ERA-MIN 2

RESEARCH & INNOVATION PROGRAMME
ON RAW MATERIALS
TO FOSTER CIRCULAR ECONOMY

MINTECO Project

MINTECO

Integrated eco-technology for a selective recovery of base and precious metals (Au, Ag) in Cu and Pb mining by-products

Project coordinator (F. Bodenan/BRGM/France)

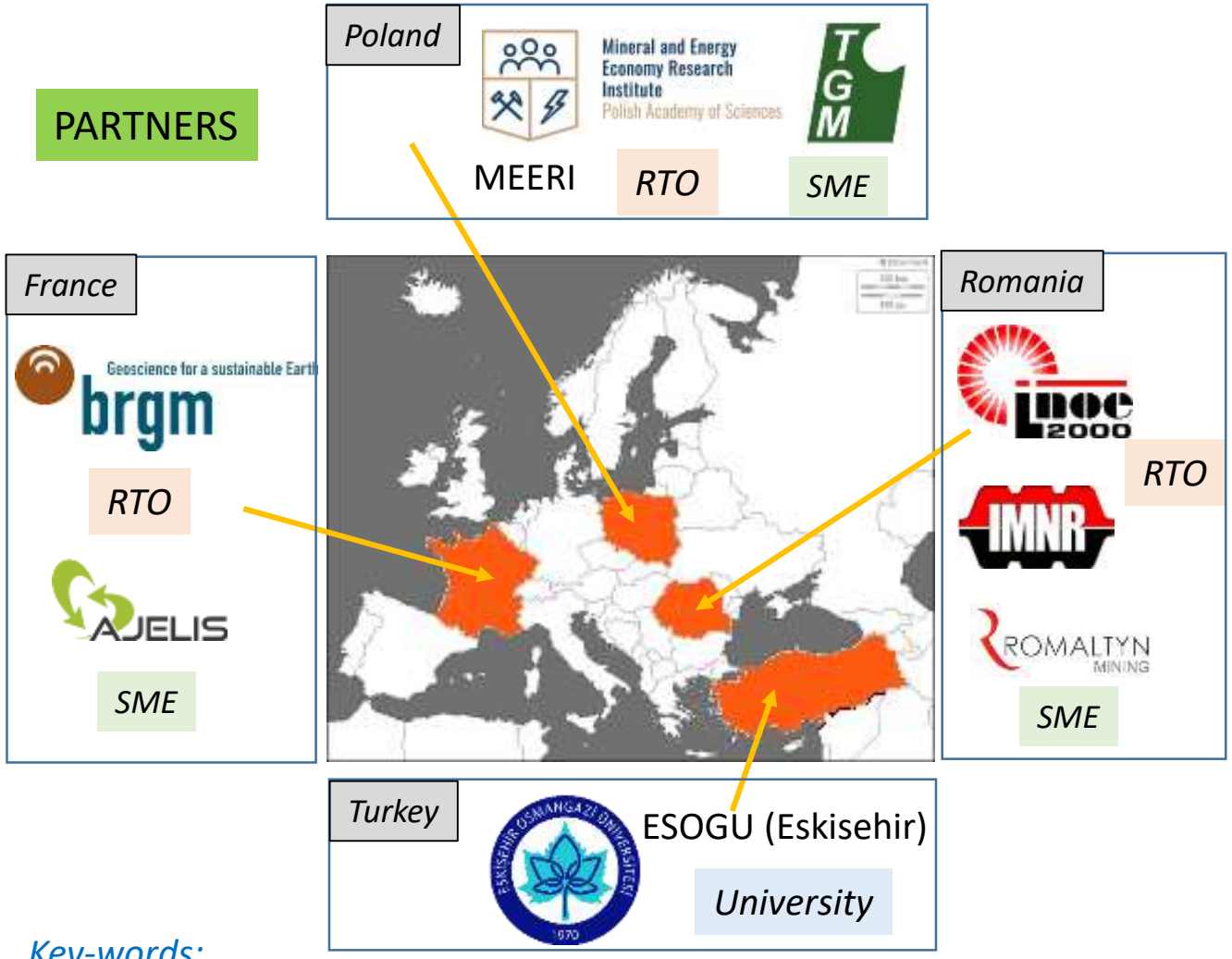
ERA-MIN 2 Final Conference and Final Seminar of Call 2017 projects
18-19th November 2021

