriented Python, GIS, REN, GRASS, open source.

Acknowledgements: This work was supported by GeoAtributo Consultadoria e Informação para o Planeamento e Ordenamento do Território, Lda,. The authors acknowledge the company for providing working conditions for the development of research skills.

Geoheritage assessment in the Calbuco volcano, Chile: defining the first stages of a geoconservation strategy

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Abstract

Calbuco volcano (41,3°S; 72,6ºW) is located in the Southern Andes of Chile, in the Los Lagos Region. Volcanic hazard is high due to historical and recent eruptions and around 300 000 inhabitants of the region are exposed to it. The main volcanic edifice reaches 2015 m of altitude and is partially located within public (Reserva Nacional Llanquihue) and private parks (Parque Valle los Ulmos y Parque Volcanes). Products of the last eruption (22 April 2015) reached a large area in the surroundings of the volcano, including the village of Ensenada. Each eruption volcanic delivers new deposits and landforms (e.g., pyroclastic flows, lahars, tephra falls, lava flows) which are key to reconstruct volcanic processes and to support volcanic hazard assessment. In that sense, some of these sites can be considered as geoheritage, taking into account their scientific value and their potential use for scientific, tourism and education activities. Moreover, education and awareness of volcanic processes are of special importance in this region, where local communities are exposed to volcanic hazard. Bibliographic research, geological mapping, stratigraphy and petrology studies supported the selection of a first set of 25 sites in the northern flank of the Calbuco volcano. These were numerically assessed, using qualitative and quantitative procedures and considering scientific value and use potential criteria. Five of the inventoried sites scored highly in this assessment, both in scientific value and use potential, having the best visibility and accessibility conditions. Besides, other sites may also be used in scientific, educational, and touristic activities if geoconservation strategies are considered in the management of the area. A similar approach is planned for the remaining areas of the volcano, as a first step to support a geoconservation strategy for the Calbuco volcano area. A complete inventory of the geoheritage and its quantitative assessment are the basis to sustain management initiatives which include conservation, dissemination through tourism and educational activities and monitoring of the sites. More knowledge and awareness of volcanic processes and hazards could benefit the social and economic development of local population. This geoconservation strategy could be managed by nature conservation bodies such as the parks that already exist in the area or through a new project such as a geopark. This management could include local institutions, such as local government bodies, universities and research units, nature conservation staff and local associations.

Keywords: Calbuco volcano, Andes, geoheritage, geoconservation, strategy.

Science communication theory and practice among geoscientists

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Abstract

The geoscientific community has been developing several efforts to engage with the public, with a significant multiplication of initiatives and an increasing recognition of the importance of science communication as part of their professional activities and duties. However, even though scientists seem to have regular and satisfactory public engagement experiences, it does not mean that their practices have positive results. Literature reveals that several factors influence their performance, frequency and willing to communicate, such as self-perceived competence or previous training.

The present study deepens the research about the Portuguese geoscientists' community regarding public engagement and our goal is to discuss the relation between perceptions and practices. For this, we use statistical and machine learning procedures to analyse the survey data. This study is part of a wider project seeking strategies to improve geoscience communication, making it more frequent and more effective.

Analysing geoscientists' communication practices, through an attitude-based questionnaire, we concluded that their experiences do not always reflect their opinions or perceptions and that they seem distant from science communication research. The goals that drive geoscientists to communicate or the way they view their audiences is a clear symptom of this fact. They tend to emphasize public knowledge deficits and to perceive public as uniform, passive and influential. Despite many years of research pointing to other direction, scientists tend to think that if they transmit the right messages to the public they will have the expected impact, changing public's attitude, increasing their interest according scientists views, difficulties such as objection or controversy being considered a mere bad communication.

A comprehensive literature review and a survey administered to the Portuguese geoscience community reveals that the majority of the public engagement corresponds to education-focused outreach. These are mainly linear communication strategies to address knowledge deficits. At the same time, bidirectional strategies such as public discussions or debates are not frequent activities among geoscientists and this resistance to shift paradigm may be explained by lack of formal training and limited influence of science communication research on practice. Lack of training, deficient skills and apparent self-confidence lead to the implementation of strategies grounded by personal instinct and experiences instead of strategic planning or updated research. Even when seeking for training, scientists mainly want to develop skills to convey clear messages, remove jargon and practice effective knowledge transmission, such as, for example, mastering techniques such as storytelling or elevator pitches. There are also few courses available to support scientists identifying engagement objectives, developing targeted strategies or fostering scientist-public dialogues.

Better geoscience communication demands a paradigm shift and a closer relationship between science communication research and practitioners. Geoscientists have to rethink the way they publicly engage and develop new skills with specific training oriented to capacity building on dialogical and participative bidirectional strategies. Geoscientists working on hazards, climate change, mineral resources or other sustainability topics would benefit from building up a better understanding of the different audiences, acknowledging personal values, understanding complexities of decision-making, dealing with uncertainty, increasing scientists' positive attitudes toward public engagement and fostering dialogue opportunities.

Keywords: science communication, public engagement, geoscientists, geoscience communication.

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G 4 – GEOCONSERVATION AND GEOSCIENCE EDUCATION

Poster communications

Fostering geoconservation strategies in Patagonia Verde (Chile): sites inventory, assessment and management proposals

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Abstract

Patagonia Verde is a territory of 19,212 km2 in the Lake District (Región de Los Ríos) in southern Chile. The population density is close to one inhabitant per square kilometre, and National Parks and National Reserves protect 28% of its territory. The region is characterised by a pristine landscape, where granite mountains, fjords, glaciers, rivers, hot springs, and volcanoes form a rugged terrain with unique ecosystems and life forms adapted to frequent volcanic eruptions, earthquakes, and landslides. This outstanding geodiversity is recognised worldwide and visited by hundreds of thousands of tourists annually. A project developed between 2017 and 2019 aimed to promote the values of geodiversity and its sustainable use in tourism. To this end, a systematic geoheritage inventory and the definition of guidelines for the sustainable use of the geological resources were implemented. The inventory was based on methodological procedures with well-defined stages: definition of the topic, the value, the scale, and the aim of the inventory; definition of geological contexts; background collection; site selection criteria; fieldwork: identification, selection and preliminary inventory of sites; quantitative assessment; data analysis. 91 sites were inventoried and the information collected was organised following a geological contexts' framework. A quantitative assessment of the scientific value, the potential for educational use, the potential for tourism use, and the risk of degradation of the inventoried sites was performed, using criteria and indicators following parametric procedures to minimise subjectivity. The results obtained in the quantitative assessment supported comparisons between the inventoried sites, and the proposal of eight management categories. 67 sites correspond to Category I (Research), 22 to Category S (Science), 45 to Category E (Education), 43 to Category G (Geotourism), 16 to Category R (Regulation), 2 to Category P (Protection) and 13 to Category Sc (Secondary). Only 30 of these sites have characteristics to be considered as geosites. Supported by the inventory and management categories, a management strategy was suggested, based on the geoparks management model. Patagonia Verde Geopark project should be implemented, considering as management and decision-making bodies a geopark association, a scientific-educational committee, a local board, and key partners. This project follows the traditional bottom-up approach in geoparks and this management model and action plans are a technical response to a need raised by the stakeholders of the territory. The Association of Patagonian Guides is currently leading and promoting the Patagonia Verde Geopark project, unifying the local communes and implementing geoconservation and geotourism initiatives in all the territory. To support the project, the Patagonia Verde Geodiversity Action Plan was proposed, being expected that adequate management, monitoring and promotion of the inventoried sites will improve the inhabitant opportunities, generating an alternative to the current nature tourism initiatives and mainly the mining development that most of the regions of Chile have acquired.

Keywords: Patagonia Verde, Geodiversity, Geological Heritage, Geoconservation, Geotourism

G 5 – ENVIRONMENTAL MONITORING AND REMEDIATION FOR SUSTAINABILITY

Oral communications

Hydrogeological characterization of a groundwater municipality reservoir (Guimarães, North of Portugal)

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Abstract

Water is an essential resource for human survival. Water demand has increased with the growth of the world population. Groundwater is the largest and safest drinking water resource, then must be carefully protected and with a sustainable exploitation.

Guimarães is a municipality located in the North of Portugal with a relevant groundwater reservoir, on the southeast of the city, and in the granitic fractured massif. The presented research intends to present a detailed hydrogeological characterization of groundwater reservoir from Montanha da Penha region. A total of forty groundwater mines on the aquifer system were selected and water physicochemical parameters were measured "in situ" (e.g. Electrical Conductivity, Temperature, pH, Eh, Dissolved Oxygen and Total Dissolved Solids) during two different seasonal periods (wet and dry season). In the dry season (june, 2022), chemical and isotopic analyzes (2H and 18O) were determined on sixteen selected groundwater points.

