



European Innovation Partnership on Raw Materials

Application for a Raw Materials Commitment

Innovative bio-mining and bio-mineralization technologies applied to extraction of low-grade ores deposits, mine by-products and recycling of man-made products

Acronym:

BioAlMinore

Links to the Strategic Implementation Plan:

- **I. Technology Pillar**
 - **I.B Priority Area: Technologies for primary and secondary raw materials' production**
 - **Action area n° I.3: Innovative extraction of raw materials**
 - **2) Mining of small deposits**
 - **3) Alternative mining**
 - **Action area n° I.5: Recycling of raw materials from products**
 - **1) End-of-life products recycling**

Objectives of the commitment:

The aim of the consortium is to develop new strategies to extract low grade primary geological resources, mine by-products, using Iberia as a case study, and to recycle technological waste for rare metal recovery. The core of the investigation is the development of innovative bio-mining and bio-mineralization techniques, based in the collection of microorganisms from hydrothermal vents. The results is expected to be in according with the strategic implementation plan on raw materials not just for Technology pillar 1B action area n° I.2 and I.3 but also 1A and 1C and as such provides fundamental knowledge for the entire technology pillar as a whole. It will enable and facilitate the development of global sustainable Innovative extraction of raw materials through the application of biotechnologies allowing the exploitation of presently uneconomically geological resources, in a more environmentally friendly way and substantially reducing mining wastes

Description of the activities:

Portugal and Spain (Iberia), traditional producers of raw materials, were affected by the crisis of the 80's and 90's, but retained a significant potential to reactive their mining industry, alleviating Europe resources deficits and driving the national economy. In the past the exploitation was focused in the economically high grade ore deposits, extracted and processed by conventional techniques. The metal recovery efficiency of these techniques was variable but not very high, and, as a

consequence, it is expected that a significant amount was discarded to the tailings dams. With the goal of developing new strategies based on emerging technologies to allow the economic exploitation of primary low grade ores as well as secondary sources from by-products of the mining activities, an interdisciplinary team was established joining geologists, geochemists, microbiologists, mining and material engineers from University of Coimbra (UC), University of Porto (UP), University of Aveiro (UA) in Portugal, University of Salamanca (USal) and Institute of Geology and Mining in Spain (IGME), and University of Copenhagen in Denmark (KU), and the Portuguese company EDM (Empresa de Desenvolvimento Mineiro). It is expected that the same technologies can also be applied to the recycling of technological man-made wastes, mainly with the purpose of recovering rare minerals.

These objectives are essential for the strategic implementation plan of the European innovation partnership on raw materials priority area I.B: Technologies for primary and secondary raw materials' production with emphasis in the action areas nº I.3 - Innovative extraction of raw materials and alternative mining and nº I.5 - Recycling of raw materials from products, buildings and infrastructure

Geological, mineralogical and geochemical studies to be developed by members of the UC, USal and IGME will improve the knowledge in low grade ores deposits of central Iberia whose exploitation in the past by conventional means was not economically feasible, as the case of W and Sn

The metal resistant microorganisms from the culture collection of UC, part of it with origin in deep-sea hydrothermal vents, will be characterized (biochemical and molecular), genetically engineered to obtain new biotechnological tools, to explore their use in improving mineral extraction. The UC and UP group will develop new processes for extracting small amounts of metal by using these microorganisms looking into hitherto neglected deposits.

UC and UA also intend to explore the microorganisms collection to perform bio-mineralization. Improving growing conditions and immobilization strategies for bio-mineralization will be developed in collaboration with material engineers from UC for strains already identified (uranium and arsenic biomineralization) and for the new bio-mineralizing strains that will be detected in the culture collection.

The section of Microbiology at KU is committed to investigation of microbial interactions and their relevance for providing novel technologies. Lead by Professor Søren Sørensen these technologies will utilize hitherto untapped or underutilized resources and the production of novel microbial derived products, for extraction of high value products or minerals bio-remediation and bio-mineralization. Techniques used are high throughput including access to the Copenhagen high throughput Sequencing facility chaired by the Co-applicant for pyrosequencing and FACS, for genome, transcriptome, and sorting of engineered strains by flow cytometry.

The biotechnological techniques will also be tested in association with other innovative non-biological techniques to explore possible synergistic effects.

The "biominers" microorganisms will be tested also in "urban mining" environments, that is to evaluate its efficiency to perform bioleaching of technological man-made waste (electric and electronic and others) for recovery of the metals, namely the rare ones.