Co-funded by the Horizon 2020 programme of the European Union

Consortium

- Main call topic and subtopics addressed by the project
- Axis 3. Processing, Production and Remanufacturing
  - 3.1: Increase resource efficiency in resource intensive production processes,
  - 3.2: Increase resource efficiency through recycling of residues or remanufacturing
- Date: May-2018 -> Oct-2021 / Duration: 42m
- TRL 1-2 -> TRL 1-4 depending on technologies
- Project budget: 0.97 M€; requested funding: 0.694; budget project execution: 100%

PARTNERS



FUNDING AGENCIES

ANR — PROJET FINANCÉ PAR L'ANR — PROJECT FUNDED BY THE ANR

UEFISCDI — Executive Agency for Higher Education, Research, Development and Innovation Funding

The National Centre for Research and Development

TÜBİTAK

MINTECO project

Key-words:
tailings, retreatment, Pb, Zn, Cu, Au, Ag, mineral processing, hydrometallurgy, thiosulfates, ionic liquids, LCA, LCC, circular economy, environment

Final Results (1/6)

- Project **objectives and expect impacts** vs **final results and impact**

➔ Develop optimized hydrometallurgy processes to recover
  - ➔ precious (Au, Ag) metals and/or base metals (Pb, Zn, Cu);
  - ➔ on polymetallic potential secondary resources.

➔ Evaluate mineral processing to preconcentrate metals in raw material (1st step) to reduce further reagent consumption

➔ Establish global coherent flowsheet of best results/ optimized experiments

➔ Perform preliminary environmental and economic assessment of case studies

➔ Evaluate the potentiality of synthesized fibers to recover metals from leachate solutions (PLS)

➔ Propose a global methodology of retreatment of mine waste

Two main case studies in Romania and Turkey: flotation tailings

Optimised process
Recovery of 'lost' metals
Decrease of environmental impacts
Reduce landfill storage
Increase social acceptance

Final Results (2/5)

- Case studies

Romania

8.5 Mt flotation tailings
Au (0.57-0.7 g/t or ppm)
Ag 11ppm

1 Mt oxidised Pb-Zn(Ag) flotation tailings
7.5 % Pb
5.8 % Zn
101 ppm Ag

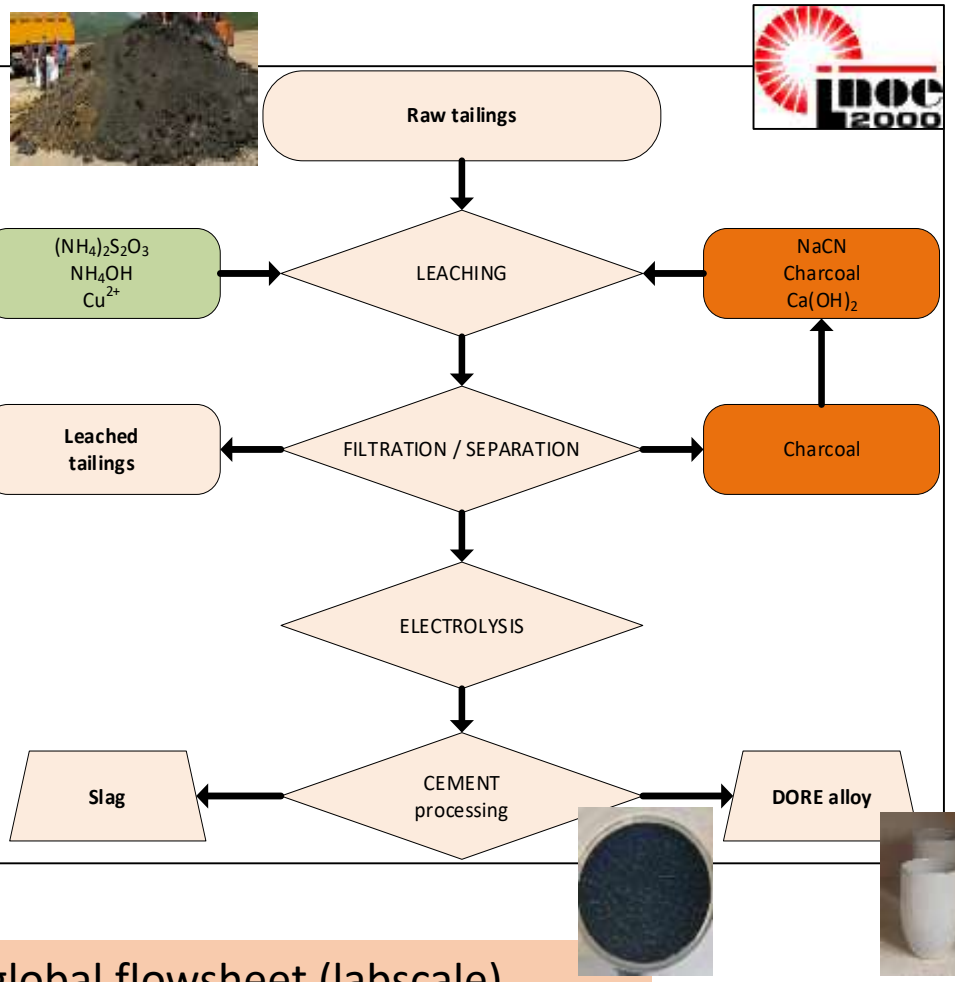
Final Results (3/6)