The groundwater system from Montanha da Penha presents an average flow of 0.17 L/s. The groundwater is slight to weakly mineralized, acidic to neutral (pH: 5.04- 7.31), with an electrical conductivity varying between 31 and 119 µS/cm, and a low Total Dissolved Solids content (TDS: 27.4 - 33.9 ppm). The water presents a dominant sodium-chloride hydrochemical facies, with chloride as the dominant anion (Cl: 6.9 - 12.9 mg/L), and sodium the dominant cation (Na: 5.4 - 10.0 mg/L). The groundwater results indicate that the water could be used for human consumption.

The environmental isotope results - 18O and 2H - obtained for groundwater aquifer system suggest a dominant meteoric origin for the groundwater, mainly associated to local water precipitation, located between 455 and 525 meters of altitude, and within a shallow flow regime. These results allowed to the elaboration of a hydrogeological conceptual model to the studied region, suggesting that the local faults and geology promote water-rock interaction processes in depth.

The presented research is an important contribution to the Sustainable Development Plan of the municipality of Guimarães and the sustainable management of groundwater resources from the region.

Keywords: Hydrogeochemistry, Environmental isotopes, Groundwater flow, water sustainability, Penha Mountain.

Acknowledgments: This research is developed under the FCT - Fundação para a Ciência e a Tecnoliga, I.P. program, UIDB/04683/2020 and UIDP/04683/2020 projects.

Monitoring and remediation of mining effluents - a phytoremediation study

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Abstract

Mining activity produces large amounts of wastes that, due to their chemical instability, generate numerous of negative impacts on surrounding ecosystems, such water, air and soil contamination. Mining effluents, originated under these conditions, typically present high acidity, sulfate content and presence of potentially toxic elements. These effluents, which may exhibit a high content of suspended matter, including nano-sized colloids, are generally referred to as acid mine drainage (AMD).

Treatment of AMD is complex and can be quite expensive as this type of pollution exhibits long-lasting effects on the environment. There is a wide range of possible treatments, from conventional and/or more ecological remediation. Phytoremediation aims to be an economically attractive technique, that uses plant species in order to clean water, thus remediating contaminated areas.

So, the present work went through the hydrochemical characterization of effluents in the Covas mining area: Poço Negro stream and Coura river. The research focused on the study of the possible treatment of effluents with AMD characteristics, through phytoremediation. For this, two pilot trials were conducted: one with filtered water and the other with unfiltered water. On one hand, the work consisted of daily monitoring of physicochemical parameters. On the other hand, it focused on the performance of the species *Phragmites australis*, namely with respect to its development and variations in chlorophyll production, in relation to different hydrochemical tests.

The results obtained did not show considerable differences for the two tests. These, in general, showed improvements in the hydrochemical parameters evaluated. The species in question showed resistance to the effluents administered.

The work carried out supports the application of natural and sustainable solutions in the management of water resources, with positive effects both for the surrounding ecosystems and in the context of climate change.

Keywords: Mining effluents; Acid mine drainage; Phytoremediation; Water scarcity, *Phragmites australis*.

Development and optimization of decentralized decision models – an application to sustainable mine activities

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Abstract

The mining and metals industry is one of the building blocks of the Fourth Industrial Revolution. Raw materials are the indispensable foundation for a future digital society. The challenge is enormous. Concretely, the 2020 Communication from the European Commission on Critical Raw Materials Resilience indicates that only for batteries for electric vehicles and energy storage, it will be needed up to 18 times more lithium and 5 times more cobalt in 2030, and almost 60 times more lithium and 15 times more cobalt in 2050, in relation to the current supply to the entire EU economy.

The main objective of this research project is to develop a scientific analysis that helps to optimise decision-making on descabonization in the mining sector and the imminent demand for strategic minerals, achieving the implementation of increasingly sustainable and efficient mining. Within this context, the analysis of big data starting from the development of bayesian models will be able to integrate and produce collective elicitation knowledge.

The resulting models should be auditable from a programming point of view. The development of numeric simulations will support in decision-making models that will consider the cost linked to the acquisition of information. From a computational point of view, thanks to the mathematical information theory introduced by Claude Shannon, the uncertainty relative to the entropy and mutual information between the variables of the mining environment will be modelled and analysed through influence diagrams. Finally, the impact on the value of flexibility within decision-making models will be considered, extending Bratvold's findings applied to the North Sea oil industry.

Finally, this research project aims to understand the impact and the future mathematical application of technologies with disruptive character in the blockchain and the mining sector. So, different protocols likewise his cryptographic characteristics and energetic consumptions will be analysed with the goal to propose potential applications in the mining sector.

The presented research project is crucial and urgent in guiding the implementation of the digital transformation on the mining and energy sector. In this context, delving into data analysis, with enough information acquisition to carry out accurate mathematical simulations leading to process optimisation is a significant challenge to overcome.

The importance of biotic and abiotic risks assessment and modelling in the development of frameworks for forest growth models in context of climate change

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Abstract

The increasing Mediterranean climate influence in Portuguese forests is pressuring the ecosystems to adapt, mainly to the rapid alteration of abiotic factors, that change the availability of radiation, temperature and water. In one side, forest ecosystems resilience is exceeded and the tree vitality is compromise by biotic factors in the form of diseases and plagues. In other side, the fire risk in increased by the new abiotic factors specially in highly flammable species that were planted in former, less risky, environment conditions. In the present presentation it will be discuss the importance of biotic and abiotic risks assessment and modelling in the development of frameworks for forest growth models in the definition of new proposals for forest landscape transformation and with the development of new silvicultural models, to match the needs for carbon and water uptake in the actual climate emergency policies.

Keywords: mathematical modelling; forest ecosystems; cork oak; adaptive management; silvicultural model.

A new artificial intelligence strategy for predicting the groundwater contamination risk over the Menzel Habib shallow aquifer in south-eastern Tunisia

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Abstract

Strategic and prudent measures for the management and protection of groundwater resources were scientifically provided by constructing reliable and accurate groundwater salinization risk (GSR) models. The aims of this study are to assess GSR using, firstly, DRASTIC approach, and then, different machine learning models. Artificial neural networks (ANN), support vector regression (SVR) and Multiple Linear Regression were applied in Menzel Habib shallow aquifer, south-eastern Tunisia. The DRASTIC Vulnerability Index is varying from 91 to 141, categorized with low (85%) and moderate (15%) vulnerability thresholds. The correlation coefficient (r) between Total Dissolved Solids (TDS) contents and DRASTIC index were 0.47. To introduce improvements in the original DRASTIC method, the vulnerability indices were adjusted by TDS contents, termed as the groundwater salinization risk (GSR). Seven DRASTIC parameters and GSR values were, respectively, used as the input and output of different machine learning models. The correlation indicator demonstrated that the ANN model outperformed the other ones, by a larger r value. Subsequently, the r for the ANN was 0.89 revealing the superiority of the machine learning models when compared with the original DRASTIC index. The new machine learning model can be considered as a good tool to map groundwater salinization risks in arid areas, yielding a useful information about groundwater resources management.

Keywords: Groundwater salinization risk, DRASTIC, machine learning models, Menzel Habib, Tunisia.

Acknowledgments: This research is developed under the FCT - Fundação para a Ciência e a Tecnoliga, I.P. program, UIDB/04683/2020 and UIDP/04683/2020 projects.

Evaluation of potential sources of soil and water contamination in Serra da Estrela

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Abstract

An investigation is being conducted in the scope of a PhD project aiming to evaluate the impact caused by forest fires and fossil fuels combustion from road traffic in the Natural Park of Serra da Estrela (PNSE). The areas to be studied include the sectors of Manteigas and the top of the mountain, where the road traffic is more intense. The motivation to study the impact of forest fires in soils and waters is related to the fact that in August 2022, a forest fire consumed a significant part of the PNSE, affecting the area surrounding Manteigas. At the same time, the PNSE is one of the most visited regions in Portugal, with annual visitors estimated in the order of millions, resulting in an intense road traffic all year round, since its creation in 1976. The first sampling campaign was carried out in October 2022, as soon as possible after the fires and before any rain event, and included the selection of twelve sampling points to collect soils on both unburned (four) and burned areas (eight). In each sampling point the superficial layers were collected as follows: horizon O in unburned soils and ash in soils affected by fires. Additionally, the underlying horizon A was also collected in all sampling points. In the laboratory, the samples were air dried, sieved and quartered to be analysed for determination of pH, electrical conductivity (EC), organic matter content, elemental chemical composition, magnetic susceptibility, and concentration of polycyclic aromatic hydrocarbons (PAH). It is planned to repeat the sampling of soils in approximately the same burned areas to identify the effects on soils along the time, principally related with erosion, percolation and mobilization processes, after six months and after one year. Regarding the waters, two sampling campaigns were carried out (October and December 2022) in four springs (two potentially affected by the fires), and four superficial water streams (three in the burned areas and one in an area not affected by the fires). *In situ* measurements of pH, EC and temperature were carried out. In the field the water samples were properly preserved and in the laboratory the parameters to be determined are colour, turbidity, total alkalinity, bicarbonates, total organic carbon, total hardness, major inorganic ions, metals and PAH. The sampling of waters in these points will be performed every two months for one year. Concerning the evaluation of impacts of road traffic, it is planned to collect the soils and waters in the region where the road traffic is more intense due to tourism (top of the mountain and along the main access roads). The parameters to be analysed are the same as described before. Standardized procedures will be developed whenever possible. It is expected to obtain a more in-depth knowledge on the impacts on soil and water, mainly resulting from biomass and fossil fuels combustion in an area of great importance and environmental sensitivity.

