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OVERVIEW OF MORECOVERY PROJECT: MODULAR RECOVERY PROCESS SERVICES FOR HYDROMETALLURGY AND WATER TREATMENT

December 3rd 2021, Morecovery Educational Workshop (online)

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BACKGROUND FOR THE MORECOVERY PROJECT

- The need for raw materials is increasing in EU and globally
- List by the European Commission containing critical raw materials (CRMs)
  - *European Commission: Critical Raw Materials*

2020 critical raw materials (new as compared to 2017 in bold)

Antimony	Coking coal	LREE	PGM	Tungsten
Baryte	Fluorspar	Indium	Phosphate rock	Vanadium
Beryllium	Gallium	Magnesium	Phosphorus	**Bauxite**
Bismuth	Germanium	Natural graphite	Scandium	**Lithium**
Borate	Hafnium	Natural rubber	Silicon metal	**Titanium**
Cobalt	HREE	Niobium	Tantalum	**Strontium**

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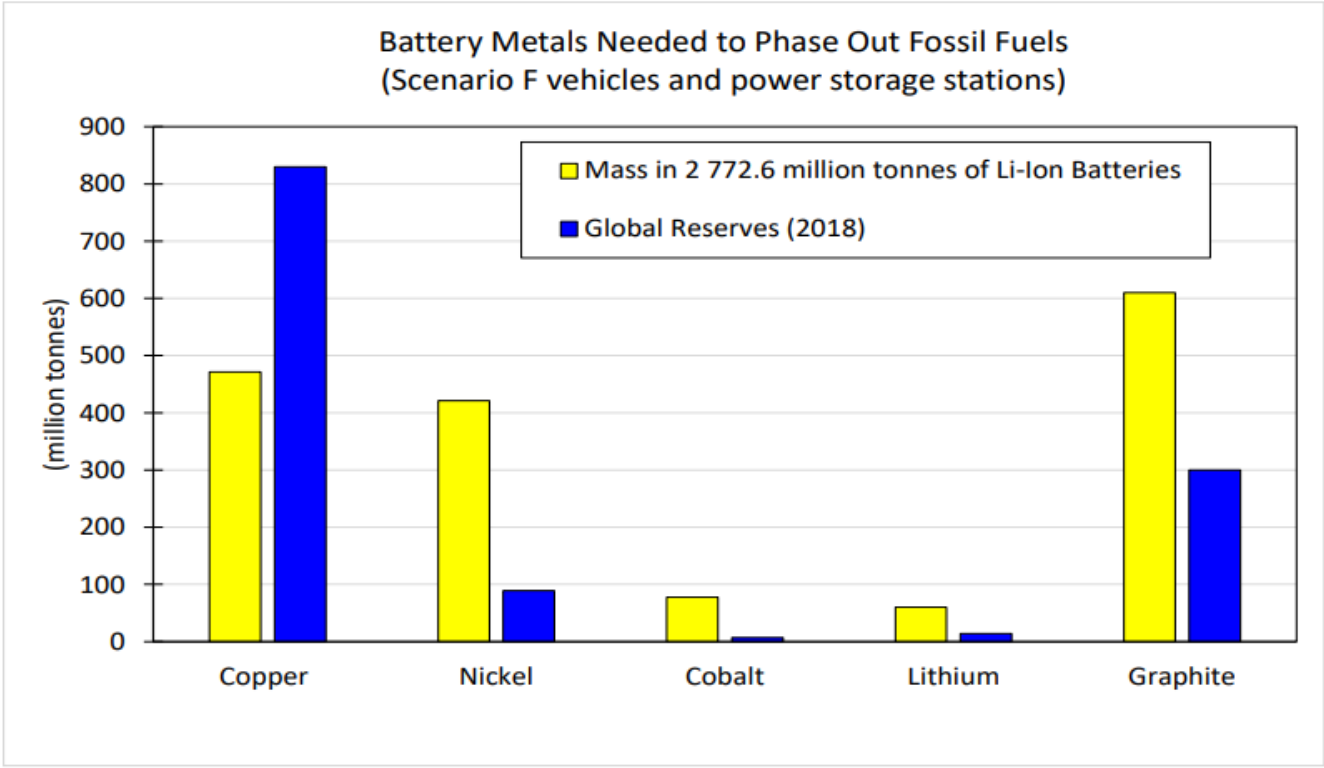
BACKGROUND FOR THE MORECOVERY PROJECT

