



Integrated innovative pilot system for Critical Raw Materials recovery from mine wastes in a circular economy context

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R&D Manager



What is AGQ Labs?

AGQ Labs is a multinational technology and engineering company:

- specializing in advanced tests and chemical engineering
- offering valuable solutions and services for the different areas

The goal of AGQ M&B is to provide solutions to the entire mining sector in the mining-metallurgical value chain.



<p>ANALYTICAL SERVICES</p> <ul style="list-style-type: none"> • Sample prep. • IR analyser • ICP-oes • XRF 	<p>ENVIRONMENTAL GEOCHEMISTRY SERVICES</p> <ul style="list-style-type: none"> • Static testing • Kinetics testing • Field test • Leaching tests 	<p>METALLURGICAL SERVICES</p> <ul style="list-style-type: none"> • comminution • froth flotation • gravity separation • Leaching processes
<p style="text-align: center;">← RESEARCH AND DEVELOPMENT →</p>		



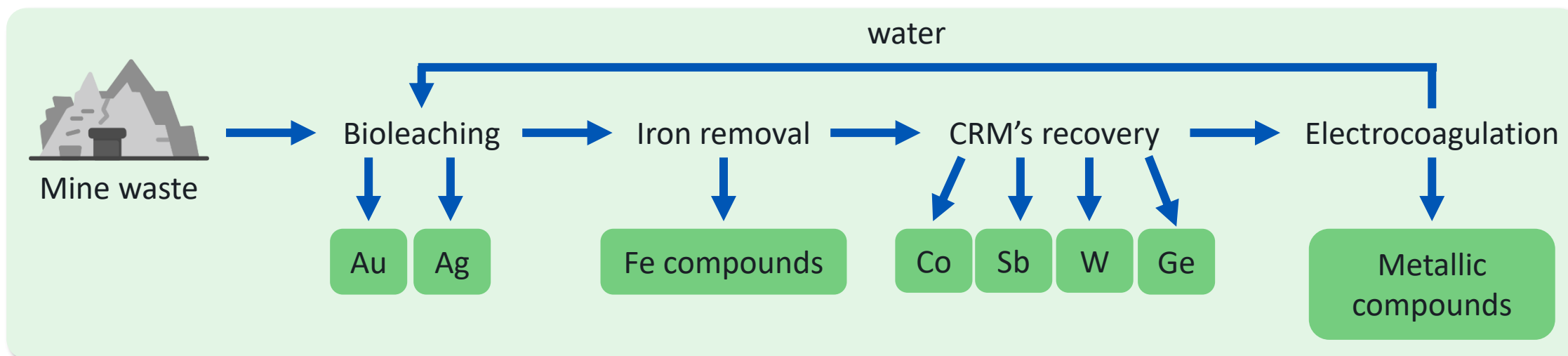
CE-SC5-07-2020 – IA
(TRL 4 to 7)

