



REMIX
Interreg Europe



European Union
European Regional
Development Fund

Circular economy: challenges being addressed by Centro Region

Alexandra Ribeiro

FCT, NOVA University of Lisbon

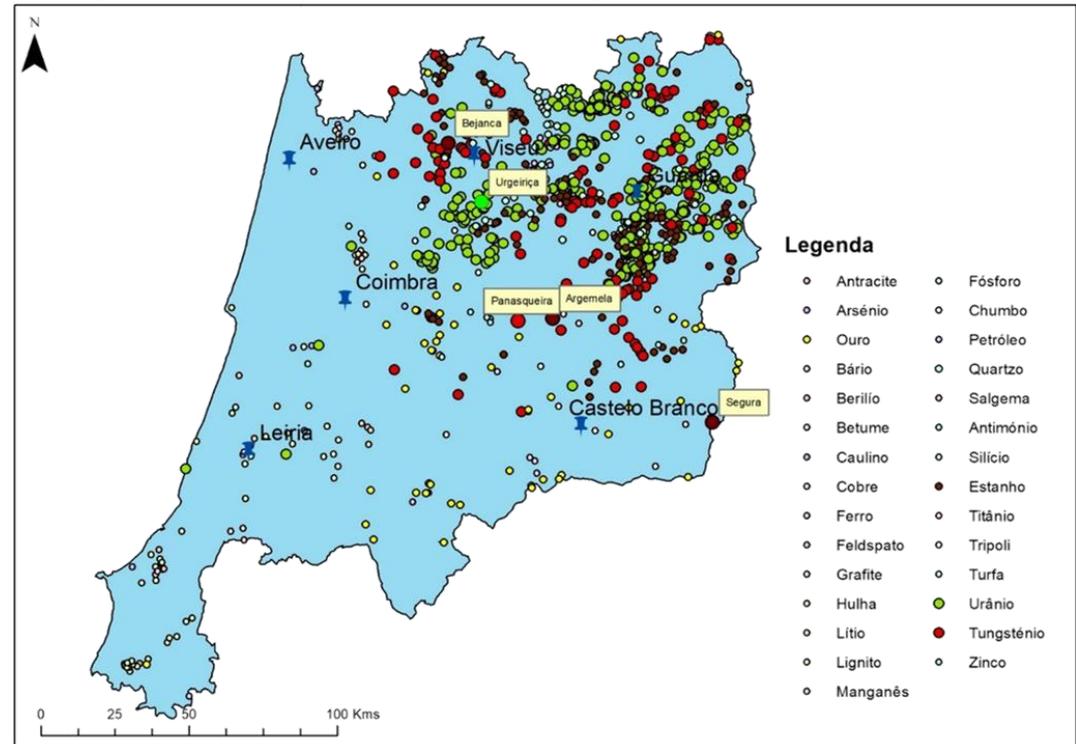
Wroclaw, 15th May 2019



Centro Mining Region – General Overview



- Tungsten, one of the EU critical raw materials, is exploited in the region for over 100 years in the Panasqueira mine.
- Apart from tungsten the potential for tin (153 oc.), lithium, uranium (409 oc.) and gold (51 oc.) is also high.





e.THROUGH

Thinking rough towards sustainability
H2020-MSCA-RISE



REMINE

H2020-MSCA-RISE

- ✓ **Projects financed by the EU Framework Programme for Research and Innovation HORIZON 2020 - (1.3.2.) EXCELLENT SCIENCE - MARIE SKŁODOWSKA-CURIE ACTIONS – Research and Innovation Staff Exchange (RISE)**
- ✓ Aim to support career development and training of researchers through international and inter-sector mobility.

Why are they important?

