Instituto de Ciências da Terra
Institute of Earth Sciences

Report

2020

Ref: UIDB/04683/2020 and UIDP/04683/2020

U.PORTO
FACULDADE DE CIÊNCIAS
UNIVERSIDADE DO PORTO

UNIVERSIDADE DE ÉVORA

Universidade do Minho

Content

ICT – Instituto de Ciências da Terra

ICT is a multidisciplinary institution, organized into six research groups covering major areas of Earth Sciences and comprising a wide range of scientific expertise and a high laboratory intensity level justified by the many facilities allocated to their activities. ICT mission is to develop exceptional-quality research, promote technological development and support public policies in the area of Earth Sciences.

Research Groups:

G1 - Atmospheric Sciences Water and Climate

G2 – Energy

G3 – GeoResources and Geomaterials

G4 – Geoconservation and Geoscience Education

G5 – Environmental Monitoring and Remediation for Sustainability

G6 – Lithosphere Dynamics

Webpage - http://www.icterra.pt/

General Remarks

In 2020 the ICT 2020-2023 project started as a result of the last FCT R&D units evaluation process in the Evaluation Panel: NATURAL SCIENCES - Earth and Atmospheric Sciences and Climate Change. ICT ranked overall quality grade of VERY GOOD, having been awarded with a base funding (UIDB/04683/2020) and a programmatic support (UIDP/04683/2020), which includes a programmatic funding, nine PhD fellowships and two junior PhD researcher contracts. This project started on the 1st January 2020 and, at the General Assembly held within the Jornadas do ICT – 2020 hosted by the University of Minho Pole, the implementation of the project was planned and approved. The scientific research is being done by the six research groups covering major areas of Earth Sciences, based on a wide range of scientific expertise and internationalization, and a strong laboratory capability with advanced facilities allocated at the three poles. The research groups are coordinated by senior researchers: Maria João Costa (G1), Paulo Canhoto (G2), Helena Sant'Ovaia (G3), José Brilha (G4), Teresa Valente (G5) and Mourad Bezzeghoud (G3). The ICT management is led by the Direction that includes Deolinda Flores, as General Coordinator, Rui Salgado, Coordinator of UÉvora Pole, Helena Sant'Ovaia, Coordinator of UPorto Pole, and José Brilha, Coordinator of UMinho Pole. The research team works together, in a committed way, towards the ICT project research goals, listed at the end of this report, comprising research members, PhD and MSc students, collaborators, and technical staff. All the team is fully committed in promoting gender inclusion and diversity.

The year 2020 was deeply affected by the constraints associated with the COVID-19 pandemic and the measures imposed by the Portuguese and foreign governments, disrupting the ICT research activity. The field activities (including sampling campaigns and data acquisition) were penalized due to circulation restrictions; lockdown reduced the laboratory activity; worldwide restricted mobility to other laboratories and institutions, to carry out internships and specific analyses, was aggravated by unsynchronized confinements; and the majority of the scientific events were postponed or replaced by online versions. In addition, the team suffered from intense and permanent stress causing tiredness, saturation, loss of focus and concentration. Nevertheless, the adaptation to methods

developed to enable online research interactions allowed ICT to continue its activity, minimizing the COVID-19 constrains.

Thus, a detailed description of the 2020 research activities is provided in this report. During this year, ICT published more than 150 research papers in international peer-reviewed journals describing original theoretical and applied relevant research, distributed in different areas of Earth, Atmospheric, Energy and Environmental Sciences. These papers include contributions related to fundamental developments in the understanding of the atmosphere, ocean and solid Earth processes that control the dynamics of the Planet. Despite all difficulties, ICT research remained strongly connected to a network of international partners, many of them long-standing partners, and mobilized a large number of young researchers. In 2020, ICT encompassed a group of 86 PhD and MSc students, enrolled in its postgraduation programs. A special reference for the Centro Ciência Viva de Estremoz for the outreach initiatives, adjusting the methods to the COVID-19 restrictions, in order to continue to bring Science For All.

ICT is deeply grateful for the effort, dedication, and commitment of all its members in the development of its activities, bringing a *normality* to this very atypical and difficult year.

ICT Research Group Activities

G1 - Atmospheric Sciences Water and Climate


Maria João Costa – G1 Coordinator

The main scientific objectives of Group 1 are related to Atmospheric Sciences, Environment and Climate and their implications in the future of the planet and health issues, focusing in the Mediterranean area and Climate Change, largely dealing with the following topics:

- Clouds, precipitation, aerosols, gases and solar radiation
- Air and water quality and health impacts
- Potammology, Limnology and lake-atmosphere interactions
- Numerical Weather Prediction and Climate models
- Surface fluxes of moment, energy, water and CO2 and the Atmospheric Boundary Layer
- Palynology, Agronomy and Health
- Meteorology and Fire
- Environmental and Health Risk Assessment

During 2020 most of these topics were addressed by the team through ongoing research projects. The main results achieved are briefly described here:

- Remote sensing studies allowed for analysing the spatial and temporal variations of aerosol and water vapour effects on solar radiation in the Mediterranean Basin during the last two decades, with impact for fields such as climate and land surface modelling where process understanding and model evaluation are crucial, as well as for energy meteorology, supporting for example the planning of future locations of solar power plants. The temporal and spatial variations of water quality related parameters were also studied using satellite remote sensing, proposing a methodology that allows for identifying problematic regions and periods that can be include in early alert systems.

- Numerical studies were successfully applied to lightning studies and to the likelihood of lightning strokes to explain wildfire ignition. There is a complex interaction between weather, lightning, fires,

forests, and so improving our understanding of these relationships is essential to better predict the possibility of the occurrence of natural ignitions and the evolution of FFE. The encouraging results that have been obtained here motivate a future work towards a better comprehension and physical interpretation of some processes that strongly influence the evolution of forest fires events. Numerical modelling was applied as well to thermal and gas regimes in lakes, capturing seasonal variations in water surface temperature and the internal thermal structure of the water mass. The results indicate that the model considered could be used in climate modelling to estimate the impacts of the climate change in the thermal and gas regimes of the lake. Also direct normal irradiance forecasts obtained from numerical models were analysed and progress in the correction of direct normal irradiance predictions was achieved.

- Pollen studies were also pursued regarding pollen production, pollen oxidative defences and allergenic potential. Significant increasing trends of the annual pollen integral of 7.9% pollen grains per year, and the pollen peak concentration of 7.5% pollen grains per year were found for Quercus in the North-Western Iberian Peninsula. On the other hand, a study focusing on Dactylis glomerata showed that pollen oxidative defences are activated by common air pollutants, affecting both its germination capacity and its allergenic activity, potentially contributing to a higher incidence of respiratory allergic diseases.

- Quantification of a group of pharmaceutical compounds (diclofenac, ibuprofen, carbamazepine) in concentrations that induced high environmental risk, at streams of Guadiana Basin located near urban areas. Temporal regimes at Guadiana Basin very sensitive to the contamination from agriculture and urban activities, which was more evident during periods of drought conditions. Changes in water physico-chemistry is highly controlled by flow intermittency and subsequent disruption of longitudinal connectivity; diatom assemblages reflect the aquatic regimes, aquatic states and sampling habitat;

benthic diatom assemblages in dry biofilm can be used as an indicator of ecological status during the dry-phase.

- The development and application of a methodology for the prediction of soil salinity and sodicity risk, in irrigated lands at the Alqueva area (a Mediterranean area in Southern Portugal), showed that 67% of the potentially irrigated area presented a low risk of salinity development, 68% had a moderate risk of sodification, and 16% was of high risk of sodicity development.

- Group members act as editors for six special issues in international indexed journals in the areas of atmospheric sciences, remote sensing, aquatic ecosystems, water quality, and environmental risk assessment.

Selected publications

Galveias, A., Arriegas, R., Mendes, S., **Ribeiro, H., Abreu, I., Costa, A. R., Antunes C. M.**, 2020. Air pollutants NO_2– and O_3-induced Dactylis glomerata L. pollen oxidative defences and enhanced its allergenic potential. Aerobiologia. https://doi.org/10.1007/s10453-020-09676-2

Rodrigues, G., Potes, M., Costa, M.J., Novais, M.H., Penha, A.M., Salgado, R., Morais, M.M., 2020. Temporal and Spatial Variations of Secchi Depth and Diffuse Attenuation Coefficient from Sentinel-2 MSI over a Large Reservoir. Remote Sens. 2020, 12, 768. https://doi.org/10.3390/rs12050768

G2 – Energy


Paulo Canhoto – G2 Coordinator

The main objectives of Group 2 are related to energy capture, conversion, transport and storage, with a special focus on solar energy, as well as reducing the environmental impacts of energy exploration and use. The activity of the Energy group covers the following topics:

- Energy capture and conversion

Solar energy resource, solar concentration technologies and solar collector development and testing, solar thermal receivers modelling and optimization, photovoltaic solar energy, biomass energy and hybridization of energy sources.

- Energy storage and energy generation management

Thermal energy storage in concentrated solar power (CSP) systems, storage of electrical energy in batteries, storage in geological formations (CAES), geothermal developments and heat pumps, energy generation and storage management.

- Flow structures and energy transfer

Fluid flow under special pressure and temperature conditions, optimization of flow and heat transfer structures, design and optimization of energy conversion and storage systems using the constructural theory, optimization of thermal systems and equipment, study of dendritic flow networks in transient regime, fractal description of materials composed of microtubes.

- Decarbonization and energy efficiency

Geological storage of CO2, decentralized generation and decarbonization, photovoltaic energy in agriculture, air conditioning systems with renewable energy, water purification and desalination using solar energy, process heat (solar) in industry, energy efficiency and rational use of energy.

These topics were addressed during 2020 through ongoing research projects and work plans of post-graduation thesis. The research activity in solar energy is also framed in the Renewable Energy Chair

(CER - Cátedra Energias Renováveis), as described in more detail below. The main results achieved are briefly described as follows:

- Solar radiation modelling and solar energy resource assessment using both radiative transfer models and ground-based measurements. Solar radiation was modelled using libRadtran, SMARTS and numerical weather prediction models (Meso-NH and IFS/ECMWF). The effect of the atmospheric variables and aerosols concentration on solar irradiance, with a special focus in the direct normal irradiance (DNI), were considered and the circumsolar component was determined. A Typical Meteorological Year (TMY) for Evora was generated using the 2003-2018 data series from the ICT measuring stations and used to produce a solar energy resource maps of South of Portugal through an Artificial Neural Network (ANN) that corrects the predictions of the Meso-NH model for the typical months of the TMY, in the continuation of the work started in 2019. A network of ten measuring stations scattered in the region was used to assess the solar energy resource and to validate the models results. A collaboration was established with colleagues of Group 1 on this topic.
- Development of a research infrastructure in the field of Molten Salt driven Concentrated Solar Power (CSP) and Thermal Energy Storage (TES), and design of a dual MS-TES system. Research on PV system maintenance and system control and optimization was carried out through the development of PV module repair techniques, EES and system control strategies, as well as irrigation applications based on solar energy. Water treatment related activities were developed with the design of photocatalysis driven water treatment pilots using solar energy and comparing direct irradiation and PV driven UV lamp systems.
- Research activity was carried out on the development of low-carbon energy and industry in Southern and Eastern Europe, with a focus on eight regions considered promising for carbon capture, utilization and storage, to encourage and support initiatives within each region and produce local development plans and business models tailored to industry's needs. Regarding the reduction of CO2 emissions, a project on a site screening process for mafic and ultramafic

rocks in southern Portugal is ongoing, which can provide a mineral carbonation opportunity for the Sines cluster. Research is focused, first and foremost, in the Sines sub-volcanic massif, located immediately adjacent to the CO2 sources.

- Research is also ongoing in the identification of flow regimes in tubes including the conditions that promote annular or dispersed flows, and the study of the oil/water separation process in porous tubes due to viscosity and surface tension. The analytical modeling of the effective permeability of porous tubes subject to intermittent potential and acoustic waves is being developed, as well as a CFD study on immiscible liquid-liquid separation using porous tubes in different situations and a study on the separation of non-miscible liquids in networks of parallel porous tubes and in tree-shaped networks of porous tubes. The optimal allometric laws for tube diameters and lengths at different levels of bifurcation in dendritic flows networks were obtained.
- Determination of fractal dimensions of materials as a function of geometric characteristics of microtubes.

Renewable Energy Chair (CER - Cátedra Energias Renováveis)

Created in 2010, the Renewable Energies Chair - University of Évora (CER-UE) has the mission of developing technological solutions and applications of solar energy for the decarbonization of different economic sectors. At the core of INIESC, the National Research Infrastructure in Solar Energy Concentration, University of Évora's Renewable Energies Chair develops research along the main vectors defining the role of solar energy technologies as a solution for the Energy Transition: PV or CSP power generation; thermal or electrical energy storage; solar energy for energy supply to industry and agriculture; solar resource and energy system integration strategies.

With expertise in non-imaging optics (NIO) the CER-UÉ is involved in different solar concentrator developments making use of NIO concepts, including the development of innovative (patented) concepts of etendue matched concentrators increasing the performance of the line-focus linear

fresnel reflector concept or stationary or quasi-stationary Compound Parabolic Concentrator (CPC) for medium temperature applications.

With its solar concentration activities coordinated within INIESC, the National Research Infrastructure on Solar Energy Concentration, part of the National Roadmap of Research Infrastructures and lead by CER-UÉ, having LNEG, IP as partner institution, activities in CER spread also to photovoltaic (PV) and electricity storage (EES) related activities, with focus on agricultural and community/quarter based applications and on the study of different EES technologies and combined hybrid EES systems.

The RE Chair integrates the main R&D European Solar Thermal networks: EU-Solaris, EERA JP-CSP, INSHIP ECRIA and SFERA and has specific R&D agreements with DLR and Fraunhofer ISE.

Along 2020 CER-UE activities included:

a) important advances in the development of an important research infrastructure in the field of Molten Salt driven Concentrated Solar Power (MS-CSP) and Thermal Energy Storage (TES): within INIESC cooperation with the German funded projects HPS2 and MS-OPERA, the solar MS loop under construction at Évora Molten Salt Platform (EMSP) got into its final stage of construction, with the completion of the solar loop hydraulics, solar field installation and electrical works conclusion. Within project NEWSOL a final decision on the location and design of a dual MS-TES system (concrete solid storage and thermocline storage) has been taken, leading to its final design and beginning of construction;

b) industrial process heat collectors and applications: conclusion of the transnational H2020 INSHIP ECRIA, aimed at the definition of a common European research agenda involving European research institutions with recognized activity in the area of solar process heat;

c) PV system maintenance and system control and optimization: development of PV module repair techniques, EES and system control strategies, irrigation applications in projects as GRECO and PEARL-PV;

d) deployment of water treatment related activities: design completed and construction started of a prototype of a photoreactor with direct use of solar radiation in a water treatment photocatalytic

process, complemented with the selection of the photochemical reaction and the definition of the parameters to evaluate the prototype efficiency in the degradation of pharmaceuticals;

e) Linear Fresnel Reflectors testing on projects as ALFR-Alentejo;

f) cooperation, joint activities and networking between research infrastructures and between researchers, and transnational access for researchers, developed under SFERA-III, INSHIP, and PEARL-PV;

g) capacity building activities: GRECO and ENBRAIN projects;

Besides these activities in ongoing projects, in 2020 participation in two new projects has started:

- SolaQua – Accessible, reliable and affordable solar irrigation for Europe and beyond, H2020, Grant nr. 952879: A project that aims at increasing the share of renewable energy in Europe, by combining photovoltaic and hydraulic technology with high efficiency irrigation;
- Solar Tech – Transferência de Tecnologia e Conhecimento em Energia Solar e Armazenamento de Energia, Alentejo 2020, Contract ALT20-03-0246-FEDER-000053: Project that is aimed to transfer technology and knowledge to the business sector, focused on the application of three major technological lines: solar photovoltaic associated with high-power pumping or irrigation systems; solar thermal for process heat in industry; and photovoltaic for residential energy and services, using advanced batteries, with intelligent management and integration. This operation aims to create infrastructures for technological didactic demonstration, through pilot projects, for knowledge transfer and technology of energy solutions solar for the business fabric.

Still along 2020, three MSc students (Borges, H., Damasceno, T., e Sanches, R.) and one PhD student (Cavaco, A.) have concluded their thesis based in works developed in CER-UÉ.

Selected publications

Barreto, G., Canhoto, P., Collares-Pereira, M., 2020. Parametric analysis and optimisation of porous volumetric solar receivers made of open-cell SiC ceramic foam. Energy 200, 117476. https://doi.org/10.1016/j.energy.2020.117476

Foles, A., Fialho, L., Collares-Pereira, M., **Horta, P**., 2020. Vanadium Redox Flow Battery Modelling and PV Self-Consumption Management Strategy Optimization. In Proceedings of EUPVSEC 2020 - 37th European Photovoltaic Solar Energy Conference and Exhibition. 7-11 Sep. 2020. https://doi.org/10.4229/EUPVSEC20202020-5EO.2.1

G3 – GeoResources and Geomaterials


Helena Sant'Ovaia – G3 Coordinator

The main objective of **GeoResources and Geomaterials Group** is aligned with the ICT mission which is to develop exceptional-quality research, promote technological development and support public policies in Earth Sciences.

Within the GRG the research focuses on two main areas (Georesources and Geomaterials), namely: (i) LCT pegmatites and deposits of rare elements associated with granites for the identification of genesis, age and mode of occurrence to improve exploration programs and processing technologies, and to improve and develop methods of evaluation of industrial wastes to promote recycling; and, (ii) the characterization of natural and anthropogenic geomaterials for the promotion of critical metals recovery, in the scope of geoarchaeological and architectural and civil engineering purposes, and in studies of soils and sediments for forensic applications.