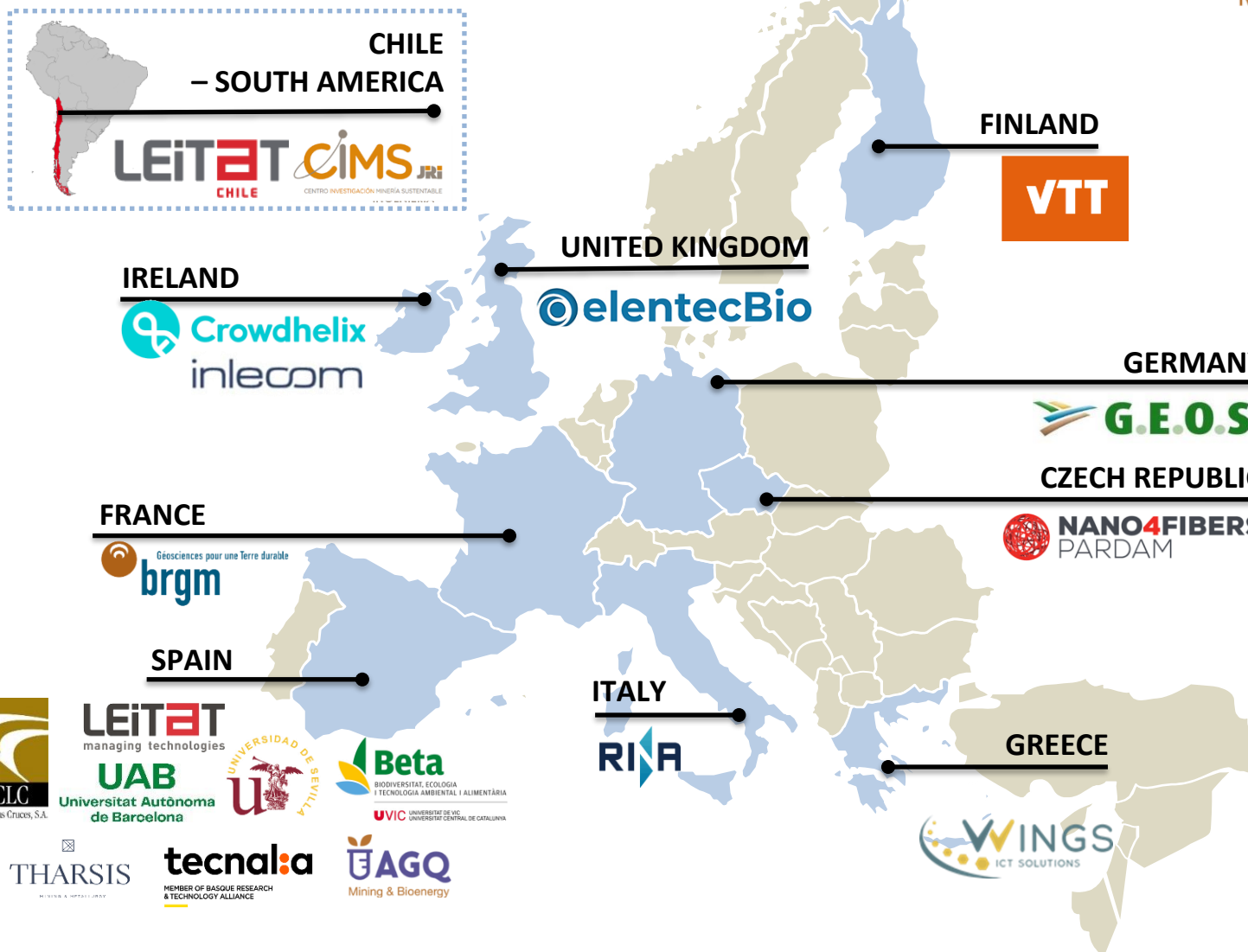


10 857 403,25 €
(EU Contribution: 9 146 967,26 €)



