MSCA-ETN

SULTAN

European Training Network for the Remediation and Reprocessing of Sulfidic Mining Waste Sites

Environmental impact of (cleaned) sulfidic mine waste integrated into construction materials

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Introduction

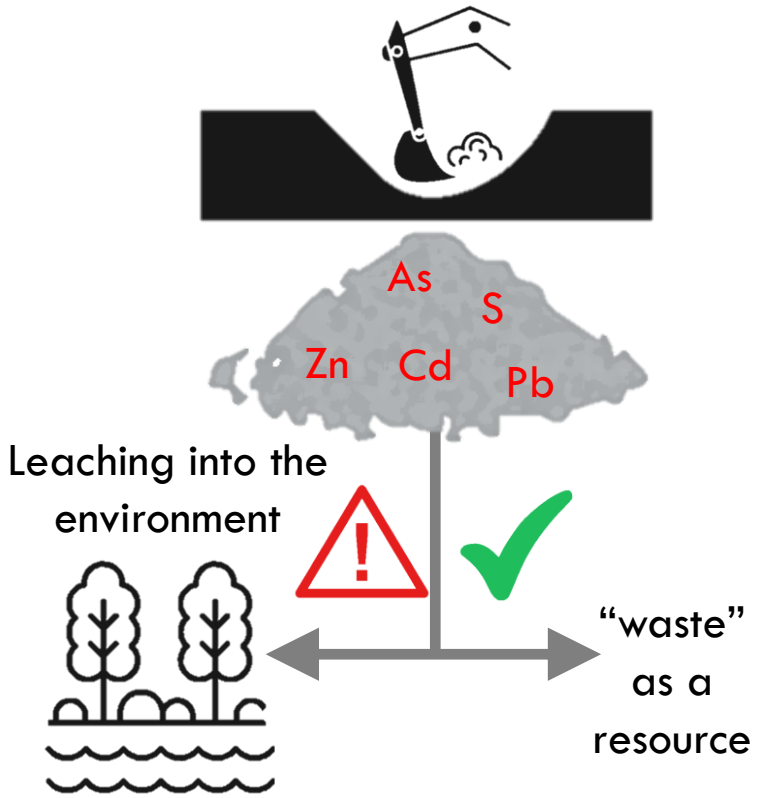
Sulfidic mine waste can pose **environmental** and **health risks** due to the **acid generation** and subsequent release of **hazardous metal(loid)s**.

Solution: Valorization of the mine waste

- **Recover** valuable and hazardous metal(loid)s and/or
- Utilize the residue/original mine waste in **construction materials**

Objective: Evaluate the **mobility** of hazardous metal(loid)s from the mine waste and derived products.

Overall: Assess the changes in **environmental risks** through the **valorization** routes.



Samples

Original mine waste
from 3 sites

- **Plombières** Pb-Zn abandoned mine (Sample: PL_62I)
- **Neves-Corvo** Cu-Zn operational mine (Samples: NC_1, NC_2, NC_3)
- **Freiberg** Cu-Pb-Zn abandoned mine (Sample: FR_1)

Cleaned mine waste

Construction materials
containing mine waste

AAM

Cement

Ceramics

- **5** samples cleaned via **bioleaching** (e.g., sample FR_3_CL_BIOL)
- **4** samples cleaned via **flotation**

- **Alkali-activated materials (AAMs):** with ≤ 100 wt% cleaned or uncleaned tailings and waste rock
- **Ceramics (CER):** with ≤ 40 wt% cleaned or uncleaned tailings and waste rock
- **Cement (CM)/clinkers(CL):** with ≤ 30 wt% uncleaned tailings

*Samples were produced/received from SULTAN early-stage researchers in work packages 1-3.

Methodology

- Comparing the mobility of metal(loid)s through:
  - **Leaching tests**

Leaching Test	L/S ratio	Extraction fluid	Time
EN 12457-2 test	10	Deionized H_2O	24 h
Toxicity characteristic leaching procedure (TCLP)	20	TCLP#1 (pH~4.9) or TCLP#2 (pH~2.9)	18 h
pH-dependence leaching test	10	HNO_3 or NaOH solution (pH 0.5, 2, 13)	24 h

  - **Mineralogical and chemical investigations:**
    - Mineralogy via X-ray diffraction (XRD)
    - (pseudo) total elemental content via aqua regia digestion (HNO_3/HCl; 1:3)