In this scope of the study of LCT pegmatites and deposits of rare elements associated with granites, several studies were successfully applied to characterize the deposits of W-Sn and associated metals in Castilla y León – Spain - and the Northern and Central regions -Portugal - with the purpose of establishing possible prospecting guides that are universally applicable in the exploration of this type of deposits.

There were also established predictive models for strategic metal-rich, granite-related ore systems by refining available concepts and exploration strategies, using mineral and geochemical criteria as pathfinders or vectors to mineralized systems. Such systems ranged from quartz-lodes, breccia pipes (e.g. Borralha) and skarns enriched in W-Sn-F(-P-Bi-Sb-Cu)-bearing mineral associations, greisenized granite cupolas (e.g. Panasqueira) and aplite-pegmatite-hosted mineral assemblages incorporating Sn-Ta-Y-F(-W-Nb) or Li-Cs-Be-Ta(-P-Rb). Particularly to Antimony (Sb), the mineralizations of Valongo

were studied and a new 3D large-scale metallogenic model integrating deep-seated processes to determine the spatial distribution of ore deposits was considered.

Considering the strategic importance of Li, the study of pegmatites evolution and the structural control of the veins several projects successfully developed software for easy and fast detection of lithium-host minerals combining drone-borne remote sensing data and field observations, and to understand how pegmatitic Li-deposits are formed.

The unlock of domestic critical mineral resources was studied to develop and validate new cost-effective exploration approaches.

Studies of granites plutons, genesis, emplacement, and geometry were performed and the role of plutonic variscan magmatism (e.g Lamas de Olo, Caria, Vila da Ponte, Esmolfe, Valpaços plutons, among others) in the genesis of mineralizations was highlighted.

In the scope of the characterization of natural and anthropogenic geomaterials the main results achieved are briefly described.

Organic petrology and geochemistry studies allowed the identification and characterization of the environmental impacts caused by the São Pedro da Cova coal mine waste pile (self-burning since 2005) in surrounding soils and waters. The monitorization of the combustion temperature and mass movements was performed through remote sensing using unmanned aerial vehicles.

Efficient processes and innovative techniques for the extraction of metals and separation of graphite from spent Li-ion Batteries and to overcome the barrier and obstacles which limit the recovery efficiency were also developed.

Innovative, multi-informative, operationally deployable, and commercially exploitable imaging solutions/technology were developed to analyze forensic evidence, including, but not limited to, fingermarks, hair, paint, biofluids, digital evidence, fibers, documents and living individuals.

Principles of CO_2 capture and storage technologies were revised to evaluate the potential of in situ mineral carbonation in mafic and ultramafic rocks in Alentejo, and to attain mitigation technologies

by studying a process that allows the industrial and power sectors to reduce their greenhouse gas emissions.

Novel solutions were evaluated to produce P-rich concentrates from aviary litter ash, as a process of recycling of phosphorus from aviary litter ash as a substituting material of phosphate rocks.

Predictability models for ornamental stones, namely in marbles in Alentejo and limestones, in construction and in exploitation were established.

Some ongoing projects developed strategies to preserve and disseminate the geodiversity, biodiversity and cultural heritage of the Natural Park of Serra de São Mamede and to understand Great Ordovician Biodiversification Event.

An extensive version of the G3 report is available on: https://www.icterra.pt/index.php/protected/

Selected publications

Cardoso-Fernandes, J., Teodoro, A. C., Lima, A., Perrotta, M., Roda-Robles, E., 2020. Detecting Lithium (Li) Mineralizations from Space: Current Research and Future Perspectives. Appl. Sci. 10, no. 5: 1785. https://doi.org/10.3390/app10051785

Cruz, C., Góis, J., **Sant'Ovaia, H., Noronha, F.**, 2020. Geostatistical approach in the study of the magnetic susceptibility variation: Lamas de Olo Pluton case study. Journal of Iberian Geology: 1-11. https://doi.org/10.1007/s41513-020-00128-x

Gonçalves, A., Sant'Ovaia, H., Ribeiro, M.A., Noronha, F., 2020. The Esmolfe - Matança granite (Penalva do Castelo, Central Portugal): a keystone to understand the ascent and emplacement of magmas under low tectonic stress. J. Struct. Geol., 139, 104-143. https://doi.org/10.1016/j.jsg.2020.104143

Guimarães, R., Guedes, A., Valentim, B., 2020. Identification and characterization of Ti-spheres (titanspheres) in cork powder fly ash. Waste and Biomass Valorization 11, 2905–2923. https://doi.org/10.1007/s12649-019-00609-w

Maia, M., Moreira, N., Vicente, S., Mirão, J., **Noronha, F., Nogueira, P.**, 2020. Multi-Stage Fluid System Responsible for Ore Deposition in the Ossa-Morena Zone (Portugal): Constraints in Cu-Ore Deposits Formation. Geology of Ore Deposits 62, 508-534. DOI: 10.1134/S1075701520060094

Moura, H., Marques, M.M., Suárez-Ruiz, I., **Ribeiro, J.**, Cunha, P.P., **Flores, D.**, 2020. Geochemical study of the natural cokes from the Peñarroya-Belmez-Espiel Basin (Spain). Comunicações Geológicas 107, 101-104. https://www.lneg.pt/wp-content/uploads/2020/07/14_Moura-et-al-2020_Cores_final_101-104.pdf

Roseiro, J., Moreira, N., Nogueira, P., Maia, M., Araújo, A., Pedro, J., 2020. Depositional environment and passive-to-active margin transition as recorded by trace elements chemistry of lower-middle Palaeozoic detrital units from the Ossa-Morena Zone (SW Iberia). Comunicações Geológicas, 107, Especial II, 39-46. https://www.lneg.pt/wp-content/uploads/2020/07/05_Roseiro-et-al-2020_final_39-46.pdf

G4 – Geoconservation and Geoscience Education

José Brilha – G4 Coordinator

The research and outreach activities planned for 2020 were deeply disturbed by the covid-19 pandemic. Most scientific events were postponed, some were replaced by online versions, field activities were suspended during most of the year and for several months the laboratory activity was also reduced to a minimum. Comparing with previous years, the number of publications does not show a significant change because they are the result of the work done before the arrival of the pandemic.

In spite this anomalous setting, these are the major results obtained by G4 during 2020:

1. Conclusion of the project: "Geoethics Outcomes and Awareness Learning (GOAL)" (2017-1-PTO1-KA203-035790), sponsored by ERASMUS+, coordinated by Clara Vasconcelos, UPorto and publication of the e-book, which represents a significant contribution to promote the geoethics teaching in universities:

> **Vasconcelos, C.**, Schneider-Voß, S., Peppoloni, S. (Eds.), 2020.Teaching Geoethics: Resources for Higher Education. UPorto Edições eBooK. DOI: 10.24840/978-989-746-254-2

2. Publication of a book with guidelines to promote the conservation of geological heritage in protected areas. This book was prepared by an international team of experts under IUCN, the International Union for Conservation of Nature. The book is now being translated into several other languages in order to be widely used worldwide:

> Crofts, R., Gordon, J.E., **Brilha, J.**, Gray, M., Gunn, J., Larwood, J., Santucci, V.L., Tormey, D., Worboys, G.L., 2020. Guidelines for geoconservation in protected and conserved areas. Best Practice Protected Area Guidelines, Series No. 31. Gland, Switzerland, IUCN, 144p. DOI: 10.2305/IUCN.CH.2020.PAG.31.en

3. Writing of 4 chapters of the book "Landscapes and Landforms of Portugal", integrated in the "World

Geomorphological Landscapes" book series published by Springer:

Brilha, J., Pereira, P., 2020. Geoconservation in Portugal with Emphasis on the Geomorphological Heritage. In: Vieira, G., Zêzere, J., Mora, C. (Eds.), Landscapes and Landforms of Portugal, Springer, pp. 307-314. DOI: 10.1007/978-3-319-03641-0_24

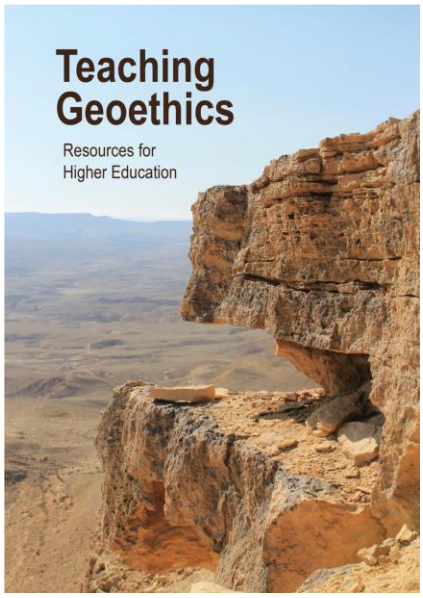
Pereira, D.I., Pereira, P., 2020. The Geomorphological Landscape of Trás-os-Montes and Alto Douro. In: Vieira, G., Zêzere, J., Mora, C. (Eds.), Landscapes and Landforms of Portugal, Springer, pp. 139–149. DOI: 10.1007/978-3-319-03641-0_11

Pereira, P., Pereira, D.I., 2020. The Granite and Glacial Landscapes of the Peneda-Gerês National Park. In: Vieira, G., Zêzere, J., Mora, C. (Eds.), Landscapes and Landforms of Portugal, Springer, 127–137. DOI: 10.1007/978-3-319-03641-0_10

Pereira, D.I., Pereira, P., 2020. Terras de Cavaleiros Geopark: A UNESCO Global Geopark. In: Vieira, G., Zêzere, J., Mora, C. (Eds.), Landscapes and Landforms of Portugal, Springer, pp. 315–327. DOI: 10.1007/978-3-319-03641-0_25

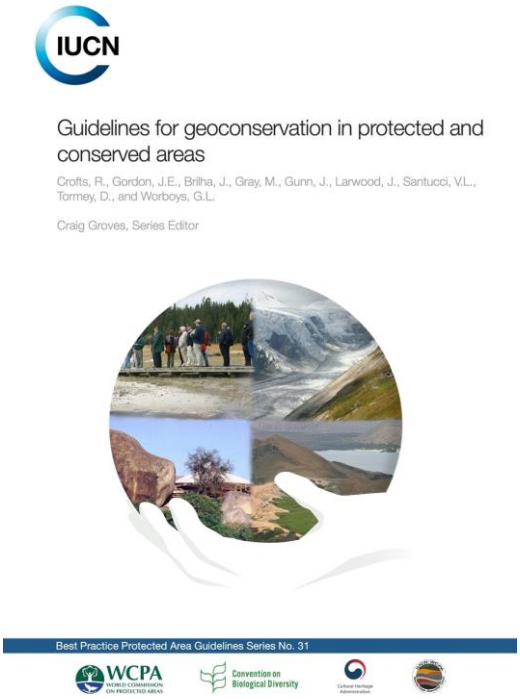
4. It is also worthwhile to mention that most of the publications produced by members of this group (papers, books, and book chapters) was done with foreign co-authors, which denotes a high internationalisation level.

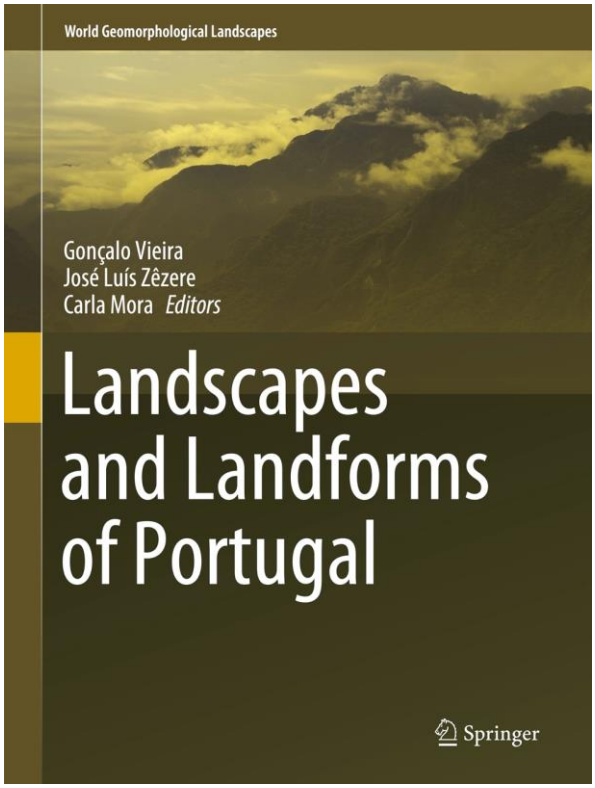
Selected publications



Vasconcelos, C., Schneider-Voß, S., Peppoloni, S. (Eds.), 2020. Teaching Geoethics: Resources for Higher Education. UPorto Edições eBooK. DOI: 10.24840/978-989-746-254-2.

Crofts, R., Gordon, J.E., **Brilha, J.**, Gray, M., Gunn, J., Larwood, J., Santucci, V.L., Tormey, D., Worboys, G.L., 2020. Guidelines for geoconservation in protected and conserved areas. Best Practice Protected Area Guidelines, Series No. 31. Gland, Switzerland, IUCN, 144p. DOI: 10.2305/IUCN.CH.2020.PAG.31.en





Brilha, J., Pereira, P., 2020. Geoconservation in Portugal with Emphasis on the Geomorphological Heritage. In: Vieira, G., Zêzere, J., Mora, C. (Eds.), Landscapes and Landforms of Portugal, Springer, pp. 307-314. DOI: 10.1007/978-3-319-03641-0_24

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Pereira, D.I., Pereira, P., 2020. Terras de Cavaleiros Geopark: A UNESCO Global Geopark. In: Vieira, G., Zêzere, J., Mora, C. (Eds.), Landscapes and Landforms of Portugal, Springer, pp. 315–327. DOI: 10.1007/978-3-319-03641-0_25

G5 – Environmental Monitoring and Remediation for Sustainability

Teresa Valente – G5 Coordinator

The main objectives of Group 5 are focused on environmental systems under pressure, contributing to the advancement and application of knowledge, specifically in the domains of monitoring and remediation, which are valuable for pursuing sustainability goals.

In continuity with the G5 strategy, the following topics are emphasized:

- Monitoring, conservation and remediation of water, sediments, soil (climate, pollution, forest fires,...).
- Mine wastes in circular economy – reactivity and valorization for sustainability of mineral sector.
- Environmental implications of system interfaces, such as mineral-water-ecology interactions.
- Environmental impact of land uses, such as mining and urbanization.
- Monitoring and assessment vulnerability of aquifers.
- Methodological tools for environmental monitoring of endangered systems
- Modelling of contamination processes.
- Assessing potential relationships between the environment and human health.

Despite the difficulties created by the special context of the Covid-19 pandemic, the group continued with the objective of internationalization, maintaining the existing networks. This included the objective of research in development nations pursuing UN SDG, specifically in Cape Verde.

Moreover, G5 members still involved in transdisciplinary international groups of recognized importance, such as the Society of Environmental Geochemistry and Health, International Mine Water Association, International Council for the Exploration of the Sea (ICES) and NICOLE Network for Industrially Contaminated Land in Europe. They integrated scientific and organization committees of international conferences like International Mine Water Conference, International Association for

Mathematical Geosciences, and XI Congresso de Geoquímica dos Países de Lingua Portuguesa. Moreover, members of G5 included permanent editorial board of specialized journals like Mine Water and the Environment, Minerals, and Environmental Geochemistry and Health and Ecological Engineering & Environmental Technology. They also coordinated special issues of recognized journals, such as “Pollutants in Acid Mine Drainage” (in Minerals); Aquatic Systems Quality and Pollution Control (in Geosciences); and Perspectives on Environment and Human Health (in Geosciences).

Most of above mentioned topics were addressed during 2020, through participation/coordination of ongoing national and international projects and PhD thesis. The following domains deserve special mention by their contribution to the strategic results:

- Environmental geochemistry and health - new studies on this field of research that envisages assessing potential relationships between the environment and human health were developed. The first papers involving several G5 members were recently published, demonstrating the wide range of topics addressed by the group within environmental sciences.

- Hydrogeochemistry of waters affected by groundwater circulation at the S. Pedro da Cova abandoned coal mine (North Portugal) - the experimental results from previous sampling campaigns were treated and the hydrogeochemical characterization of mine effluents has been improved.

- Hydropedological features of the waste pile of S. Pedro da Cova coal mine - in order to identify changes induced by the waste pile self-burning, the following tasks were carried out: (i) the morphological description of soil profiles; (ii) geochemical and mineralogical characterization; (iii) field tests using a mini disk infiltrometer for measuring the unsaturated hydraulic conductivity; (iv) characterization of Technosol leachates in terms of major ions, potentially toxic elements, and PAHs.

- Hydrogeochemistry and biogeochemistry in abandoned metallic mines, including sulfide and uranium mines - the results from previous sampling campaigns were analyzed in order to model the seasonal patterns of acid mine drainage, to characterize acidic pit lakes, estimate metallic loads, and determine pollution indexes.

- Mineral-water-biosphere interactions in acid mine drainage, with emphasis in sulfide-rich mines in

Iberian Pyrite Belt - this field of research was focused on the role of acidophilic algae in acid mine drainage, including participation in biomineralization processes, association between secondary iron-rich minerals and algae, as well as definition of ecological indicators of metallic contamination.

- Acid mine drainage precipitates, especially colloidal material in the nanometric scale - methodological approaches based on inductively coupled plasma optical emission spectrometry, X-ray diffraction, electron microscopy, and Fourier-transform infrared spectroscopy were applied to further description of geochemical, mineralogical and morphological properties that could have influence on the fate and transport of pollutants.

