

## 'Advanced Leaching of Cu-Zn, Zn-Pb and Cu-Zn-Pb Tailings using Microwave Heating'

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**KU LEUVEN**



### Objective, Milestones & Deliverables

#### Objective:

Development of advanced metal-extraction processes using microwave (MW) heating to increase selectivity, efficiency and kinetics of hydro- and solvometallurgical leaching systems for sulphidic tailings

#### Milestones:

MW-assisted hydro/solvometallurgical leaching processes with :

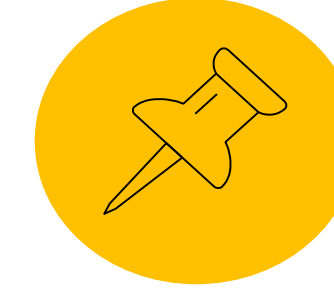
- > 15% energy saving,
- > 15% solvent/reagent saving,
- > 50% shorter leaching time (with respect to conventional heated leaching processes)

#### Deliverables:

- D2.4: 1<sup>st</sup> peer-reviewed paper, M25
- D2.11: 2<sup>nd</sup> peer-reviewed paper, M48



### Project Set-Up



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#### Setting Boundary Conditions:

- Material Characterizations -> XRD, XRF, SEM, TGA-MS, ICP-AES, Spectrophotometer
- Thermodynamic Modelling

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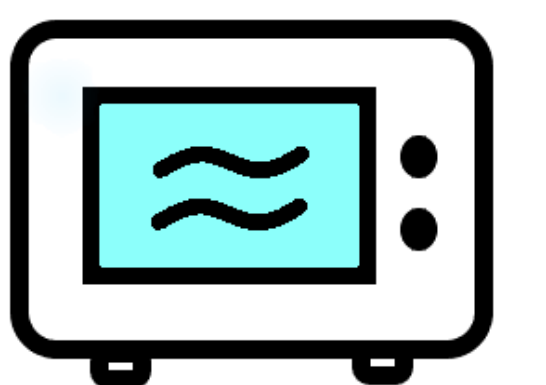
#### MW-Pretreatments:

- MW application to change physical properties of sulphidic tailings
- MW application to change chemical properties of sulphidic tailings -> MW-assisted roasting

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#### MW-Assisted Leachings:

- Hydrometallurgical leaching
- Solvometallurgical leachings :
  - 1) Molecular organic solvents based system
  - 2) Ionic liquids based system
  - 3) Deep eutectic solvents based system



