LEACHING OF METALS FROM SECONDARY LEAD SMELTER MATTE

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VITO VISION ON TECHNOLOGY

Energy

Materials

Chemistry

Health

Land use

https://vito.be/en

UNIT SUSTAINABLE MATERIALS (SUMAT)

THE SuMAT-TEAM

80 Employees

80

Full Time Equivalents

72

Function

R&D 51 | Tech&Labo 20 | 9 Adm & Mgt

14 PhD's

3 post-docs

Male/Female

46 58%

34 42%

Nationality

72 Belgium

8 Netherlands(2) Italy(1) Romania(1) Russia(2) Slovakia(1) South-Korea(1)

THE SuMAT OUTPUT

140 Research projects

6,5 M€ ext. turnover

1.4 M€ Reference tasks

2.4 M€ Contract research

2.7 M€ Strategic basic research

25+6 Patents

25 Granted

6 Applications in 2015

35 SCI-Papers

THE SuMAT NETWORK

20 SME's

Were involved in research projects in 2015.

50 Research partners

EIT Raw Materials

VITO is core member of EIT Raw Materials

eit RawMaterials

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Our expertise

Closing cycles

Design of ceramic and metallic components

Surface treatment with plasma technology

Circular business models

Policy for the transition to a green circular economy

Material analysis and tests

TECHNOLOGICAL CORE: WASTE TO PRODUCT (WtP)

from **WASTE**

industrial residues & wastes:

- inorganic sludges
- ashes
- slags
- construction & demolition
- shredder
- urban & landfill mines

RESEARCH LINE 1

over **VALUABLES**

separation and recovery by physico-chemical (pre-)treatment technologies including physical separation and hydrometallugy

RESEARCH LINE 2

to **PRODUCTS**

matrix valorisation into new products via sustainable binder and shaping technologies for residues.

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Innovations in hydrometallurgy

Challenges

- Energy efficiency ↑
- Leaching efficiency ↑
- Leaching kinetics ↑
- Selectivity ↑
- Environmental friendly
- Simple process
  (simultaneous leaching and recovery)
- Cost effective

Hybrid process

Methods for advanced leaching

- Microwave assisted leaching
- Microwave assisted roasting/heating/milling
- Mechanical activation
- Ultrasonic assisted leaching
- Alkali roasting

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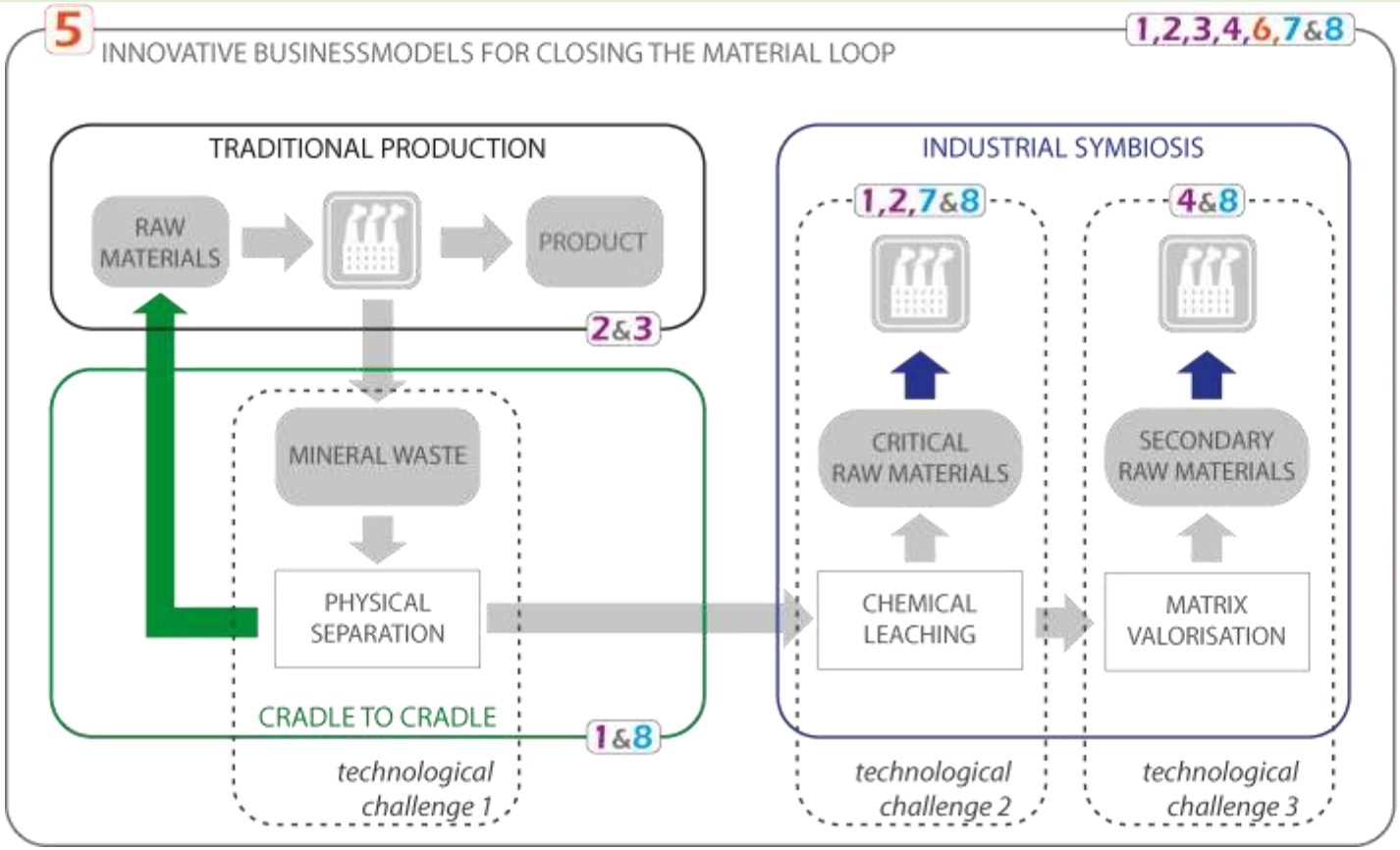
MAXIVIA PROJECT