Keywords: Soil, Water, Combustion, PAH, Contaminants.

G 5 – ENVIRONMENTAL MONIROTING AND REMEDIATION FOR SUSTAINABILITY

Poster communications

Natural attenuation processes in AMD context by mineralogical control: iron oxyhydroxides, oxyhydroxysulfates, and efflorescent sulfates

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Abstract

Acid mine drainage (AMD) is a common problem associated with the weathering of metal sulfide wastes in abandoned mining areas, which can be rich in toxic metals and metalloids. Oxidative dissolution of these minerals may negatively affect the soils and water reservoirs nearby. The formation of secondary mineral phases such as iron oxyhydroxides, oxyhydroxysulfates, and efflorescent sulfates may be a natural attenuation process in these areas because these minerals can scavenge potentially toxic elements. Typically formed by the evaporation (efflorescent salts) or precipitation (ochreous iron-rich oxyhydroxides) these minerals are highly soluble and reactive. Therefore, their characterization and inventory are particularly important for predicting the cycles of retention/contamination or accumulation zones of potential toxic elements (PTE) and acidity in mining contaminated systems.

The abandoned mines of Valdarcas and São Domingos were selected for the present study due to their AMD signature and occurrence of some of these secondary minerals. Valdarcas (north of Portugal) is a W-mine associated with a skarn deposit with sulfides that has already been rehabilitated. However, the AMD problems remain in the watercourse that receives leachates from the waste dumps. São Domingos is a Cu-mine composed of massive sulfide deposits that belong to the Iberian Pyrite Belt (south of Portugal). This mining area, which is presently under remediation process, is highly contaminated and AMD is a long-lasting problem. The samples collected in these mining areas were characterized by their morphology, size, mineralogy, and chemical composition using different techniques: binocular microscopy, SEM-EDS, TEM, BET, DRX, FTIR, and XPS.

In Valdarcas mine area, typical ochreous phases such as schwertmannite and goethite were identified as the dominant secondary phases. These brownish-yellow ferric amorphous and poorly crystalline minerals with high surface area (125 mg^2/m) can remove PTE via adsorption processes, contributing to their retention in the mining environment. In contrast, at São Domingos, efflorescent sulfate salts are more abundant. Melanterite and copiapite were the prevailing salts identified. With different morphologies, these minerals are highly soluble and therefore play a relevant key in the retention/mobilization cycles of hazardous contaminants, such as arsenic (As).

This integrative methodologic approach, based on the use of several techniques, allowed a complete characterization of these minerals. In addition to composition, the surface properties that are relevant for the adsorption ability, were also obtained. Therefore, the study revealed a diversity of behaviors for the identified phases, suggesting various roles in increasing the resilience of the contaminated systems.

Keywords: AMD, mineral attenuation process, secondary minerals.

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Geological setting of the chipindo mine: a preliminary analysis

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Abstract

As a contribution to the metallogenic model for the Chipindo mineral deposit, the preliminary characterization of the geology of the area is presented. The open-pit mine is located in Huíla, Angola, and currently explores primary gold. It is included in the South Sheet D-33/J of Caconda from the Geological Map of Angola at 1:250 000 scale.

Geologically, the mineral deposit is part of the "Coarse-grain porphyroid leucogranites" unit that is, essentially, composed by leucocratic granites, with potassium feldspar phenocrysts of idiomorphic habit and poikilitic texture.

The exploration targets mineralised quartz veins. For this work, and as part of a PhD thesis of Kumoleha A., a total of 49 rock and mineral samples were collected in the mining area for the lithological and mineralogical characterization of the deposit. 21 samples were collected in the mining area, including the mineralized structures, and host rocks. The field description encompasses i) Quartz associated with leucogranites; ii) Mineralized quartz veins; iii) Pegmatitic veins; iv) Strongly fractured quartz; v) Quartz veins with en-echelon structures; vi) Weakly mineralized quartz; vii) Highly altered and deformed volcanic tuffs; viii) Volcanic rocks, with copper sulphides (mainly bornite); ix) Altered dolerite rock. To characterise the regional geological setting, 20 rock samples were collected in the following geological units: a) Acid metavulcanites; b) Granites to biotitic-amphibolic, porphyroid granodiorites; c) Gabbros, diorites and quartz-diorites, variably foliated, metamorphosed and/or metasomatized; d) Coarse-grained porphyroid leucogranites. Eight samples of mine waste were collected from the floatation tanks for geochemical analysis and study of tailings, including the potential environmental impact.

The sampling and sample description already carried out allows the preliminary characterization of this gold deposit.

Future investigation will include mineralogical, geochemical, petrographic and metallographic studies that will certainly increase our understanding of the processes that formed this mineral deposit.

Keywords: Gold, Sampling, rock, waste.

Reducing the carbon footprint through textile reuse: the case study of a textile valuation company

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Abstract

After food, housing, and transport, textiles are the fourth most pressured category in terms of raw material and water use, and the fifth in terms of greenhouse gas emissions. In order to significantly reduce waste and the use of natural resources in the textile and clothing industry, and to reduce the environmental impact associated with the sector, thus contributing to sustainable development, there is a need to create business models based on the principles of circular economy, in which clothes, fabrics, and fibers re-enter the economy after their use. In environmental terms, we can say that reuse provides greater benefits than recycling because it reduces the impact generated by the life cycle of textiles, particularly in reducing greenhouse gas emissions (GHG). Currently, a few companies exist in the country to collect urban textile "waste" with the purpose of textile valuation. Ultriplo (U3) is a nationwide company that aims essentially at the valuation of collected textile waste by promoting reuse, contributing to sustainable development in its environmental, social, and economic dimensions. The main objective of this study is to evaluate the potential environmental benefits of reusing clothing at the end of product life, namely by reducing the carbon footprint associated with the textile industry. For this study, the company provided a database for the northern part of the country. The company's database is extensive and complex and can be described simplistically as a table that compiles and integrates all the information regarding all the textile collection routes. Furthermore, the database was limited to the first six months of the year 2021. In this study, only variables such as Id, Start, End, Schedule, Mileage (Km), Total Pickups, Contentores, Filing, Weighing, Id Contentor, Município, Filing contentor (%), and Weighing contentor (kg) were used. These variables were selected because they were required to evaluate the reduction in greenhouse gas emissions (GHG) resulting from the textile reuse activity developed by U3. Each kilogram of clothing that is reused and not incinerated avoids the emission of 3.169 kg of CO_{2e}, according to data from the European Commission. This value was used to acess the reduction in GHG emission reduction assessment methodology developed in this study. This methodology has allowed estimating the amount of CO_{2e} not emitted to the atmosphere at the municipality scale. The results show that, for instance, for Santa Maria da Feira municipality, for the six months under study, a total of 330,61 tonnes of CO_{2e} were not emitted to the atmosphere due to the total weight of clothes collected for reuse. The developed methodology has the potential to be replicated in other regions of the country.

Keywords: clothing, circular economy CO_{2e} not emitted, norther sector municipalities, sustainable development.

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Groundwater degradation in a semi-arid region - current and future damages under climate change scenarios

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Abstract

As a semi-arid area, Gabes region (southern Tunisia) is characterized by a water-stressed situation, with groundwater as a principal water resource. Actually and future impact of climate change and human activities, through increases in temperature and fluctuations in rainfall, will escalate water scarcity and degradation across the uncontrolled overexploitation combined with a low recharge rate. In this context, the present research aims to present the current status of the groundwater resources in Gabes region in order to simulate possible future hydric scenarios, using several methods such as remote sensing (RST), geological and hydrogeochemical data, with the application of machine learning techniques. The obtained results on the studied region show a desertification danger situation considering the high soil degradation and poor water quality due to water overexploitation, especially in agricultural and coastal areas.