### Current Research:

## Solvometallurgical Leaching based on Molecular Organic Solvents



#### Goal:

To develop ammoniacal-alcohol systems to selectively recover Cu, Pb, Zn

#### Solubility test of metal sulphates in alcohols

**Solvents :**  
Water, Methanol, Ethanol, Butanol, PEG 200, Glycerol, Ethanolamine

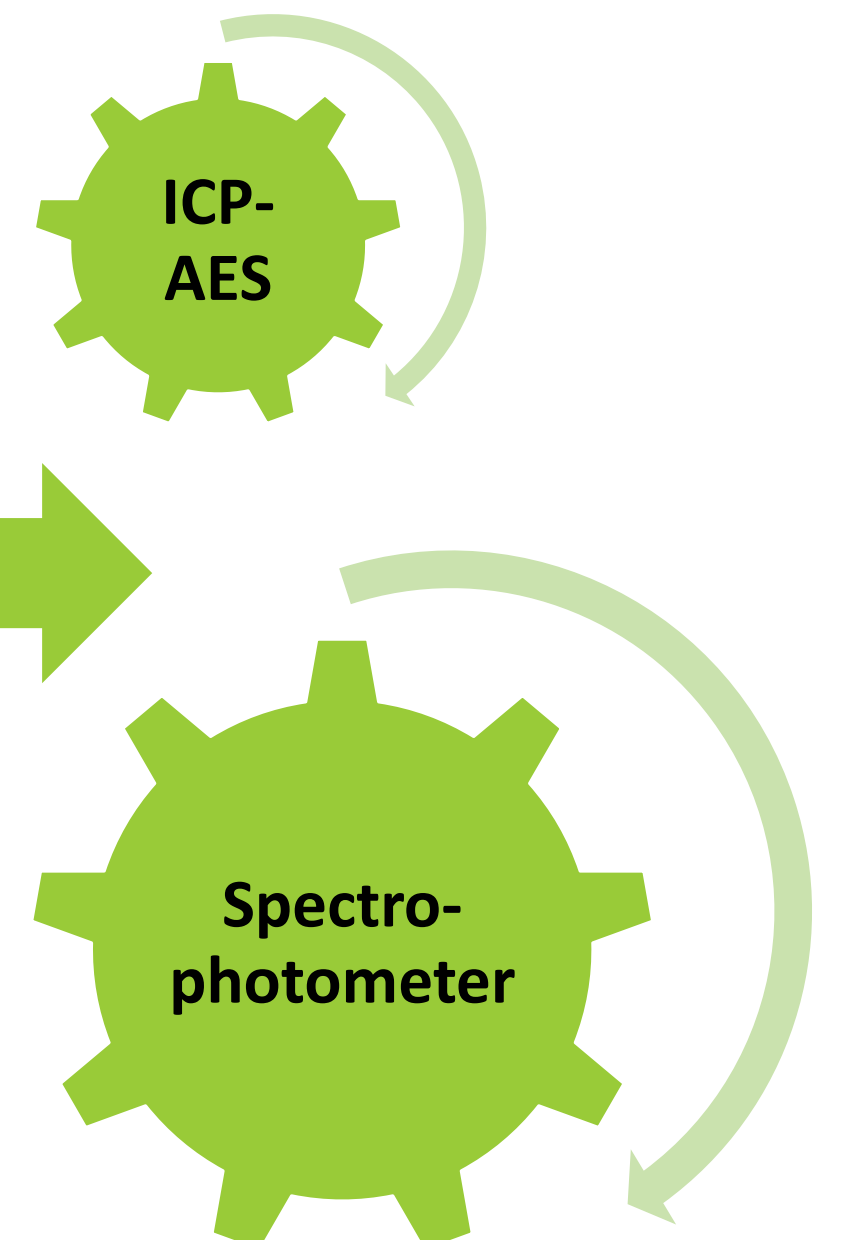
**Metals :**  
Copper sulphate, Lead sulphate, Zinc sulphate, Iron sulphate\*

\* : to be tested

#### Solubility test of ammonium salts in alcohols

**Solvents :**  
Water, Methanol, Ethanol, Butanol, PEG 200, Glycerol, Ethanolamine

**Salts :**  
Ammonium sulphate, Ammonium chloride, Ammonium nitrate\*, Ammonium acetate\*, Ammonium carbonate\*



#### ICP-AES Analysis

Solvents	Cu		Zn		Pb	
	Conc (mmol/l)	RSD (%)	Conc (mmol/l)	RSD (%)	Conc (mmol/l)	RSD (%)
H <sub>2</sub> O	40	0.7	760	0.2	0.056	1
Methanol	20	1.4	50	1.5	< 2.4*	67
Ethanol	0.013	2.4	0.160	0.8	< 2.4*	50
Butanol	0.740	0.3	0.023	0.6	< 2.4*	82
Ethanolamine	4	1.1	240	0.7	0.13	1.2

\* : below reporting limits

#### Method for MW-assisted roasting and leaching experiment:

SUL\_FR\_01 & SUL\_NV\_02 samples will be dried at 40°C until reaching its constant weights

The samples will be pretreated by MW-roasting at different temperatures and times to change its physical & chemical properties