- **Romanian case study**

➔ Sampling, characterisation and mineral processing tests: magnetic, gravimetric, electrostatic

➔ **Thiosulphate as an alternative to cyanides to recover Au (Dore alloy):**

- ➔ **Leaching/ electrolysis/ decupration/ smelting**
- ➔ **Optimised parameters: S/L, stirring speed, T°C, pH, concentrations of reagents, air flow, duration**



➔ Alternative to electrolysis step: tests with on METALICAPT® fibers to recover Au in PLS (adsorption/elution)

➔ Ionic liquids also tested

Establishment of global flowsheet (labscale)
Extraction efficiency: about 70 % Au and 80% Ag
Electrolysis with recirculation steps

Published articles (list at the end)

Final Results (4/6)

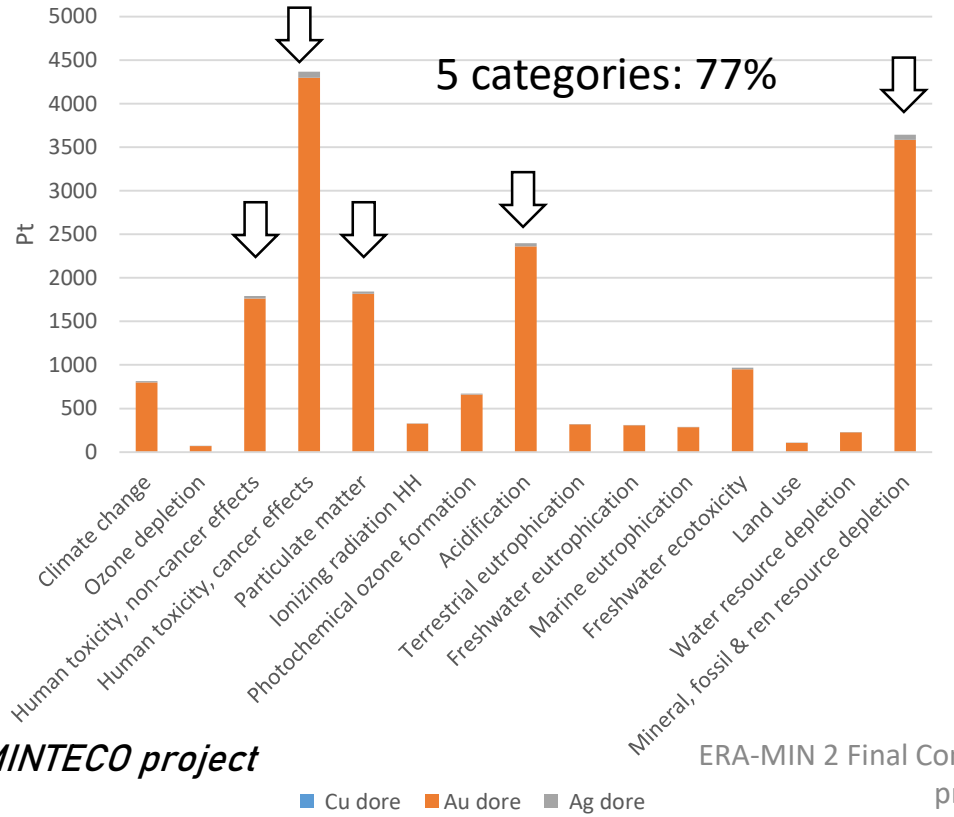
- **Romanian case study**

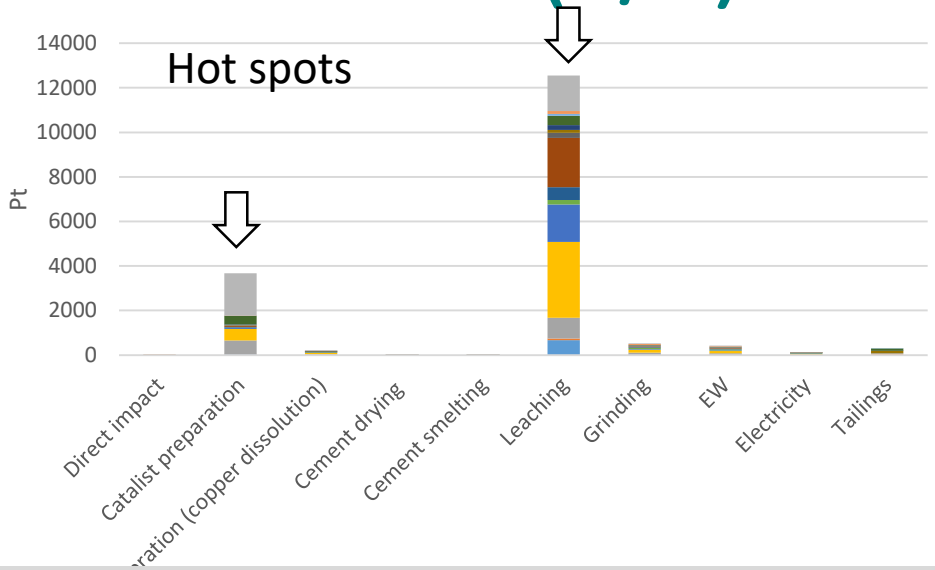
➔ Environmental assessment - LCA

➔ Ecoinvent 3.0; LCI; ILCD 2011

➔ UF: production 1kg Au

➔ System boundaries: process, final disposal





➔ Economic assessment: CBA considering CAPEX and OPEX

- 5-year operation: 1.7 Mt/y and final tailings disposal (geomembrane)
- Investment: 13 M€ (low estimation) // 26 M€ (high estimation)
- Costs (reactants, energy, transport, HR): around 21 M€.
- Revenues from Au (Dore alloy): around 27 M€

➔ Financial analysis: possible profitable operation at this stage of assessment but still preliminary estimation considering labscale results and assumptions

