IMPACT

BIO-BASED WASTE COULD SECURE THE FUTURE

http://www.uc.pt/en/org/biocriticalmetals

This project is funded by the European Union

Impact Objectives

- Investigate the concept that waste can become a valuable resource
- Research options to supply target minerals/metals that are extracted today by other processes
- Develop innovative methods and processes for extracting even faint traces of these elements

Bio-based waste could secure the future

***Paula Vasconcelos Morais** from the **University of Coimbra** is the coordinator of **BioCriticalMetals** (Recognition of microbial functional communities and assessment of the mineralising potential or bioleaching for high-tech critical metals) project that seeks to develop bio-based tools to solve known problems. Here, she describes her specific role, how waste can become a valuable resource, and some upcoming dissemination activities*

Can you describe what your role entails and how you are leading the project?

The coordinator is responsible for the complete implementation of the project as well as being pivotal for communication between partners and society in general. In science and research projects there are always some results that are not what we expected. Therefore, the coordinator's role is to adjust the working plan in such a way that any findings – preliminary or otherwise – have a positive impact on the project. The main objective of the BioCriticalMetals (Recognition of microbial functional communities and assessment of the mineralising potential (bioleaching) for high-tech critical metals) project is to develop bio-based tools to solve known problems. It is therefore a need-driven-research. Thus, consideration of each partner's challenges and sample specification should be carefully assessed in order to prioritise sample analysis. Additionally, sample selection and allocation as well as organism sharing throughout the consortium must be coordinated.

Who are the project partners in the consortium?

The consortium is composed of scientists, entrepreneurs and engineers that have to share both materials and results at different levels. These experts come from across Europe: from Portugal there is the University of Coimbra, University of Porto, Beralt Tin and Wolfram S.A, Geoplano S.A and Empresa de Desenvolvimento Mineiro; from Argentina there is the National University of San Luis, Direction de Mineria de la Provincia de San Luis, G.T. Ingenieria S.A. and the National Commission for Atomic Energy; and from Romania there is the National Institute of Research and Development for Biological Sciences and the National Research and Development Institute for Nonferrous and Rare Metals.

How do you propose to extract elements that will contribute to a world that promotes recycling and minimises harmful waste?

Most mining wastes consist of low-grade mining rejects or tailings. Depending on the case, they may contain elements of interest, but their relative abundance is below a level where it is not technically and/or economically viable to extract through current processes, or the purity is not enough to guarantee the necessary quality requirements to sell a product in international markets. Our focus is on developing technologies that allow an environmentally and economically sustainable process for the acquisition of these elements. Ultimately, this can result in concentrated particles with added value that would be rejected and useless otherwise.

Have any challenges come about during the course of the project up to this point?

Fortunately, we can say that until now there have been no problems in the development of the projects. Nevertheless, because of the fact that the projects are developed with the participation of groups from two different continents, some small challenges had to be solved. One of these challenges was language. Interestingly, it wasn't because we all speak different languages, as we all communicate in English – it was more a result of the multidisciplinary aspect of the project, since we use different technical languages from different fields. It has been an interesting journey so far!

Can you tell us what ways you plan to disseminate the project results?

We have organised within the project two workshops until now, one in Portugal and one in Argentina, which are open to the scientific community, institutions, and companies, as well as the wider society. Over the course of the first year we have produced several publications related to the project theme; four in international peer-reviewed journals; 10 in non-indexed journals; and two book chapters. However, by the end of the current year, we will produce the first important paper containing global research results. Our most recent publication reports the high uptake of tungsten by bacterial strains, recovered from solution.