- Mining contamination associated with dam collapse – a work is under development by a post-doc of the Federal University of Ouro Preto, in the AmbiTerra laboratory, comprising characterization of materials and modelling of the contamination after a serious environmental disaster in Minas Gerais, Brasil.

- Acid mine drainage (AMD) remediation – this domain includes several activities that are under different stages. One outcome was achieved with collaboration with Colombian researchers and allowed the definition of a remediation approach and respective operational conditions for AMD treatment with sand and zeolites; another activity comprised the definition/sampling/characterization of different geological materials (clays, zeolites, iron-oxyhydroxides) to develop further adsorption experiments with AMD from Iberian Pyrite Belt.

- Valorization of reactive mine wastes in the context of circular economy– this research field intended to assess the economic potential of critic/strategic elements in rock waste dumps and tailing dams (e.g., Ag, Au, As, Se, Sc) as a way of transforming environmental liabilities into economic outcomes. The work was focused on wastes from Portuguese and Brazilian mining areas and comprised geochemical and mineralogical characterization, followed by some preliminary recuperation experiments.

- Assessment of the surface water and groundwater quality from the village of Drave (North Portugal) - this assessment has been concluded and recommendations for managing drinking water sources

have been issued.

- Assessment of water and soil quality in semi-arid developing regions, focused on the Santiago Island, Cape Verde - the results from previous sampling campaigns were analysed in order to assess environmental quality issues in this country, which is facing increasing scenarios of water scarcity and soil degradation. Major outcomes are: a monitoring plan that could contribute for future monitoring procedures of water sources in the Island, risk assessment of soil salinization, and recommendations for water and soil management in order to preserve the natural resources in dry conditions under a climate change context.

- Soil degradation by fire and remediation – this domain included selection of pilot areas, mapping, field surveys, use of UAV (for topographical monitoring), sampling campaigns and analytical characterization of soils. During this year, the work aimed to obtain chemical, mineralogical and pedological characteristics of the burned soil. Future work is being planned for development of monitoring and remediation strategies.

-Sediments Assessment and prediction – this research line continued, generating knowledge valuable for different territorial and geological contexts, including contaminated mining areas in Brazil, and unpolluted river-lacustrine Dominican systems.

- Mapping of the Alentejo's continental shelf - during the current year this mapping was completed and the assessment of the reservoir characteristics of the onshore Cretaceous and Triasic siliciclastic units (CO_2 storage reservoirs) were more detailed.

It is noteworthy that most of these results were obtained through collaborative work between G5 members of the three poles, including by co-supervision of PhD and MsC students. Moreover, results associated with projects like CoalMine, Nano-MINENV, InCarbon, and PilotSTRATEGY are examples of the added value obtained by integrating the skills and expertise of researchers from different groups of the three ICT poles, namely G2 and G3.

Selected publications

Araújo, J., Nogueira, P., Fonseca, R., Pinho, C., Araújo, A., 2020. Geochemistry of lacustrine sediments in systems with high sedimentation rates due to extreme climatic events: case studies in the Dominican Republic. Comunicações Geológicas 107, Especial I, 07-09, ISSN: 0873-948X; e-ISSN: 1647-581X DOI. https://repositorio.lneg.pt/bitstream/10400.9/3573/1/geoqu%c3%admica-de-sedimentos-lacustres-em-sistemas-com-elevadas-taxas-2020.pdf

Wolkersdorfer, C., Nordstrom, D.K., Beckie, R.D., Cicerone, D.S., Elliot, T., Edraki, M., **Valente, T.**, França, S.C., Kumar, P., Oyarzún Lucero, R.A., Soler i Gil, A., 2020. Guidance for the Integrated Use of Hydrological, Geochemical, and Isotopic Tools in Mining Operations. Mine Water Environ 39, 204–228 (2020). https://doi.org/10.1007/s10230-020-00666-x.

G6 – Lithosphere Dynamics

OBJETIVES

Mourad Bezzeghoud – G6 Coordinator

This report is the continuation and concretisation of the main goal of G6 research of the group. We study the dynamics of the lithosphere at different temporal and spatial scales using multidisciplinary geological and geophysical methodologies: structural mapping combined with advanced microscope digital analysis and geochemistry; seismic, geoelectric, magnetic, gravimetric and high precision down hole temperature measurements methods to infer the internal complex structure of oceanic and continental lithosphere. All our studies were be funded by the 16 projects listed below (section G). Identification and summary description of several contributions and results deemed most important provided in 2020 by the researchers who belong to the G6 group are listed, below, through several national and international projects (16) and international publications (39 articles in peer review Journals) were carried out in the domain of Lithosphere Geodynamics, competitively funded, with a strong collaboration with the other groups of the ICT and national and international network of researchers (European, Mediterranean and African countries, and others). So, we have focus our efforts in the following topics:

- The geodynamic evolutionary model of Iberia's Ediacaran basins; Tracking the Laurussian- and Gondwana-type sources of siliciclastic rock; Geochronology U-Pb data on the Carboniferous (Variscan) silicic volcanism of the Ossa-Morena Zone; Pseudosection modeling of High-pressure metamorphic rocks.

- Study of the change from endorheic to exhorreic drainage in the Cenozoic basins of the Iberia Peninsula; study of marine terraces in the Portuguese west coast (Peniche, Lisbon and Arrábida Chain) and study of the terraces of the Tejo and Mondego rivers, progressing with new pIRIR absolute dating with the following objectives: i) To know the main drivers and mechanism that

promote that reorganization of the drainage from endorreic to exhorreic systems in Cenozoic basins of the Iberia Peninsula in the transition from Pliocene to Pleistocene; ii) To evaluate the crustal uplift and the paleo-eustatic seal level curves; iii) To use the fluvial terraces as geomorphic markers to evaluate the Quaternary environments, landscape evolution, fluvial incision rates and the neotectonics movements.

- The Antarctic study (with campaign carried out in January/February 2020) using geophysical methods.

- Seismic hazard: strengthening of our methodology combining seismic source studies and ground motion modelling with a 3D velocity model. Our studies cover always the same geographic area (western part of the Eu-Nu plate boundary, Africa and Ibero-Maghrebian area). This work includes, also, the study of the seismicity and the seismotectonic of this area.

- Seismic networks and instrumentation. Install seismic networks and develop low-cost seismic sensors.

- Archaeological Geophysics, in which we participate with multidisciplinary teams that study archaeological sites. We have consolidated this technic with funded projects, finalized the first Phd and published the corresponding first papers in this area.

RESULTS

- The geodynamic evolutionary model: update of the geodynamic evolutionary model of Iberia's Ediacaran basins in the context of the Cadomian active continental margin, using geochemical data. Advances in tracking the Laurussian- and Gondwana-type sources of siliciclastic rocks from the Carboniferous Ossa-Morena and South Portuguese Variscan synorogenic basins and the Triassic Algarve basin. New geochronology U-Pb data on the Carboniferous (Variscan) silicic volcanism of the Ossa-Morena Zone and the atypical Ordovician granodiorite-tonalite of the Central Iberian Zone. Pseudosection modelling of High-pressure metamorphic rocks (blueschists) of the Badajoz-Cordoba unit (Variscan Orogen, SW Iberian Massif).

- Cenozoic basins of the Iberia Peninsula: It was published one article in a per review journal in 2019

about the mechanism and age estimates from transition, from endorheic to exorheic drainage of the Douro River and a second paper in 2020 concerning the beginning of the incision of the Tejo River in the culminant surface of the Lower Tejo and Mondego Cenozoic sedimentary basins.

- A strong and transversal collaboration took place between the groups, in particular, with the G2, G3, G5, G6, in the following topics: i) Geochemistry of lacustrine sediments in systems with high sedimentation rates due to extreme climatic events; ii) Experiments on mineral carbonation of CO2 in gabbro from the Sines massif; iii) The Ossa-Morena marbles used in the Classical Antiquity; iv) Mineral Carbonation of CO2 in Mafic Plutonic Rocks; v) Depositional environment and passive-to-active margin transition; vi) Prasinophyte bloom and putative fungi abundance near the Kačák event (Middle Devonian) from the Odivelas Limestone, Southwest Iberia; vii) Portable X-ray fluorescence and clustering methods applied to mineral exploration: the significance and nature of Batigelas anomaly (Ossa-Morena Zone - Cabeço de Vide, Portugal); Environment and Solar Energy.

- Antarctic campaign carried out in January/February 2020, was to determine the lateral and deep extension of the permafrost in the area next to the Peruvian Antarctic station Machu Picchu. The main conclusion is that there is a decrease in the thickness of permafrost compared to previous years. The climatological interpretation of the results is being studied by Peruvian colleagues.

- Seismic hazards: EMSO-PT (http://emso-pt.pt/) is an infrastructure jointly funded by the Portuguese government and by the European Commission that aims to create and develop infrastructures for scientific and technological research within the scope of Marine Sciences. One of the goals of EMSO-PT is to improve the national seismic monitoring network, thus allowing for the development of an Earthquake Early Warning System (EEWS), including earthquakes generated in the Atlantic region adjacent to the Portuguese territory. Considering the seismogenic Eurasia-Nubia plate boundary located south of mainland Portugal, current efforts by the University of Évora and IPMA aim to densify the seismic network in the extreme SW tip of mainland Portugal. The 4 new planned seismic stations will comprise both a broadband station installed at 30-m depth and an accelerometer installed at the surface. The new stations will integrate a new network with code VS (University of Evora, 2000). In

this work we will present our network planning involving some issues such as the zone to be monitored and the characterization of its seismicity and mechanism of earthquake rupture, geographic distribution of seismic stations, detectability and response time, option in the type of instruments, the integration of our stations with other national and international networks, and finally, the logistics needed to successfully achieve this task whose purpose has been described above. EMSO-PT intends to have continuous data in real time supporting alert systems and the establishment of adaptation measures.

- Seismic networks and instrumentation:

a) In 2020, the QNET (8H) seismic network (Fontiela and Dias, 2019), a consortium of ICT (UÉvora), Instituto Dom Luiz (University of Lisbon), and IPMA, continued to operate. The instrumentation includes broadband, short-term sensors, geophones, and accelerometers. In total, 31 instruments were in operation. This seismic network's objectives are the study of the structure of Terceira island using tomography, the seismotectonic analysis, and the seismicity induced by the geothermal plant installed in the Central Zone of the island. Analyzing seismicity of the first months, it is high inland and around the island. From the seismicity, it is possible to distinguish a cluster associated with the Santa Bárbara Volcano and another related to the transition of the Caldeira Guilherme Moniz to the Pico Alto Volcano. Note that the mentioned volcanoes are active but in a dormant state. Besides these clusters, the seismicity to the south of the island is also high. The Arraiolos Seismic Network (7N) (Fontiela and Bezzeghoud, 2018) continued to operate with four broadband stations despite the difficulties experienced in the GPS and power supply system. The network's objectives are to monitor seismic activity in Aldeia da Serra;

b) we have installed 2 temporary seismic networks (with international registration, DOI) and reenforced the Nacional Seismic Network with an international recognition (with also an international registration, DOI);

c) Towards High-Dense Seismic Network Deployments: we have, also, developed low-cost Micro-Electro Mechanical Systems (MEMS) accelerometers and demonstrated the capability to generate

relevant data for seismic analysis in dense deployment contexts.

All this work has concrete results already published. The thesis manuscript of Marco Manso, about this topic, is under review.

- Archaeological Geophysics: in this case, we have proposed methodologies that allows the correction of the excessive background noise in GPR profiles, solve issues of under sampling and lack of definition in 3D-GPR data and lack of simultaneous perceptibility in GPR and magnetic gradient data. The removal of background noise from the GPR data was performed using spectral filters, with the selection of the useful information through data factoring techniques which allow the semi-automation of the process, making it personal to the data and less dependent of the user. The 3D-GPR data densification was performed using Fourier interpolation, applied through automatic event identification algorithms, which allows obtaining GPR profiles between each two existing profiles. To the interpretation of the results, we propose a methodology to fuse GPR models and a magnetic gradient based in the fusion techniques used in Medicine for tumour detection. The method uses 2D Wavelet discrete transform and the Single Value Decomposition Multiresolution. To evaluate the results, we developed routines that allow quantitative comparisons, through the calculation of sharpness, quality and similarity indices. Finally, the developed methodologies were applied to the geophysical study of Villa de Pisões, whose data have very low perceptibility. The sequential use of the methodologies conceived allowed to move from a scenario of apparent lack of useful information to one in which it became possible to identify geophysical anomalies. This allowed the production of a global interpretative model of the unexcavated area of the Villa de Pisões.

Selected publications

Rui Oliveira's PhD thesis for being the first in the area of Geophysics applied in the field of archeology and with evident and promising results, in addition to being published in national and international journals.

Oliveira, R.J., 2020. Prospeção geofísica aplicada à Arqueologia. Earth and Space Sciences PhD, Institute for Advanced Studies and Research, University of Évora (Supervisors: **B. Caldeira**, T. Teixidó).

- The work of Rui Dias in the field of dissemination:

Rui Dias, i) Live-long learning of pre-University school teachers (with Estremoz Science Centre) due to the pandemic situation we have tightening our links to the educational community, with 26 presential days of credited practical training (20 days in the field all over Portugal) involving 292 teachers. ii) Science video channel (with Estremoz Science Centre- ccvestremoz.com) to help teachers giving their internet-based classes due to the closure of schools, we open in May 2020 a video channel with the production of pedagogical videos explaining Earth Science processes (5165 visualizations during 2020). The effort of Rui Dias was very efficient in terms of dissemination on a national and international scale.

ICT Post-Graduation Programmes

ICT offers an interesting variety of courses covering a wide range of Master's and PhD's in Earth Sciences. They are research-based programs that offer solid formation joining fundamental knowledge in Earth Sciences with applied skills covering priority areas and training and skills to undertake professional employment in the area of Earth Sciences.

PhD Programmes

- Earth and Space Sciences – University of Évora

It is a PhD programme that provides advanced knowledge in four areas of specialization, on the Earth, Atmosphere and Space subsystems and on the methodologies of observation, monitoring and modelling of these subsystems, with marked interdisciplinary potential in emerging domains - from Natural and Technological Risks to development of technologies with a broad application spectrum.

- Mechatronics Engineering and Energy – University of Évora

This PhD programme provides advanced training in different areas of specialization, with strong interdisciplinary potential in emerging fields, from product design engineering, instrumentation, automatic control and process supervision, to the development of application spectrum technologies to Mechatronic Engineering, the energy efficiency of Processes, the capture, conversion and concentration of Energy.

- Geology - Geoconservation, Environmental Geology and Geological Resources – University of Minho

This programme has the overall objective to offer, in a research environment, training in advanced areas of Geology. In this context, the aim of this course is to train highly qualified human resources in the field of Geology and subjects of recognized interest for the development of research activities, theoretical or experimental, or use in areas of industry and services.

- Earth Sciences – University of Porto

It is a PhD programme that aims to train broadly educated Earth scientists able to compete at an international level for careers in academia, research, government, and industry. All the facilities and

equipment necessary for modern studies in the Earth Sciences are available for the use of students in the FCUP and ICT. The fields available for advanced training by research in this doctoral degree include: Geological Resources and Geomaterials; Geodynamics; Petrology and Geochemistry; Applied Geology and Exploration Methods; Hydrology/ Hydrogeology; Coastal and Marine Geology; Stratigraphy and Sedimentology.

- Environmental Sciences and Technology – University of Porto

The PhD programme in Environmental Sciences and Technology provides the following core competencies: ability to understand and solve problems in new situations or in wide and multidisciplinary contexts, whether in the scope of scientific research, or in professional specialization; to acquire knowledge in the field, by means of research, innovation or professional skills; ability to conceive, design and develop scientific research in Environmental Science and Technology, identifying appropriate research methods for solving complex problems, in new situations that require the use of multidisciplinary knowledge.

- Surveying Engineering – University of Porto

The PhD programme in Surveying Engineering aims to provide high level education in the field of Surveying Engineering. During the course the students should acquire a solid and advanced knowledge in the field of surveying Engineering, the required skills to perform autonomous and advanced research on a topic of scientific and technological relevance.

- Teaching and Dissemination of Science – University of Porto

The PhD Programme in Science Education and Dissemination aims to provide advanced training for science teachers and communicators. The diversity and range of experiences, skills and subject areas of the Faculty of Sciences is a major advantage to secure a solid and balanced range of opportunities for advanced training through research in science teaching and outreach. The programme addresses issues associated with education, communication and/or public outreach, but it deliberately remains closely linked to the each of the corresponding scientific areas in any of the physical and natural sciences.