19 Partners
48 Months
(Today → M46)





19 partners

- 5 RTOs
- 3 Universities
- 6 SMEs
- 5 Large enterprises

9 EU countries

1 Non-EU countries

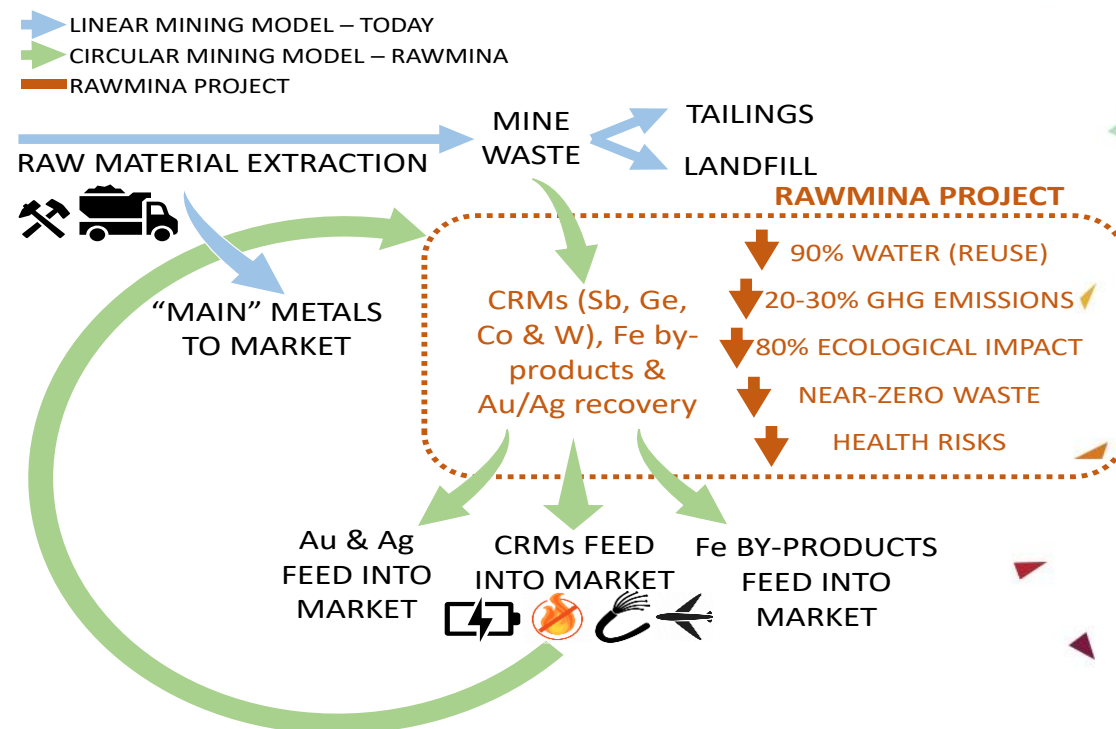


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RAWMINA's main objective is **to develop and to demonstrate the innovative RAWMINA pilot system:**

- **Industrially scalable and flexible for MW valorisation** in continuous operation
- **95% recovery rate and selectivity** for CRMs (Co, Sb, W and Ge)
- **80-90% recovery rate and 95% selectivity** for Au, Ag and Fe-based high-value products
- Treat up to **100-150 kg MW/day** on an industrial demonstration.
- *Transformation of the Mine Waste into a Resource*