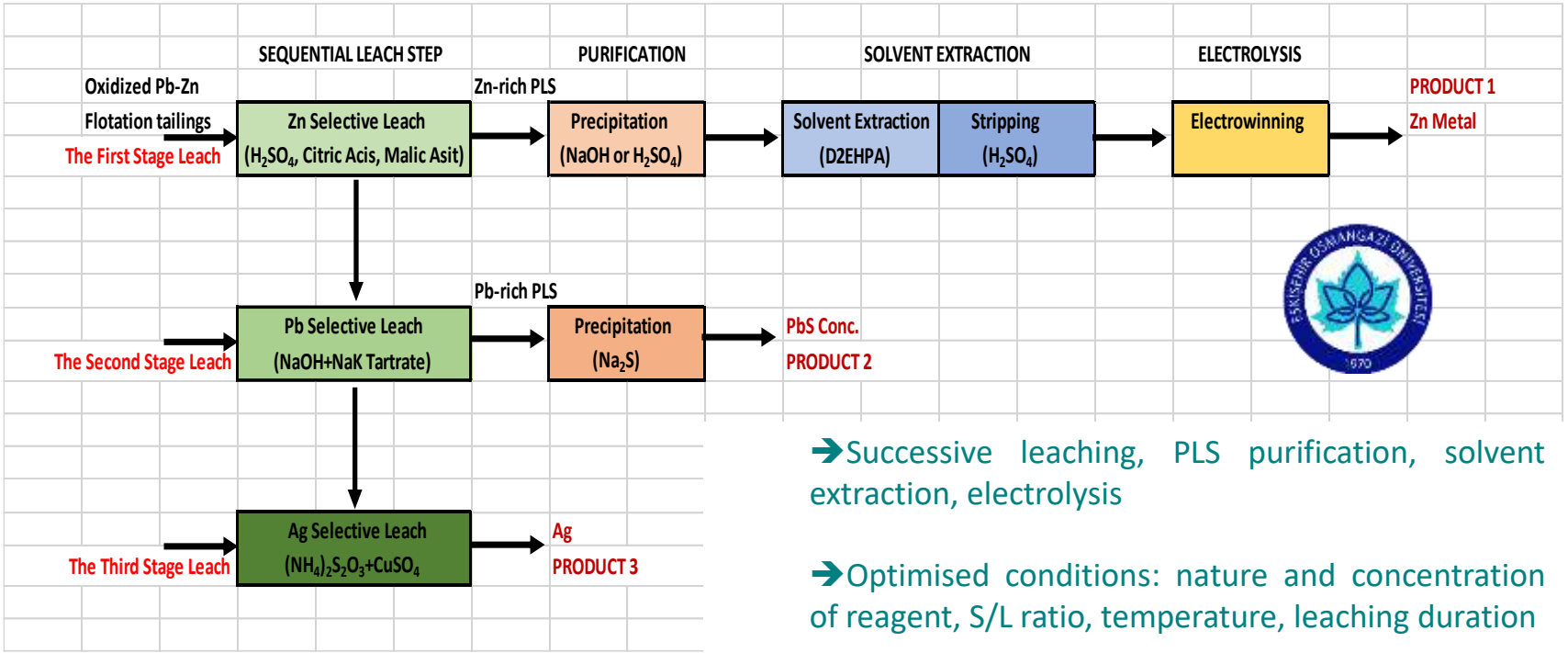
➔ Hot spots: Au market price, investment and reagent costs.

Final Results (5/6)

- **Turkish case study**

➔ Sampling, characterisation

➔ Direct hydrometallurgy to recover Zn°, PbS, Ag (in solution)



➔Successive leaching, PLS purification, solvent extraction, electrolysis

➔Optimised conditions: nature and concentration of reagent, S/L ratio, temperature, leaching duration

Establishment of global flowsheet (labscale)
Mass balances:
42-51 kg Zn/t tailings;
63-70 kg Pb/t;
67-85 g Ag /t

Published articles (list at the end)

Final Results (6/6)