To tackle its critical raw material (CRM) dependency, Europe needs comprehensive strategies based on sustainable primary mining, recovery from secondary resources and recycling.

e.THROUGH has the **ambitious vision of turning the challenge of CRMs dependence into a strategic strength for Europe** by:

1. Promoting new trends in the characterization and exploration of mineral deposits;
2. Mapping CRMs between EU mining regions;
3. Gaining knowledge on innovative processes for recovery secondary CRMs;
4. Redesign construction materials using secondary materials, closing loops, strongly supporting waste minimization;
5. Life Cycle Assessment (LCA) for the evaluation of global environmental impacts;
6. Transferring newly generated knowledge to stakeholders, both for policy development and standardization, and for shaping responsible behaviours.



e.THROUGH
Thinking rough towards sustainability



Coordinator: A. B. Ribeiro



UNIVERSIDAD DE MÁLAGA



Technical University of Denmark



E-MINES



Northeastern University



— Coordinator

— University

— SME



e.THROUGH
Thinking rough towards sustainability



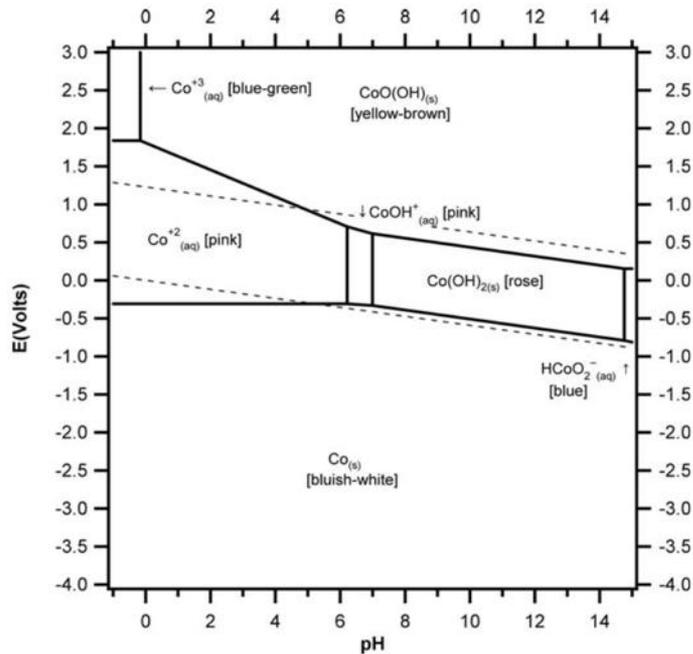
WC-Co scrap powder



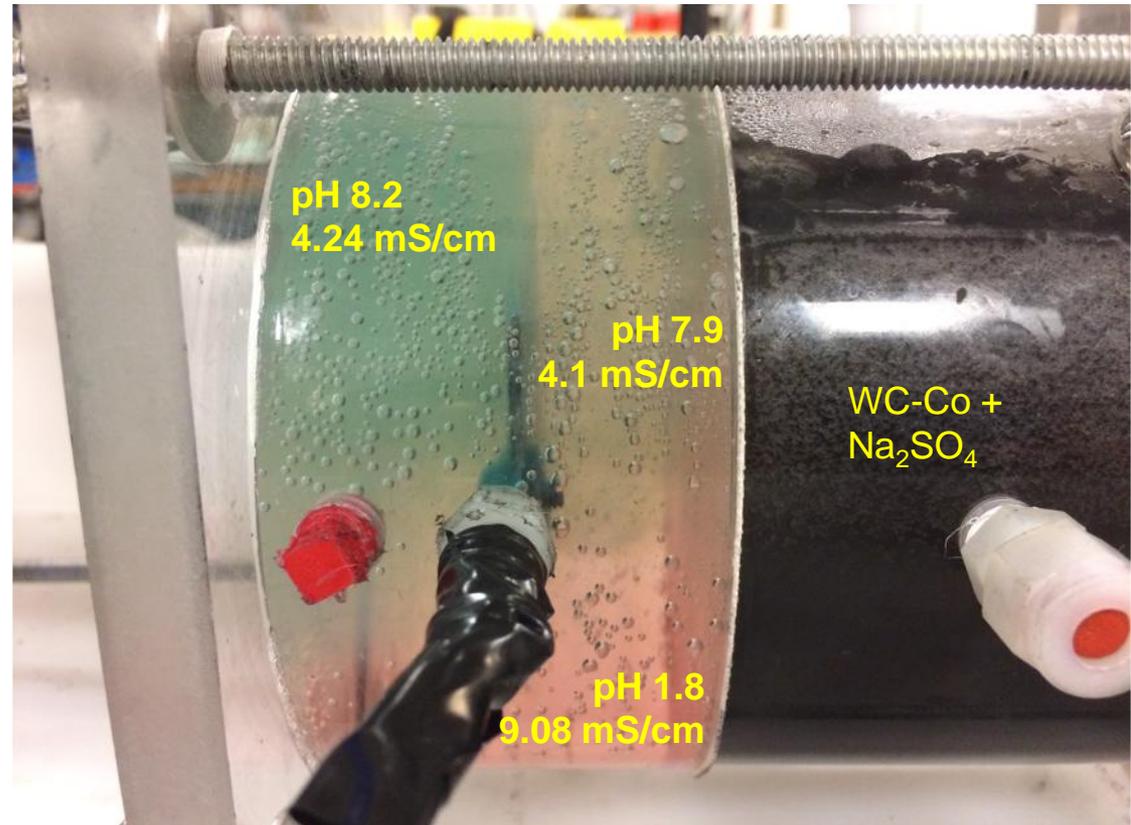
Tungsten carbide
scrap powder



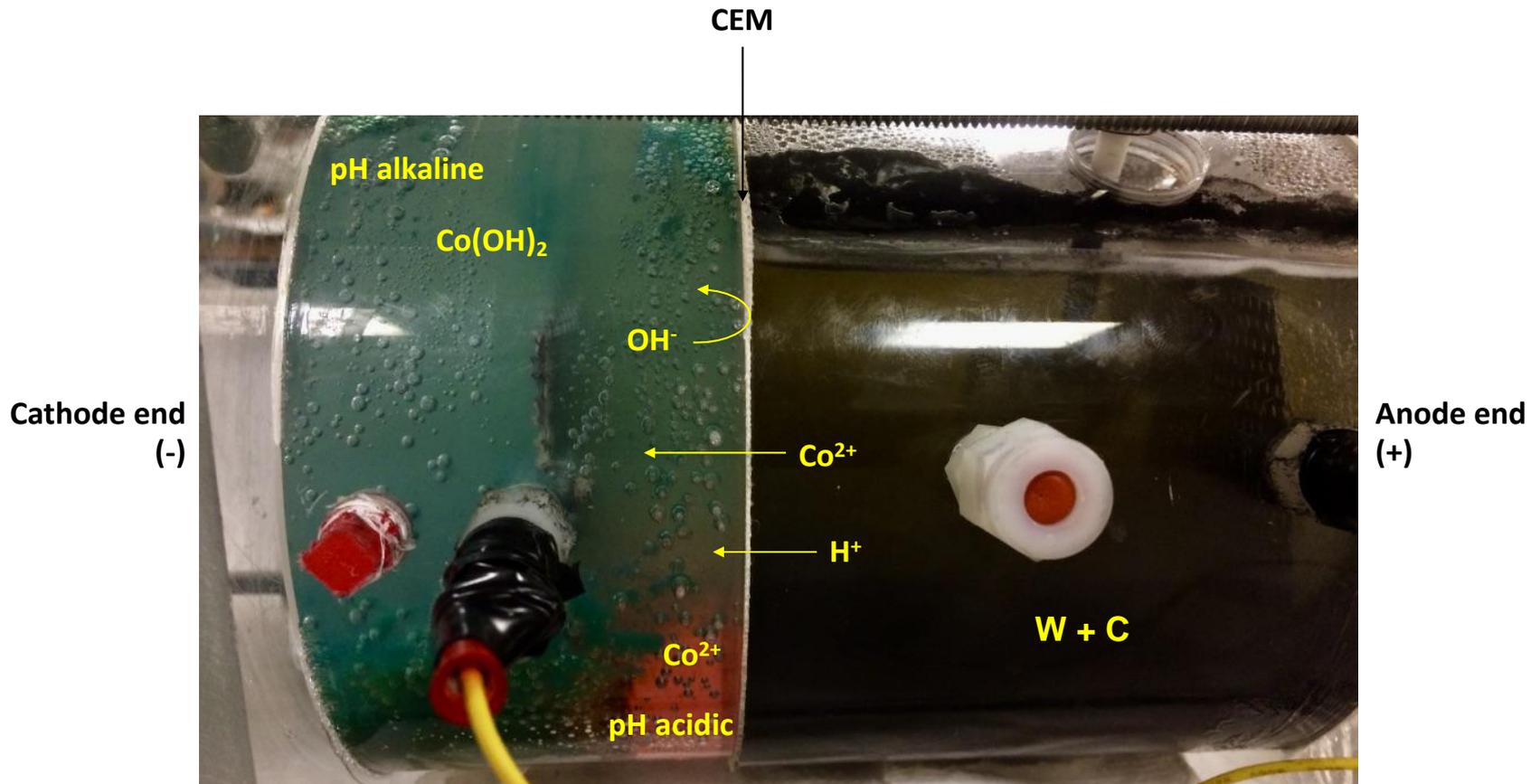
Electrodialytic W and Co recovery



E-pH diagram for Co species. Soluble species concentrations (except H^+) = $10^{-1.0}$ M. Soluble species and most solids are hydrated. No agents producing complexes or insoluble compounds are present other than HOH and OH^- .



Electrodialytic W and Co recovery





e.THROUGH
Thinking rough towards sustainability



e.THROUGH
Thinking rough towards sustainability



e.THROUGH project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 778045

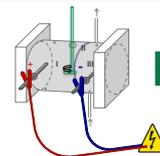
Recovery of mining residues from Panasqueira mine

Secondary resources



- High amounts of MT → landscape, environmental and public health problems
- MT have contents of critical raw materials (CRM EU List 2017)
- Limitation: harmful compounds

Potential motor for sustainable technologies innovation to remediate harmful compounds (arsenic) and recover CRM (tungsten), contributing for circular economy in EU



Electro-based technologies

Safe MT reuse in building materials

Panasqueira tailings (particularly waste-mud) also contain high sulphide (As) concentrations and sulphide-related heavy metals (Cd, Cu, Pd and Zn)