WP1



Bio-leaching

Alkaline Leaching

Au/Ag gangue

Alkaline Leachate: Ge, W, M²⁺

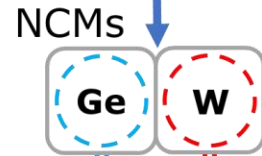
Iron removal process

Iron species

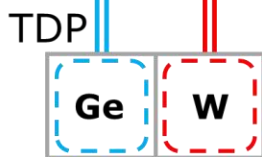
Acid Leachate: Co, Sb, M²⁺



Water reuse



Electrocoagulation



Electrowinning

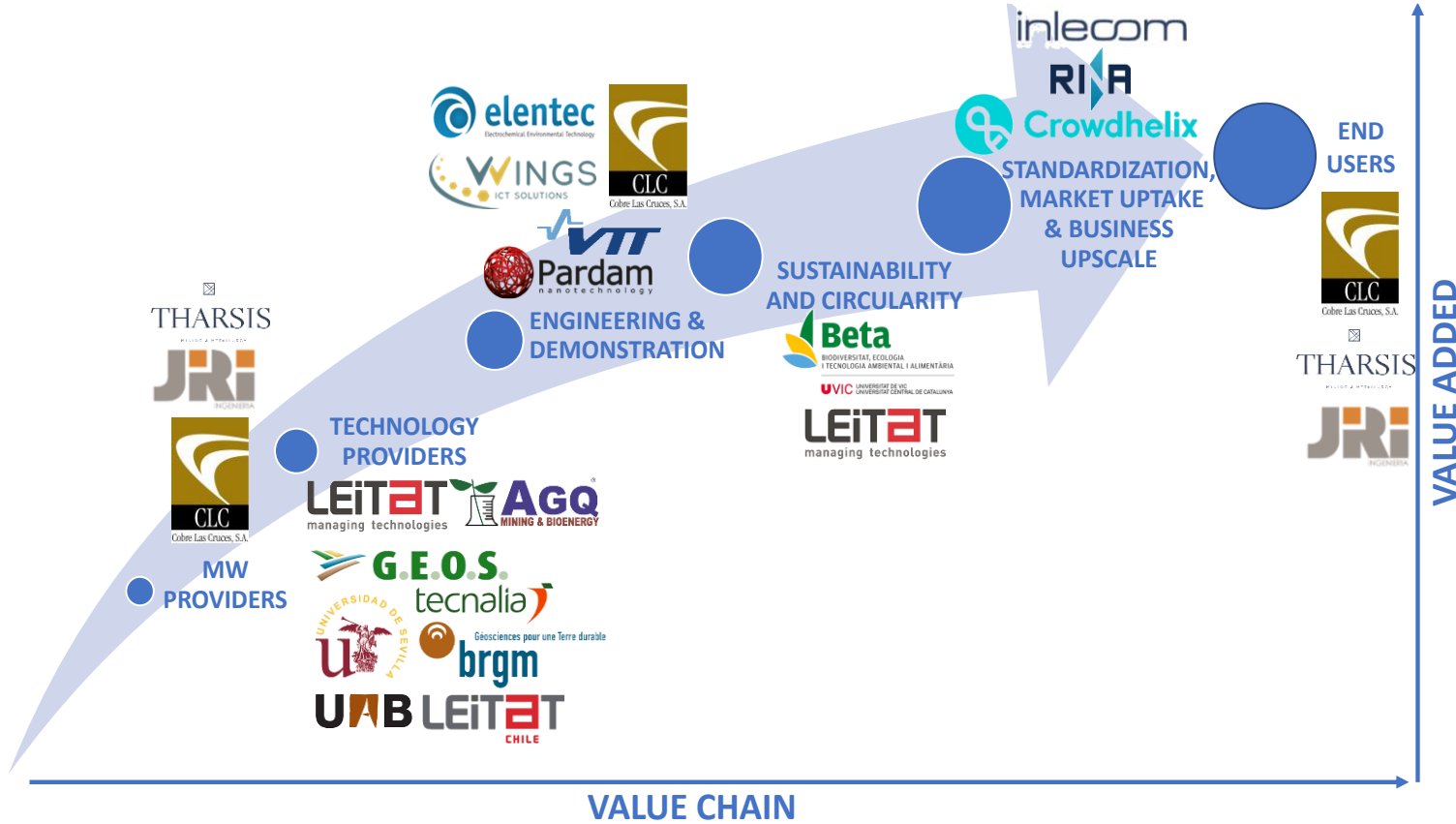
Ge W Sb Co

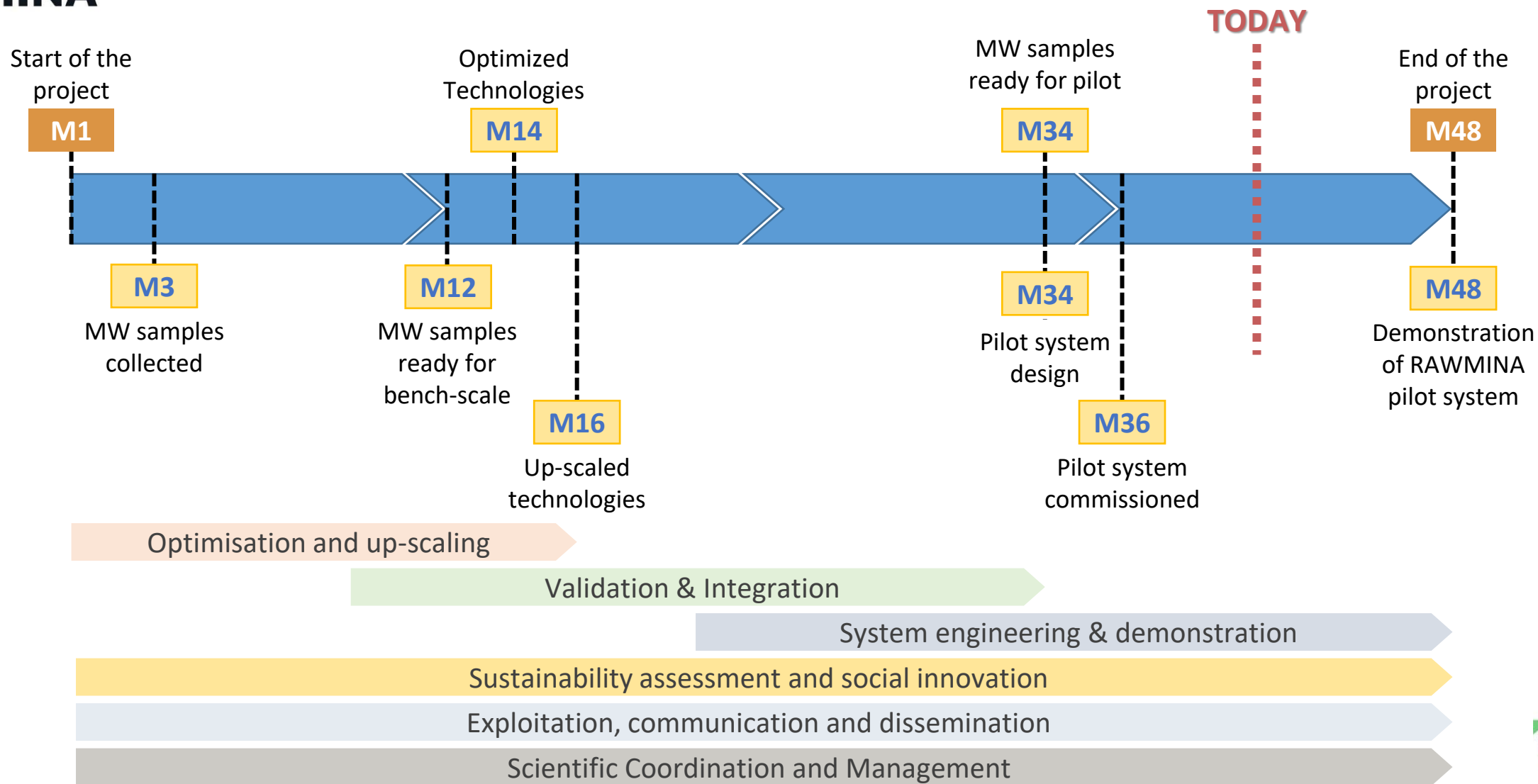
Metallic compounds



WP4







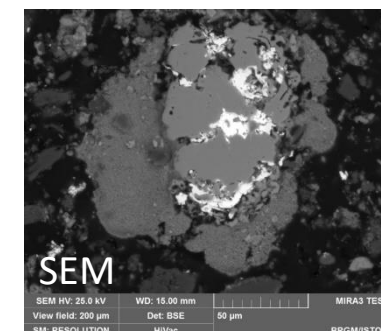
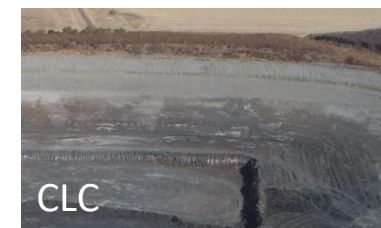
In WP1: Mining waste conditioning