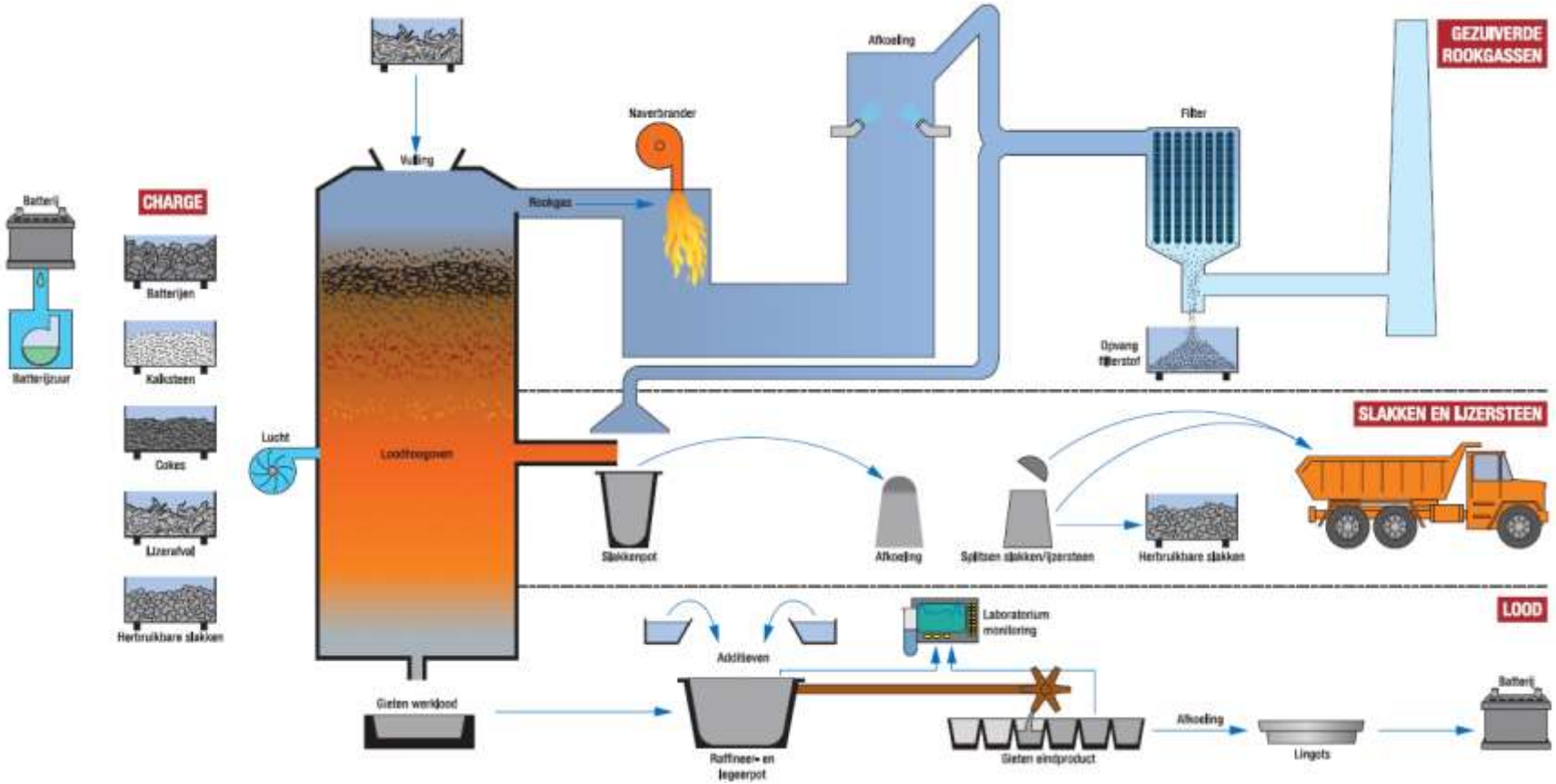


Industry
1. AZR nv
2. Campine nv
3. Daniël Cardinael & C° Comm.V
4. Jacobs nv

Society
5. Plan C
6. Stakeholders (e.g. OVAM, FEBEM, AGORIA)

Research institutes
7. KU Leuven
8. VITO

SECONDARY LEAD PRODUCTION



SLAG AND MATTE

ca. 9000 t/y

ca. 6000 t/y

Slag is broken and sieved, 2/3 (~> 15 cm diameter) is reused in process.