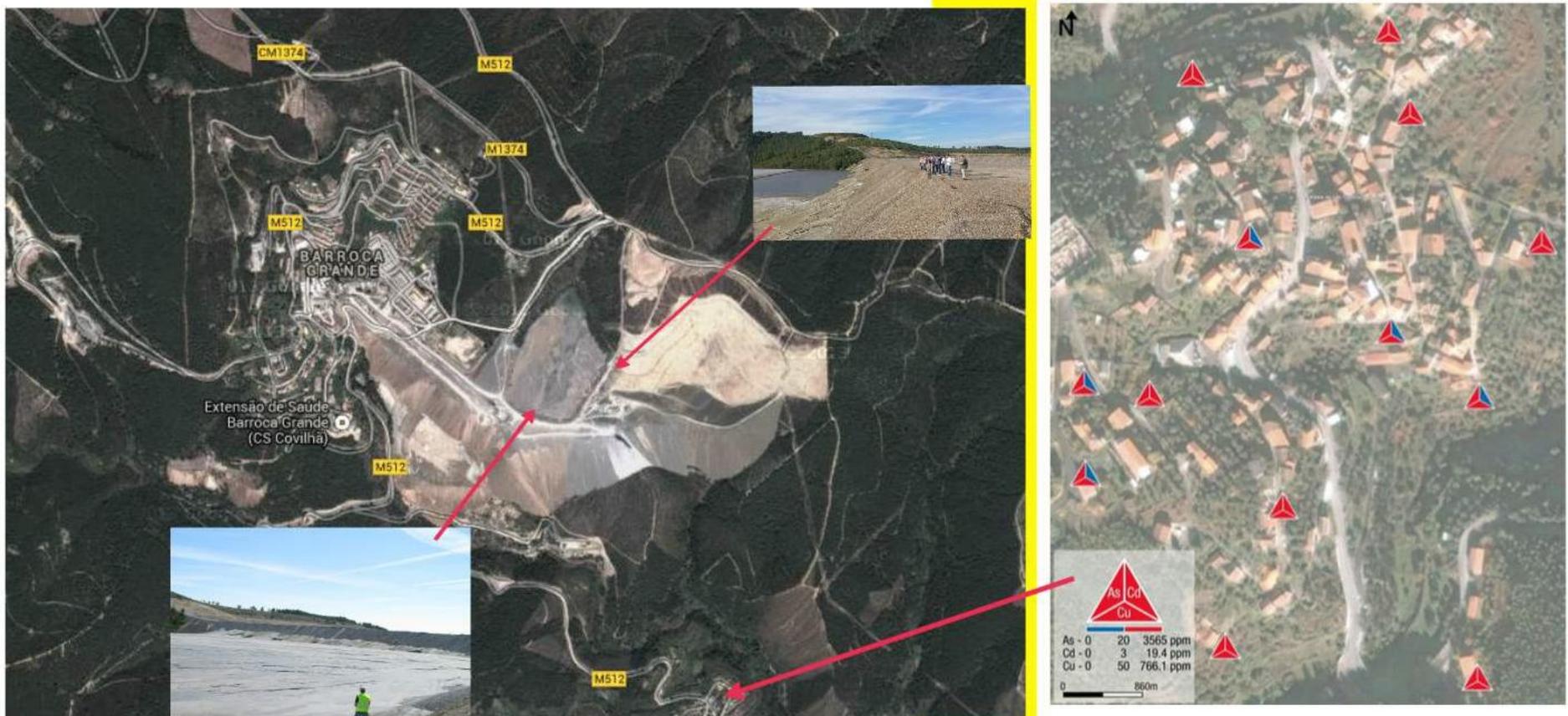


Fig. 5. Cartography of road dust contents for As, Cd and Cu (Google Earth image modified).

Heavy metal pollution in mine-soil-plant system in S. Francisco de Assis – Panasqueira mine (Portugal)



Carla Candeias^a, Rita Melo^a, Paula Freire Ávila^{b,*}, Eduardo Ferreira da Silva^a, Ana Rita Salgueiro^a, João Paulo Teixeira^c



e.THROUGH

Thinking rough towards sustainability



e.THROUGH

Thinking rough towards sustainability



e.THROUGH project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 778045



REMINE
H2020-MSCA-RISE

Reuse of Mining Waste into Innovative Geopolymeric-based Structural Panels, Precast, Ready Mixes and Insitu Applications

João Castro Gomes

Civil Engineering and Architecture Department
University of Beira Interior
castro.gomes@ubi.pt

Project no. 645696, Coordinator: Beira Interior University (PT) (participants: Brunel University (UK), Silesian University (PL) Bologna University (IT), Granada University (SP), Strathclyde University (UK), Kyiv National University of Construction and Architecture (KNUCA), Alsitek Ltd (UK). Sofalca, Lda (PT), Beira Serra (PT)),



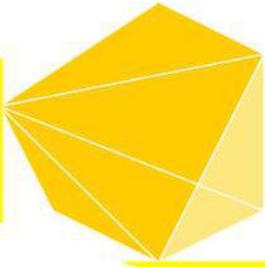
ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA



Universidad de Granada



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 645696



REMINE
H2020-MSCA-RISE

Panasqueira mine is one case study for REMINE

Largest Tungsten mine in World;
Major production in 1943:
2500 ton of Wolfram;
During 80's, generates about 600
thousand tones of coarse wastes/
year to explore only 2 thousand
tones of Wolfram ore:
0,3% of total escavated!
currently, it is still generating 100
to 200 tons per day.
Around 20% is **waste mud.**