- ✓ Samples collected for characterisation & pre-treatment:
 - ✓ CLC Tailings (Spain)
 - ✓ CLC Gossan (Spain)
 - ✓ Tharsis ore (Spain)
 - ✓ Covas waste (Portugal)
 - ✓ Wastes from mining activities in Chile

- ✓ Samples preparation for lab testing.

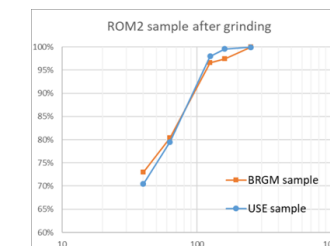
- ✓ Samples preparation for bench scale testing (CLC tailings & Tharsis ore)

- ✓ Samples preparation for piloting (CLC tailings & Tharsis ore)

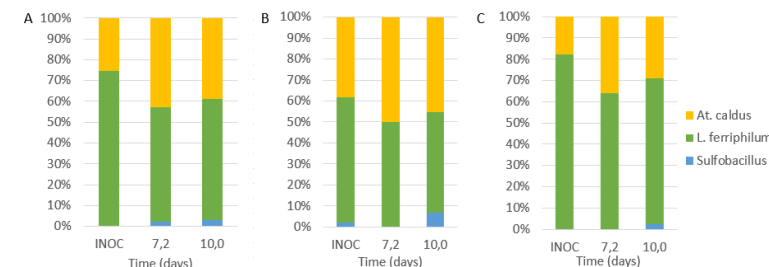
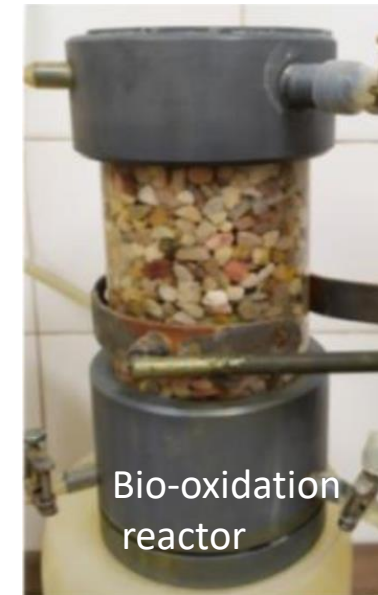