Furthermore, groundwater mixing processes and sea water intrusion phenomena will have a very important role in groundwater quality degradation. Thus, the prediction of the future piezometric level suggests a progressive drawdown until the year of 2100 and a predicted decrease in the annual groundwater recharge of 13.6% and 21.2% under RCP4.5 and RCP8.5 emission scenarios, respectively, on the end of the present century. Markov chain and RST approach is a useful methodology for groundwater spatial distribution and simulation, which is relevant tool on decision maker processes to require adequate groundwater sustainable management strategies.

Keywords: groundwater resource, water quality, climate change, Gabès region, Tunisia

Acknowledgments: This research is developed under the FCT - Fundação para a Ciência e a Tecnoliga, I.P. program, UIDB/04683/2020 and UIDP/04683/2020 projects.

Establishment of a vulnerability model in the Sete Fontes aquifer system - land use constraints

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Abstract

Urban development promotes several alterations in aquifer system recharge processes, mainly due to soil type and land use. Consequently, land use and soil occupation will be responsible for the creation of a rainwater drainage networks, making runoff faster and decreasing the water residence in the watershed, and difficulty groundwater infiltration.

The municipality of Braga has been experiencing a high urban growth since the last quarter of the 20th century. The published data indicates that, in 1960, there were 92 thousand inhabitants registered in the municipality while in 2021, this number doubled to 193 thousand inhabitants. The Sete Fontes aquifer system, located mostly in the parish of São Vitor, municipality of Braga, has lost much of its former rural occupation, dominant in the 70´s years. As a result of land occupation, mainly by industrial activities and urban areas, potential sources of water pollution have multiplied, with several changes in the watershed area, particularly on rainwater flow and infiltration.

Since 2018, more than half of the Sete Fontes area watershed correspond to artificialized territories with an increase of more than 24% on the last twenty years. Forest and agricultural areas have decreased significantly and abruptly, respectively.

Cumulatively, the construction of the Braga Public Hospital and parking infrastructures have been built on top of one of the galleries from Sete Fontes aquifer system, and consequently one of the groundwater mine have been destroyed with access roads construction. These two situations will be the main responsible for the water flow decrease in the Sete Fontes aquifer system. The industrial zone, located at the northern edge of the watershed, has also been expanded, and although part of the area is located outside the watershed, the rainwater drainage system will probably drain towards inside the watershed. The urbanization and industrialization processes represent another potential source of water contamination to the aquifer system of Sete Fontes.

On the study area, the rainwater drainage system could be a possible source of groundwater contamination, due to the improper connections of wastewater on the hydrogeological system. According to the presented situation, the main research of this project is to propose a vulnerability model to the aquifer system from Sete Fontes, considering the natural characteristics (intrinsic vulnerability) and environmental factors (extrinsic vulnerability), which should include the main variables associated to an adequate drainage network and groundwater.

Keywords: Urban hydrogeology, Artificialized areas, Pollution sources, Rainwater drainage, Aquifer vulnerability.

Acknowledgments: This research is developed under the FCT - Fundação para a Ciência e a Tecnoliga, I.P. program, UIDB/04683/2020 and UIDP/04683/2020 projects.

Modeling land aptitude for crops: proposals for a more efficient resources management in the North of Portugal

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Abstract

The North Region of Portugal hosts a great diversity of socioeconomic contexts and edaphoclimatic conditions that make it rich and diverse in terms of natural land aptitude for the development of crops. However, the decisions of farmers in the choice of the crops to be developed, especially of new farmers, are not always based on local or technical knowledge and are increasingly out of context with the real land suitability, limiting themselves to business conditions and trends in investment, leading to failures due to mismatch between the choice of crop and the conditions of the places to install it.

As part of a training-action funded by ON2 program (Geosimplex+), with the support of the academia (Instituto Politécnico de Viana do Castelo) and business sector (Esri Portugal), a group of students and technicians from the Direção Regional de Agricultura e Pescas do Norte (DRAPN) developed a methodology based on Geographic Information Systems (GIS) to delimit the natural land suitability for important crops (vineyards, olive groves, kiwis and corn) in the North of Portugal.

The methodology consisted in using basic geographic information, with 94 biophysical variables (soil, climate and topography), selecting the variables that differentiate each of the crops and studying their land suitability at the regional level, based on the crop's current distribution.

The biophysical variables were subjected to a correlation study (Wilcox test) to determine the variables with low correlation with each other, thus not overestimating the influence of one variable over the others and on the distribution of the four studied crops.

Through a set of GIS operations, the selected biophysical variables were characterized for each crop, in a specific signature for the region, or in the case of vineyards for the Demarcated Region. Thus, based on the effective regional distribution, the raster information was reclassified on a scale with three aggregation degrees. Then, the final result was obtained by adding the scores of the variables and aggregating them into four quartiles (levels), resulting in a land aptitude chart adjusted to the regional distribution of the crop.

The natural land aptitude for crops charts of the Northern Portuguese region that resulted from the used base information (soil, climate, topography and presence of the culture) present satisfactory levels of adequacy, being able to support crop planning and substantiate strategic options that reduce the waste or bad usage of investment funds from the Common Agriculture Policy. Ultimately, similarly to what happens with the positive (administrative) discrimination of criteria such as depopulation (low density territories), the natural land suitability charts for crops could also be used as a valuation criteria in different scales.

Keywords: Agriculture; Planning; Agricultural Potential; Geographic Information Systems; Land Aptitude for Agriculture.

Geothermal research in the Cávado basin – preliminary results

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Abstract

Geothermal resources are considered a sustainable and environmentally friendly alternative to produce renewable energy, and due to the latest geopolitical developments, the use of geothermal resources as a strategic alternative for energy production/heating is increasingly being studied.

The exploration of geothermal resources combines a set of different methods and techniques, in which the use of geophysics has an important specific role. However, there is always a significant degree of uncertainty that creates gaps that need to be filled with consistent geological and geochemical models and data.

The north of Portugal seems to be a suitable area regarding geothermal resources potential due to its mean geothermal gradient and heat flow, and could be considered as a zone with well-defined geostructural indicators. The Braga region, located in NW Portugal, within the Cávado and Ave River watersheds, is a zone with well-defined geostructural indicators, namely the existence of several sulphurous alkaline thermal water springs/occurrences, spatially associated with a deep-rooted structure - the Vigo-Régua shear zone, set in a crystalline basement.

The results generated by the conducted exploratory research, although encouraging, must be viewed with caution. In fact, there are many questions that arise from the obtained results. The scale and detail of the gravimetric and radiometric surveys must be increased in order to show small anomalies related to the outcropping geo-structural data. Also, the scale and definition of the geo-structural mapping must be improved, at least in the already studied sites and in the areas near the thermal water occurrences. The now defined regional exploration guides, which consist of overlapping gravitic lows with radiometric highs and cross-cutting brittle structures in the vicinity of a large polyphasic shear zone, must be thoroughly tested with a refining of geophysical surveys, as well as geological mapping combined with seismic data analysis. Ongoing research work comprising overlapping analysis of seismic, radiometric, geochemical data combined with gravimetric surveys has provided a better insight of the deep geological structures. However, as encouraging as these results may be, there are huge knowledge gaps that need to be filled in order to have an exploratory approach towards a geothermal reservoir definition.

Keywords: Geophysics; renewable energy; deep geothermal systems; exploration

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Advances and setbacks in designing the best remediation solution in an abandoned mine highly contaminated with mercury (case study of Canal Caveira mine)

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Abstract

The GeoMatRe project aims to find low-cost solutions for water and sediment rehabilitation using raw geomaterials, in abandoned mines of the Iberian Pyritic Belt (IPB). One of our case studies is the Caveira mine in southwestern Portugal. Large piles of mining waste, containing significant amounts of metals that record the long history of its exploitation for Au and Ag, which dates back to Roman times. After the exhaustion of its reserves, the extraction of the remaining metals (Cu, Pb, Zn) and S continued, until its abandonment during the 60s. These waste piles represent the main sources of metals in watercourses, some with very high toxicity, such as Hg, resulting from mixing with the gold-containing ore, widely used in gold mining in the past. This Hg can also have a lithogenic source, through the alteration of massive sulfide ore. The design of the best remediation technique using the most suitable geomaterials for retaining pollutant metals began with the preliminary study and characterization of the spatial distribution of Hg in stream sediments. Geostatistical modeling was used, throughout conventional variography followed by Sequential Gaussian Simulation algorithm (SGS) and local G clustering, to the definition of hot and cold spots for contamination risk of sediments.

Sediments under the direct influence of the mine heaps were collected in February 2022, during an atypical period of a very dry winter with anomalous low precipitation and high temperature values. Elemental Mercury was determined in water and sediment samples stored at about 4°C using a mercury analyzer (NIC MA-3000) based on thermal decomposition, gold amalgamation and cold vapor atomic absorption spectroscopy detection. The main objective of our study is the restoration of surface waters in this metallogenic province and the potential for reproduction in other territorial settings.