Completed PhD Theses

1. **Barreto, G.**, 2020. Modelling and optimisation of porous volumetric receivers in point-focus solar concentration systems. Mechatronics Engineering and Energy PhD, University of Évora, Portugal, FCT Grant No. SFRH/BD/115923/2016 (Supervisors: **P. Canhoto**, M. Collares-Pereira).
2. **Cavaco, A.**, 2020. Medição de DNI e previsão a longo prazo da sua disponibilidade no sul de Portugal. Earth and Space Sciences PhD, University of Évora, Portugal (Supervisors: M. Collares-Pereira, **P. Canhoto**).
3. **Cruz, C.,** 2020. Post-tectonic Variscan magmatism from Northwest Iberia. Implications for W-Mo metallogeny. Case study of Lamas de Olo Pluton. PhD thesis (published). Faculdade de Ciências da Universidade do Porto, Universidade de Aveiro, Portugal, 252 pp. https://hdl.handle.net/10216/129301. (Supervisors: **H. Sant'Ovaia**, **F. Noronha**).
4. **Fernandes, I.**, 2020. Geomorfologia da região do Porto: caraterização, evolução e património. Doutoramento em Ciências, na especialidade de Geologia, Universidade do Minho (Supervisor: **D.I. Pereira**).
5. Gonçalves, N., 2020. Monitorização da qualidade da água e do solo na Ilha de Santiago - Cabo Verde: focos de degradação e estratégias/medidas de conservação. Doutoramento em Geologia - Geoconservação, Geologia Ambiental e Recursos Geológicos, Universidade do Minho. (Supervisor: **T. Valente**).
6. Lopes, E., 2020. Envolvimento público na proposta de criação de um geoparque: o caso da Figueira da Foz. Science Education and Communication PhD, Universidade do Porto (Co-supervisor: **C. Vasconcelos**)
7. **Lopes, F.**, 2020. Short-term Forecasting for Direct Normal Irradiance with Numerical Weather Prediction Models in Alentejo (Southern Portugal): Implications for Concentration Solar Energy Technologies. Earth and Space Sciences PhD (Supervisors: **H. Silva, R. Salgado,** M. Collares-Pereira).

8. **Oliveira, R.J.,** 2020. Prospeção geofísica aplicada à Arqueologia. Earth and Space Sciences PhD, Institute for Advanced Studies and Research, University of Évora (Supervisors **B. Caldeira**, T. Teixidó).
9. Pepe, V., 2020. Estudo do escoamento de fluidos multifásicos em rede de dutos com paredes porosas e com oclusões (Study of the flow of multiphase fluids in a network of ducts with porous walls and occlusions). UNISINOS Universidade do Vale do Rio dos Sinos, Campus São Leopoldo, Brazil (Supervisors: L.A.0. Rocha, **A.F. Miguel**).

Nacional and International Projects

ACTRIS-IMP - Aerosol, Clouds and Trace Gases Research Infrastructure – IMplementation Project. H2020-EU.1.4.1.1. - Developing new world-class research infrastructures. Grant agreement ID: 871115, 2020-2023. Participants: D. Bortoli (PI at University of Évora).

ACTRIS is a pan-European research infrastructure producing high-quality data and information on short-lived atmospheric constituents and on the processes leading to the variability of these constituents in natural and controlled atmospheres. Different atmospheric processes are increasingly in the focus of many societal and environmental challenges, such as air quality, health, sustainability and climate change. ACTRIS brings essential information for understanding atmospheric processes merging data from different observational network such as EARLINET for atmospheric aerosol monitoring. The ACTRIS IMP project will take ACTRIS into a new level of maturity and will set the needed structures for the implementation actions, both at the national and European level. ACTRIS IMP builds on three main pillars: securing the long-term sustainability, implementing of ACTRIS functionalities, and positioning ACTRIS in the national, European and international science and innovation landscape. ACTRIS IMP will enable ACTRIS to respond to the users' needs and requirements.

Pyroc.pt - Advanced wildfire modelling for risk assessment and pyroconvection understanding in Portugal. PCIF/MPG/0175/2019, 2020-2023. Participants: R. Salgado (PI), F. Couto (co-PI).

Advanced computation project: CPCA/A2/2500/2020 (50 000 CPU core.hours, 6 meses), Participant: R. Salgado (PI).

COST action: CA18235 – PROfiling the atmospheric Boundary layer at European scale. Supported by European Cooperation in Science and Technology: Brussels. 2019-2023. Participants: D. Bortoli, M.J. Costa.

This Action aims at: Capacity building of instrument operators to improve the use of state-of-the-art Atmospheric Boundary Layer

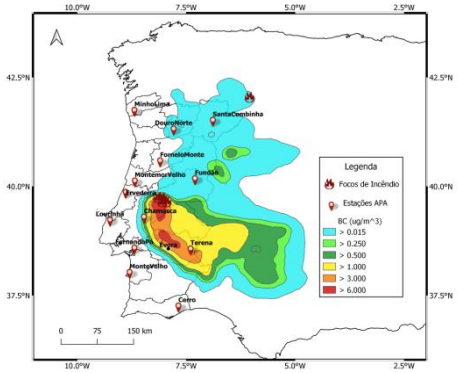
profiling instruments; Fostering coordination between operational agencies and academia to tailor measurement networks for well identified applications; Enhancing pan-European research coordination to develop new products and tools for data assimilation and long-time series reanalysis; Identifying knowledge brokers enabling rapid exchange between academia, operational agencies, industry and end-users to ensure full exploitation for societal benefit.

COST action: CA18226 – ADOPT- New approaches in detection of pathogens and aeroallergens. Supported by European Cooperation in Science and Technology: Brussels, 2019-2023. Participants: C. Antunes, H. Ribeiro, A. Costa. Integration in WK2 and WK3.

This COST action will establish an interdisciplinary network of experts currently involved in the detection of bioaerosols using both existing methods as well as upcoming technologies such as real or near real-time technologies from atmospheric chemistry and physics or eDNA methods used in molecular biology.

CILIFO – Centro Ibérico para la Investigación y Lucha contra Incendios Forestales. 0753_CILIFO_5_E. EU- INTERREG V A España Portugal (POCTEP), 2019-2022. Participant: R. Salgado (PI).

The project aims at: reinforcing and combining cooperation, work procedures and training between devices for the Prevention and Extinction of Forest Fires in the cooperation area of the Euroregion Alentejo-Algarve-Andalusia. Promoting the creation of durable and quality employment in the area; reducing the economic cost of fires creating rural economy linked to the landscape. Improving the capacity of response to forest fires of administrations and authorities involved in the fight against them in the three participating regions.



LEADING – Land usE chAnges anD mItigation of global warmiNG. PTDC/CTA-MET/28914/2017. EU – Portugal 2020 / Alentejo 2020 – FEDER, 2019-2022. Participants: R. Salgado, M. Potes.

Climate change is one of the most important challenges facing humanity in the 21st century. The objective of the project is to establish robust biophysical impacts of land use changes (LUC) on climate across Europe, from regional to local spatial scales and time scales from a few days to multi-decadal. A pilot region in the south of Portugal is chosen to investigate the local impacts of land use changes.

AdaptAlentejo – Predicting ecosystem-level responses to climate change. POCI-01-0145-FEDER-030793. EU – Portugal 2020 – FEDER, 2019-2022. Participants: R. Salgado, M. Potes.

Freshwater ecosystems are particularly vulnerable to climate change. Unravelling the links between food web structure and GHG emissions is critical to be able to predict how aquatic ecosystems may potentially be enhancing greenhouse gas emissions, leading to further global warming. AdaptAlentejo will address this challenge by combining multiple disciplines (physiology, biogeochemistry and geophysics) to answer simple, though complicated to questions: (1) can aquatic species adapt to increased temperatures? Does temperature change how they interact with each other? Do those changes have impacts at ecosystem-level.

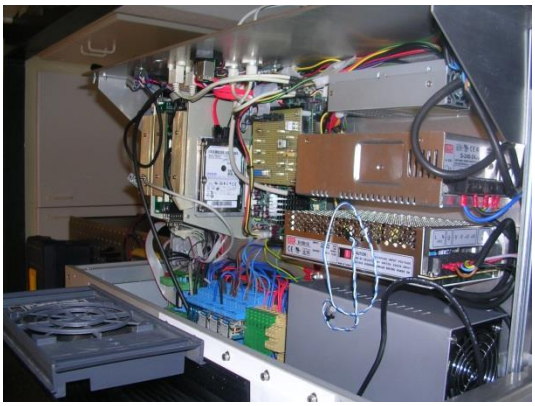
EUMETNET - AutoPollen Programme: "Proof-of-Concept for a European automatic pollen monitoring network using high temporal-resolution real-time measurements. 2018-2022. Participants: C. Antunes, H. Ribeiro.

This programme aims to establish a proof-of-concept for automatic pollen monitoring networks across Europe.

TOMAQAPA - Multispectral Observation Techniques for Air Pollution and Water Quality Assessment. PTDC/CTA-MET/29678/2017. Supported by National Funds through FCT - Foundation for

Science and Technology (239.400,80 EUR), 2018-2022. Participant: D. Bortoli (PI).

The project aims are twofold: the setup of an Air Quality measurement station (AQS) with remote sensing equipment developed at the University of Évora; the development, setup and deployment of a new underwater spectrometric system for the assessment of concentrations of dissolved gases with marked absorption features in the UV-Vis-NIR spectral range in lakes, river and sea environments.



AquaQ2 - System demonstrator for the acquisition, treatment and interpretation of water quality data and water resources collected in sensor network, ALT20-03-0145-FEDER-039494. Funded by EU-Portugal 2020/ Alentejo 2020 – FEDER, 2019-2021. Participant**:** P. Palma (PI at IP Beja).

The proposed project is the design and implementation of a demonstration system for the recognition of water quality standards and quantity of water resources.

NORTE-01-0247-FEDER-033647 - GesPSA Kiwi - Integrated operational tool to the sustainable management of Pseudomonas syringae pv. Actinidiae. Funded by Fundo Europeu de Desenvolvimento Regional (FEDER), Programa Operacional Regional do Norte (NORTE2020), 2018-2021. Participants: I. Abreu, H. Ribeiro.

This project aims combining a multidimensional Integrated Operational Tool to improve the management of kiwi Orchards and increase their productivity, even in the presence of the bacteria. The ICT members integrated in the project are in charge of analyse the impact of Psa3 on male performance and on production of viable pollen.

NanoSen-AQM - Development of gas nanosensors for air quality monitoring. SOE2/P1/E0569. EU-INTERREG-SUDOE, 2018–2021. Participants: D. Bortoli, M.J. Costa.

The main challenge of the project is the monitoring of ambient air pollution and the real-time air quality information to the public in a sustainable way. The goal is to develop an electronic system based in low cost and low consumption sensors and validate the system in different locations of the Sudoe territory, based on certified instruments for measuring air pollutants.

FitoFarmGest - Sustainable management of phytopharmaceuticals in olive groves, vineyards and arable crops in the area of influence of Alqueva, PDR2020-101-030926. Financiado pela EU- Portugal 2020/ Alentejo 2020 – FEDER, 2017-2021. Participant: P. Palma (PI at IP Beja).

EERES4WATER - Promoting Energy-Water nexus resource efficiency through renewable energy and energy efficiency, 2019-2022. The main aim of the project is enhancing the institutional, technical and social framework to promote the direct use of renewable energy sources and energy efficiency in the water cycle by influencing related policies and introduction of new processes and technologies.

PilotSTRATEGY - CO_2 Geological Pilots in Strategic Territories (started in 2020).

The project aims to characterize potential sites for pilot installations of CO_2 injection in geological formations. It is intended to investigate the geological storage of CO_2 as a technology to mitigate climate change, the geological characterization and the presentation of preliminary engineering studies that allow the technical and scientific support necessary for a final decision on the financing of pilot storage facilities for CO_2 in geological formations of the Lusitanian Basin (Portugal), Paris Basin (France) and Ebro Basin (Spain).

SolaQua – Accessible, reliable and affordable solar irrigation for Europe, H2020, Nr. 952879 (started in 2020).

SolaQua aims to increase the share of renewable energy in Europe, by combining photovoltaic and hydraulic technology with high efficiency irrigation. Solar irrigation will allow the supply of energy for irrigation with zero emissions and a cost up to 70% lower than existing fossil fuel-based solutions. Some of the technological knowledge, materials and tools that will be shared in this project are the result of experiences tested in the MASLOWATEN project, directed to develop high power photovoltaic irrigation systems.

Solar Tech – Transferência de Tecnologia e Conhecimento em Energia Solar e Armazenamento de Energia, Alentejo 2020, ALT20-03-0246-FEDER-000053 (started in 2020).

Project aimed to transfer technology and knowledge to the business sector, focused on the application of three major technological lines: solar photovoltaic associated with high-power pumping or irrigation systems; solar thermal for process heat in industry; and photovoltaic for residential energy and services, using advanced batteries, with intelligent management and integration.

EuroPatMoS – European Parabolic Trough with Molten Salt (approved in 2020)

The EuroPaTMoS project pulls together the European expertise and testing infrastructure for parabolic trough (PTC) with molten salt (MS), to accelerate transfer of technology from R&D to commercial deployment.

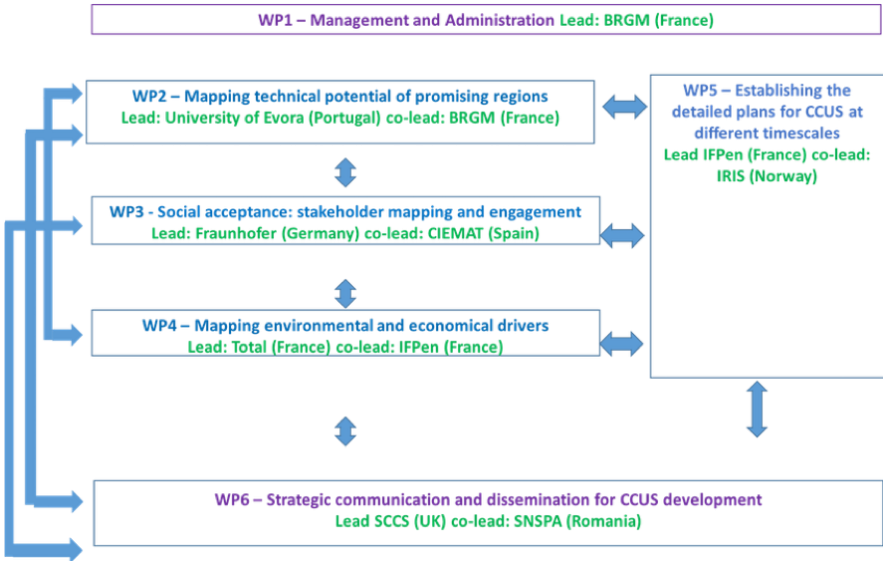
CASPER – Separação de crude e água salgada por meio de tubos porosos, e aumento da permeabilidade ao escoamento, ALT20-03-0145-FEDER-029624.

Research on the identification and mapping of flow regimes in tubes, including the conditions that promote annular or dispersed flows, and the study of the oil/water separation process in porous tubes due to viscosity and surface tension. The analytical modelling of the effective permeability of porous tubes subject to intermittent potential and acoustic waves is being developed, as well as a CFD study

on immiscible liquid-liquid separation using porous tubes in different situations, and a study on the separation of non-miscible liquids in networks of parallel porous tubes and in networks of porous tubes in the shape of a tree.

STRATEGY CCUS - STrategic planning of Regions And Territories in Europe for low-carbon enerGy and industrY through CCUS. Ação de Coordenação e Suporte. Horizonte 2020 da Comissão Europeia. 2019-2021.

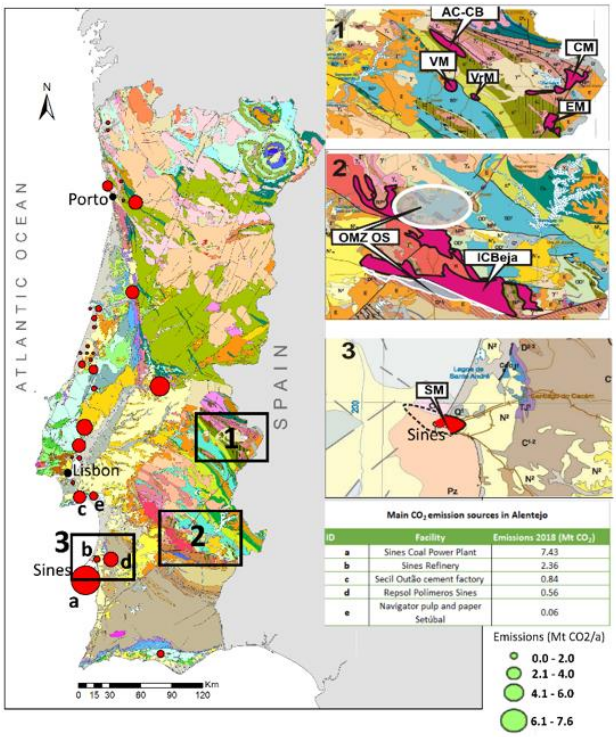
STRATEGY CCUS is an ambitious three-year project funded by the European Union to support the development of low-carbon energy and industry in Southern and Eastern Europe. We are focusing on eight regions considered promising for carbon capture, utilisation and storage (CCUS). We aim to encourage and support initiatives within each region by producing local development plans and business models tailored to industry's needs.



INCARBON – In situ Carbonation for reduction of CO2 emissions from energy and industrial sources in Alentejo. Financiado pela FCT, projeto PTDC/CTA-GEO/31853/2017. 2018-2020.

The project InCarbon intends to conduct a site screening process for mafic and ultramafic rocks in southern Portugal that can provide a mineral carbonation opportunity for the Sines cluster. Research is focused, first and foremost, in the Sines sub-volcanic massif, located immediately adjacent to the CO22sources, outcropping along 300 km onshore and offshore and mostly composed of gabbro's and diorites. Other mafic formations occurring in Southern Portugal, such as the olivine-gabbros,

peridotites and pyroxenites rocks of the Beja, Alter do Chão, Campo Maior, Elvas, Veiros and Vale Maceira massifs, will also be ranked according to a uniform set of criteria.



ALFR Patente, ALT20-03-0145-FEDER-040164

This project aims to support a European Patent Application No. 3524901 (19161768.7) "Linear Reflective Solar Concentrator Designed for Direct Operation of Salt Molten as Heat Transfer Fluid in Evacued Pipes". The present invention relates to an Advanced Linear Fresnel Reflector type solar concentrator developed at the Renewable Energies Chair of University of Évora to produce dispatchable electricity at temperatures above 500° C and using molten salts as heat transfer fluid and storage media.