Remainder of slag and iron stone is currently disposed = materials studied in MaxiVIA

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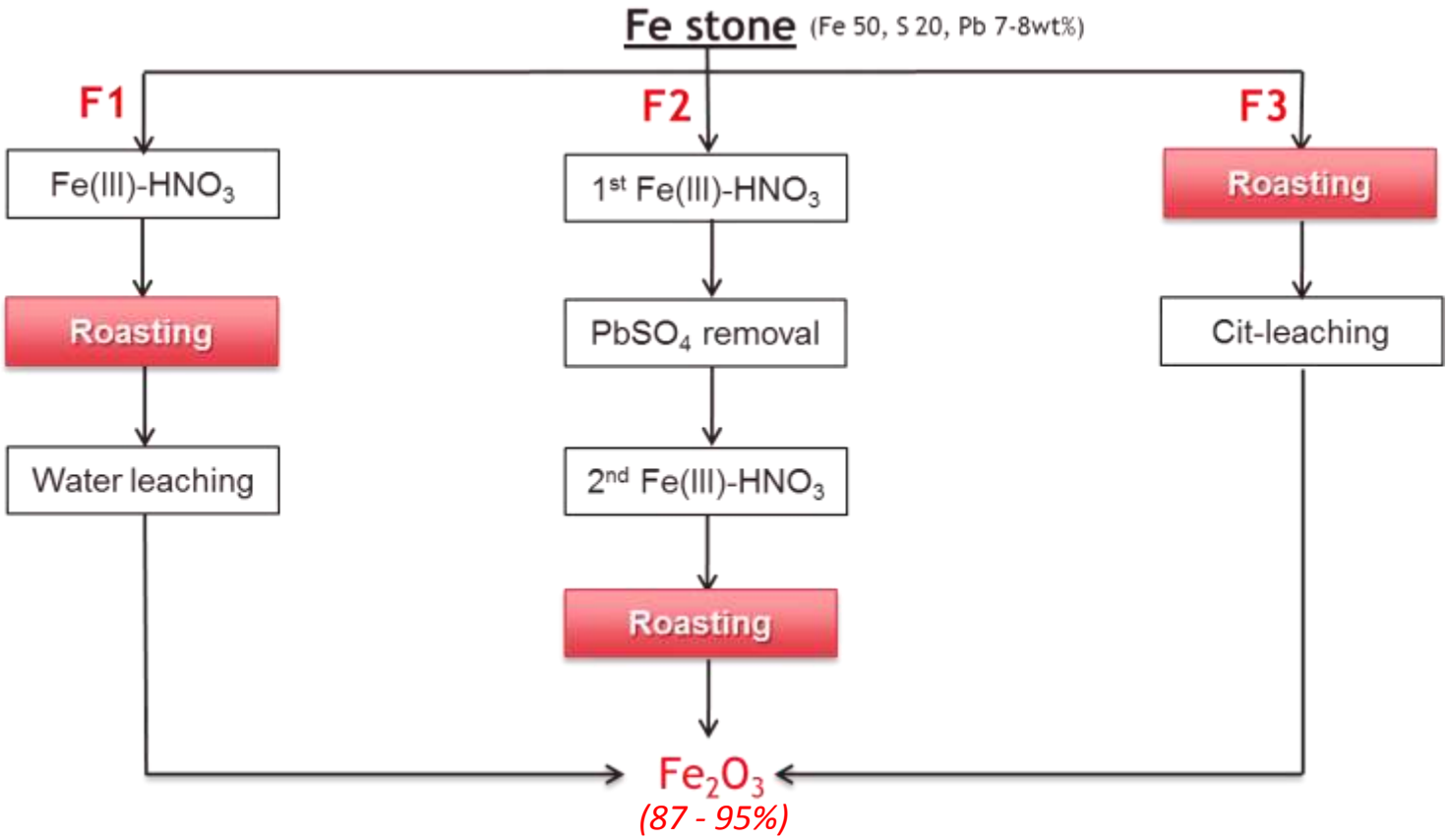
MATERIAL CHARACTERIZATION

Slag (Pb slag)		**35% Fe** 4-10% S 3-4% Pb 5-7% Ca 0.5% Zn 2-3% Al	FeS Fe_2SiO_4 Pb PbS SiO_2 Ca-Mg-Fe silicates Na-K-Al silicates
Matte (Fe stone)		**45-50% Fe** 20% S 4-7% Pb 0.5% Zn 3% Ca 1% Al	FeS Fe_3O_4 FeO Fe Pb Ca-Mg-Fe silicates

- FeS to Fe_2O_3
- Purification of Fe-rich product
- Aim to reach Fe content >60 % (as secondary iron ore)

LEACHING OF FM FRACTION OF MATTE



Kim et al. : Hydrometallurgy 169 (2017) 290–296

Kim et al. (2017), Hydrometallurgy, In press, Accepted manuscript: http://dx.doi.org/10.1016/j.hydromet.2017.02.027