By the end it is expected to design and build a pilot biotechnological plant in a former mining mine for testing the laboratory results. EDM will make available mining areas for implementation of this plant.

Description of the expected impacts:

The deliverables expected from the project are essential for the strategic implementation plan of the European innovation partnership on raw materials, not just for Technology pillar 1B action area nr I.2 and I.3 but also I.A and IC. These will also impact alternative mining through the application of biotechnologies substantially reducing generation of mining waste and as such provides fundamental knowledge for the entire technology pillar as a whole. We expected to:

Innovative extraction of raw materials
Improving the recovery efficiency of rare minerals from technological wastes
Reducing the amount of mine wastes
Reducing the amount of technological waste, namely electronic and electric equipment
Developing a more sustainable exploitation of raw materials (from economic, environment and social issues)
Identify new resources, discarded in the past due to the low content of the metals and high cost of exploitation
Discover new tools (modified microorganisms) for mining and recycling
Design and implement of biotechnological plants for low grade geological resources and mine by-products
Bringing together a team of experts from different fields (geology, mineralogy, geochemistry, microbiology, chemical, mechanical and mining engineers)

Expected innovation outcomes:

New processes
New technologies

Name of the coordinating organisation:

University of Coimbra - Mechanical Engineering Research Center (CEMUC)

Country:

Portugal

Entity profile:

Academia

Role within the commitment:

The University of Coimbra, through its Research Center of Materials, will carry on the field work for geological prospecting works and co-operate in the field of petrographic and mineralogical studies of the ore minerals. The core of the microbiological studies would be conducted in the same research center. The Coimbra group would be also involved in the design and monitoring on the pilot plant.

Other partners:

Name of partner:

Section of Microbiology, University of Copenhagen

Country:

Denmark

Entity profile:

Academia

Role within the commitment:

Investigation of industrially relevant microbial synergistic interactions

Name of partner:

University of Porto, Engineering Faculty

Country:

Portugal

Entity profile:

Academia

Role within the commitment:

Develop laboratory scale bench and continuous bio-reactors for testing extraction of specific

metals by microorganisms. Study the influence of the main parameters on the extraction yield. Process optimization. Study alternative recovery methods for specific metals solubilized by the microorganisms

Name of partner:

University of Salamanca

Country:

Spain

Entity profile:

Academia

**Role within the
commitment:**

The University of Salamanca, through its Research Group of Characterization of Geomaterials, will carry on the chemical analysis (major and trace elements) and petrographic description of the materials used for the present project (minerals, rocks and mine waste). Physical and mechanical testing can be used on the samples if needed.

Name of partner:

Instituto Geológico y Minero de España (IGME)- Spanish Geological Survey

Country:

Spain

Entity profile:

Academia

**Role within the
commitment:**

Collaborate in the field study and mapping, focused in resources exploitation and their impact in the human activity and environment (related to underground water and aquifers, developing strategies of remediation in case of contamination due to waste) Inventory of geological and mineral resources and their correct exploitation. Analysis and testing in the specific unit of metallurgy.

Name of partner:

University of Aveiro

Country:

Portugal

Entity profile:

Academia

**Role within the
commitment:**

Role within the commitment: FINE-GRAINED MINERALS AND BIOSYSTEMS INTERACTIONS - Fine-grained minerals and human body interaction. Fine-grained minerals and microorganisms. Biomineralization. Biaccessibility and laboratorial assesement.

Name of partner:

edm

Country:

Portugal

Entity profile:

Governmental/public body

Role within the commitment:

EDM owns the W and Sn exploration rights for 2 areas in Portugal. EDM has geological, geophysical (magnetic and induced polarization), geochemical (soil and stream sediments sampling) and drilling data for one of these areas, and will have it for the other one. Both areas include abandoned mines and tailings that will be used for test sites. Therefore, these data and infrastructures will provide real world mineralized environment to be tested in the project and will host the biotechnological pilot plant.

Existing EU contribution:

Yes

Source:

Cohesion Policy Funds: European Regional Development Fund

Period to implement the commitment:

Thursday, 1 January, 2015 to Sunday, 31 December, 2017

Source URL: <https://ec.europa.eu/growth/tools-databases/eip-raw-materials/en/content/innovative-bio-mining-and-bio-mineralization-technologies-applied-extraction-low-grade-ores>