Results: EN 12457-2 leaching test

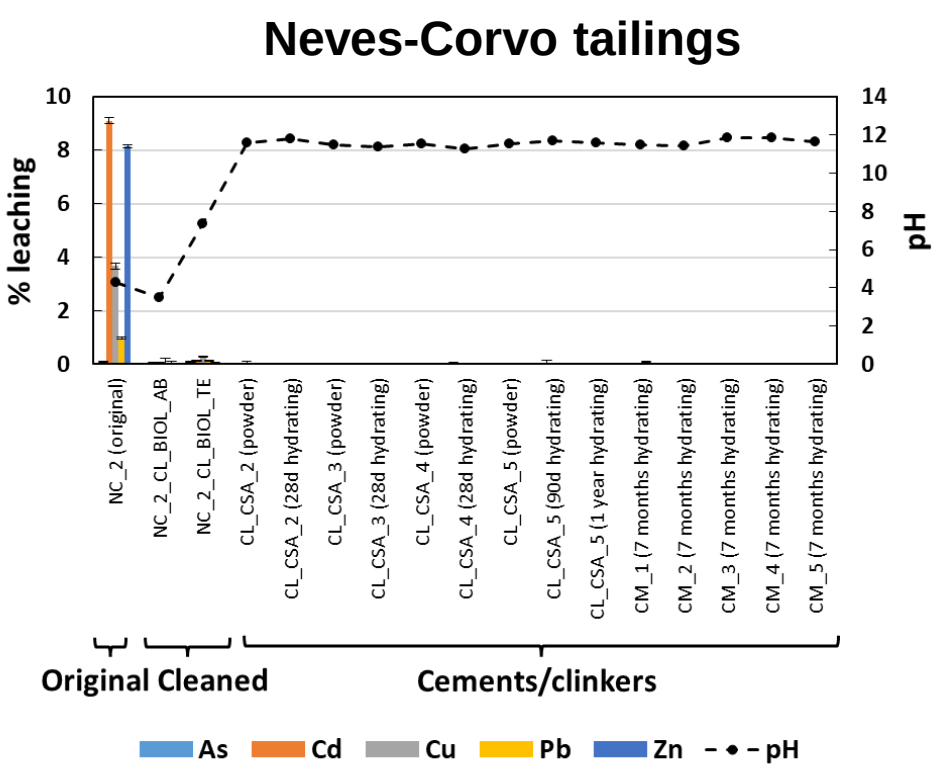


Figure 1. Results of original Neves-Corvo tailings (**NC_02**), **cleaned** and **construction materials** containing NC_02.

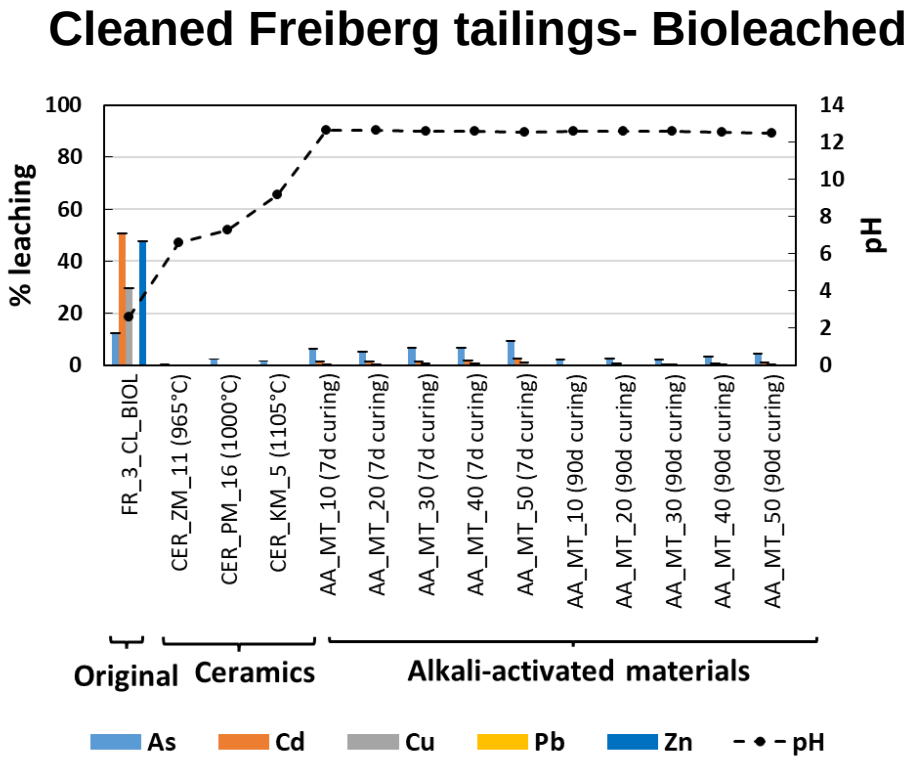


Figure 2. Results of Freiberg **tailings** 'cleaned' via **bioleaching (FR_03_CL_BIOL)** and **construction materials** containing FR_03_CL_BIOL.