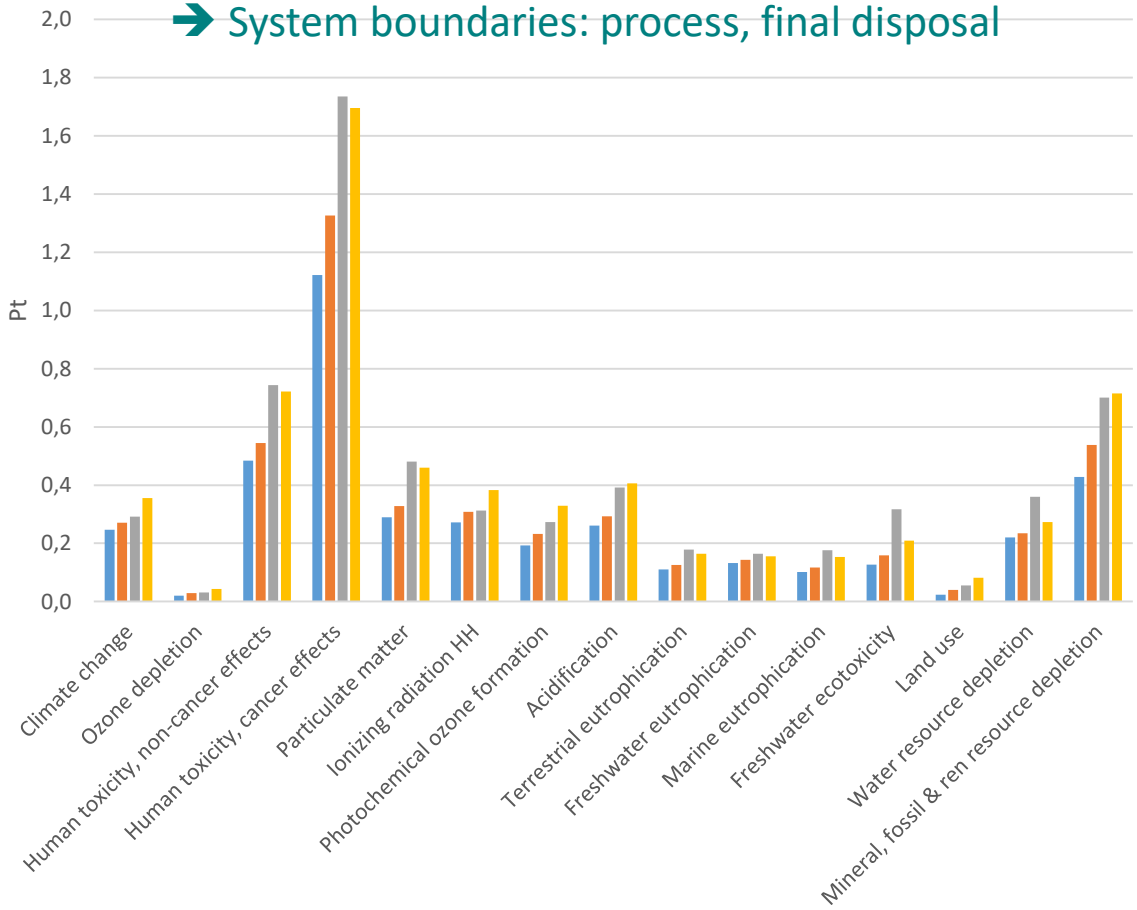
- **Turkish case study**

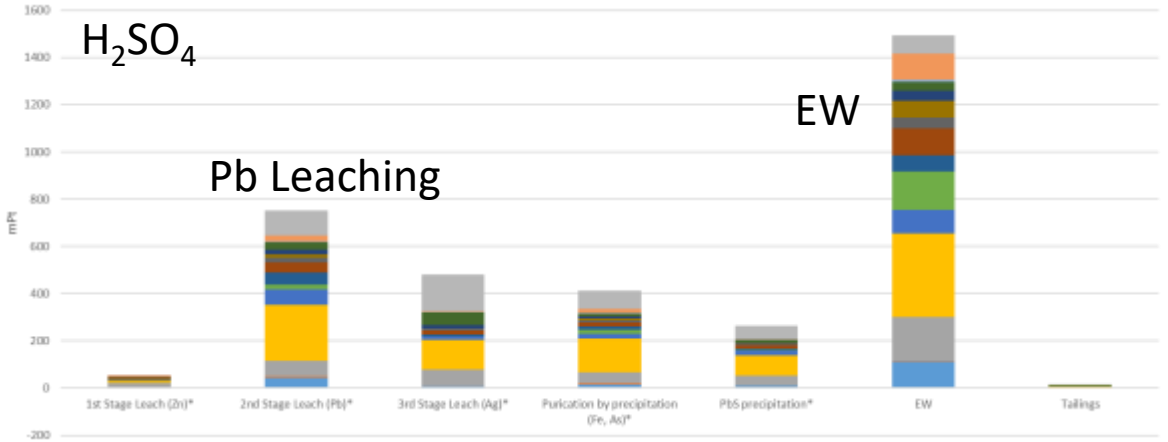
➔ Environmental assessment - LCA

➔ Ecoinvent 3.0; LCI; ILCD 2011

➔ UF: production 1t of Zn, Pb + Ag

➔ System boundaries: process, final disposal





➔ Economic assessment: CBA considering CAPEX and OPEX

- 20-year operation: 50000t/y and final tailings disposal
- Investment: 50 M€
- Costs (reactants, energy, transport): around 21 M€.
- Revenues from Pb, Zn, (Ag): 13-16 M€

➔ Financial analysis: non profitable operation at this stage of assessment but preliminary estimation considering labscale results and assumptions

➔ Hot spots: metals market price, investment and reagent costs.