Particle size	Distribution	Fe	Al
µm	% mass	%mass	%mass
>1000	5.7	6.1	2.8
500-1000	24.5	5.7	2.4
250-500	24.9	5.9	2.7
100-250	19.4	65.6	2.7
40-100	13.8	76.7	2.9

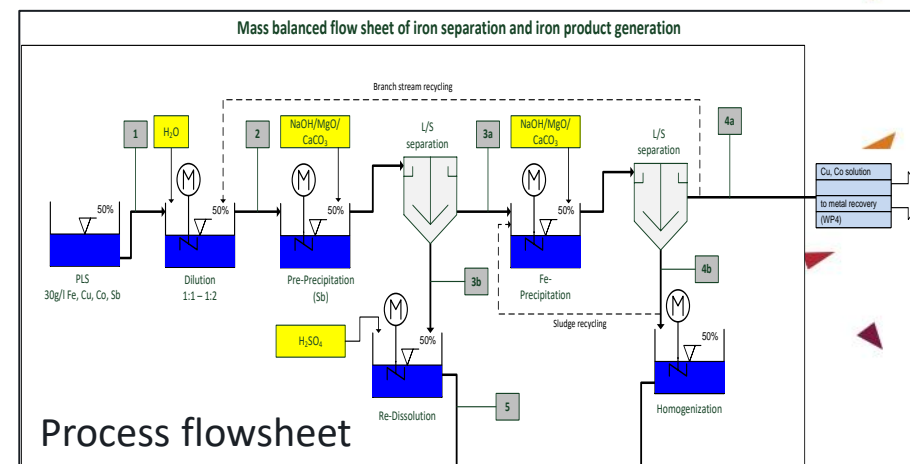
Particle size & assay



- ✓ ***In WP2: Bioleaching process for metal extraction***
- ✓ Bioleaching testing on RAWMINA samples
 - ✓ Microbial consortium
 - ✓ Optimum process parameters (pH, T^o, agitation, SD, ...)
 - ✓ Extraction performance for each sample
 - ✓ Bioleaching continuous testing at lab scale
- ✓ Bio-oxidation of ferrous iron testing
- ✓ Alkaline leaching testing
- ✓ Scaling up parameters determination



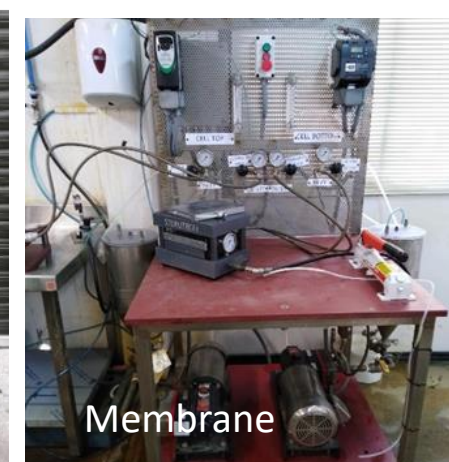
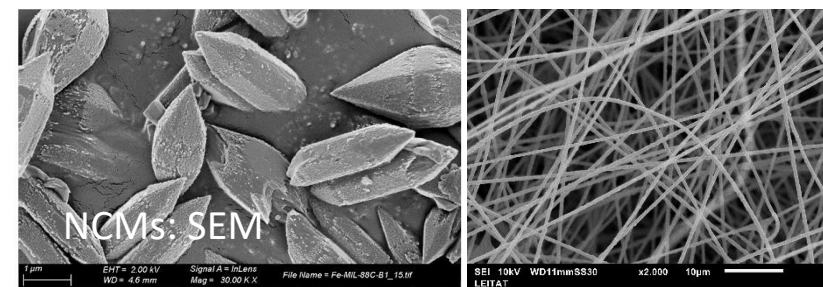
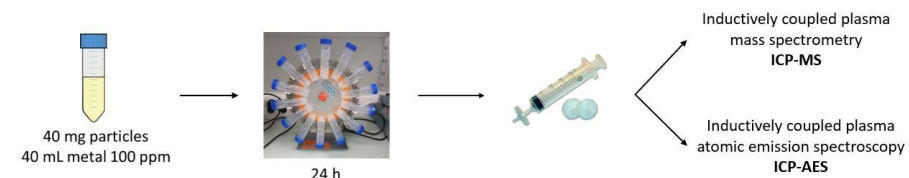
- ✓ ***In WP3: Iron removal process***
- ✓ Iron precipitation lab studies
 - ✓ Testing with synthetic solutions (preliminary studies on process behaviour, including different alkali)
 - ✓ Testing with real PLS from bioleaching
 - ✓ Production of samples for CRM selective recovery process
- ✓ Arsenic handling
- ✓ Magnetite synthesis and separation
- ✓ Scaling up parameters determination