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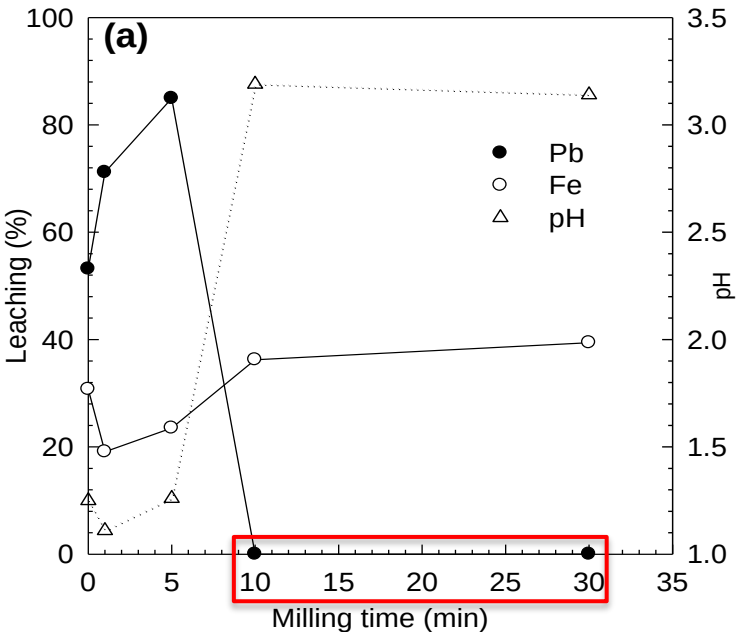
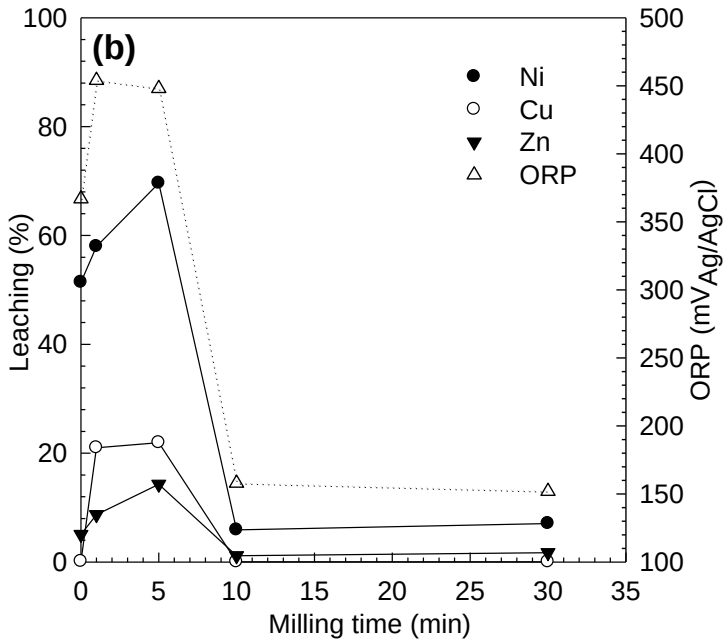
EFFECT OF MILLING TIME

- milling is a common pretreatment operation prior to the leaching step
- to liberate Pb phases and increase the surface area = beneficial for leaching
- dry vs. wet milling and their effect on leaching efficiencies

0.5M HNO_3 + 0.15 $Fe(NO_3)_3$; L:S = 10 (20 ml/2g); 200 rpm; 25°C ; 90 min.