- According to Simon Michaux / GTK, to completely replace fossil fuels by alternative electrical power systems, the mass of batteries required is enormous, around 2.78 billion tonnes of Li-Ion batteries
- Mainly for solar and wind energy buffer storage
- More Ni, Co, Li, graphite needed than global reserves were in 2018
- Reference: Michaux, S.P. (2021). Assessment of the Extra Capacity Required of Alternative Energy Electrical Power Systems to Completely Replace Fossil Fuels. GTK Open File Work Report 42/2021
  - *Link to the report*
  - *Link to a summary*



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BACKGROUND FOR THE MORECOVERY PROJECT

- The eco-efficiency of mining and circular economy can be enhanced by the utilization of side streams and mine waste
- Need to develop more efficient recovery methods and to efficiently remove dissolved metals from mine water streams, while securing the surrounding environment and ecosystem

→ MORECOVERY project

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MORECOVERY OVERVIEW

- The scope of the project:
  - *Support recovery process testing and design by creating and validating a modular recovery process service package for hydrometallurgy and water treatment*
- The Morecovery service includes:
  1. *Preliminary investigations for recovery potential*
  2. *Testing of suitable recovery processes in laboratory*
  3. *Testing of suitable recovery processes in pilot scale*

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MORECOVERY OVERVIEW

- The new recovery service package will complement the existing processing services
  - *Conventional mineral processing services from lab to large scale piloting by GTK Mintec*
  - *Water treatment piloting services from lab to large scale piloting by Savonia*

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MORECOVERY OVERVIEW

- An EIT RawMaterials project
- Partners: GTK (lead), Finnish Minerals Group (FMG), Keliber, LTU Business, Savonia University of Applied Science, University of Eastern Finland (UEF), University of Huelva (UHU) and the Spanish National Research Council (CSIC)
- Commercializing partners: GTK and Savonia
- Duration: 2019-2021
- Total budget: 1.5 M€

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SCREENING AND SAMPLING OF POTENTIAL SITES

- Existing drainage data from 18 potential extractive waste facilities from 10 mine sites was inspected
- Further sampling of mine wastes and drainages from Hitura, Siilinjärvi, Kotalahti, Särkiniemi and Hammaslahti
- Keliber case sample material produced at GTK Mintec from Li-ore as part of convential mineral processing tests
- Tentatively interesting elements for recovery
  - *Hitura: Ni, Co*
  - *Keliber: Nb, Ta*
  - *Siilinjärvi: REE, P*