In WP4: Novel materials and processes for selective recovery

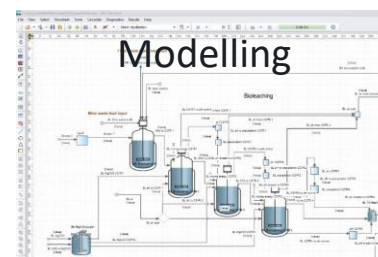
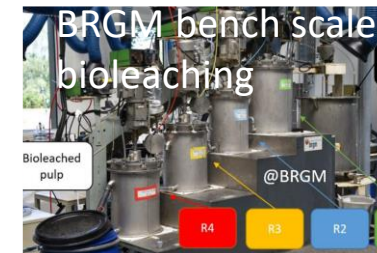
- ✓ Synthesis and characterization of adsorbents
- ✓ Laboratory testing on adsorption
- ✓ Laboratory testing on thermal desorption
- ✓ NCMs selectivity studies and development
- ✓ Impurities removal testing with membrane techniques
- ✓ Impurities removal testing using chemical precipitation
- ✓ Electrowinning for CRMs recovery
- ✓ Electrocoagulation and electrowinning testing.

Adsorption testing



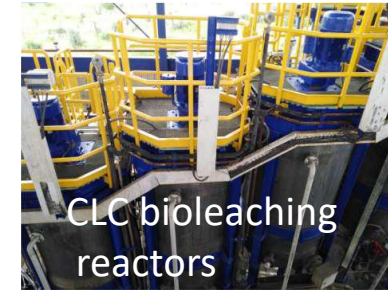
In WP5: Bench-scale validation, process simulation and pilot design

- ✓ Definition of the requirements for bench scale validation
- ✓ Bench scale of Bioleaching
- ✓ Bench scale testing of Iron Removal
- ✓ Bench scale for selective CRMs recovery
- ✓ Integrated process modelling
- ✓ Design of the Pilot System



In WP6: System engineering & demonstration

- ✓ Construction of RAWMINA pilot system
- ✓ Intelligent Management System implementation
- Pilot system commissioning and demonstration of continuous integrated process
 - Bacteria culture adaptation
 - Hot commissioning
 - Start up and ramp up