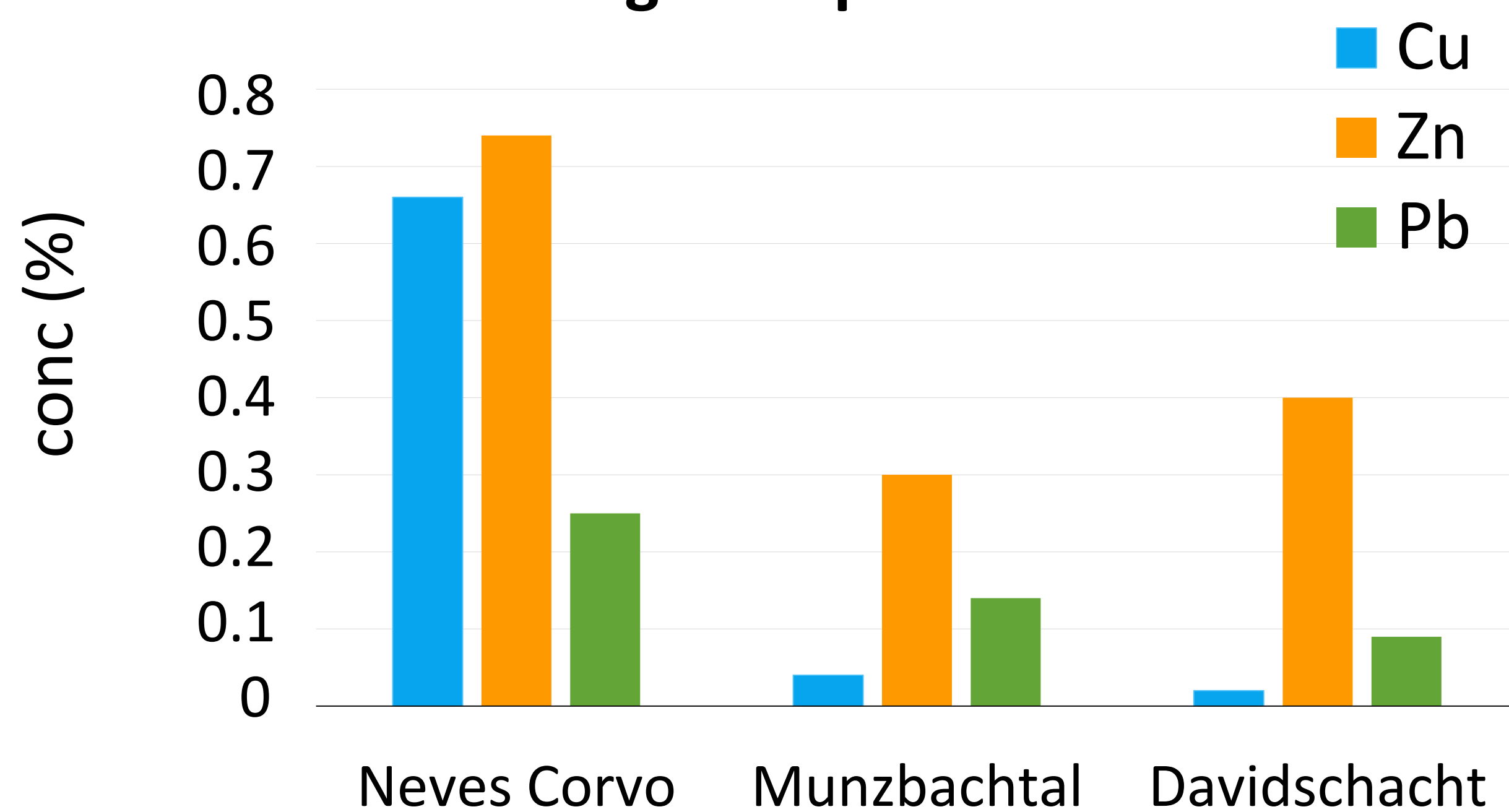
MW-assisted leaching, using ammoniacal-alcohol as leaching agents, will be applied to the samples at different temperatures & times

Leachates & residues will be analysed to measure the efficiency and selectivity of ammoniacal-alcohols in recovering Cu, Pb, Zn



### Material Characterisation

#### Tailings composition



### Conclusions

#### Solubility of metal sulphates:

$\text{CuSO}_4$  : H<sub>2</sub>O > Methanol > Ethanolamine > Butanol > Ethanol

$\text{ZnSO}_4$  : H<sub>2</sub>O > Ethanolamine > Methanol > Ethanol > Butanol

$\text{PbSO}_4$  : Ethanolamine > H<sub>2</sub>O ; (Methanol, Ethanol, Butanol : below reporting limits)

### Outlooks

- Analysis of soluble ammonium salts in alcohols using spectrophotometer
- Development of ammoniacal-alcohol systems, to be tested to metal sulphate and metal oxide samples
- Application of MW-assisted roasting and MW-assisted leaching based on ammoniacal-alcohol systems for SULTAN's samples (SUL\_FR\_01 and SUL\_NC\_02)