ALFR-Alentejo - Installation, testing and analysis of an Advanced Reflective Linear Fresnel concentrator for electricity production by means of solar thermal storage, Alentejo 2020, Contrato nº 039487

ALFR Alentejo

The goal of this project is to implement the construction, testing and analysis an Advanced Linear Fresnel Reflector solar concentrator prototype for thermal electricity production and coupling it to

thermal storage systems with mixtures of molten salts. This operation and its data collection are crucial to the crowning of the development of this technology, which aims at a substantial reduction of costs in the production of electricity via solar thermal to a LCOE (Levelized Cost of Electricity) of USD 8¢/kWh.

EERES4WATER - Promoting Energy-water Nexus resource efficiency through Renewable Energy and Energy Efficiency, INTERREG Atlantic Area. EAPA_1058/2018

EERES4WATER aims to enhance the institutional, technical and framework to promote the direct use of renewable energy sources and energy efficiency in the water cycle by influencing related policies and introducing new processes and technologies. Those improvements were meant to bring the Atlantic Area to the forefront of strategies, policies and utilization of RES and energy efficiency as well as sustainability.

ENBRAIN - Building capacity in Renewable and sustainable ENERgy for Libya. Erasmus + KA2 programme, nº 586221.

ENBRAIN is an exchange of good practices and cooperation project, that aims to capacity building in the field of Higher Education. If, nowadays, we face a sustainability challenge, there's still an imperative necessity of energy to develop countries. Thus, educational institutions are a fundamental player to create and empower new professional and future generations able to cope and implement the new paradigms, crucial to achieve a transformative change.

GRECO - Fostering a Next Generation of European Photovoltaic Society through Open Science, H2020, Nr. 787289

GRECO is a multinational research project which its main goal is putting Open Science and other Responsible Research and Innovation (RRI) approaches into action in a research project in the photovoltaic sector. It tries to demonstrate how knowledge coalitions comprising researchers, civil organizations, citizens,

governments, industry and non-profit organizations may adopt RRI approaches such as Open Science. To do this, GRECO sets out a framework where citizens actively participate in the process of research, development and innovation both in the design of new photovoltaic solutions and in the provision of data.

INSHIP – Integrating National Research Agendas on Solar Heat for Industrial Processes, H2020 GA 731287

ECRIA INSHIP aims at the definition of a common European research agenda involving European research institutions with recognized activities in the area of solar process heat, through an integrated structure that could successfully achieve the coordination objectives of: more effective and intense cooperation between EU research institutions; alignment of different Solar Heat Industrial Processes (SHIP) national research and funding programs; acceleration of knowledge transfer to the European industry, and to be the reference organization to promote and coordinate the international cooperation in SHIP research.

HPS2 – High Performance Solar 2

This project aims to analyze the efficiency and reliability of parabolic plants with molten salt as a means of heat transfer at high temperatures, replacing the use of thermal oil as mode of heat transfer generated by solar radiation. Molten salts have advantages over the level of lower costs and heating potential at higher maximum temperatures (up to 560º). The testing is implemented on the EMSP platform.

INIESC – National Research Infrastructure Solar Energy Concentration, 01/SAICT/2016, nº 22113

INIESC infrastructure is focused on thermal conversion of solar energy at medium and high temperature and aims at the development of solar energy concentration technologies. The establishment of INIESC enables an ideal framework for the

activities already in progress by both partners (Renewable Energies Chair and LNEG) at computational, laboratorial, infrastructural, and capacity building levels.

NEWSOL – NewStOrage Latent and sensible concept for high efficient CSP Plants, H2020, grant agreement nº 720985

The project's main objective is to develop advanced materials solutions based on innovative storage media and concepts for Concentrated Solar Power (CSP) up to validation in field of their performance by real time monitoring. This will be supported by an innovative thermal energy storage design based on the combination of new functional and advanced materials into two innovative plant architectures: single tank thermocline storage and concrete type module.

SFERA-III- Solar Facilities for the European Research Area – Third Phase, H2020, Grant Nº 823802

The overall objective of SFERA-III is to carry on with the work done during the SFERA 1 an SFERA 2 projects and reinforce the sustainability of the activities of the European Advanced Concentrating Solar Power research infrastructures. The activities to achieve those goals include networking and cooperation between research infrastructures, transnational access to European researchers to technological and research infrastructures, and joint research activities.

PEARLPV – Performance and Reliability of Photovoltaic Systems: Evaluations of Large-Scale Monitoring Data, EU COST Action, CA16235

The PEARLPV's main objective is to improve the energy performance and reliability of photovoltaic solar energy systems in Europe leading to lower costs of electricity produced by photovoltaic systems, by a higher energy yield, a longer life time, and a reduction in the perceived risk in investments in photovoltaic projects. The aim of the project is the formation of an inclusive network of system photovoltaic researchers and experts, from 36 countries.

POCITYF - Positive Energy CITY Transformation Framework, H2020, Nr. 864400

POCITYF is a smart city-oriented project, whose major goal is to deliver a set of Positive Energy Blocks – a limited geographic area whose average local renewable generation is greater than its consumption - in the lighthouse cities of Evora and Alkmaar, and in the fellow cities of Granada, Bari, Celje, Ujpes, Ioannina and Hvidovre. The creation of Positive Energy Blocks and Districts aims to transform those cities' mixed-urban environments, with a strong emphasis on cultural and historical protected areas, into cheaper, healthier, more accessible and reliable spaces for their citizens.

GREENPEG - New Exploration Tools for European Pegmatite Green-Tech Resource, H2020-SC5-2018-2019-2020 (Proposal number: SEP-21059772), 2020-2024. Participants: A.C. Teodoro (Workpackage leader), A. Lima.

GREENPEG started contributing to a number of European agendas by developing and validation of new cost-effective exploration approaches to unlock domestic critical mineral resources. GREENPEG outcomes will contribute to both the Action Plan on Critical Raw Materials as part of the new EU Industrial Strategy, the European Green Deal, and the EU COVID-19 Recovery Plan for Europe ensuring resilience through a secure and sustainable supply of critical raw materials. www.greenpeg.eu.

MOSTMEG - Predictive models for strategic metal rich, granite-related ore systems based on mineral and geochemical fingerprints and footprints. ERA-MIN Joint Call 2019, 2020-2023. Participants: A. Guedes (PI), V. Ramos, B. Valentim.

The main goal of MOSTMEG project is to develop and validate predictive models for strategic metal-rich, granite-related ore systems by refining available concepts and exploration strategies, using mineral and geochemical criteria as pathfinders or vectors to mineralized systems. Such systems may range from quartz-lodes, breccia pipes and skarns enriched in W-Sn-F(-P-Bi-Sb-Cu)-bearing mineral associations, greisenized granite cupolas and aplite-pegmatite-hosted mineral assemblages incorporating Sn-Ta-Y-F(-W-Nb) or Li-Cs-Be-Ta(-P-Rb).

CALCINATA – Produção de argamassa à base de cal a partir da calcinação de lamas carbonatadas provenientes da indústria das rochas ornamentais (mármores e calcários), ALT20-03-0247-FEDER-072239; co-financed by: Alentejo 2020, Portugal 2020 e União Europeia através do Programa "Fundo Europeu de Desenvolvimento Regional (FEDER)", 2020-2023. Participant: L. Lopes.

ANTECIPA – Modelos de previsibilidade de Rochas Ornamentais em obra e em exploração, ALT20-03-0246-FEDER-000070, co-financed by: Alentejo 2020, Portugal 2020 e União Europeia através do Programa "Fundo Europeu de Desenvolvimento Regional (FEDER)", 2020-2022. Participant: Luís Lopes.

CoalMine - Coal mining waste: evaluation, monitoring and recovery of environmental impacts through remote detection and geostatistical analysis (www.fc.up.pt/coalmine/), POCI-0145-FEDER-030138, co-financed by: COMPETE 2020, Portugal 2020 and European Regional Development Fund, 2018-2021. Participants: D. Flores (PI), A.C. Teodoro, J. Ribeiro, L. Duarte, J. Espinha.

CoalMine is a project financed by FCT (AAC nº 02/SAICT/2017) developed by a consortium consisting of ICT (Porto and Évora Poles) and Requimte. This project aims: (i) to identify and characterize the environmental impacts caused by the São Pedro da Cova coal mine waste pile (self-burning since 2005) in surrounding soils and waters; and, (ii) to monitor the combustion temperature and mass movements through remote sensing using unmanned aerial vehicles. During this year the focus was the hydrogeochemical characterization of groundwater and surface water affected by

mining, as well as in the hydropedological study of soils, including Technosols from the S. Pedro da Cova mine waste pile.

C4G - Colaboratório para as Geociências, Roteiro Nacional de Infraestruturas de Investigação de Interesse Estratégico. Project POCI-01-0145-FEDER-022151. Participants: A. Guedes (FCUP), M. Bezzeghoud (UÉvora).

The Collaboratory for Geosciences (C4G) is a distributed research infrastructure that promotes the networking and the sharing of equipment, data, collections and tools in Solid Earth Sciences (SES). Participates in the ESFRI project European Plate Observing System, promoting Portugal as a service provider in the international research arena. Research fellow in the GT8 – Geomathematics, Computation and Modelling and GT12 – Geo-resources, exploitation and processing - http://www.c4g-pt.eu/.

ESMIMET - Desarrollo de capacidades interregionales en torno a los recursos estratégicos en minería metálica, 0284_ESMIMET_3_E. INTERREG V A España-Portugal (POCTEP), 2017-2020. Participants: F. Noronha (PI), H. Sant'Ovaia, M.A. Ribeiro, I. Bobos, A. Guedes, A.C. Teodoro. Grant holders: L. Lima, A. Mota Fernandes; Collaborators: A.M. Gonçalves, C. Cruz, S. Leal.

The project aims, among other objectives, to characterize the deposits of W-Sn and associated metals in Castilla y León – Spain - and the Northern and Central regions -Portugal - with the purpose of establishing possible prospecting guides that are universally applicable in the exploration of this type of deposits. (https://www.esmimet.eu/pt/).

LIGHTS - Lightweight Integrated Ground and Airborne Hyperspectral Topological Solution, ERA-MIN/0001/2017, 2018-2021. Participants: A. Lima (PI), M.A. Ribeiro, A.C. Teodoro.

The LIGHTS project brings together world-leading industrial and research organizations to develop new methods and tools for drone-based lithium exploration. Has two main goals: to develop a

software for easy and fast detection of lithium-host minerals combining drone-borne remote sensing data and field observations, and to understand how pegmatitic Li-deposits are formed. This is critical to establish how remote sensing and field observations can be used to unveil lithium deposits.

AUREOLE - Argeting eU cRitical mEtals (Sb, W) and predictibility of Sb-As-Hg envirOnmentaL issuEs – ERA-MIN/0005/201, 2019-2022. Participants: A. Lima (PI), MA. Ribeiro, H. Sant'Ovaia, A.C. Teodoro, L. Duarte.

Antimony (Sb), a critical metal for Europe strategic for the European (EU) aircraft industry & battery manufacturing plants, is widely used in industrial operations. Its most promising use may be for rechargeable Li- & Na-ion batteries. The project is based on disruptive concepts: i) new 3D large-scale metallogenic model integrating deep-seated processes to determine the spatial distribution of ore deposits; ii) the use of mineral prospectivity data weighted by surface data to determine the probability of environmental risk over large areas. Despite a high EU potential, the knowledge on Sb remains poorly constrained. EU remains under the threat of the Chinese supply. In parallel, metalloids (Sb, As, Hg) of geogenic origin are recognised as a global threat for human health. Then, a large-scale identification of these areas should be a priority. In this 3 years project, it will produce i) a new 3D metallogenic model that will contribute to the understanding of the mineralizing processes; ii) a new understanding of surface processes that control the mobilisation & transport of metalloids; iii) a new large-scale mineral prospectivity and iv) a new large-scale environmental risk assessment by weighting mineral prospectivity with earth surface properties.

AUREOLE

Targeting European Critical Metals (Sb, W) & predictibility of Sb-As-Hg environmental issues

DEASPHOR - **Design of a product for SUBSTITUTION of phosphate rocks,** ERA-MIN/0002/2017. Participants: B. Valentim (PI), A. Guedes.

The main objective of this project is the recycling of phosphorus from aviary litter ash as a substituting material of phosphate

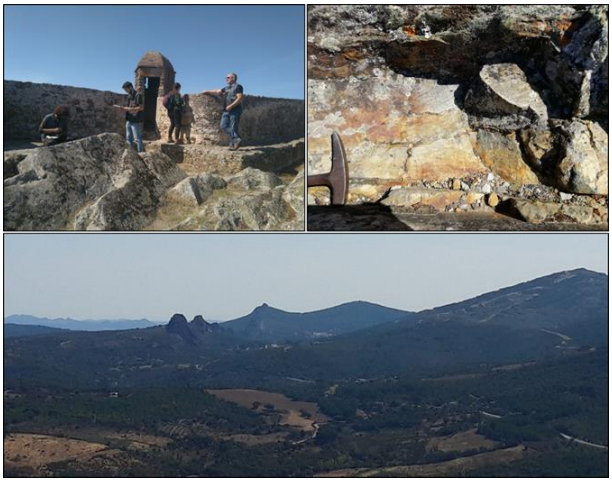
ERA•MIN 2
RESEARCH & INNOVATION PROGRAMME ON RAW MATERIALS TO FOSTER CIRCULAR ECONOMY

rocks. However, aviary litter ash is not economically attractive to substitute phosphate rocks, and also composed by materials that are impurities of the P2O5 extraction process. Therefore, novel solution is proposed to produce P-rich concentrates from aviary litter ash.

NEXT-LiB - **Novel Circular Economic Approaches for Efficient Extraction of Valuables from Spend Li-ion Batteries,** ERA-MIN/0003/2018. Participants: B. Valentim (PI), A. Guedes.

The project aims to develop and demonstrate efficient processes and innovative techniques for the extraction of metals and separation of graphite from spent LIBs and to overcome the barrier and obstacles which limit the recover efficiency.

CIMarvão - Interpretive Centre and Gates of the Natural Park of Serra de São Mamede, ALT20-08-2114-FEDER-000216, 2019-2021. Participant: J. Pedro.



The CIMarvão project intends to build an interpretive centre in order to preserve and disseminate the geodiversity, biodiversity and cultural heritage of the Natural Park of Serra de São Mamede.

PIPA - GUIFARQ II - Projeto de Investigação Arqueológica de Guifões, project from Universidade de Letras da Universidade do Porto, 2019 - 2022. Participant: H. Couto (scientific consultant for the area of Geology and Geological Characterization of Materials).

International Geological Correlation Project 653, 2016-2020. Participant: H. Couto.

The onset of the Great Ordovician Biodiversification Event of IGCP (International Geoscience Programme) – Project co-lead by Thomas Servais, David Harper, Olga T. Obut, Cristian Rasmussen, Alycia Stigali and Zhang Yuandong, IUGS/UNESCO International Geoscience.

INOVSTONE 4.0 – Tecnologias Avançadas e Software para a Pedra Natural. LISBOA-01-0247-FEDER-024535, 10/SI/2016 - I&DT Empresarial (Programas Mobilizadores), 2017-2020. Participant: L. Lopes.

BRO-CQ – Controlo de Qualidade de blocos em Rochas Ornamentais, Projecto nº 17659 –33/SI/2015 – I&DT Empresarial (Copromoção), Portugal 2020. Copromotor – Metalviçosa, Fabricação de Máquinas Industriais, Lda, 2016-2021. Participant: L. Lopes.

LITHOS - Laboratory for Innovation and Technological Hub for Ornamental Stone, ALT20-03-0246-FEDER-000036, Portugal 2020. Participant: L. Lopes.

Cost Action MULTI-FORESEE - MULTI-modal Imaging of FOREnsic SciEnce Evidence - tools for Forensic Science - OC-2016-1-20419, 2017-2021. Participant: A. Guedes.

The main objective of this Action is to promote innovative, multi-informative, operationally deployable and commercially exploitable imaging solutions/technology to analyse forensic evidence. Forensic evidence includes, but not limited to, fingermarks, hair, paint, biofluids, digital evidence, fibers, documents and living individuals.

BEGIN - AbBandono vErsus riGenerazIoNe. Project POR FESR Basilicata 2014-2020, 2020/2022.

The main objective is the development of a univocal and multilevel operating protocol, acting in national and European operational contexts, aimed to the dissemination of knowledge, the enhancement and use of abandoned sites, adopting high-tech ICT services also for the removal of physical and cultural barriers to accessing the sites. The project includes three case studies (Portuguese, Italian and Albanian).

Nano-MINENV - minerals with environmental relevance in systems contaminated by acid drainage: properties and reactivity at the nanometric scale, European Regional Development Fund (ERDF) through the Competitiveness and Internationalization Operational Programme - COMPETE 2020 and by National Funds through FCT - Foundation for Science and Technology under the project POCI-0145-FEDER-029259.

The main aim is to understand the role of nanoparticle in mine waters and their contribution to fate and transport of pollutants (Consortium: University of Minho, University of Évora, International Iberian Nanotechnology).

TERRAMATER - Medidas innovadoras de recuperación preventiva en áreas quemadas. Universidade do Minho, projeto 0701_TERRAMATER_1_E, financiado pelo Fundo Europeu de Desenvolvimento Regional – FEDER, através do Programa INTERREG V A España Portugal (POCTEP).

Aims to recover burned areas, increasing resistance to fire through the development and application of technosols. (Consortium: Universidade do Minho, Instituto Politécnico de Bragança, Instituto Superior de Engenharia do Porto and RVA, under the coordination of Universidad de Santiago de Compostela (https://www.terramaterpoctep.eu/).