Sourcing technologically critical metals in a responsible way

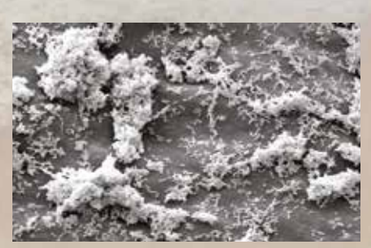
***BioCriticalMetals** (Recognition of microbial functional communities and assessment of the mineralising potential or bioleaching for high-tech critical metals) is a three year project that focuses on the concept that waste can become a valuable resource. The results could provide a secure supply of metals required for technological developments in Europe, in an efficient, economically responsible way*

The ever-burgeoning global population has, somewhat inevitably, led to a significant increase in the demand for technological equipment. Given that raw materials are essential to the development of such equipment, the need for these materials has risen too. However, this presents a problem that is not easy to solve: the two most populous countries, India and China, have a particular appetite for raw materials to enable them to keep up with international demand. This, in turn, depletes resources which can have the effect of jeopardising industrial development with Europe.

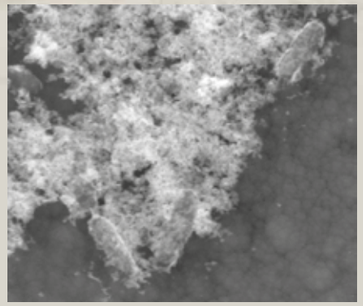
In addition to the time and energy it takes to mine for raw materials, the Earth has a finite amount of these resources, so attention has recently turned toward securing alternative sources. With that in mind, a team based at the University of Coimbra in Portugal has established a project which aims to identify secondary sources to supply raw material and, in enabling them to be obtained locally, helps to remove many of the logistical problems associated with importing from countries from far-off regions.

PROMOTING THE CONCEPT OF A CIRCULAR ECONOMY

The BioCriticalMetals (Recognition of microbial functional communities and assessment of the mineralising potential (bioleaching) for high-tech critical metals) project was conceived as a need-driven-research investigation. With a duration of three years, the project focuses on the concept that waste can perhaps become a valuable resource, one that provides the metals required for technological developments in ways not achieved before. Paula Vasconcelos Morais is the coordinator of the project, and she is clear what the success of the project will enable. 'Considering the limited amount of available primary resources for raw materials, Europe needs to secure alternative sources, preferably obtained locally. Our current project aims to contribute to one of these alternatives,' she explains. 'First, by developing methodological alternatives able to be applied to low concentrated primary and secondary sources and secondly, since these methods allow us to use residues as low-grade raw materials, the project promotes a circular economy concept.'



Strains of Ochrobactrum tritici immobilised on surface modified PTFE.



Strains of Rhodanobacter sp. immobilised in sputtered modified PTFE after being grown in the presence of uranium.

BioCriticalMetals is composed of a consortium of 11 partners from several countries across Europe and Argentina. As such, it includes researchers and partners with a diversity of roles within society, such as university research groups and companies who work in the field of prospecting and exploitation. 'While research groups focus on the development of new cost-effective and environmental-friendly methodologies for acquisition of materials of interest, the companies focus on field application and response to international demand on said raw materials,' highlights Morais. 'Outputs of the project will be transferred to the industry due to the close collaboration inside the project with major companies in Portugal and Argentina.'

Excitingly, by facilitating the supply of metals using methods by processes other than mining, recycling is promoted, while production of harmful waste is minimised. In addition, the specific selection of target minerals and metals within the context of the project addresses the need for a continuous supply of them within Europe. Ultimately, this will promote technological developments with cost-effective potential. By enabling improvements in efficiency, output and cost-effectiveness, the team will improve the acquisition of raw materials, thereby creating an industrial competitive advantage for those industries that rely on the supply of such materials, and thus, further benefiting the European economy as a whole.

EFFICIENCY AND COST-EFFECTIVENESS

'This project employs innovative methods and processes to extract even minimal traces of the desired elements,' outlines Morais. Tailings are defined as the materials left over after the process of separating what elements are required from those that are not. However, while tailings have historically contributed to damaging the environment by releasing toxic metals, such as arsenic and mercury, the BioCriticalMetals project wants to turn the negative connotations of tailings into a positive. For instance, tailings often contain a significant amount of microbial diversity, which represents untapped potential.