- conditions chosen based on the previous studies

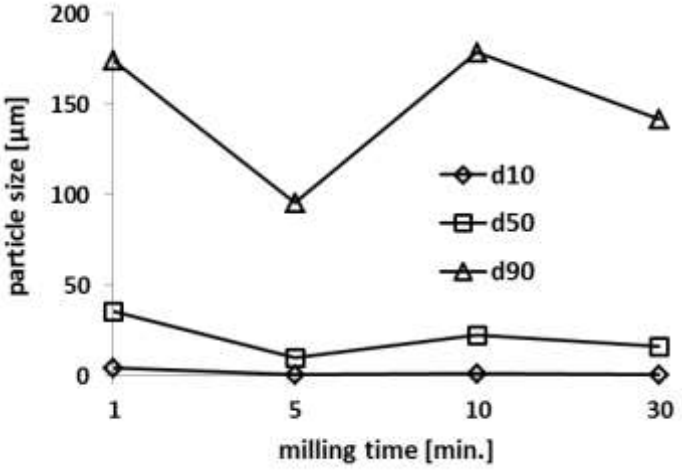


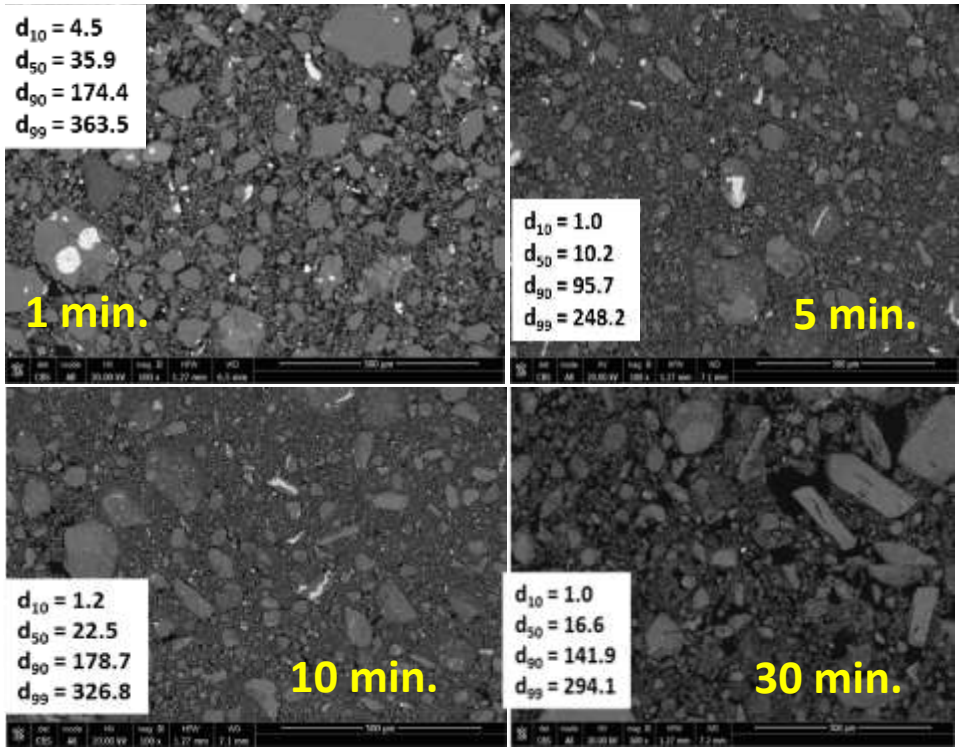


MILLING VS. LEACHING EFFICIENCY

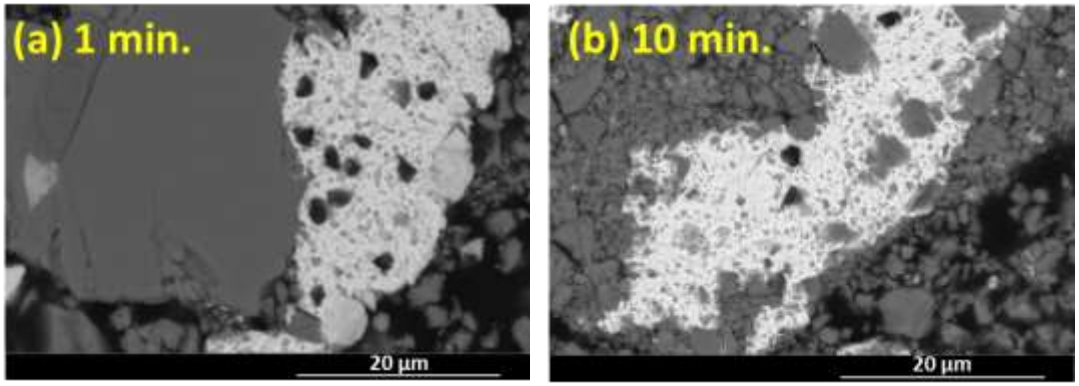
Dry milling

Planetary ball mill (PM 400, Retsch), 400 rpm,

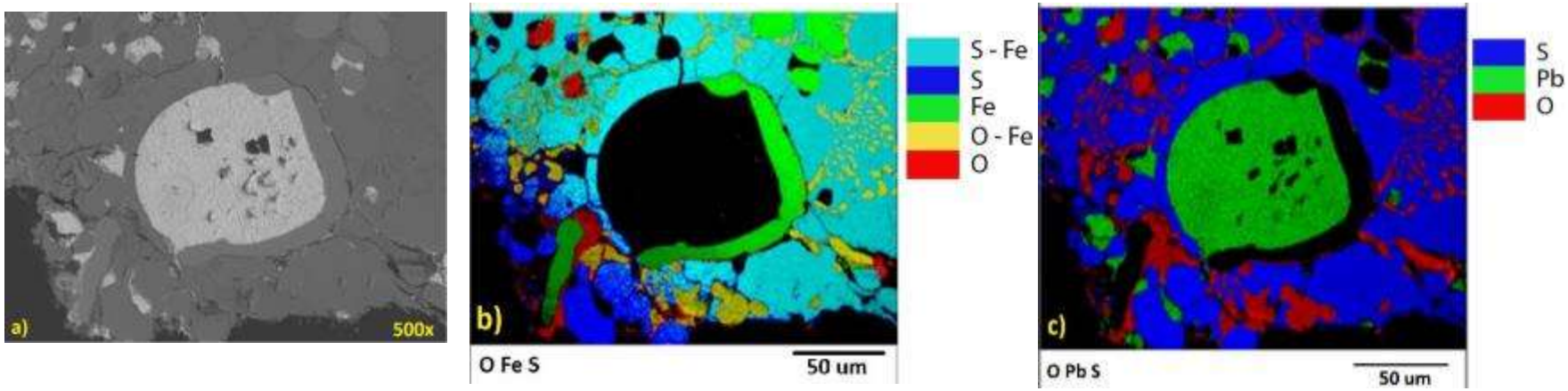