NE/T004401/1: The Home Biome Project (DUST). DUsty SecreTs: characterising, communicating and connecting the hidden world within our homes.

Aims at shining a spotlight on our home biome, revealing similarities/ differences between different regions around the world. (Consortium: University of Minho, the National and Kapodistrian University of Athens, Health Canada, the University of the West of Scotland, and the British Geological Survey, under the coordination of the Northumbria University).

NEXT-SEA project - Next generation monitoring of coastal ecosystems in a scenario of global change" (NORTE-01-0145-FEDER-000032)

Aims to create the foundations to the next generation of marine systems management, based on knowledge and innovation and supported by the team's expertise in the areas of electronics,

materials, taxonomy, ecology, conservation and metagenomics, using the NW of Portugal as a case study.

CLIMALERT - Climate Alert Smart System for Sustainable Water and Agriculture, an ERA-NET initiated by JPI Climate (ERA4CS programme) co-funded by the EU commission (Grant Agreement 690462) and FCT (ERA4CS/0004/2016).

This work was supported by the “Contrato-Programa” UIDB/04050/2020 funded by national funds through the FCT I.P. (GP)The main goal is co-developing innovative tools – web and mobile apps – to predict and mitigate impacts due to extreme climate events, namely drought and floods, by implementing new long-term preparedness plans of actions that may significantly reduce the risks and vulnerabilities to relevant stakeholders for the agriculture and water management sectors.

ATLANTIDA - Platform for the monitoring of the North Atlantic ocean and tools for the sustainable exploitation of the marine resources. P2020|Norte2020-Projetos Integrados ICDT. NORTE-01-0145-FEDER-000040.

ATLANTIDA will develop a platform for the monitoring of the North Atlantic Ocean and tools for the sustainable exploitation of the marine resources. It is implemented by a multidisciplinary team of HYPERLINK "http://UNorte.pt" UNorte.pt – UMinho, UPorto, UTAD – and CIIMAR. Its strategy potentiates the expertise of the human resources involved in the consortium and implements a comprehensive approach of the Ocean observation and of the tools for its sustainable use.

MINEPLAT - Assessment of the mineral resources potential in the continental shelf of Alentejo and of the environmental conditions caused by the tectonic uplift in the Pliocene-Quaternary (ALT20-03-0145-FEDER-000013).

The main goal will be achieved by producing a detailed mapping and characterization of the seafloor. Geophysical surveying, sampling and mineral and chemical characterization are the main methods to be used.

TagusGas - Tsunami hazard assessment of the Lisbon city associated to the Tagus delta landslide (PTDC/CTA-GEO/031885/2017).

Aims answering questions, such as what are the geotechnical characteristics of the sediments and what is their factor of safety?; How old is the Tagus delta landslide?; What is the potential size of a tsunami generated at the Tagus delta, how it propagates and what are the effects in the adjacent coastal areas?

D4Ss - Food-web approaches to assess the functional benthic ecosystem interactions for Marine and Coastal management under the Marine Strategy Framework Directive (PTDC/CTA-AMB/29400/2017).

The goal is to investigate the bottom-up interaction effects of the different sediment trophic status, as the biogeochemistry and associated microbiome on estuarine (Sado estuary) and marine (continental shelf) benthic food web.

PO35719 - Turismo Arqueológico do Alentejo: Presente ao Passado, funded by Turismo de Portugal - Support line for the tourist valuation of the Interior; Coordination of the Archaeological Field of Mértola and Univ. of Évora; 09/2020-09/2021. Participant: B. Caldeira (PI).

It aims to revisit the Archaeological Itineraries in Alentejo, implementing immaterial actions aimed at investing in information technologies as a current and priority mechanism in education, communication and dissemination of information, modernizing the archaeological tourism offer in Alentejo. To this end, its mission is to develop an application that guides the visitor in accessing the existing archaeological heritage, taking as a starting point the sites that were part of the Alentejo Archaeological Itinerary valorization program, with the aim of promoting them individually and collectively and of make content not “visible” by the general public perceptible. It is a guide that covers the cultural and logistical aspects of the visit.

Requalification of Villa Romana de Pisões. ALT20-14-2019-01, financed by the Regional Operational Program of Alentejo, Cultural and Natural Heritage line. 2019-2021. Participant: B. Caldeira (PI).

Project whose mission is to enhance the archaeological heritage of Villa de Pisão through conservation and restoration missions and also the accessibility conditions to that villa, improving the visibility circuit, providing the villa with means of transport for people with reduced mobility and developing materials audiovisual and multimedia that incorporate the results of geophysical research carried out in the last 3 years**.**

INNOACE Innovación abierta e inteligente en la EUROACE. INTERREG V Spain Portugal program (POCTEP) Coordinated by the Centro de Investigaciones Científicas y Tecnológicas de Extremadura (CICYTEX). Council of Economics and Infrastructure of the Junta de Extremadura, 2017-2020. Participant: B. Caldeira (PI).

Non-invasive methods in Archeology and Precision Agriculture for the revaluation of the Patrimony and the development of a sustainable and productive agricultural activity.

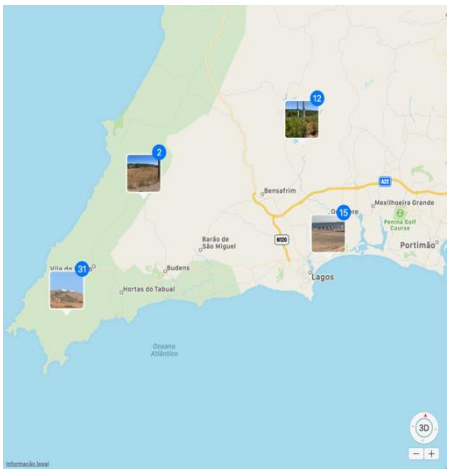
SSN-Alentejo, High-Density Seismic Monitoring Network for a High Spatial Resolution of the Seismic Activity in Alentejo, FCT, Ministry of Science, Technology and Higher Education, Portugal, Portugal, PTDC/CTA-GEF/31260/2017, 2018-2021. Participant: M. Bezzegoud (PI).

It consists of developing low-cost seismic sensors, based on MEMS technology, and installing a high-density network using these same sensors.

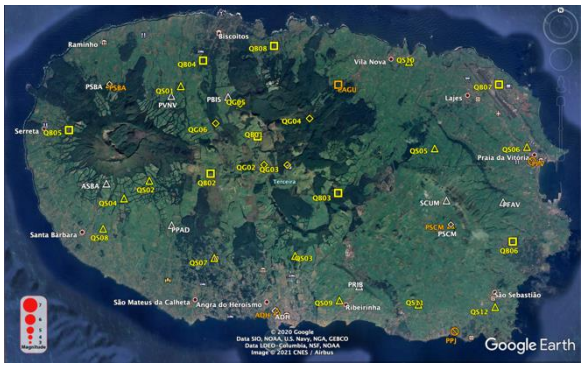
BRO-CQ - Quality Control of Ornamental Stone Blocks. ALT20-03-0247-FEDER-017659, coordinated by the company Metalviçosa, Produção de Máquinas Industriais, Lda, with the participation of Marmetal - Mármores e Material de Construções S.A and the University of Évora. 2016-2021. Participant: M. Tlemçani (PI).

EMSO-PT – European Multidisciplinary Seafloor and Water Column Observatory – Portugal, 01/SAICT/2016 Research Infrastructure – Roteiro, Fundação para a Ciência e Tecnologia (FCT) – Ministério para a Ciência, Tecnologia e do Ensino Superior (Portugal), 2017-2021. Participant: M. Bezzeghoud (PI UÉvora).

Research infrastructure of the Roadmap program of the Foundation for Science and Technology (FCT 2015) with financial support from FEDER through COMPETE 2020 within the scope of SAICT. Within the scope of this project, the ICT's Lithosphere Dynamics group coordinates the installation of a broadband seismological network in SW Portugal, consisting of BB post-hole seismometers installed at 30m depth and accelerometers on the surface, designed to support an early earthquake alarm infrastructure (EEWS-Earthquake Early Warning System).



Project P74 - Design, location and processing of a regional array in SW Portugal - Europe, under the framework of SERA - "Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe" (SERA — H2020-INFRAIA-2016-2017/H2020-INFRAIA-2016-1). Participant: J. Fontiela (PI).



The project aimed to transfer knowledge in the seismic array subject. The project took place in January 2020, and the fieldwork still suspends due to the COVID-19 outbreak.

E-TECHSTONE 4.0 - Desenvolvimento de soluções tecnológicas de evolução da extração de Pedra Natural para a Indústria 4.0. POCI-01-0247-FEDER-017882. Funded by QREN-Alentejo2020. Project led by FRAVIZEL - Equipamentos Metalomechanics, Lda, 2017-2020.

FIRE - Fogo Island volcano: multi-disciplinary Research on 2014 Eruption. PTDC/GEO--GEO/1123/2014. Project funded by the Foundation for Science and Technology (FCT). Led by the University of Beira Interior with the collaboration of eleven more entities from the Portuguese university and research system. 2016-2020. Participant: J.F. Borges (PI UÉvora).

HYDROPERMA-2 - Geoelectric study of permafrost and hydrological regime of the aquifer that supplies the Peruvian Antarctic Base, Rei Jorge Island, Maritime Antarctica. Participant: A. Correia (PI UÉvora).

Electrical Resistivity Study in the Permafrost and Aquifer of Machu Picchu Antarctic Station, Punta Crepín, Almirantazgo Bay, King George Island, Antarctica. Project financed by the Peruvian Polar Program, 2019-2021. Participant: A. Correia (PI UÉvora).

POCITYF -**A POsitive Energy CITY Transformation Framework**. Nº 4212 Tipo: Investigação Arquivo: SCC Referência:864400 CCA: 931137.

High-Density Seismic Monitoring Network for a High Spatial Resolution of the Seismic: PTDC/CTA-GEF/031260/2017.

A Protecção Integrada do olival alentejano. ALT20-03-0145-FEDER-000029. Participant: M. Tlemçani (IP UÉvora).

Contributions to innovation and improvement against your key enemies.

Étude de l'évolution paléoclimatique dans la région de Figuig (Maroc Oriental), bilateral cooperation project CNRST (Morocco) - FCT (Portugal). Participant: A. Correia (PI UÉvora).

Study of paleoclimatic evolution in the region of Figuig (eastern Morocco) using temperature logs obtained in boreholes.

Scientific Events

Jornadas do ICT 2020 - Instituto de Ciências da Terra (ICT), UMinho Pole. An annually scientific initiative organized by the ICT young researchers of the three poles. This year it was held on the 13th-14th February, at the University of Minho pole. During the first day, 16 oral and 44 posters on the new advances of the ICT research activities were presented and discussed. The book of abstracts is available on: https://www.icterra.pt/index.php/protected/. In the second day was held the ICT General Assembly, where the 2019 report was presented and the implementation of the new projected 2020-2023 was planned.

X Congress of Young Researchers in Geosciences, LEG 2020 that took place at the Estremoz Pole of the University of Évora in 20-22 November 2020. Includes two days of oral presentations, invited speakers and poster sessions and a geological excursion.

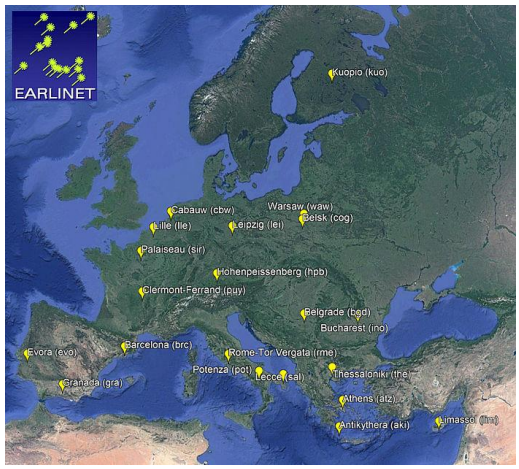
COVID-19 NRT lidar measurement campaign - 1-31 May

This campaign is organized as part of the ACTRIS initiative for studying the changes in the atmosphere during the COVID-19 lockdown. ACTRIS, on behalf of its users, asks: Can we quantify the impact of decreased emissions on the state of the atmosphere outside the urban areas, on a timespan of several weeks?

As an active contributor to ACTRIS, EARLINET is running its lidars and intensifies its regular measurements in order to provide a scientifically relevant answer.

The scope of the campaign is twofold:

- to monitor the atmosphere's structure during the lockdown and early relaxation period in Europe; weekly reports will be provided to ACTRIS and made publicly available on the EARLINET website
- to identify possible changes due to decreased emissions, by comparison to the aerosol climatology in Europe; all findings will be published as part of an extended study.



The map shows the participating EARLINET stations.

Organization of the session "Fluid Flow, Energy Transfer and Design" at the 16th International Conference on Diffusion in Solids and Liquids.

Advances in understanding fluid flows and energy transfer continue to be crucial to achieve better performance and efficiency in a wide range of systems. This special session receives contributions on analytical, computational (CFD) and experimental studies on the study of heat and fluid flow. It is intended to be a platform for exchanging experiences and information, boosting academic thinking and promoting further research on these topics.

Technical Inspection and Commissioning Tests of the Montes Velhos Photovoltaic Plant of the Roxo Beneficiaries Association

The Renewable Energies Chair carried out the technical inspection and commissioning tests of the Montes Velhos photovoltaic plant. This independent technical inspection allowed the detection and correction of non-conformities in the commissioning phase of this plant by Efacec. Thermographic and

visual inspection of all equipment in this plant was carried out, in addition to the plotting of I-V curves of the photovoltaic sets and solar tracking tests. This technical inspection is included in the final commissioning procedures, after 1 year of operation and allows the production of a detailed report with results and recommendations for the owner and for the company executing the installation. It allows to ensure compliance with good practices and technical clauses, allowing to meet the expected performance over the expected life of 25 years.

SFERA-III 2nd General Assembly and Management Board Meeting - February 11-13

The 2nd General Assembly and the 3rd Management Board Meeting of the SFERA-III - Solar Facilities for the European Research Area - Third Phase, took place in Cassacia, Italy. Over the course of three days, representatives of the 15 partner institutions of the project, from nine member countries of the European Union (EU), discussed the functioning and activities of SFERA-III and the cooperation between academy and companies.

EERES4WATER 1st Meeting - May

The first meeting of associated partners of the EERES4WATER project took place remotely, through digital platforms, and served to present the technical progress during the first year of execution. In this project, the University of Évora is coordinating activities related to the development of more sustainable technologies for water management systems, such as wave-driven desalination, wastewater treatment by solar photocatalysis, floating solar platforms for water pumping, supplying photovoltaic energy to desalination plants, and energy recovery using microturbines.

“Mais Fotovoltaico, Mais Energia” Campaign

Campaign of inspection of photovoltaic systems in Portugal, which stared on June 24. The “Mais Fotovoltaico, Mais Energia” campaign aims to promote the articulation of the academic community

with society and seeks to encourage citizens to use this clean energy, through a process of technical inspection and diagnosis of solar photovoltaic systems, available free of charge. The campaign is part of the CER-UÉ mission "to contribute to the transfer and valorization of knowledge, the provision of services to the community and, in particular, the promotion of the country's development in the solar energy sector". As part of this campaign, 5 facilities were visited and inspected, considering the restrictions due to the Covid-19 pandemic. These visits included the electrical characterization of photovoltaic systems, and the issuance of an individualized report with results and recommendations for the owners.

EU PVSEC 2020 – European PV Solar Energy Conference and Exhibition - September 7-11

The CER-UÉ was present at the EU PVSEC 2020, which took place online, with the communication “Vanadium Redox Flow Battery Modeling and PV self-consumption strategy optimization, by Ana Catarina Foles, Luís Fialho, Manuel Collares-Pereira and Pedro Horta.

Second life batteries testing - September

A partnership with Batteries for testing used batteries from electric vehicles, in an intervention integrated in the POCITYF - POsitive Energy CITY Transformation Framework. Batteries delivered the first second-life lithium-ion battery modules from electric vehicles, and the configuration, installation and testing of these batteries began at the University of Évora facilities. This is the first experimental intervention in the POCITYF

project in Évora, encompassing a period of testing the batteries, through the portable applications from Batteries, integration into the experimental microgrid of the University of Évora and testing with other partners, which will be followed by a second phase in which the second life batteries will be installed in selected residences in the village of Valverde, in an intervention promoted within the scope of POCITYF.

SolaQua Kick-off Meeting - October 14-15

The Kick-off Meeting of the SolaQua - affordable, reliable and accessible solar irrigation for Europe and beyond - took place online, due to the current situation of the Covid-19 pandemic in Europe.

Responsible Research and Innovation (RRI) workshop - November 18

An initiative which is part of the GRECO - Fostering a Next Generation of European Photovoltaic Society through Open Science project (H2020 nº 787289) that was aimed at researchers and scientists in any area of knowledge or career stage and intends to equip participants with an overview and tools to make their research activities more responsible.

University of Évora Solar Systems Design, Inspection and Commissioning (Polo da Mitra)

The RE chair supported the Technical Services of the University of Évora in the public tender for photovoltaic and solar water heating systems to be installed in the buildings Ário Lobo de Azevedo and Colégio dos Regentes Agrícolas (Polo da Mitra), within the scope of the POSEUR project to increase energy efficiency in public infrastructures. This collaboration included:

- design and integration of the systems in the buildings, in view of construction restrictions, architectural framework and historic protection area;
- conception of the technical clauses of the tender specifications;
- support in the technical assessment of the submitted proposals and selection of the winning proposal;
- monitoring of installation and commissioning activities -technical inspection and characterization tests of the photovoltaic system of the Ário Lobo de Azevedo building;
- emission of the inspection report for provisional commissioning.