Outputs/ Communication and dissemination

- 6 publications, 1 book chapter, 5 conferences, workshops
- Technical fairs (Pollutec, EKOTECH, Aquatec, etc,)
- Final public webinar online (2021, Oct), all partners (2h)

- 3 improved methods, 2 process (labscale),
- 1 product/ prototype (fibers)
- 1 model (LCA/CBA)

Impact

- Large consortium of 8 partners from 4 different countries (France, Romania, Poland, Turkey): sharing of expertise and large vision of the topic
- Cooperation between Research Organizations and University with SMEs: increased and broaden expertise
- Access to case studies (EU, non EU); new perception of stakeholders
- Education: thesis, Master degree (including 1year work study)
- Links with other European projects (EIT RM, H2020) on closed topics
- Increase of visibility of partners
- Covid-19: less physical meeting and site visit - reduced interactions

Follow-up

- How will the research results of the project be used?
  - Still low TRL 1-4: research continues
  - Method/ process possibly to be applied to other sites/ waste not forgetting active mine generating higher and higher volumes
  - Integrate reuse of free-metal mineral fraction issue vs construction application
- Will the cooperation continue after the end of this project?
  - Not yet define but possible on some expertise and in link with technical and analytical means
  - Additional articles under discussion

Articles

- Neag E., A. Török, Z. Dincă, M. Senila, C. Varaticeanu, E. Levei, E. Shilova, F. Bodenan, (2021) Optimization of gold sorption from ammoniacal thiosulphate solution STUDIA UBB CHEMIA, LXVI, 2, 151-161 http://chem.ubbcluj.ro/~studiachemia/issues/chemia2021_2/13Neag_etal_151_161.pdf
- Neag E., E Kovacs, Z Dinca, A Török, C Varaticeanu, E Levei (2020) Hydrometallurgical recovery of gold from mining wastes, in Solid Waste Management, Ed. Hosam El-Din Saleh, IntechOpen, London, UK, 2020, DOI: 10.5772/intechopen.94597. https://www.intechopen.com/online-first/hydrometallurgical-recovery-of-gold-from-mining-wastes
- Kaya, M., Hussaini, S., Kursunoğlu, S., 2020, Critical review on secondary zinc resources and their recycling technologies, Hydrometalurgy, 195, 105362. DOI:10.1016/j.hydromet.2020.105362.
- Kursunoglu, S., Top., S., Kaya, M., 2020, Recovery of zinc and lead from Yahyali non-sulphide flotation tailing by sequential acidic and sodium hydroxide leaching in the presence of potasium sodium tartrate, Transactions of Nonferrous Metals Society of China, 30, 12, https://doi.org/10.1016/S1003-6326(20)65468-1.
- Kursunoglu, S., Kursunoglu, N., Hussaini, S., Kaya, M.,2021. Selection of an appropriate acid type for the recovery of zinc from a flotation tailing by the analytic hierarchy process, Journal of Cleaner Production, 283, 124659. DOI:10.1016/j.jclepro.2020.124659.
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- Hussaini, S., Kursunoglu, S., Top, S., Kaya, M., 2021. Testing of 17-different leaching agents for the recovery of zinc from a carbonate-type Pb-Zn ore flotation tailing, Minerals Eng., DOI:10.1016/j.mineng.2021.106935.

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PARTNERS

brgm – Geoscience for a sustainable Earth
IMNR
INOC 2000
AJELIS
ROMALTYN MINING
ESKİŞEHİR OSMANGAZİ ÜNİVERSİTESİ 1970
Mineral and Energy Economy Research Institute Polish Academy of Sciences
TGM

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Thank-you for your attention