PARTICLE VS. AGGLOMERATE



EPMA analysis



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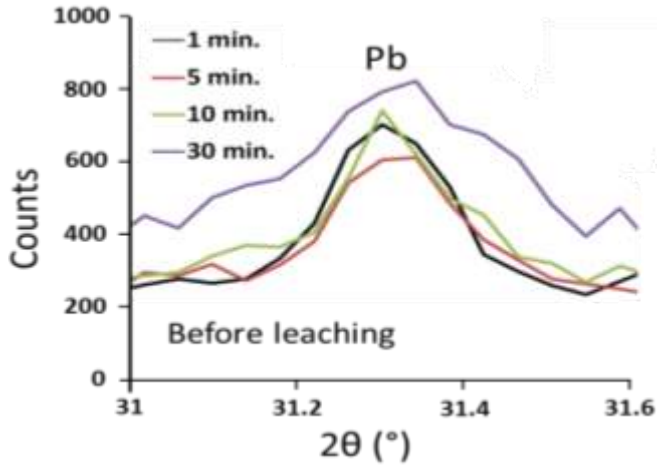
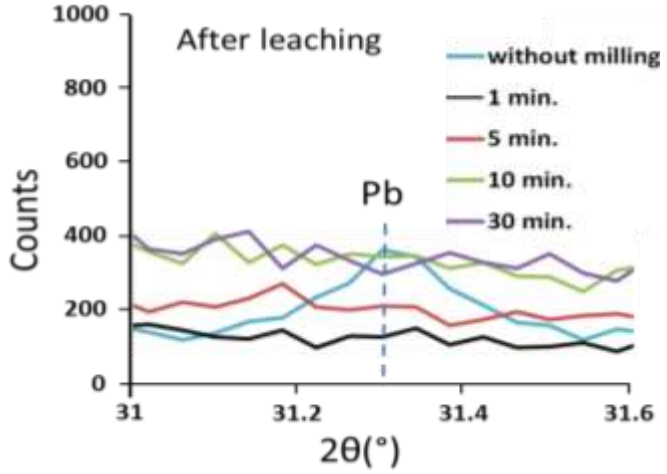
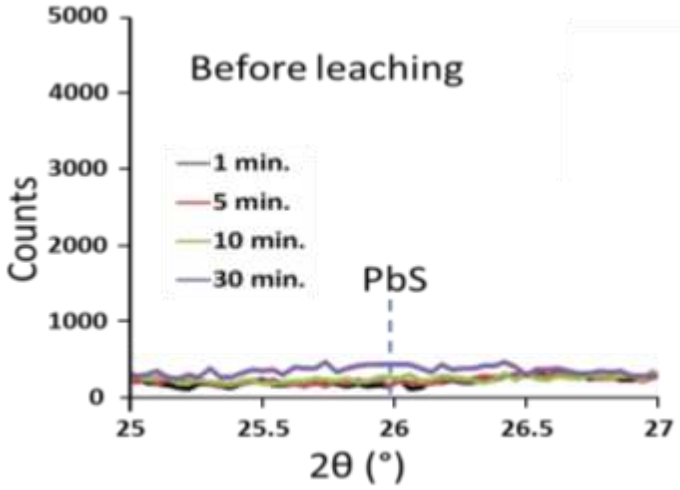
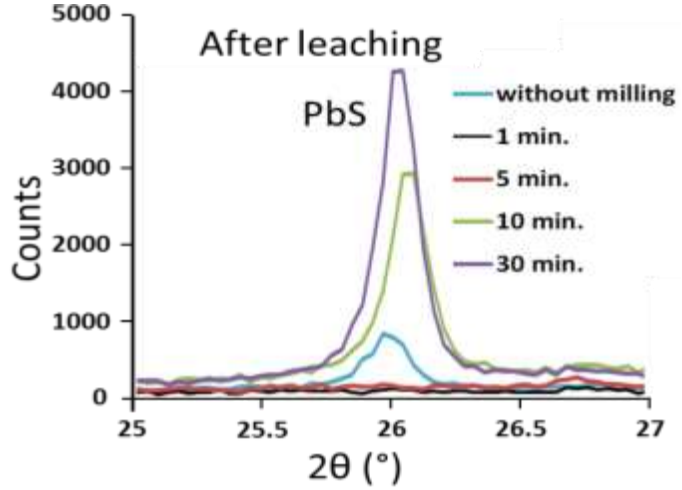
XRD RESULTS