International Energy Agency - Solar Heating and Cooling programme - April and November

Maria Helena Novais and Tiago Osório participated in the 4th and 5th Expert Meetings (April 21-22 and November 26-27), and in the Solar Energy for Water Industry Workshop (November 25) in the IEA SHC Task 62 - Solar Energy in Industrial Water and Wastewater Management - Applying solar thermal energy and solar radiation to disinfect, decontaminate and separate industrial process water and waste-water.

ERA MIN project LIGHTS international meeting - July

In July the Portuguese team of the ERA MIN project LIGHTS did an international meeting with colleagues from France, Spain, and Portugal to the Pegmatite field of Almendra-Fregeneda, collecting many samples and measures for research during the one-week field trip.

Aureole project fieldwork - July

In July 2020, Portuguese and French teams of the Aureole project participated in fieldwork in the Catromil area.

Improving Resource Efficiency and Minimize Environmental Footprint – a case study preliminary results in a mining area - 14th of January. Biology, Ecology and Earth Sciences Department (DiBEST), Università' della Calabria, 87036 Arcavacata di Rende (Cosenza) – Italy.

Aquifer Vulnerability Mapping and Associated Spatial Uncertainty: a Spanish case study - 15th January. Biology, Ecology and Earth Sciences Department (DiBEST), Università' della Calabria, 87036 Arcavacata di Rende (Cosenza) – Italy.

Optimizing soil screening levels for the delimitation of pollution risk zones in high-density industrial areas - 16th of January. Biology, Ecology and Earth Sciences Department (DiBEST), Università' della Calabria, 87036 Arcavacata di Rende (Cosenza) – Italy.

Surface and groundwater in urban areas: an example from the Braga region - 24th January, University of Minho, Braga, Portugal (invited speaker).

Future of Water Resources: Water in the actual society - 3rd March. X engineering week, EST/Polytechnic Institute of Castelo Branco, Castelo Branco, Portugal (invited speaker).

X SEMANA DE ENGENHARIA 3-4-5 DE MARÇO 2020

Field expeditions for soil sampling, vegetation surveys, and topographic monitoring with UAV in the Minho and Bragança regions. Collaboration with researchers from University of Santiago de

Compostela and Instituto Politécnico de Bragança, under the scope of Terramater project. January and July 2020.

Papel de la biogeoquímica y de la mineralogía en monitorización ambiental. XIV SEMANA TÉCNICA DE GEOLOGÍA, INGENIERÍA GEOLÓGICA Y GEOCIENCIAS. Universidad de Pamplona, Colombia, 15-17 Octubre (invited speaker).

British Geological Survey interlaboratory trial to characterize a set of 10 soil candidate reference materials (BGS110 a BGS119, Soil Reference Material Data Sheets, available from http://nora.nerc.ac.uk/id/eprint/528285/.).

Outreach and Other Activities

Centro Ciência Viva de Estremoz-CCVEstremoz

The ICT always considered a priority the linkage to the general community. Indeed, the very wide spectrum of the ICT research around the understanding of Earth (e.g. from atmosphere to geophysics, from raw materials to different kind of energies, from hydrology to decontamination of water and soils) is crucial for the future sustainability of our societies. To be more efficient in the transfer of our knowledge to the society the ICT signed in 2014 a protocol with the Estremoz Science Centre (Centro Ciência Viva de Estremoz-CCVEstremoz). Since then, the ICT have giving is scientific support to hundreds of activities involving tens of thousands of participants, most of them from the pre-university school community. Our out-reach effort was increased during 2020, because the schools have been closed part of the year due to the pandemic situation. With the students and the teachers involved in an internet-based study, the ICT feels that it must cooperate with these studies, putting its knowledge to the community. From the several new activities we have been involved we emphasize:

- **Science video channel** (with Estremoz Science Centre- ccvestremoz.com)

  In May 2020 the CCVEstremoz open the "A Ciência no Tal Canal" an open access channel video, were several films produced with the scientific support of ICT were periodically widespread. In these videos the teachers and the students learn the fundamentals of several major Earth

  processes (like conduction, convection or the relation between the plate tectonics and the spreading of living beings) in an experimental based approach. The importance of these videos to

the school community could be accessed by is visualizations; 5165 visualizations during 2020 several of them in a class environment which mean that much more persons have profit from them.

- **Live-long learning of pre-University school teachers** (with Estremoz Science Centre)

We consider that the quality of the education is strongly dependent form the quality of the teachers.




Thus, it is a civic obligation of the researcher and the research centres to contribute to their scientific actualization. In 2020 the ICT have been involved in 26 days of national credited practical training involving 292 teachers. Most of these formations (20 days) have been geology field training all over Portugal.

- **Do Field Geology... inside** ("Faz Geologia de Campo... Cá dentro" with Estremoz Science Centre)

As the possibility to take students to the field becomes impossible with the confinement, we have developed several activities based in real outcrops, but that could be worked with students at home. These activities have been spread by our mailing lists involving more than 70 000 contacts, with more than 20 000 teachers.

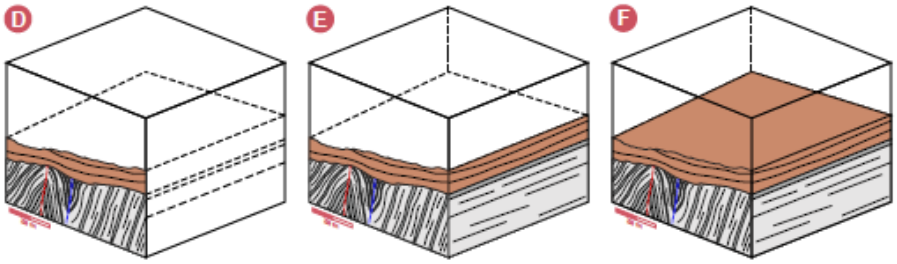
A fotografia é de um afloramento e uma pequena baía perto da praia do Telheiro junto a Sagres; é sem dúvida o afloramento mais conhecidde Portugal, sendo famoso mesmo a nível internacional. As rochas da série inferior são uma alternância de ardósias e de grauvaques do Carbonífero; as da série superior são arenitos continentais do Triásico.

Faz o esquema do afloramento realçando os aspectos com interesse geológico e conta a história geológica da região a partir dos dados que observas na imagem.

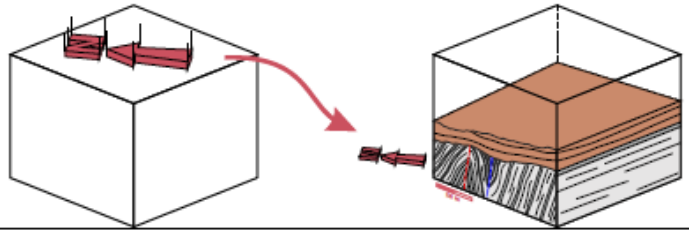
1. TELHEIRO (1)

FAZ GEOLOGIA DE CAMPO... CÁ DENTRO...
PORTUGAL DE ANTES DA HISTÓRIA
Centro de Formação
Centro Ciência Viva de Estremoz

Em seguida na outra face vertical traçamos linhas guia horizontais (pois tanto a série superior como os eixos da série inferior são horizontais) passando pelos limites das unidades existentes no corte **(D)**. Utilizando estas linhas como auxiliar, extrapolamos para a face vertical perpendicular ao corte as unidades geológicas **(E)**. Depois, falta apenas marcar a face superior utilizando a informação das duas faces verticais e adaptando-a à face superior do cubo **(F)**.



Neste momento falta-nos apenas marcar a orientação do bloco diagrama e, embora fosse possível utilizar pontos cardeais nas faces verticais, fica melhor desenhar uma seta 3D na face horizontal utilizando o mesmo truque do cubo 3D como auxiliar. Começamos por desenhar apenas a parte superior da seta com a orientação pretendida na face superior do cubo e depois extrapolamos para fora dessa face utilizando essencialmente linhas verticais de apoio.



Portugal de antes da História //// 600 milhões de anos de Evolução
//// Volume _1 //// Da dinâmica global aos processos geológicos

- Exhibitions (with Estremoz Science Centre)

Altghough during most of 2020 the Science Centres and museums have been closed, the ICT continues to cooperate with CCVEstremoz giving scientific support not only to the exhibitions (news or in preparation), but also to the workers of CCVEstremoz. In 2016, we have been involved in:

- Permanent exhibition of CCVEstremoz (6468 visitors)

- "Por que somos como somos?", an interactive exhibition concerning life evolution in our planet. It was inaugurated in 20th September 2020 in S. Miguel Science Centre (Azores islands) end until the end of 2020 it has 1005 visitors.

- Out-reach conferences (with Estremoz Science Centre)

During 2020 the ICT has been partner in 16 conferences not only for school community of all Portugal, but also for general public (in the continent and Azores islands). These conferences have been attained by 1376 participantes.

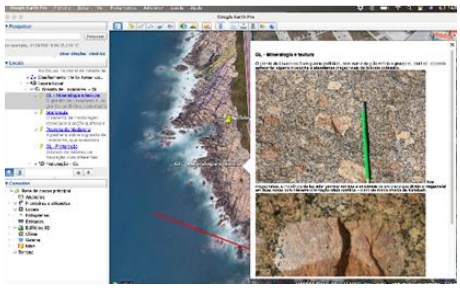
ICT in contact with the school community

Students from the science and technology and socio-economic courses of S. Brás de Alportel, visited, on the 16th of January, the ICT UÉvora pole. Within the scope of the theme of climate change, the ICT received the students and provided them with a lecture on the theme given by Professor Rui Salgado. The students also visited the atmospheric sciences observatory, the seismology and applied geophysics laboratory, the Évora Molten Salt Platform and the Hercules laboratory, having contact with various areas and scientific instrumentation.

CoalMine Project workshop held in **partnership with Eco-Escolas Project of Carolina Michaelis Secondary School,** including 2 conferences ("A escombreira de São Pedro da Cova – um laboratório ao ar livre" and "Noções (e conceitos) sobre navegação e posicionamento por satélite"), a fieldtrip of

the Carolina Michaelis Secondary School's students to the São Pedro da Cova waste pile. Students carried out activities of soil and water sampling in the field, explored the analytical methodologies and procedures used, as well as the environmental monitoring techniques. Participants: A.C. Teodoro, L. Duarte, J. Ribeiro, J. Espinha Marques, D. Flores.

Partnership ICT with "Agrupamento de Escolas de Rio Tinto nº3" - Clubes de Ciência Viva na Escola: several activities were carried out: 3 conferences, 1 article, 1 virtual fieldtrip, and 2 projects. Participants: F. Noronha, D. Flores, H. Couto, M.A. Ribeiro, C. Cruz, P. Nogueira, H. Sant'Ovaia.



Mostra UP (23 July). Participant: A. Guedes

Canelas Geological Interpretation Center (CIGC), Arouca Geopark - collaboration as a scientific adviser: H. Couto.

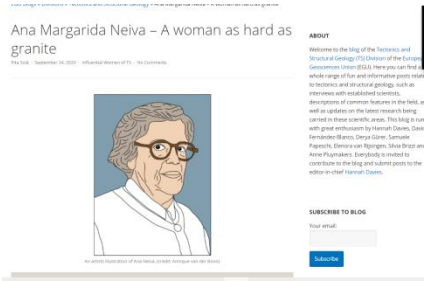
Scientific Culture Day (25 November) celebration which this year was dedicated to honor the poet António Gedeão and his poem "Pedra Filosofal". Participants: A. Almeida, M.A. Ribeiro.

“90 Segundos de Ciência” National radio Antena 1: episode nº 902 (Presentation of the project TERRAMATER), July, 21. Participant: T. Valente https://www.90segundosdeciencia.pt/episodes/ep-902-teresa-valente/; and, episode nº 953 (Presentation of the project TAGUSTA), November, 9, 2020. Participant: C. Ribeiro https://www.90segundosdeciencia.pt/episodes/ep-953-carlos-ribeiro/.

Water and society. Clubes Ciência Viva na Escola do Agrupamento de Escolas Amato Lusitano. 16th December 2020 (Castelo Branco, Portugal; invited speaker). Participant: I.M.H.R. Antunes.

“**Clubes Ciência Viva na Escola**” initiative aims to create knowledge spaces aimed at the entire community, including families and the rest of the local community, to promote access to innovative scientific applications that stimulate enthusiasm for science and lifelong learning.

EGU Blogs - Influential Women of TS “Ana Margarida Neiva – A woman as hard as granite”, September 24. https://blogs.egu.eu/divisions/ts/2020/09/24/ana-margarida-neiva-a-woman-as-hard-as-granite-2/. Participant: I.M.H.R. Antunes.



Pandemia da COVID-19 na região Entre Douro e Minho: Qual o impacto do confinamento na qualidade do ar?” - CCT Co(m)vid(a) - Session #4 - 7 September, online. Participant: P. Marinho-Reis.

“Geotraverse in the South Portuguese Zone from Sagres to Mértola: Contribution of Fieldwork in the South Portuguese Zone to the teaching of Geosciences”. Presentation by A. Araújo in the training course for teachers (CCPFC / ACC - 106352/19), 16 to 19 July.

European Research Night 2020, University of Évora, Geophysics and Heritage (https://argos.ict.uevora.pt/nei2020/) and

"Conheça a Estação Meteorológica de Évora" activity (https://noitedosinvestigadores.org/evento-evora/)

Summer School "Ciência e Tecnologia no Património" 2020, Roman Villa of Pisões (Beja, Portugal), Geophysical methods applied to Archaeology.

"Smartphone: laboratório portátil de Ciência" Workshop apresentado no curso de formação de monitores Ciência Viva. CCV de Estremoz 08/09. Participant: B. Caldeira.

Seismic risk and Geophysical methods for risk prevention in the Cultural Heritage sector. Winter School do ED ARCHMAT (European Joint Doctorate in ARchaeological and Cultural Heritage MATerials Sciences), 24-30th January 2020, University of Évora. Participants: M. Bezzeghoud, B. Caldeira.

Prospeções geofísicas na Villa Romana de Pisões, workshop Agricultura intensiva, inovação tecnológica e preservação das paisagens culturais na região Euroace, 17 de janeiro de 2020. Centro Unesco de Beja, Portugal. Participants: B. Caldeira, R.J. Oliveira, J.F. Borges.

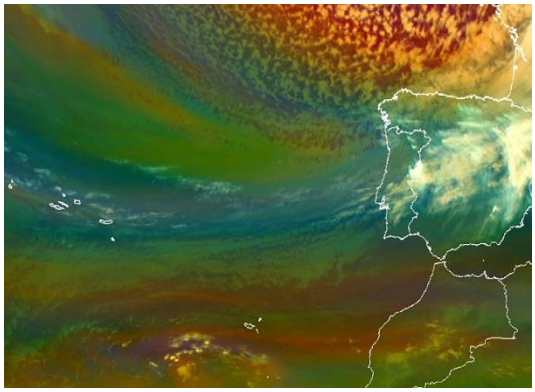
Projeto LouMu – Projeto que combina física de partículas e geofísica para fazer o mapeamento de grandes estruturas geológicas em ambiente subterrâneo, utilizando para tal a técnica de tomografia muónica- - https://lousal.cienciaviva.pt/muoes-cosmicos-na-mina/. Participants: P. Teixeira, C. Bento, J.F. Borges, M. Bezzeghoud

Four newspaper articles describing the work in Antarctica and the relationship between the Antarctic field work and the local and global climatic effects. Participant: A. Correia.

ZOM-3D - Valorization of the Alentejo mineral resources. 3rd Serie - Lab Collection. Audiovisual series, composed of 15 episodes, about laboratorial work in Geosciences. Conceptualization and scientific content. Production and edition: Infimoframe; Available at

https://www.youtube.com/c/ZOM3D/videos. Participants: P. Nogueira, M. Maia, N. Moreira.

Interview about Dora depression. R. Salgado talks about Dora depression. Interview: https://observador.pt/programas/e-mc2/o-que-esperar-da-tempestade-dora/?fbclid=IwAR0-e8mPgVgP_H5IQ073m_ei8Ba7JSYVMJDeuS2z1cBz4qDHOCH85GfLvuU



Interview about Bárbara storm (19/10): https://observador.pt/programas/e-mc2/tempestade-barbara-nao-e-nada-de-extraordinario/.

FÍSICA 2020 – 22ª Conferência Nacional de Física e 30º Encontro Ibérico para o Ensino da Física (03/09). Oficina em "Clima e Alterações Climáticas", incluída em curso de formação para professores do Ensino Secundário. Participants: R. Salgado and M.J. Costa.

Encontro Nacional sobre Investigação em Alterações Climáticas (17-18/02). Organized by IDL/FCUL and da Câmara Municipal de Lisboa no âmbito de Lisboa, Capital Verde Europeia. Participants: M.J. Costa and R. Salgado.

