Circular economy: challenges being addressed by Centro Region

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

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.
Coordinator: A. B. Ribeiro

Technical University of Denmark

E-MINES

Northeastern University

Lehigh University

Coordinator

University

SME
WC-Co scrap powder

Tungsten carbide scrap powder
Electrodialytic W and Co recovery

- pH 8.2
  - 4.24 mS/cm

- pH 7.9
  - 4.1 mS/cm

- WC-Co + Na₂SO₄

E–pH diagram for Co species. Soluble species concentrations (except H⁺) = 10⁻¹⁰ 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

\[ \text{Co}^{2+} + \text{Co(OH)}_2 \rightarrow \text{Co(OH)}_2 \]

\[ \text{W} + \text{C} \]
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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

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)

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e.THRough
Thinking rough towards sustainability

HORIZON 2020

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

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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)),
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 excavated! Currently, it is still generating 100 to 200 tons per day. Around 20% is waste mud.
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**

**Precursors**
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/SiO$_2$ = 0); (Al$_2$O$_3$/Na$_2$O$_{eq}$ = 2.9) and (SiO$_2$/Al$_2$O$_3$ = 4); Y (CaO/SiO$_2$ = 0); (Al$_2$O$_3$/Na$_2$O$_{eq}$ = 3.1) and (SiO$_2$/Al$_2$O$_3$ = 3.1).
Ceramic materials - thermal insulation

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

1000 °C firing

Porosity ≥ 50%

Mosh hardness: 6
Thermal Conductivity W/m-K 0.117904
Main valuable materials for infrastructure and building products.. with market perspectives.

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

artificial aggregates for infrastructures (AAI)

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

lightweight foamed materials, perforated blocks + mud waste + brick waste powder
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. Adaptable plant species; b. Upper layer in expanded cork board (ECP); c. Base layer in alkali-activated cement.
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. h0.5

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
some ideias for GEOGREEN system
**ECO2 BLOCKS**

- Industrial waste
- Non potable water
- Carbon dioxide

**Specifications**

- 48 hours fast hardening blocks
- CO2 stored as Calcium Carbonates
- Recognized International publications
- Patented (provisional)
- Ongoing industrial prototyping tests
ECO2BLOCKS

50% cheaper

10x faster manufacturing process

Traditional manufacturing machines
Thank you!

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