REMINE

H2020-MSCA-RISE



REMINE has three main objectives:

- Development of a **high energy-efficient alkali-activated-based structural panel** for building facades, and advanced experimental characterization of rheological, mechanical and physical properties;
- Development of **lightweight and fire resistant precast applications**, combining mining waste mud and natural cork for artistic, architectural and historical heritage restoration;
- Improving opportunities for reuse of mining wastes in **pavements infrastructure and as pouring pavement materials** for insitu application;





Alkali-activation - novel binders

Precursores

Reactive aluminosilicate powder, particularly metakaoline and fly ash

Alkali-activators

Sodium hydroxide;
Sodium silicate;
Potassium Silicate;
calcium hydroxide;



alkali-activated binder

disordered alkali aluminosilicate
amorphous gel phase in SEM

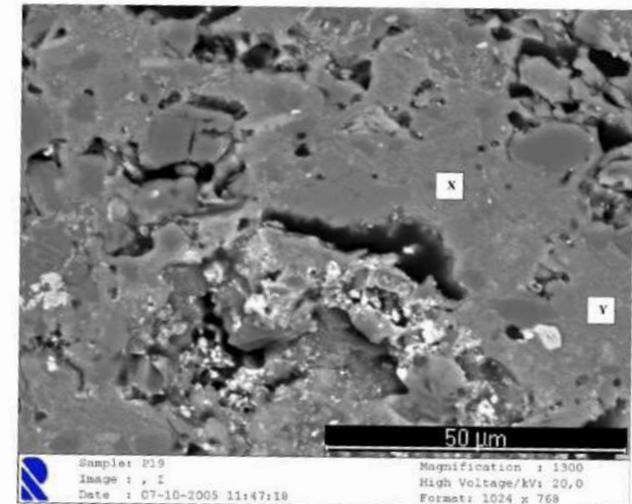


Fig. 3a. SEM micrographs of tungsten mine waste geopolymeric mortar. The areas marked as X and Y are identified as some type of aluminosilicate with the following composition: X [(CaO/SiO₂ = 0); (Al₂O₃/Na₂O_{eq} = 2.5) and (SiO₂/Al₂O₃ = 4); Y [(CaO/SiO₂ = 0); (Al₂O₃/Na₂O_{eq} = 3.1) and (SiO₂/Al₂O₃ = 3.1).



REMINE
H2020-MSCA-RISE



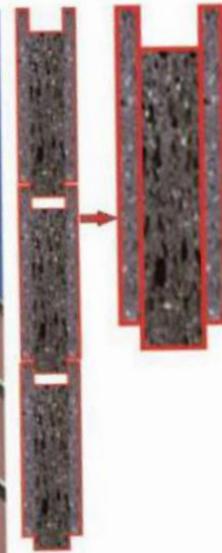
Ceramic materials - thermal insulation

Ceramic isolation panel,
made from mud, cork
and glass.

1000 °C firing

Porosity $\geq 50\%$

Mosh hardness: 6
Thermal Conductivity
W/m-K 0.117904



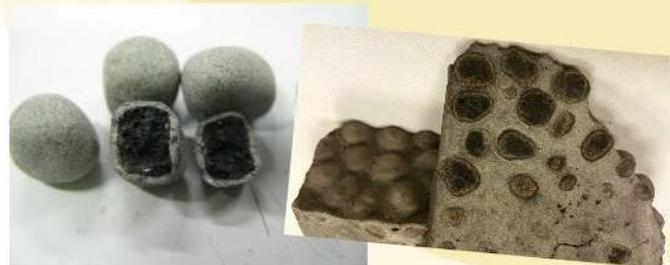


REMINE

Main valuable materials for infrastructure and building products .. with market perspectives.