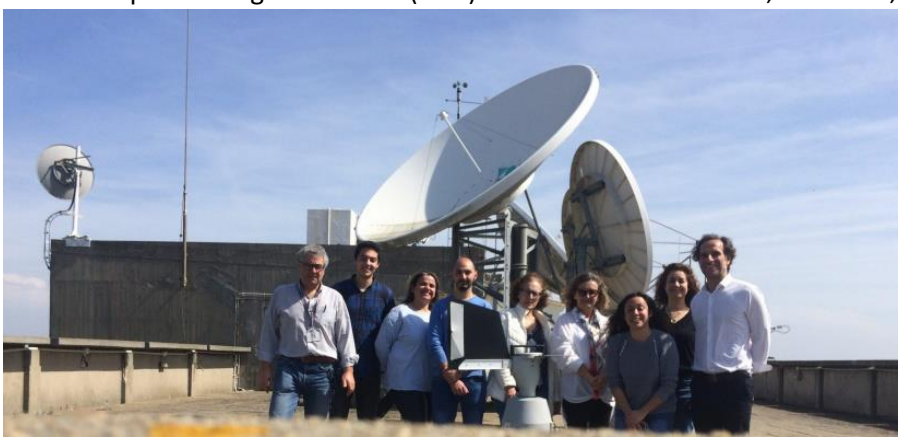
CILIFO Social Awareness Day. The Iberian Center for the Investigation and Fighting of Forest Fires (CILIFO), a project co-financed by POCTEP, carried out, on the 17th of June, an online day of social awareness with the theme: Break up barriers to emergency situations in the context of forest fires.

During this day, the most common needs of people with disabilities and other more vulnerable sectors of the population were discussed, with the aim of raising awareness and providing information to enable inclusive management of emergencies and disasters. Self-protection measures and forest fire prevention measures were also pointed out.

ICT collaborated, together with other partners of the CILIFO project, with this journey developed by the ONCE Foundation.

Pollen Alert – Risk level. It was created by researchers from ICT with the collaboration of the Informatics Department of the School of Sciences and Technology of the University of Évora. Here information can be consulted for 4 Portuguese cities - Évora, Porto, Guarda and Lisbon - which results from the close collaboration of the ICT in Évora and Porto (Universities of Évora and Porto), with the Polytechnic Institute of Guarda and with the Portuguese Institute for Sea and Atmosphere - IPMA.

New pollen monitoring station at IPMA, in Lisbon. The IPMA has, as of March 12, 2020, a new pollen site integrated in the Pollen Monitoring Network in Portugal, operated by the ICT, researchers from the University of Évora, University of Porto and the Polytechnic Institute of Guarda. These pollen stations are associated with the European Allergen Network (EAN) and are a source of data, observed, of extreme importance for the activity carried out under the CAMS23 project which aims to generate forecasts of the risk of exposure to



pollen. This information constitutes a relevant public consultation tool, very useful for researchers, municipal officials, health professionals, people with allergic pathology and the general public. It is also very important for the preservation of the ecosystem by monitoring the pollen flows of invasive species and the forest, as well as the effect of climate change on plants.

CILIFO meeting. The University of Évora hosted, on 20 and 21 February, the second meeting of the Steering Committee of the CILIFO Project - Iberian Center for Investigation and Fighting Forest Fires, in which the 15 beneficiary entities were present. During the two days, the annual meeting of the Management Committee (Management), the biennial meeting of the Technical Committee and the quarterly meetings of the project's Working Groups took place. The CILIFO Project is a POCTEP Project (2014-2020) 75% financed by the Interreg VA Spain - Portugal Cooperation program. In addition to the meeting, which dealt with the development of the project's activities, a seminar was held on forest fire prevention and extinguishing and a training course on raising community funds and innovative solutions for the prevention and adaptation to climate change, fires forestry. More news at http://cilifo.eu/evora-acoge-el-2o-comite-de-direccion-del-proyecto-cilifo.

RE Chair Social media page – Linkedin: In the International Sun Day, May 3, the Renewable Energies Chair at University of Évora started its presence on the social media network Linkedin. This social media presence has the goal of promoting RE Chair research, scientific events, and other activities. It

also pretends to strengthen the research community (https://www.linkedin.com/company/renewable-energies-chair-uevora).

Conversas com Ciência (January 30): The RE Chair Holder, Pedro Horta, was the speaker "Conversas com Ciência" initiative, with the talk: "**A Energia: de onde vem e como a usamos?**" [**Energy: where does it come from and how do we use it?**], which took place at the Eugénio de Almeida Foundation, Évora.

Opinion article – Público newspaper (May 29): Pedro Horta writes about the **European Green Deal and its opportunities for Portugal and for Europe** (https://www.publico.pt/2020/05/29/opiniao/noticia/pacto-ecologico-europeu-transformar-desafio-oportunidade-historica-1918354).

Journalistic RTP TV Report – Solar energy research at UÉ (June 5): RTP TV report about solar energy research, the Renewable Energies Chair and SolaQua project with Luís Fialho (https://www.rtp.pt/play/p6557/e476740/portugal-em-direto/835431).

Rádio program Geração Digital (RDP África) – SolAqua (June 13): Interview with Luís Fialho about solar irrigation technologies developed in SolaQua project (https://www.rtp.pt/play/p4068/e477735/geracao-digital).

Rádio program Geração Digital (RDP África) - Enbrain (June 27): Interview with Diogo Canavarro about the Erasmus+ capacity building project for higher education institutions in Libya. (https://www.rtp.pt/play/p4068/e480478/geracao-digital).

Exame Informática magazine and SIC Notícias – SolaQua (July 23 and August edition): Luís Fialho was interviewed to SIC Notícias and Exame Informática magazine about SolaQua project. (https://visao.sapo.pt/exameinformatica/videos-ei/reporterei/2020-07-23-solaqua-luz-solar-em-alter-do-chao-usada-para-irrigar-os-terrenos/).

Antena 2 Ciência – Hydrogen (September 28): Pedro Horta explains what green hydrogen is and the opportunities for our research and country (https://www.rtp.pt/play/p783/antena2-ciencia).

Opinion article – Cadernos de Economia (Nr. 132 – July/September): **Energy transition and opportunities to the national economy** is the main topic addressed by Pedro Horta in this opinion

article in the magazine of the Order of Economists.

Journalistic RTP TV Report – Solar and wind power (October 10-11): RTP TV report about different types of renewable energy. Ana Foles, Diogo Canavarro and Pedro Horta explain the RE Chair research in energy storage, solar thermal molten salt testing (https://www.rtp.pt/play/p6559/e500018/telejornal).

Diana FM Radio – Solar Green Hydrogen (October 14): A one hour talk between the RE Chair Holder, Pedro Horta, and Diana FM Director José Faustino about solar green hydrogen opportunities and risks (https://www.dianafm.com/event/falando-com-pedro-horta).

Antena 1 – 90 segundos de ciência (November 17): Interview with Luís Fialho about the H2020 GRECO project validation of methodologies of PV modules on site repair (https://www.90segundosdeciencia.pt/episodes/ep-962-luis-fialho/).

e-Global Notícias em português – Green Hydrogen and Portuguese science (21-22 November): Interview with Pedro Horta where are addressed green hydrogen technologies and Portuguese research and science (https://e-global.pt/noticias/nacional/portugal-tem-condicoes-vantajosas-para-entrar-no-mercado-do-hidrogenio-verde-entrevista-com-o-investigador-pedro-horta/ and https://e-global.pt/noticias/exclusivo/entrevista/em-portugal-temos-muita-e-boa-ciencia-entrevista-a-pedro-horta-investigador/).

Alentejo Green Business Innovation video (November 30): Video developed by NERE – Núcleo Empresarial da Região de Évora, under the scope of Alentejo Green Business Innovation project, where Diogo Canavarro and Luís Fialho recall the Renewable Energies Chair history and address the HPS2 – High Performance Solar 2 project, and the PV solar and energy storage installations and research (https://www.youtube.com/watch?v=BYFjaZK_pJM).

"Os Melhores do Portugal Tecnológico" Awards – SolaQua (November 30): Awards ceremony. Interview with Luís Fialho about the SolaQua project (https://visao.sapo.pt/exameinformatica/eventos/premios-os-melhores-as-maiores-do-). Portugal-tecnologico/2020-11-30-os-melhores-sustentabilidade-solaqua-entrevista-com-luis-fialho/

Awards and Distinctions

Cláudia Cruz: "Award Prof. Doutor António Ribeiro" - Distinction attributed to the scientific research work "Anisotropy of out-of-phase magnetic susceptibility: a non-standard approach for magnetic subfabrics determination" presented at the "X Congresso de Jovens Investigadores em Geociências, LEG 2020", which took place between the 20th and 22nd of November 2020, at the Estremoz Pole of the University of Évora.

António Oliveira and **Gonçalo Silvério: "Honorable mention award Prof. Doutor António Ribeiro"** - Distinction attributed to the scientific research work presented at the "X Congresso de Jovens Investigadores em Geociências, LEG 2020", which took place between the 20th and 22nd of November 2020, at the Estremoz Pole of the University of Évora.

Lia Duarte: Prémio Melhor Estágio Norte da Ordem dos Engenheiros with the theme: "Improving risk management models in GIS through open-source development and applications", October 2020.

Maria Teresa Durães Albuquerque - Prémio de Mérito Científico do Instituto Politécnico de Castelo Branco/Banco Santander.

Rui Dias elected as Corresponding Member of the Lisbon Academy of Sciences.

Luís Lopes: Eleito Presidente da Associação Portuguesa de Geólogos.

Tlemçani M., Prémio Portugal Venture: Startup Neural Solar.

SolaQua project distinguished with an Honorable Mention in the category of 'Sustainability' in the "The Best of Technological Portugal" Awards (Exame Informática magazine).

Research team

Members

Alexandre Martins Campos Lima
Amélia Paula Martins Marinho Dias dos Reis
Ana Cláudia Moreira Teodoro
Ana Cristina Bugalho Oliveira Rodrigues Costa
Ana Maria Guedes de Almeida e Silva
António Alberto Chambel Gonçalves Pedro
António Alberto Ferreira Miguel
António Alexandre Ventura Araújo
António Antunes Martins
António Domingos Heitor da Silva Reis
António José Nogueira Gomes de Moura
António Manuel de Carvalho Soares Correia
Bento António Fialho Caeiro Caldeira
Bruno Renato Valério Valentim
Carlos Alexandre da Silva Ribeiro
Célia Maria Miguel Antunes
Clara Maria da Silva de Vasconcelos
Cristina Maria Pinto Gama de Castro Pereira
Daniele Bortoli
Deolinda Maria dos Santos Flores Marcelo da Fonseca
Diamantino Manuel Insua Pereira
Diogo Canhão de Sousa Canavarro
Eduardo Antonio Morales Luizaga
Eduardo Jorge dos Santos Gonçalves
Fernando Manuel Pereira Noronha
Filipa de Sequeiros Barreto e Araujo Moreno
Flavio Tiago do Couto
Halidi Abdoulghafour
Helena Cristina Brites Martins
Helena Isabel da Costa Ribeiro
Helena Maria Sant'Ovaia Mendes da Silva
Heloísa Helena Corrêa Ribeiro
Hugo Manuel Gonçalves da Silva
Iakunin Maksim
Ilda Conceição Abreu Noronha
Isabel Margarida Horta Ribeiro Antunes
Iuliu BOBOS-RADU
Joana Margarida dos Santos Simões Torres
Joana Paula Machado Ribeiro
João Guilherme Fontiela Figueiredo
Joaquim Luis Galego Lopes
Jorge Manuel Costa Pedro
Jorge Manuel Espinha Marques
Jorge Manuel Vieira Pamplona
José Bernardo Rodrigues Brilha
José Fernando Borges
Júlio Ferreira Carneiro
Lia Bárbara Cunha Barata Duarte
Luís André Pereira Fialho
Luis Filipe Lopes Guerreiro
Mafalda Maria Morais Seixas
Manuel Armando Oliveira Pereira dos Santos
Manuel Francisco Colaço de Castro Pereira
Maria Alexandra de Mascarenhas Guedes
Maria Alexandra Marchã Penha
Maria Amália de Castro Sequeira Braga
Maria Ângela de Carvalho Fernandes Almeida
Maria Armanda Viana Antunes Guimarães Silva Dória
María de los Ángeles Obregón Muñoz
Maria dos Anjos Marques Ribeiro
María Fernández González
Maria Helena Batista da Costa Guerreiro de Novais
Maria Helena Macedo Couto
Maria João Tavares da Costa
Maria Manuela Queiroz Martins Mantero Morais
Maria Teresa Durães Albquerque
Mário Rui Melício da Conceição
Masud Rana Rashel

Miguel Joaquim Fernandes Potes
Mouhaydine Tlemçani
Mourad Bezzeghoud
Noel Alexandre Fontes Moreira
Patrícia Alexandra Dias Brito Palma
Paula Alexandra Sá da Silva Gonçalves
Paulo Jorge da Silva Pereira
Paulo Manuel Ferrão Canhoto
Pedro André Santos Ribeiro Horta
Pedro Miguel Ferreira Cardoso Madureira
Pedro Miguel Madureira Pimenta Nogueira
Pedro Miguel Martins Pereira
Renato Henriques
Ricardo Filipe Carrão da Conceição
Rita Maria Ferreira da Fonseca
Romeu André Carvalho Vieira
Rui Manuel Soares Dias
Rui Miguel Marques Moura
Rui Paulo Vasco Salgado
Sara Batista Gomes Moutinho
Sílvia Cristina Martins Aires
Teresa Maria Fernandes Valente
Vanda Cristina Pires Salgueiro
Violeta Isabel Monteiro Ramos

Students

Adriana Filipa Batista da Silva
Ailton César Moniz Tavares
Alexandra Jorge Macedo Cardoso
Ameno Délcio João Paulino Bande
Ana Catarina Galveias Jorge
Ana Catarina Gomes de Pinho
Ana Catarina Neves Foles
Ana Claudia Alves Santos
Ana Cláudia Mendes da Costa
Ana Filipa Santos da Mota
Ana Marta Vasques Gonçalves
Ana Raquel Ascensão Barroso
André Filipe Rendeiro Albino
Andreá Trevisol
António João Teixeira Oliveira
Apolo Pedrosa Behring
Bruna Patrícia da Silva Mouta Ribeiro
Carla Daniela Ribeiro de Carvalho
Catarina Alexandra Rodrigues Matos
Cátia Alexandra Gomes Dias
Cláudia da Conceição Ferreira da Cruz
Diana Sofia Coelho da Silva
Dulce Manuel Cruz Henriques de Lima
Edgar Francisco Mendes Abreu
Eliana Margarete de Abreu
Estefânia Gomes da Cruz Lopes
Fahad Faisal
Fátima Patrícia da Silva Soares Gomes
Filipa Catarina Lopes Dias
Flávio da Silva Dias
Francisco Manuel Tavares Lopes
Germilly Reki Morais Barreto
Gonçalo Correia da Fonseca Rodrigues
Gonçalo Gomes Silvério
Guilherme de Oliveira Alves Ínsua Pereira
Hélder Samuel Leite de Sousa
Ines Hamak
Isabel Maria Romero Sousa Magalhães Fernandes
Isaías da Luz Ramos Gomes
Jessica Larissa Lima Torres
Joana de Castro Rodrigues
Joana Ferreira da Fonseca Ventura Araújo
Joana Maria Cardoso Fernandes
João Alberto Cruz Vieira
Joao Carlos de Carvalho Branco Perdigao Marques
João Manuel Gouveia de Figueiredo

Jorge Dinis da Silva Lopes Oliveira
Jorge Miguel Lino Correia
José Diogo Bivar de Weinholtz Roseiro
José Pedro da Silva Neves
Karina Lucia Garcia
Luís Antonio Santos Lima
Luís Bernardo Ferreira Fernandes
Mafalda Peixoto Costa
Marcela Filipa Carneiro Rodrigues
Marcelo Godinho da Silva
Marco Antonio Azinheira Morais Lourenço Manso
Maria Manuela Domingues da Silveira Catana
Maria Olívia da Silva Mendes
Mariana Gazire Lemos
Mário Diogo Carvalho Costa Gomes
Md Tofael Ahmed
Miguel Cardoso Maia
Mónica Gabriela da Silva Sousa
Natália Mota Silva
Nemias Moniz Dos Reis Gonçalves
Oumaima Mesbahi
Oussama Dhaoui
Pedro Manuel Machado Teixeira
Renato Filipe da Costa Rodrigues Guimarães
Ricardo Fernandes Ribeiro
Rita Alexandra Rodrigues Pereira
Rita Isabel da Rocha Lamas
Rui Jorge Braga de Oliveira
Rute Isabel Martins Arriegas
Samuel Patrício Maló das Neves
Samuel Queijo Fernandes
Sara Manuela Ferreira Leal
Sara Raquel Alves Pereira
Sónia Gonçalves Pereira
Thais de Siqueira Canesin
Tiago Moisés Azevedo Ribeiro
Tiago Vaz Pato Osório
Ubaldo Ginova Ombe Gemusse
Vanessa Figueiredo Laranjeira
Violeta de Souza Martins
Vítor Manuel Oliveira Silva

Collaborator

Ana Luísa Abreu Alferes Lourido
Ary Delmar Pinto de Jesus
Carlos Dinges Marques de Sá
Carlos José Pinto Gomes
Carlos Victor Rios da Silva Filho
Filipe Miguel de Vasconcelos Pinto
Helena de Souza Corrêa
Ivaneide Oliveira Santos
João Pedro Castro Oliveira Primo Silva
José Pedro Rebelo Ferreira Maia
Luís Miguel Barros Gonçalves
Maria Isabel dos Santos Rosa Caetano Alves
Maria Rosa Alves Duque
Nuno Miguel Silva Araújo Ribeiro
Pedro Alexandre Pereira Correia
Pedro Manuel de Matos Pimenta Simões
Priscila Lopes De Abreu Santos
Ricardo Nepomuceno Pereira
Rui Ernesto da Silva Gomes
Souhila Chabane

Technical staff

Ana Sofia Correia Fernandes
Joel Gonçalo Alvino Barrenho
Josué Manuel Amaral Figueira
Marta Maria Medinas Pereira
Samuel Ramos Bárias
Sérgio dos Santos Aranha