Analysis showed very high values for Hg (50-130 $\mu g g^{-1}$), in the sediments of the mainstream crossing the mine heaps which reached 340 $\mu g g^{-1}$ near the major waterway of the region. Surface water is mainly used in agriculture, livestock, and domestic uses. These concentrations are well above the reference values, 0.3 $\mu g g^{-1}$, according to the European Regulation (2009) and following the legislated Hg thresholds, mitigation measures are required whenever concentration are greater than 36 $\mu g g^{-1}$. Given the high toxicity of this element, its concentrations will serve as a basis for the choice of the most suitable geomaterials for its retention. It was already performed a laboratory scale tests, to evaluate the suitability to dredge the contaminated sediments. However, the results were not satisfactory, due to the release of mercury and other elements such as Fe, As and Pb, to the water column. A new approach, which is under study, is the sediment capping using geomaterial layers, to immobilize this toxic element and other metals with critical concentrations (Zn and Cu). Analysis of methylmercury will also be performed to evaluate the bioaccumulation capacity of this system for Hg, for better design the best remediation solution for this case study.

Keywords: Mercury, Sediment Contamination, Remediation, Canal Caveira Mine, Sequential Gaussian Simulation.

Valorization of Caldela´s thermal area (Amares, North of Portugal)

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Abstract

In Portugal mainland, particularly in the North region, there are several thermal water springs with emerging temperatures upper than 20 ºC. Since the Roman period, these spring water have been used for balneotherapy. In recent years, there is a growing interest on the potential use of this water type as geothermal energy. Geothermal energy is an alternative energy source to be applied on thermal infrastructures heating, hotel units, swimming pools, agriculture greenhouses and others. Simultaneously, the application and use of thermal waters to medical and recreational use (SPA) also have registered a global increase. However, there has been a shift in the type of clients that uses thermal areas. Thermal areas are not only used by people of advanced age and have become increasingly popular within younger population in search of leisure, and the quality of thermal area services have been improved. Furthermore, it becomes crucial the valorisation of thermal areas to promote their scientific and technical relevance, because it constitutes an important social and economic development factor to the surrounding areas.

The thermal area of Caldelas is located in the Alto Minho region, parish of Caldelas, municipality of Amares, and district of Braga. The region is represented in the Portuguese topographic map of Vila Verde and has an area of about 4.47 km^2 and 872 inhabitants. The thermal water from Caldelas has a unique typology in Portugal's hydrogeological heritage. Generally, the thermal water has a low mineralization (TDS: 130 mg/L; Electrical conductivity: 150 µS/cm), is alkaline type (pH: 8.0) and classified as hyposaline. The water presents a dominant calc-sodium bicarbonate composition (Ca/Na – HCO_3- type), mainly associated with the hydrolysis of plagioclases from the granitic rocks, and as a first product of water-rock interaction processes. As a secondary composition, the water is a fluoride type (F-: 2.1 mg/L), with origin associated with deep water hydromineral fluids. The low mineralization and low enthalpy temperature (T: 25°C) suggest that it corresponds to water associated with a shallow aquifer system and with a low residence time in contact with the host-rock.

The present research intents a detailed hydrogeological and hydrogeochemical characterization of the thermal water from the region of Caldelas and the temporal features evolution. The main goal is to highlight the relevance and valorization of this natural resource and to promote it to on the scientifical and technical community. Moreover, this study will be a contribution to an increase in the number of visits to the SPA area and its territorial surroundings, representing a contribution to the economic and social development of the region of Caldelas.

Keywords: hydrogeology, hydrogeological resources, thermal waters, valorization, land use planning.

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Study of the use of geomaterials as an alternative for the remediation of two water systems affected by mining activity: Canal Caveira Mine (Portugal) and Trimpancho Mining System (Spain)

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Abstract

The exploitation of mineral deposits eventually exposes tailings and rock waste to the earth's surface, which are subject to processes such as leaching, weathering, and oxidation. When in contact with the atmosphere, the minerals in the tailing piles become chemically unstable, generating geochemical and mineralogical changes, modifying the natural conditions of the environment. In the Iberian Pyrite Belt (IPB), a metallogenic province in the SW of the Iberian Peninsula, acid mine drainages are the result of the oxidation of sulfide minerals present in the waste rock of abandoned or poorly managed mining areas, with sulfate, hydrogen ions, and metal ions as products of this reaction. Because of this process, the drainages have low pH values and high concentrations of dissolved metals.

The GeoMatRe project (Polytechnic Institute of Castelo Branco and University of Évora) has as one of the main goals to evaluate geomaterials in the retention capacity of potentially toxic elements present in acid drainage waters. This would guarantee a low-cost solution for the rehabilitation of these waters. Laboratory-scale tests are being conducted using several materials with distinguish physical and chemical properties that favor the process of adsorption of metallic elements. Among the characteristics evaluated in the selection of the geomaterials used in this research are high availability, economic costs and high efficiency on removal of desired elements.

The adsorption capacity of the materials is being analyzed by means of kinetic and equilibrium tests performed through direct contact with solutions containing potentially toxic elements dissolved into them. The tests are based on real conditions of the collected water: solutions are reproduced in laboratory with corresponding concentrations to those solutions found in the natural waters. At the end of the pre-determined times for contact with the materials, possible decreases in the concentration of the elements are verified in the solutions. Subsequently, a column filled with the most suitable geomaterial will be percolated by the waters collected from the acid mine drainages to simulate and evaluate the selected materials behavior in a real situation. The purpose is to identify the most appropriate materials for the recovery of degraded water systems, considering different mining contexts.

Two water systems influenced by mining activity were evaluated for contamination degree: Canal Caveira Mine (Portugal) and Trimpancho River Mining System (Spain), inserted in the IPB. Water samples from these systems were collected for analysis of their physical-chemical characteristics and determination of the concentration of potentially toxic elements. Among the elements that presented higher pollution indices in the two systems were Cd, Cr, Cu, Fe, Hg, Mn, Pb and Zn. In addition, along the drainage lines waters with pH values lower than three were commonly found, showing the acidic character of these waters. The evaluation of the application of the most appropriate geomaterials for each of these mining contexts in the removal of pollutant elements will contribute to a more efficient management of water resources in similar mining areas, whether abandoned or in activity.

Keywords: acid mine drainage, adsorption, geomaterials, Caveira Mine, Trimpancho.

Acid mine drainage properties in different climate, paragenetic and rehabilitation conditions

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Abstract

Whenever mining occurs, large quantities of mining wastes are produced, in different states and with different physical and chemical properties. These wastes have no economic value, so they are discarded and deposited in heaps and tailings dams.

When these wastes result from sulfide mining, they have sulfide minerals, which in the presence of oxygen, water, and acidophilic micro-organisms undergo oxidation, which leads to the production of H^+ ions, and consequently the production of acidity. This process culminates in contamination by acid mine drainage (AMD).

In order to understand this phenomenon, a characterization of AMD in three distinct mining areas was performed: Valdarcas, located in Vila Nova de Cerveira (northern Portugal); São Domingos, located in Mértola (Portuguese sector of the Iberian Pyritic Belt (IPB)); and Campanário, located in Valverde del Camino (Spanish sector of the IPB). In all mining areas there are important differences between the regional background and the effluent. In the background, high pH values were obtained, while for the parameters: electrical conductivity (EC), total dissolved solids (TDS), redox potential (Eh), acidity, and sulphate, low values were obtained. In the case of effluents, the opposite was observed, with low values for pH and high values for EC, TDS, Eh, acidity, and sulphate. The effect of natural attenuation is also verified, especially by dilution and precipitation, which are more accentuated in Valdarcas and São Domingos. The Eh parameter is in agreement with the concentration of Iron(III) and Iron(II), which is related to oxidation-reduction reactions. Thus, the analysis of the results shows the existence of AMD contamination in the three mining areas studied.

The results obtained demonstrate the need to implement monitoring and rehabilitation plans in abandoned mining areas in order to mitigate the effects of acid drainage.

Keywords: Mining effluent; Environmental monitorization; Valdarcas; São Domingos; Campanário.