CLC bioleaching reactors



CLC bioleaching filtration



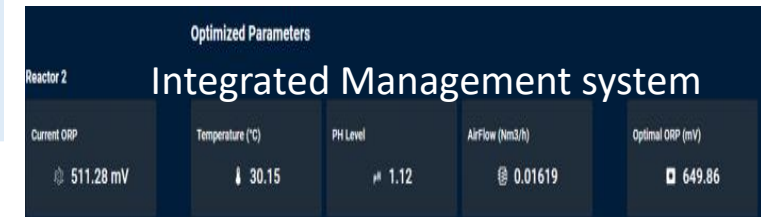
Technalia EW pilot system



ElentecBio Electrocoagulation pilot system



Piloting activities ongoing



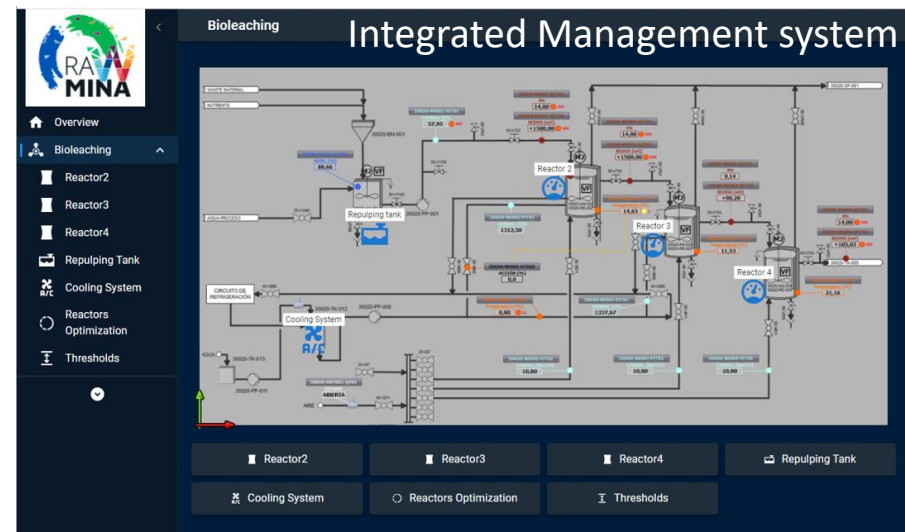
Pilot plant operation

- Construction of RAWMINA pilot system with Intelligent Management System implementation
- **Bioleaching process** is an efficient technology able to extract **~90 % Fe**, **~95 % Co** and **~60 % Sb** of the waste materials.
- Iron removal of bioleaching pregnant solutions is able to remove **> 99 % Fe & As** from the solution



Working on pilot plant operation and characterization of samples

- Bioleaching process promising results according to previous lab and bench scale testing. It is an efficient technology able to extract $\sim 90\%$ Fe, $\sim 95\%$ Co and $\sim 60\%$ Sb of the waste materials
- Alkaline leaching applied after bioleaching is able to extract more than 90% of W.
- The final solid cyanidation testing showed $\sim 83\%$ Au extraction
- Iron precipitation process showed high efficiency on iron and arsenic removal, confirmed results from lab and bench scale testing $> 99\%$ Fe & As removed from the solution
- Nanofibrous Composite Materials \rightarrow NCMs developed for the 4 metals (Co, Sb, W and Ge). Good results for W and Ge.
- Electrowinning $\rightarrow 99\%$ Co, 65% W y 77% Sb.
- Electrocoagulation of other metals $\rightarrow 95-100\%$ depending on the metal



01

Individual technologies were up-scaled to bench-scale and validated to establish the specifications for the RAWMINA process and to strengthen the integration

02

Pilot system engineering and efficient construction of the RAWMINA Pilot System including control system and integrated management system

03

Both sustainability and risk assessment have been carried out bench-scale to evaluate the exposure scenarios.

04

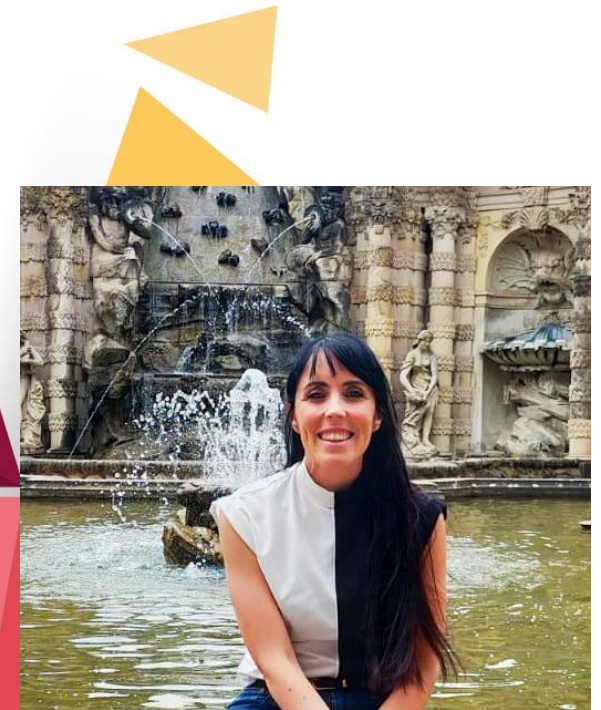
Preliminary work with RAWMINA pilot system has been carried out using CLC and Tharsis waste streams

05

20 exploitable results have been identified with the goal to file 3 patents.



Thanks for your attention



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