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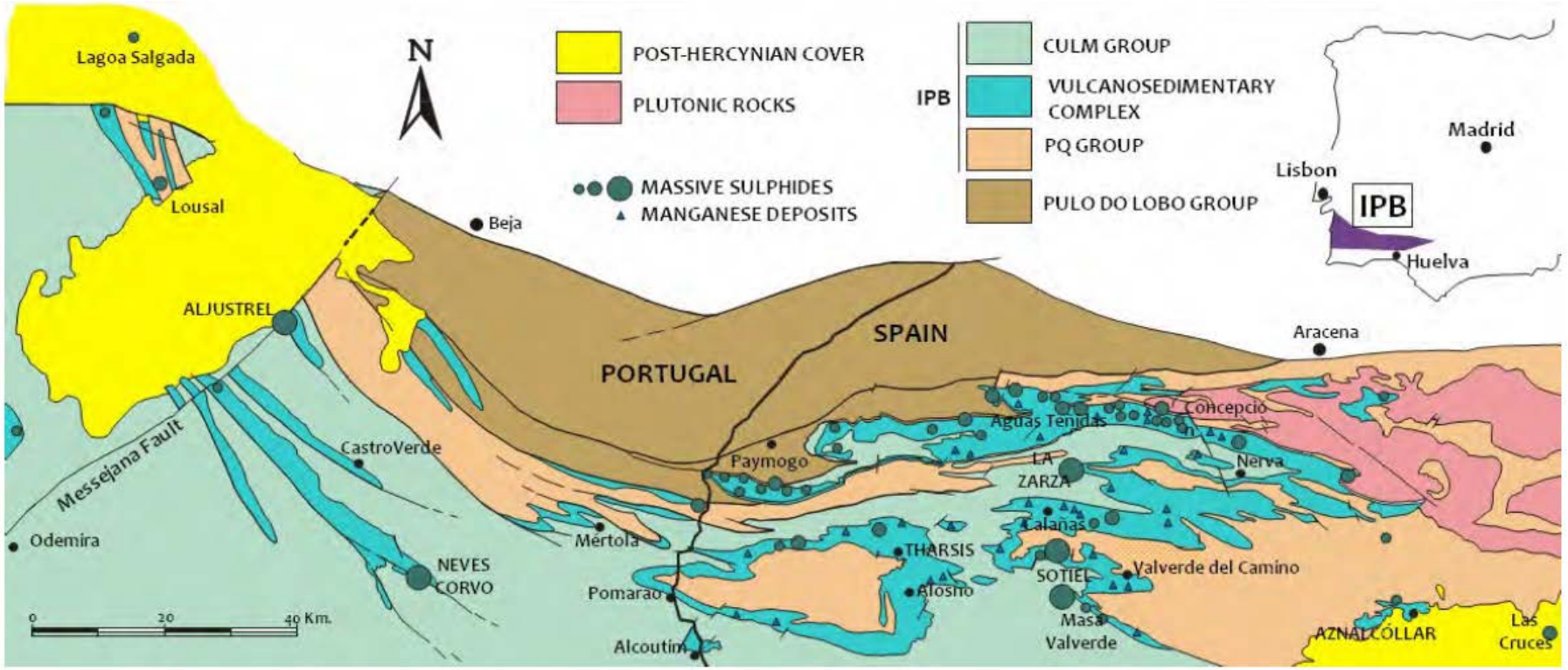
REE RECOVERY POTENTIAL AT THE IBERIAN PYRITE BELT, SPAIN

- Investigations on the SCYRE-rich acid mine drainages (AMD) in the Iberian Pyrite Belt (IPB)
- Potential targets found
  - *E.g. high-REE containing (mean 9.2 mg/L) drainage water from the Poderosa mine*



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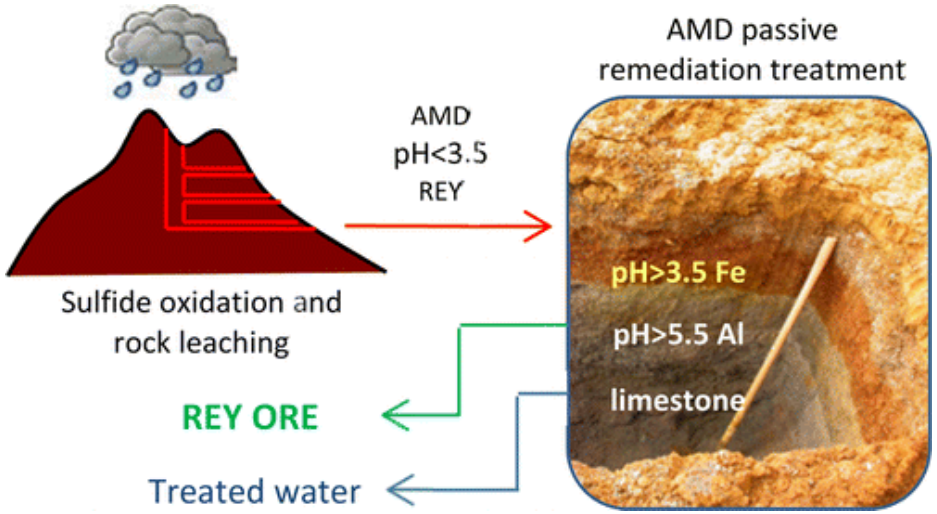
REE RECOVERY BY SELECTIVE METAL ACCUMULATION, SPAIN