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Agricultural Valorization of Livestock Effluents and Management of Nutrients Based on the Chemical Composition of Effluents

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Abstract

The Agricultural Valorization of Livestock Effluents (AVLE) has been associated with the loss of plant nutrients and environmental problems related with the increase of the nutrients concentration, especially nitrogen (N) and phosphorus (P) in the soil and in surface and ground waters.
Management and valorization of effluents produced in livestock farms of the 1st and 2nd classes is conditioned by the Livestock Effluents Management Plan (LEMP) whose Agronomic Balance of Nutrients (ABN) uses standard values for the chemical composition of livestock effluents, defined in the Code of Good Agricultural Practices.
The ABN results from the difference between the nutritional needs of crops and the amount of nutrients provided by AVLE. The nutritional needs of crops are dependent on the amount of nutrient in the soil, the type of crops and the expected productivity. The available nutrients depend on the valorized livestock effluents volume and on the chemical composition of the used Livestock Effluents (LE).
The chemical composition of LE differs from farm to farm, which variation is essentially due to the use of raw materials for animal feeding with different nutritional compositions. Therefore, using chemical analyzes done in LE produced in a sample of 20 dairy farms in the municipality of Barcelos, ABN were done using the chemical concentration of LE. In this way, it was possible to compare the amount of nutrients provided to crops by AVLE.
The ABN done by the dairy farmers, the LEMP does not result in the excessive availability of the main nutrients (N and P). However, by the ABN performed for the analyzed years (2011, 2016 and 2022), the use of LEMP resulted in the excessive availability of P to the crops. In this way, it can be stated that there is an increasing risk of P_2O_5 loss to the environment and degradation of water quality.
This paper's conclusions indicate the need for a decrease in the LE volume to be valorized, allowing to reduce the risk of loss of nutrients. This reduction can be achieved by implementing strategies of: *a)* exporting the volume of LE to farms with have a deficit of nutrients; *b)* a increase in the cultivation area on livestock farms, so that the total LE volume produced annually can be valued; *c)* the reduction of the total number of animals in livestock farms. These strategies used individually or combined can contribute to the decrease of the total LE volume produced.

Keywords: Livestock Effluents; Soil Management; Phosphorus; Nitrogen; Agricultural Valorization of Livestock Effluents.

A closer look at two cases of acid mine drainage (AMD) contamination: Canal Caveira (Portugal, NW of the Iberian Pyritic Belt) and Trimpancho (Spain, SE of the Iberian Pyritic Belt)

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Abstract

The geological heritage is an essential basis for demographic development, concerning technological, tourist and agricultural promotion. To sustain this development, the recognition and subsequent exploitation of this heritage is essential, which inevitably causes environmental and ecological impacts. The present work, inserted in the GeoMatRe Project, an ongoing project funded by Fundação LaCaixa, intends to analyze the level of impacts on water bodies from the exploration of polymetallic sulfidedeposits, that took place in the Iberian Pyrite Belt (IPB) since the Roman occupation period, with particular incidence in the last 200 years, until the end of the 60s-70s.

This study focuses on two water systems impacted by deactivated mining complexes: Canal Caveira (Portugal) which is embedded in Paleozoic formations, in the NW region of the IPB, about 10km SE of Grândola (Reis et al., 2012) and Trimpancho, located in the SW of Spain, in the SE region of the IPB and which flows to the Chança dam (Pérez Ostalé, 2014). To characterize both systems, geochemical analysis was performed in the stream sediments. This work aims to achieve the necessary tools to minimize those impacts, by using geomaterials in the retention of potentially toxic elements present in the mining effluents and responsible for the contamination of the watercourses of these two mining areas.

Granulometric characterization of sediments was done through wet sieving to separate coarse and fine fractions, followed by dry sieving and X-Ray Sedimentation. It was observed a mainly sandy nature of the sediments from both sites. The methods of sediments preparation for the geochemical study were very diverse, ranging from fusion, partial digestion with Aqua Regia through a microwave assisted-digestor and extraction with ammonium acetate, for quantification of the more labile forms. The water samples were analyzed for elements in their dissolved and total forms, the latter being obtained through digestion in a high-pressure microwave. These analytical procedures were followed by the analysis of metals by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Mercury was also analyzed in previously frozen sediments and in the water through a Mercury analyzer.

Only with a detailed geochemical study, accompanied by hydrological and geomorphological studies, it is possible to understand and consider the best way to implement an environmental remediation technology. This knowledge will promote the preservation of the integrity of fauna and flora, as well as of all those who subsist from activities installed in the region, whether being related to the food industry, agriculture or to other industries that are dependent on these hydrogeological resources.

Keywords: Canal Caveira mine, mining system of Trimpancho, Acid Mining Drainage, Heavy Metals, Geomaterials.

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Analysis and characterization of microplastics in coastal sediments

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Abstract

Litter and plastic on the ocean are a major problem at the present time, although it has been poorly studied. Beaches are very important structures as they work as storages for ocean's matter and, since it's a place of public benefit and usage, the importance of studying microplastics and litter increases. This project was aimed at the usage and adaptation of methods of sampling, analysis, and identification of microplastics in coastal sediments in the northern beaches of Portugal since there are no studies or records about it. We were able to observe a vast variety of microplastics of multiple types, shapes, and colours, with a total of 362 microplastic particles, mainly fibers (58% of the total particles). The identification of microplastics was done with an optical microscope assisted with a polarized lens, to dismiss any doubts about crystalline material. We also characterized the sediment, having observed a similarity between the 8 samples, being the most predominant the coarse and medium sands apart from the sample RAM 002 that exhibits a very coarse grain. We were not able to do a chemical characterization for we had no time available, being a motivation to carry on with this project.

Keywords: Microplastics, Northern beaches, Coastal Sediments, Litter and Plastic.

G 6 – LITHOSPHERE DYNAMICS

Oral communications

Statistical procedures applied to floods in the Douro River Basin

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Abstract

The aim was to study flood event triggers. To this end, flood occurrence data were collected and stored, as well as hydro-meteorological variables for the Douro River basin.
The Douro River and its tributaries have very steep longitudinal profiles in some sections, and consequently sudden rises in water levels are observed after heavy precipitation.
The data treatment and analysis begins with a univariate study of the different variables. Several statistical procedures are used, in order to understand the possible relationship of each of the observed factors with the occurrence of floods, either individually or globally. This is done using Fisher's exact tests, chi-square tests, logistic regression models, and random forests explaining the flood phenomenon, adjusted on the basis of available data.
In the logistic regression model, there is a need to use the categorized predictors because their empirical distributions exhibit very sharp positive skewness, with many outliers. In this model, the important predictors are monthly-accumulated precipitation (mm) and monthly surface discharge (dam^3). The model has a specificity of over 90% but sensitivity of only 33.3%, which is not surprising given the complexity of the phenomenon under analysis. The discriminatory ability of the logistic regression model, measured by the area under the ROC curve, AUC, is 76.8% and is therefore acceptable.
The random forest algorithm is used with the uncategorized variables, since it does not depend on their distributions. With the same predictors, specificity higher than 99% and a sensitivity of only 60% is obtained with this procedure, indicating an excellent performance taking into account the complexity of the phenomenon and the fact that only two predictors are being used.

Keywords: Douro River basin, floods, statistical procedures

Real-time Wildfire Detection using Smart Sensors Network

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Abstract

This work describes the development of a smart embedded system designed for forest fire protection. The system utilizes a combination of sensors, cameras, and machine learning algorithms to detect and alert of potential fire hazards in real-time. The sensors are strategically placed in the field to detect variations in temperature, humidity, and other surrounding environmental factors that may indicate the presence of fire. The machine learning algorithms analyze the data from the sensors and cameras to determine the likelihood of a fire and to predict its potential spread. The system can also be integrated with existing fire suppression systems, such as sprinklers and drones, to aid in extinguishing fires. The developed system has the potential to significantly enhance the efficiency and effectiveness of fire protection efforts in forests, helping to prevent devastating wildfires. The proposed system also includes a predictive maintenance module which detects any malfunction of the sensors, cameras and other devices and asks for the assistance.

Keywords: Smart Sensor, Machine Learning, Wildfire Detection, Wireless Mesh Network, Image Processing.

Temperature Impact and Efficiency Analysis of Hybrid PVT System

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Abstract

Hybrid photovoltaic thermal (PV/T) systems are a type of solar system that combines the functions of a photovoltaic and a solar thermal in one unit [1]. The PV panels generate electricity from sunlight, while the thermal collection system captures the excess heat produced by the PV panels and uses it to produce warm water or space heating [2].

According to the recent analysis, the efficiency of the solar energy production in particular solar photovoltaic system is still low [3]. There are several factors to be considered that affect the energy production during the operation of hybrid PVT system. There are several internal and external or environmental parameters are responsible for this output disruption. The parameters found to be affecting are solar irradiance, environmental and module surface temperature, humidity, wind speed, shading, dust and many others [3]. Solar irradiance and temperature are the key role-players among all the variables. The light intensity or solar irradiance value is related with PV production as it affects short circuit current of the absorbed photons in the semiconductor material.

The most important parameter which is the main concern of this work is the inside and outside temperature of the panel. If there is rise in ambient temperature, then the short circuit current only increases that results in decrease in power output [3-4]. As a result, the maximum power point (MPP) also decreases with the rise of temperature. Temperature is considered as a negative parameter in the panel, but it turns into positive in the proper use of hybrid PVT system. In this work, the impact of temperature rises in the panel and its related power output is shown which clearly identifies the negative result on the panel. Additionally, the MPP output due to temperature rise is also explained in the figure. Afterall, the changes in efficiency due to the temperature rise also analyzed in this work.