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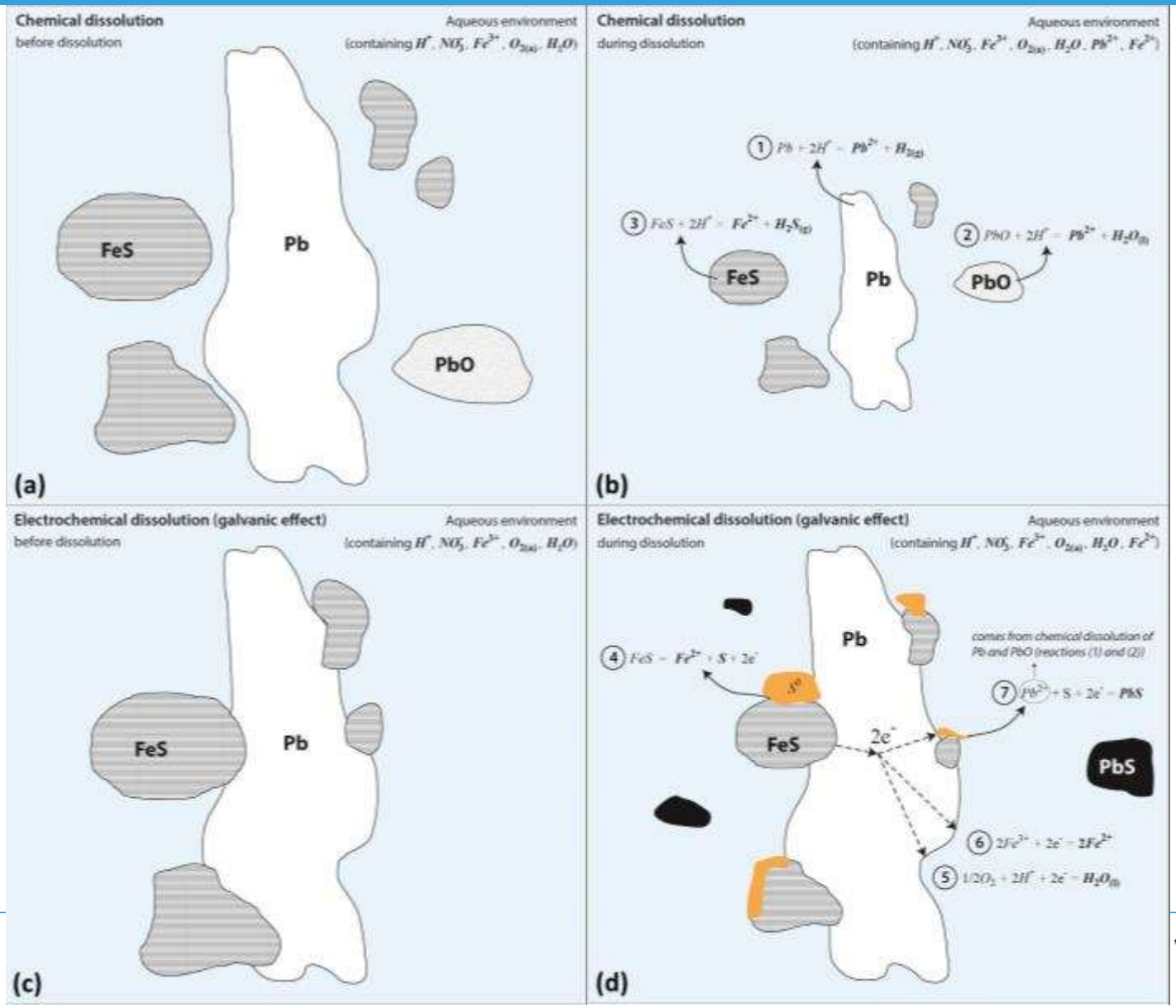
CHEMICAL VS. ELECTROCHEMICAL DISSOLUTION



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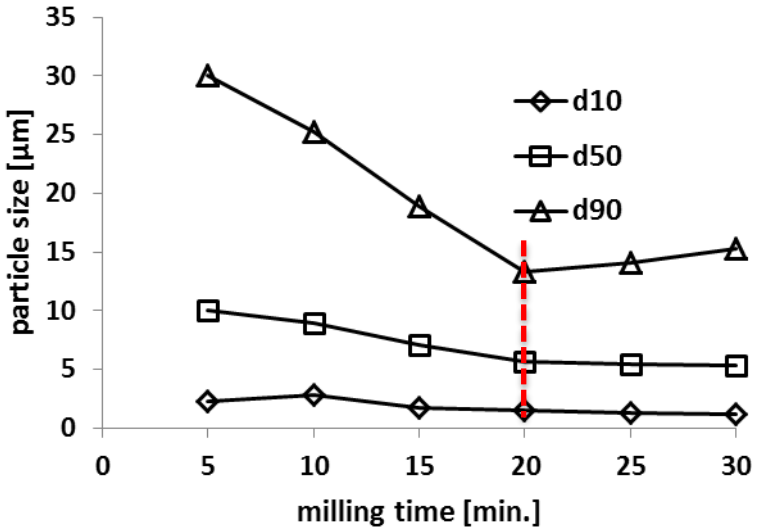
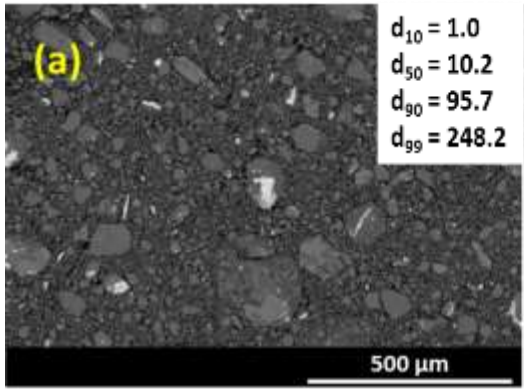
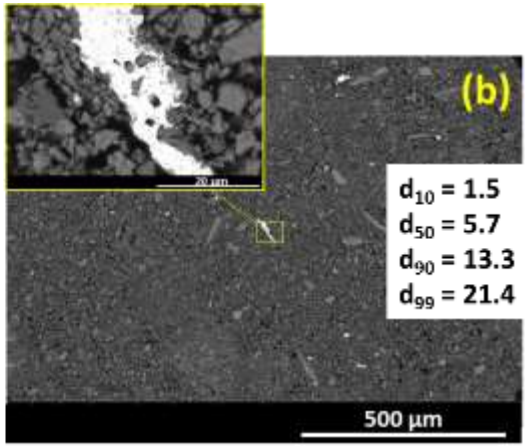
HOW TO AVOID AGGLOMERATION ?