The ultimate focus will be to apply microorganisms in the extraction process through bioleaching and to recover the minerals from leachates by biomineralisation and bioaccumulation

MICROORGANISMS RECOVERING MINERALS

The new microorganisms that have been characterised as having a number of potential applications in biosolubilisation, biomineralisation and bioaccumulation processes are currently being studied by the team. We are also exploring other microorganisms for their ability to be highly specific in the metals they mobilise and immobilise. 'We are targeting the activity of mined autochthonous microorganisms towards critical high-tech metals such as Indium, Gallium, Tellurium and Tungsten, located in different geological and climatic settings,' explains Morais. 'The ultimate focus will be to apply microorganisms in the extraction process through bioleaching and to recover the minerals from leachates by biomineralisation and bioaccumulation.'

By applying bacteria and nanoparticles, Morais and the project's researchers hope to develop a range of combined strategies for the recovery of the metals. Another important aspect is that a comparative environmental risk assessment will be performed for the residues produced by bioleaching, both with and without nanoparticles. This will help ensure a minimum environmental impact, thereby upholding a core tenet of the project.

MULTI-DISCIPLINARY APPROACH KEY

The success of the BioCriticalMetals project is dependent on the effective collaboration of the researchers, institutions and industries that form part of the consortium. The project is highly multidisciplinary. It requires an extremely diverse team of partners all working together in order to achieve the aims of the project. 'We depend on samples provided by our partners at University of Coimbra, University of Porto, Beralt Tin and Wolfram, Empresa de Desenvolvimento Mineiro and Geoplano in Portugal, and from National University of San Luis and Direction de Mineria de la Provincia de San Luis in Argentina, just like our partners from National Institute of Research and Development for Biological Sciences in Romania depend on samples from National Research and Development Institute for Nonferrous and Rare Metals,' emphasises Morais. 'The team requires the expertise of geologists for sample characterisation, and microbiologists for the isolation and cultivation of microorganisms present in those samples.'

In addition to the industrial partners that form part of the BioCriticalMetals project, there is another project called PT-W (Biotools for a sustainable supply of tungsten - from biodetection to bioleaching and biorecovery), which was developed in Europe with partners from Germany and Portugal. Both projects support the inclusion of the next generation of researchers and feature work by Post Doctorate students Rita Branco, Romeu Francisco and Ana Paula Chung, PhD student Pedro Farias, and Technician Carina Coimbra. In that particular project, the microorganisms that are isolated will be applied in bioprocesses tested at a laboratory scale.

A NEW ELEMENT TO FOCUS ON

After the three year duration of the project Morais expects that it will reach a Technology Readiness Level of 4, which corresponds to lab-scale validation. Once this has been achieved, the team hopes to reach higher Technology Readiness Levels by scaling-up to prototype tests in relevant or operational environments. 'This would allow companies to have the opportunity to finally benefit from the research. The bioleaching processes are already applied to obtain elements such as Copper and Cadmium, and produce less residues and use less chemicals.'

Ultimately, Morais and her team will develop new methodologies for the bioleaching of elements in low concentrations. By focusing on elements that have not yet been the focus of research such as this, there are real economic and environmental benefits.

Project Insights

FUNDING

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PARTNERS

Beralt Tin and Wolfram S.A (Portugal) • Direction de Mineria de la Provincia de San Luis (Argentina) • Empresa de Desenvolvimento Mineiro, EDM (Portugal) • Geoplano S.A (Portugal) • G.T. Ingenieria S.A. (Argentina) • National Commission for Atomic Energy (Argentina) • National Institute of Research and Development for Biological Sciences (Romania) • National Research and Development Institute for Nonferrous and Rare Metals (Romania) • National University of San Luis (Argentina) • University of Coimbra (Portugal) • University of Porto (Portugal)

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PROJECT COORDINATOR BIO

Dr Paula Vasconcelos Morais graduated in Biology in the Department of Zoology of the Faculty of Sciences and Technology of the University of Coimbra in July 1984. In May 1992, she received her doctorate in Biology, with a specialty of Microbiology. Morais has been an Assistant Professor with Habilitation of the DCV/FCTUC since September 2009. She is the principal investigator of several projects, including two in collaboration with mining companies. She is a member of the Operational Group of the European Innovation Partnership in Raw Materials.