One of the main advantages of hybrid PVT system is that it helps to regulate the panel temperature that tends to improve its efficiency. The PVT system can keep the panels cooler with high efficiency by capturing and using the excess produced heat. Temperature can be regulated in a PVT panel using several methods which will improve overall efficiency. Thus how, the PVT panel will be cooled producing more electric energy including thermal energy. This work proves that the impact of temperature rise can be mitigated, and efficiency is improved using hybrid PVT system properly.

Keywords: PVT System, Temperature Effect, Efficiency Analysis, MPP.

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$^{87}Sr/^{86}Sr$ in carbonates: one tool, several applications

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Abstract

The geochemical techniques, namely whole-rock and isotope geochemistry, are powerful tools when applied to the geodynamic evolution. The application of these tools allow a better understanding of the processes linked to plate tectonics and the geological processes that occured in the lithosphere, from magmatism, to metamorphism, passing through sedimentation but also weathering or contamination processes. The evolution of chemical tools applied to geodynamic processes currently allows, for example, to trace the magmatic or sedimentary sources, the tectono-magmatic and paleodepositional environments, the geochemical alterations related with metasomatic or hydrothermal processes, or dating geological events, this is, the minimum age of deposition of clastic rocks, the age of metamorphic episodes or ore deposition and the emplacement age of plutonic bodies.

The strontium isotope ratio ($^{87}Sr/^{86}Sr$) in marine carbonates is variable over the geological time, resulting of changes in strontium fluxes to the ocean from the hydrothermal circulation in oceanic lithosphere and continental crust weathering processes. In every moment of geological time, the strontium ratio is homogeneous in seawater of all oceans, and the marine carbonates preserve this seawater $^{87}Sr/^{86}Sr$ fingerprint during sedimentation process. This way, the $^{87}Sr/^{86}Sr$ signature in carbonates from stratigraphic record can be correlated with the variation curve of the $^{87}Sr/^{86}Sr$ signature of seawater along the geological time, allowing, in some cases, to constrain the age of the carbonated sedimentation episode and, as such, the strontium isotopic fingerprint can be used to correlate the local scale stratigraphic record.

The Ossa-Morena Zone (OMZ) stratigraphic successions show four well-constrained marine carbonate sedimentation episodes during the Palaeozoic: Cambrian, Upper Ordovician, upper Silurian and Lower-Middle Devonian. The application of the $^{87}Sr/^{86}Sr$ fingerprint in OMZ carbonates was useful to strengthen the lithostratigraphic correlations and sepatate distinct episodes of carbonate sedimentation, allowing to discuss the depositional age of carbonated successions, namely when the biostratigraphic data is scarce, which is common in OMZ due to the effect of metamorphic processes. The obtained $^{87}Sr/^{86}Sr$ signature data allowed to:

(1) well characterize the strontium ratio fingerprint of Lower-Middle Devonian Limestones, which is totally compatible with global $^{87}Sr/^{86}Sr$ curves;

(2) characterize the lower Cambrian fingerprint, namely in carbonates (very low grade marbles) from the Elvas Carbonate Formation, which is also compatible with global curves;

(3) correlate the isotope fingerprint from Elvas Carbonate Formation with other carbonate successions, namely the Estremoz Marble succession and, as such, a Cambrian age was proposed for this succession;

(4) clearly distinguish the Devonian and Cambrian fingerprints from those obtained in other carbonates, being proposed an upper Silurian age for Ferrarias and Barrancos limestones.

However, several changes in the primary signature were imposed by the post-depositional processes. Work in progress show that processes as metasomatism, hydrotermalism and dolomitization change the primary strontium ratio of carbonates and, as such, the alteration processes of carbonates should be carefully taken into consideration for the use of this methodological approach.

The $^{87}Sr/^{86}Sr$ signature of OMZ marbles has been also applied to archeometric studies, once the isotope fingerprint, supported by petrographic studies, allows to define the geological provenance of marbles used along the historical times, namely during Roman times.

Keywords: $^{87}Sr/^{86}Sr$, geodynamic evolution, Ossa-Morena Zone, marbles, archeometry

Advancements in the LouMu Project – Muography for Geological Surveys

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Abstract

The LouMu Project is an ongoing collaboration between the Laboratory of Instrumentation and Experimental Particle Physics (LIP), the Institute of Earth Sciences – University of Évora and the Lousal Ciência Viva Center, and also with the support of the National Laboratory of Energy and Geology. In this collaboration, the potential of the muography technique is being explored in the Lousal Mine. The end-goal is to create the conditions for the use of muography as a novel method for geophysical surveys in Portugal. Muography is an imaging technique that uses muons, a natural background radiation created in the atmosphere, as a means of observing through matter. The purpose of the muographic observation in the underground environment of the mine gallery is to do a first geological survey of the ground above it, mapping already known structures, like the Corona Fault, ore masses and measuring their densities. In the end, newfound data will be added to the existing information to improve it, but the whole process is also serving to test the performance of the telescope and the muographic analysis tools.

The well-known geology of the Lousal Mine is being used as a test site for the muography. A muon telescope, developed by LIP, was installed in vertical position in a storeroom of the Waldemar gallery, 18 m below the surface. It is equipped with 4 robust RPC detectors of 1x1 m size, that observe muons passing through in real time. Consecutive detections in different detectors give the muons trajectory, and a map, called muograph, is created showing the attenuation of the muons that were transmitted through the ground. Besides muography, existing geological and geophysical information and new measurements made with seismic refraction and ground penetrating radar are also being used to build a 3D reference model. From the muography data, an equivalent 3D density map will be reconstructed, and the geological model will be used to cross-check and improve the muography results.

The intension of this communication is to show the advancements done so far in this work and to present a preliminary muograph showing, in particular, the Corona Fault, N-S direction, present at the site of the gallery under study. The previous and future work progression is also described.

Keywords: Cosmic Muons, Underground Muography, Geophysical Survey, Lousal Mine, Iberian Pyrite Belt.

An instrumentation amplifier with automatic and adaptive gain

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Abstract

In the realm of signal amplification and going beyond the transistor, two concepts emerge swiftly. Operational amplifiers play a crucial role in electronics since the mid-XX century. Also, instrumentation amplifiers are very important in the instrumentation field, to fit signals assuring their suitability to certain instruments and operations.

This work aims the discussion and presentation of the project for an instrumentation amplifier design with amplification and attenuation capabilities, featuring automatic and adaptive gain via feedback with the receiver load, with the objective of increasing the exploration efficiency for the input range of acquisition systems.

In terms of software, emphasis is given to the implementation and improvement of optimization algorithms. At the hardware level, the use of noise suppression techniques stands out.

To accomplish the work, it's considered de use of ubiquitous electronic parts ICs, namely operational amplifiers, instrumentation amplifiers, digital potentiometers and microcontrollers. With such a set of cheap fundamental parts, the device envisioned should be rather inexpensive. Furthermore, considering that such a device accomplishes an automatic and adaptive amplifier / attenuator module, that can be used and reused in several contexts, that also contributes to the reduced costs when adopting it.

The optimization algorithm classes already studied and considered suitable are the searching algorithms, seen as optimization algorithms and the genetic algorithms. But the list shouldn't be restricted to those; actually, safeguarding the algorithm suitability, virtually, the microcontroller processing capabilities will define the boundaries.

It's concluded that a device like the one study object in this research is doable and can present a relevant contribution in the instrumentation and measurement field in general and particularly for the development of "smart" photovoltaic panels. Still and considering that such a device is intended for wide usage with acquisition systems, it's possible to envision its use with several sensors – including those for earth sciences applications.

Recognizing the work presented here as being the genesis of a project to be carried out, resulting in a device to be developed as a proof of concept, in this stage and taking in account the initial perception based in the study carried out so far, two main challenges seem to emerge. In one side, the implementation and improvement of optimization algorithms to accomplish the automatic and adaptive gain, possible to implement in a microcontroller as the one considered in the studies developed, constitute a concern. In other side, the identification and implementation of effective noise suppression techniques, surely will claim attention.

Keywords: instrumentation amplifiers, automatic and adaptive gain, optimization algorithms, noise suppression techniques, photovoltaic panels

G 6 – LITHOSPHERE DYNAMICS

Poster communications

Geophysical Data Integration at Lower Tagus Valley: case of Ciborro Fault

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Abstract

The Lower Tagus Valley (LTV) is a sub-basin located at filling plains of Tagus River, at central-west portion of the Portuguese continental territory and is a stage of some historical seismic events. The basin is defined as a tectonic depression under fault control subsidence developed during Neogenic.