macro-encapsulated aggregates (ME-LWAs) for a precast panel application

patented



artificial aggregates for infrastructures (AAI)



lightweight foamed materials, combining mud + waste glass + expanded cork



lightweight foamed materials, perforated blocks + mud waste + brick waste powder

patented





natural vegetated panels for energy-efficient building green roofs and facades - GEOGREEN Modular System

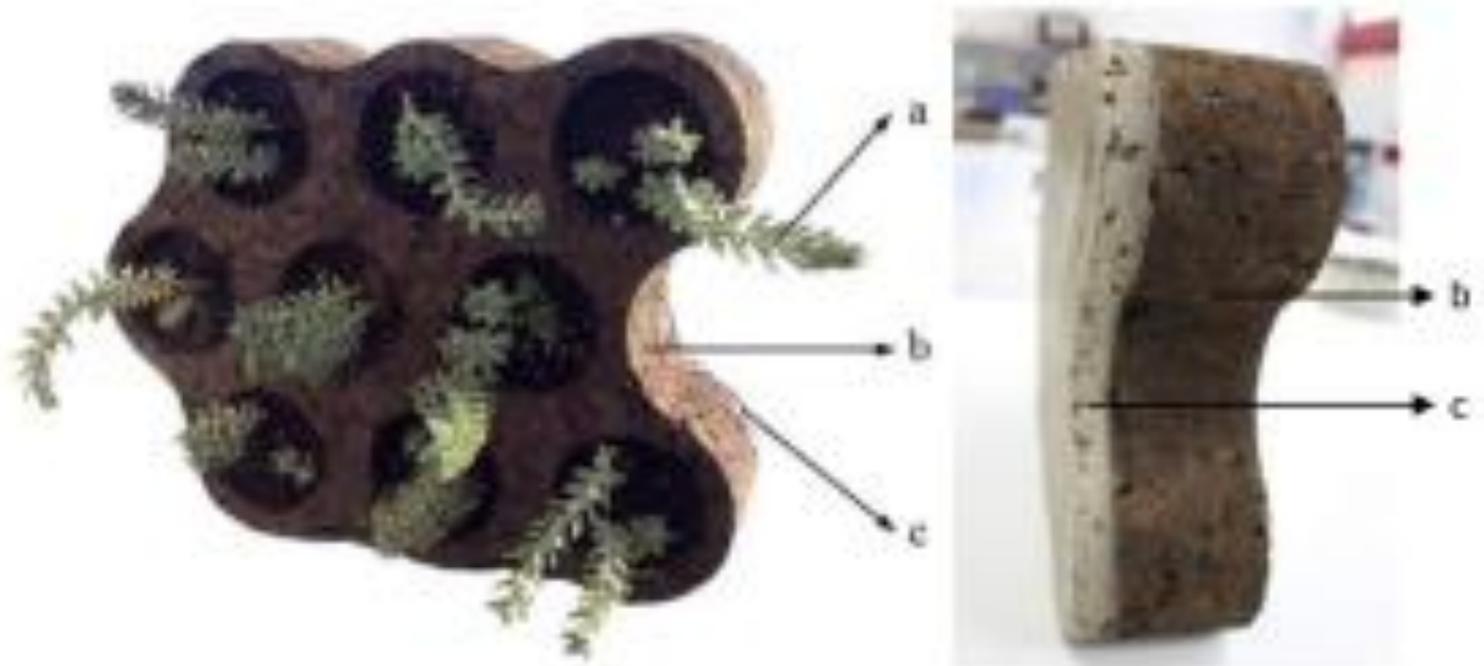


Figure 9 - Geogreen modular system design with plants and substrate.

a - Adjusted plant species; b - Upper layer in expanded perlite-based (EPR); c - Base layer in alkali-activated



REMINÉ

AAM mortar

GEOGREEN

REMIX 

blend of mine waste mud and other waste materials.