Results: pH-dependent leaching test and TCLP

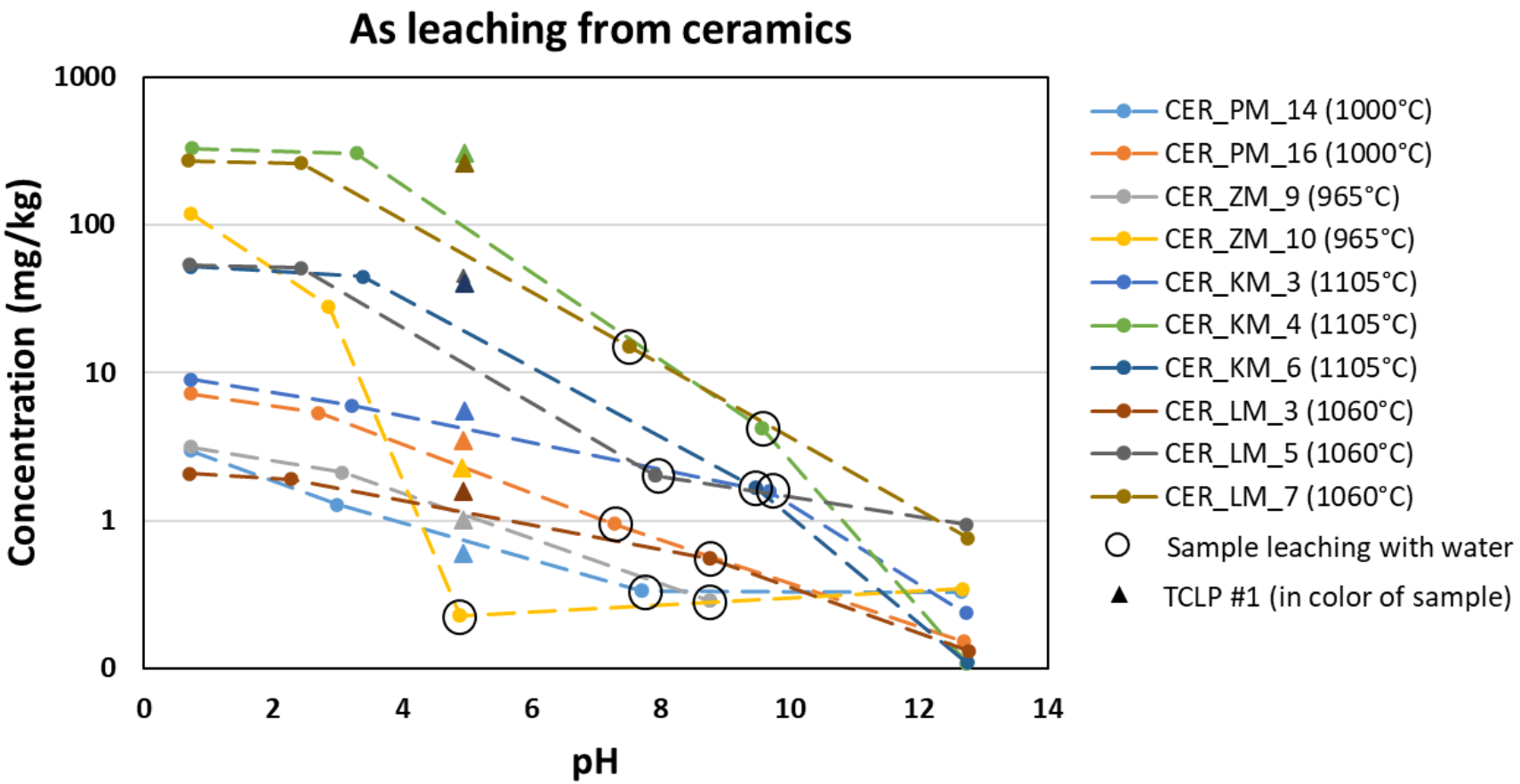


Figure 1. **Arsenic** leaching from **ceramics** as a function of pH from the pH-dependent leaching test and TCLP.

Conclusion

Original and **cleaned** mine tailings and waste rock:

- Most of the original **mine waste** samples contained high levels of As, Pb, and Zn
- The cleaning methods were only effective for a few samples (e.g., **FR_3_CL_BIOL**).
- All samples still **exceeded** Flemish legislative (VLAREMA) **guide values** for **As, Cd, Cu, Pb, Sb** and/or **Zn**.

Construction materials containing mine waste:

- **Metal(loid)s** were most efficiently **immobilized** via physical or chemical encapsulation in **cements/clinkers**.
- **AAMs** and **cements/clinkers** are highly alkaline with high acid buffering capacities.
- High **firing temperatures** of **ceramics** played a major role in **decreasing** the mobility of some metal(loid)s, while **increasing** the mobility of others.
- Longer **curing times** of the **AAMs** generally improved the **immobilization** of **metal(loid)s**.
- **Increasing pH** of ceramics, **decreased** mobility of **metal(loid)s**, including As.

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