In a review of seismic history at LTV, Veludo *et al.* (2017) relocated events from years 2000 to 2014 and demonstrated high epicentral concentration distributed along WNW-ENE lineaments consonant to faults systems orientation found in the basin's border and previous geophysical maps shown at Carvalho *et al.* (2014). This direction coincides to a segment of Ciborro Fault but there is no topographic evidence that points the fault in the surface nor even the fault's extension due to erosive and depositional processes in the region.

In this present work, reinterpretations from previous airborne magnetic maps were performed and ground magnetic data were added in a way to map Ciborro Fault more accurately. All data were processed interpolated to highlight interesting features and remove noise from the magnetic map.

Interpretations of magnetic maps confirmed lineaments presented at Carvalho *et al.* (2014) work and indicated the fault's extension westward. According to Araujo *et al.* (2010), Ciborro Fault reveals features of seismic activity, possibly correlated to historic and instrumental seismic events that occurred in the area. Therefore, identification and characterization of Ciborro Fault may upgrade the knowledge of faults system at LTV, which includes more recent events.

To certify the depths of Ciborro Fault and sediments, HVSR soundings (Nakamura, 1989) and autocorrelation (Schimmel, 2011) were surveyed. These passive seismic methods recorded ambient signal and noises that, after Fourier Transforms, generated frequency spectrum curves that allowed to infer the depth of basement along the profile oriented in approximated NE-SW orientation. These surveys suggested rebounds in the basement, possibly related to the existence of tectonic faults that affects de Cenozoic base. The integration of all geophysical data is fundamental for better understanding the structural arrange in the area, hence generates improvement for seismic hazard analysis for LTV.

Keywords: seismic hazard; applied geophysics; lower tagus valley; magnetics; HVSR.

Can garnets from the high pressure rocks from the Ossa-Morena Zone register the subduction-exhumation processes of the Variscan Orogeny?

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Abstract

In the southwest border of the Iberian Massif, specifically in the southernmost domains of the Ossa-Morena Zone and in the South Portuguese Terrain, several relics of the active margin processes that occurred during upper Palaeozoic, with the edification of Pangea, are found, representing the accretionary and collisional episodes of the Variscan Cycle. In this region are found allochthonous (Internal Ophiolite Sequences) and parauthochtonous (Moura Phyllonite Complex) units, and subduction-related magmatic bodies. The parauthochtonous structure constitute an imbricated complex that includes (besides the Internal Ophiolite Sequences) segments of the autochthonous units with variable metamorphic grade, thrusted towards the inner autochthonous domains of the Ossa-Morena Zone. Particularly, in the Safira (Montemor-o-Novo) and Viana do Alentejo – Alvito (VAA) sectors are documented two belts of basic rocks with evidence of high-pressure metamorphism (achieving the eclogite facies, though retrogressed) characterized by the presence of garnet minerals (exceptionally useful minerals, commonly used as tectonic 'tape recorders'). However, garnets display different textures in both sites: i) in Safira, atoll-shaped garnets are interpreted to be a result of fluid infiltration induced by temperature increase during high-pressure metamorphism, that promoted element exchange with the enveloped mineral, and ii) in VAA, large garnet porphyroblasts and the frequent fracturation pattern often resembling small aggregates which seems to indicate slow heating rate and/or multiple nucleation and coalescence sites within each crystal, thus suggesting growth during early stages of metamorphic crystallization. Regarding their chemistry, Safira garnets show grossular composition in the core of the crystals, and an increase in the almandine component towards the border or in the atolls, which is common in amphibolite facies metamorphism; in VAA the garnets are consistently composed of almandine-grossular, with small variation within the crystal. The general chemistry of garnets is sensitive to changes in P-T-X conditions, often generating complex textures and chemical zonings, related to deformation, metamorphic reactions and dissolution/reprecipitation mechanisms. The growth of atoll-shaped garnets in Safira concomitant with the increase of the almandine component towards the border of the crystal could indicate their formation occurred in the metamorphic retrogression (from eclogite to amphibolite facies) during exhumation, while the VAA garnets show features typical of crystallization in subduction zone metamorphic conditions. Therefore, the detailed study of the texture and composition of those garnets can infer on the different crustal levels of emplacement, thermobarometry conditions in which they formed, and further in-situ geochronology studies should provide precise ages for the subduction and exhumation events in Iberia.

Keywords: Garnet; Eclogite; Ossa-Morena Zone; Variscan Cycle

Addition of local and teleseismic events to Arraiolos seismic tomography.

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Abstract

Seismic tomography is a methodology used for several decades to image the Earth interior. This technique is proposed to generate the crustal structure beneath Arraiolos, a region located in central Portugal. This project was developed after the Mw4.9 magnitude earthquake occurred on the 15th of January 2018 .

During this project, a first seismic tomography was performed, inverting a number of 467 aftershocks recorded by 34 seismological stations (from the Institute of Earth Science, ICT and Institute Dom Luiz, IDL) using LOTOS code. The results were showing poorly resolved images due to the narrow concentration of aftershocks in a located area. After obtaining the 3D velocity model, 62 local and 39 teleseismic events, recorded during a different period of time (May 2011 to Sept 2012) by the temporary local station network Deep Ocean Test Array, DOCTAR (University Potsdam, Portugal), were added to the study. After integrating these additional events, the distribution of earthquakes started to show a uniform expansion, with an improvement of the coverage in the peripheral regions.

Reliable and accurate velocity images are generally obtained after inverting travel times of uniformly distributed earthquakes. Nevertheless it is unlikely to observe this kind of earthquake spatial coverage within the whole area, and impossible to control it. This is the case of this thesis project which intends to increase the number of earthquakes within the region and cover it entirely and uniformly by seismic rays. Therefore, in order to enhance the ray density within the region not only supplemental earthquakes were integrated but a new methodology was also employed, consisting of adding late seismic phases, in this case Moho reflected wave paths (PmP and SmS), to the inversion.

Currently, additional local and teleseismic events are being detected on the DOCTAR seismic network on the purpose to improve the spatial distribution of the epicenters within the Arraiolos area and provide robustly resolved crustal images of the subsurface. After locating those events, a selection of epicenters is carried out aiming to enhance the spatial distribution, specifically on the peripheral areas of the studied region. This main step of the project will be presented in order to show clearly the methodology employed having the goal of obtaining a credible and accurate tomographic model and contribute to a better understanding of the tectonic phenomena surrounding the area.

Keywords: Aftershock sequence, Seismic tomography, Late seismic phases, Arraiolos region.

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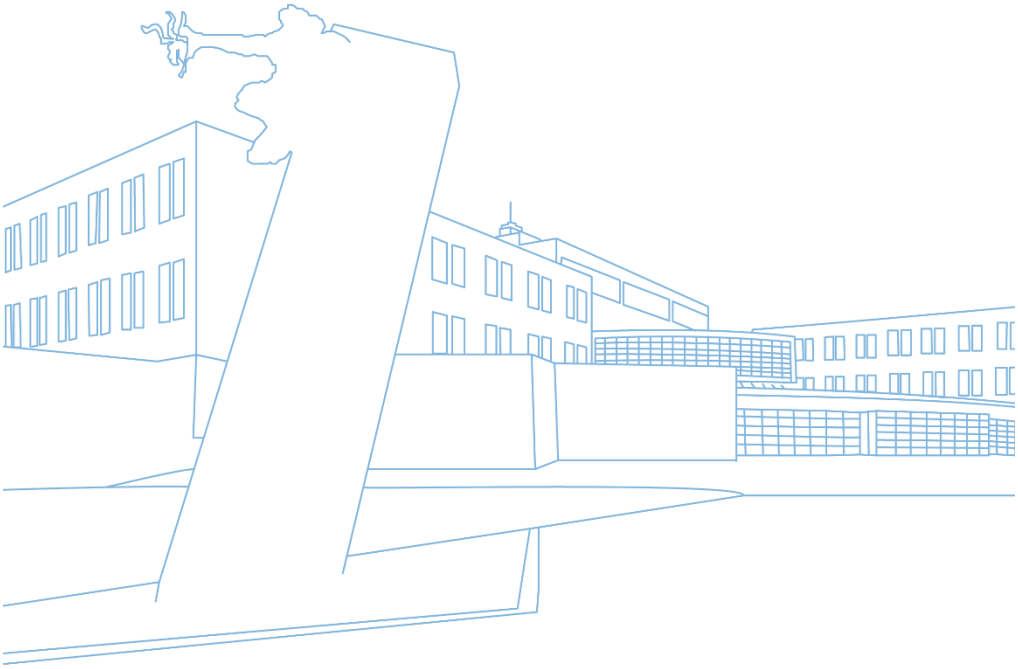

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