Density - 1,3g/cm³

Weight 2.4Kg per plate – 26Kg/m² Compressive strength

6 MPa (7 days curing at 60°C)

Capillarity absorption coefficient
0,63 - 1,33 Kg.m⁻². h^{0,5}



Insulation cork board

Natural eco-friendly material

- Density 105 - 125 Kg/m³
- Weight 0,650Kg per plate
- 7Kg/m²
- Thermal insulator 0.5 W/m². K
- Thickness 8 cm / 3,15 inches





REMINE
H2020-MSCA-RISE

REMIX
Interreg Europe

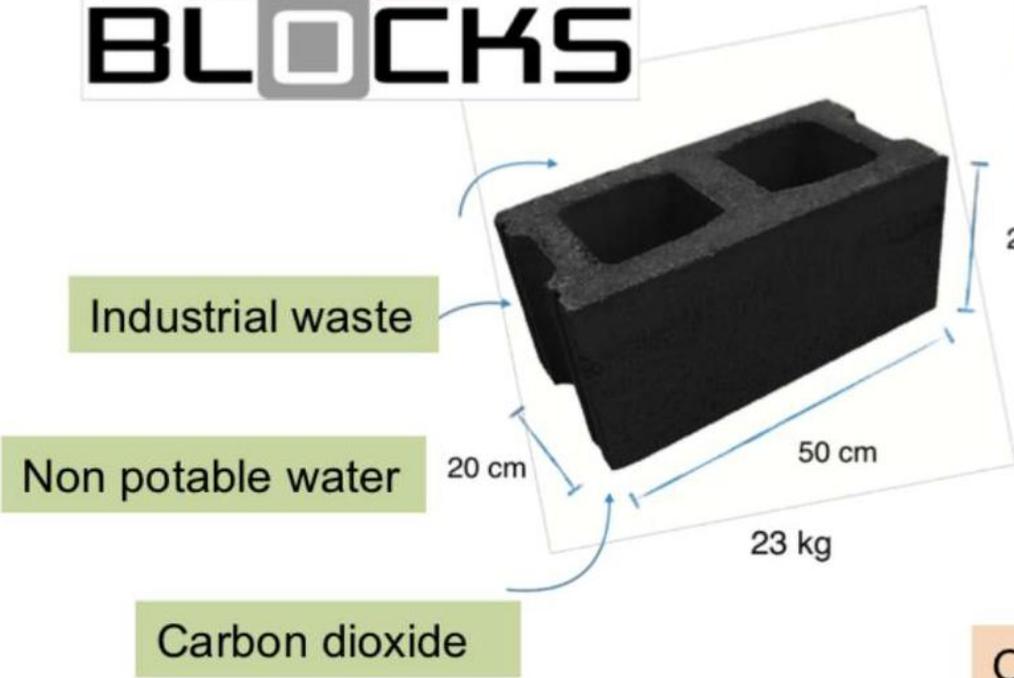
UNIVERSIDADE
BEIRA INTERIOR

some ideias for GEOGREEN system





ECO² BLOCKS



48 hours fast hardening blocks

CO₂ stored as Calcium Carbonates

Recognized International publications

Patented (provisional)

Ongoing industrial prototyping tests



REMINE
H2020-MSCA-RISE

REMIX
Interreg Europe

UNIVERSIDADE
BEIRA INTERIOR

ECO²
BLOCKS

50% cheaper

10x faster manufacturing process

Traditional manufacturing machines



First prize
Prémio
Manuel
António da Mota



Climate
Launchpad



First Prize Winner Climate Launchpad
Grand Final
Sustainable Production Systems Winner
Climate Launchpad Grand Final



REMINE
H2020-MSCA-RISE

REMIX
Interreg Europe

UNIVERSIDADE
BEIRA INTERIOR





e.THROUGH

Thinking rough towards sustainability

(abr@fct.unl.pt)



REMIX

Interreg Europe



REMINE

H2020-MSCA-RISE

(castro.gomes@ubi.pt)

Thank you!



https://sites.fct.unl.pt/e_through/

<https://reminemsc.wordpress.com/>



Grant Agreements No. 778045 and 645696 – H2020-MSCA-RISE