Wet milling
planetary ball mill; 400 rpm





Dry (5 min.)



Wet (20 min.)

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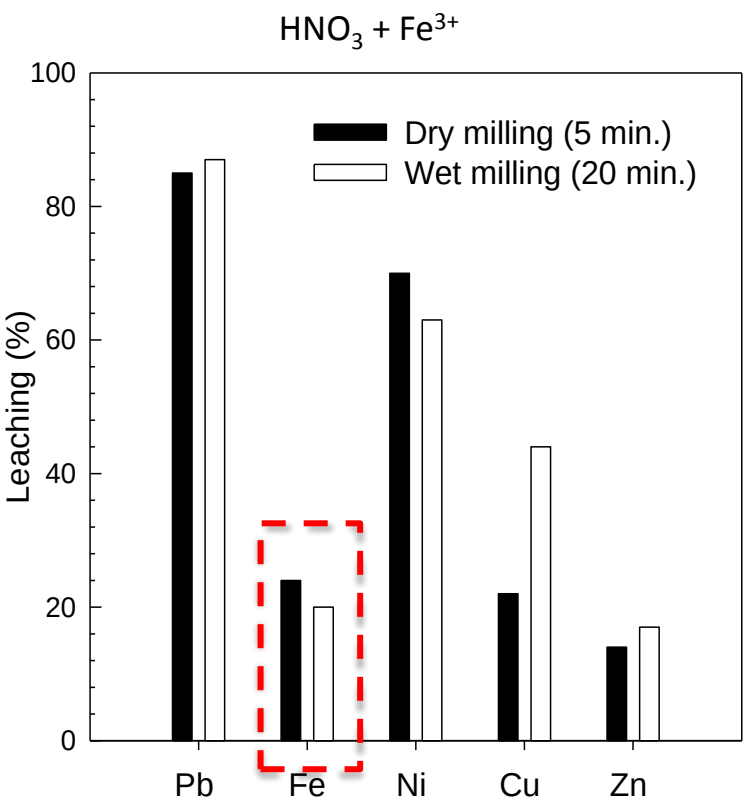
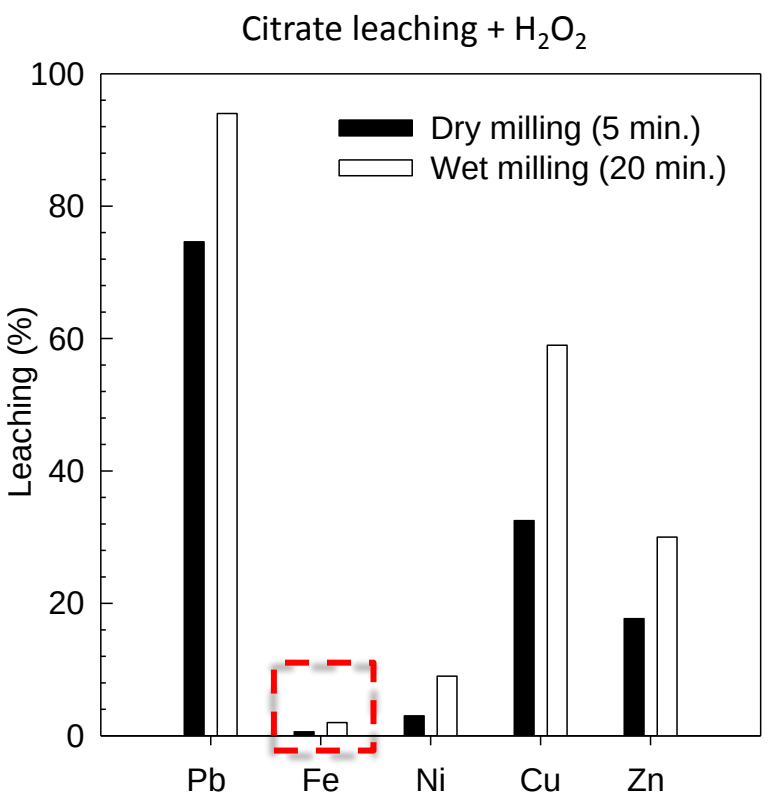


Pb - 2300 mg/L
Fe – 8000 mg/L



Pb - 2500 mg/L
Fe – 150 mg/L

citrate leaching is more selective

Kukurugya et al.(2017), submitted to Hydrometallurgy

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CONCLUSION

- Leaching of metals from a matte can be **significantly** affected by milling time
- After dry milling longer than 5 min. (at 400 rpm), **agglomeration rate > breakage rate**
- Pb - FeS agglomeration induces a **galvanic effect** = ↑ Fe dissolution and Pb precipitation as PbS
- To avoid agglomeration, **wet milling** can be used = finer particles = ↑ reaction area
- After wet milling and citrate leaching **94% of Pb** can be **selectively** leached out
- Solid residue can be used (after treatment) as **secondary iron ore**

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Thank you for your attention !