- Investigating selective metal accumulation by passive AMD remediation system
  - *In the passive treatment system, the REEs are mainly bound to the Al-rich layer, onto basaluminite*



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Related to the Morecovery project, several scientific publications have been written by the UHU and CSIC:

Lozano A.; Ayora C.; Fernandez-Martinez A. (2019) Sorption of rare earth elements onto basaluminite: The role of sulfate and pH. Geochimica et Cosmochimica Acta, 258: 50-62.

Lozano, A.; Fernandez-Martinez, A.; Ayora, C.; Di Tommaso D.; Poulain A.; Rovezzi M.; Marini C. (2019) Solid and Aqueous Speciation of Yttrium in Passive Remediation Systems of Acid Mine Drainage. Environmental Science & Technology, 53: 11153-11161.

Basallote, MD; Canovas, CR; Olias, M; Perez-Lopez, R; Macias, F; Carrero, S; Ayora, C; Nieto, JM (2019) Mineralogically-induced metal partitioning during the evaporative precipitation of efflorescent sulfate salts from acid mine drainage. Chemical Geology, 530, DOI: 10.1016/j.chemgeo.2019.119339

Cama J., Soler J.M., Ayora C. (2019) Acid Water–Rock–Cement Interaction and Multicomponent Reactive Transport Modeling. Reviews in Mineralogy and Geochemistry, 85: 459-498.

Canovas, CR; Macias, F; Olias, M; Basallote, MD; Perez-Lopez, R; Ayora, C; Nieto, JM (2020) Release of technology critical metals during sulfide oxidation processes: the case of the Poderosa sulfide mine (south-west Spain). Environmental Chemistry, 17:93-104. DOI: 10.1071/EN19118.

Lozano, A., Ayora, C., Macias, F., Leon, R., Gimeno, M.J., Auque, L. (2020) Geochemical behavior of rare earth elements in acid drainages: Modeling achievements and limitations. J. Geochem. Explor. 216, DOI: 10.1016/j.gexplo.2020.106577.

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Olías M, Cánovas CR, Macías F, Basallote MD & Nieto JM (2020). The Evolution of Pollutant Concentrations in a River Severely Affected by Acid Mine Drainage: Río Tinto (SW Spain). Minerals 10(7), 598. https://doi.org/10.3390/min10070598

Moreno-González R, Cánovas CR, Olías M & Macías F (2020). Rare earth elements in a historical mining district (south-west Spain): Hydrogeochemical behaviour and seasonal variability. Chemosphere 253, 126742. https://doi.org/10.1016/j.chemosphere.2020.126742

Cánovas CR, Nieto JM, Macías F, Basallote MD, Olías M, Pérez-López R & Ayora C (2020). Recovery of Critical Raw Materials from Acid Mine Drainage (AMD): The EIT-Funded MORECOVERY Project. In: Recovery of Byproducts from Acid Mine Drainage Treatment (Eds: Fosso-Kankeu E, Wolkersdorfer C & Burguess J), 219-234. Wiley, ISBN: 9781119620075. https://doi.org/10.1002/9781119620204.ch8

Canovas, C.R.; Basallote, M.D.; Macias, F.; Olías, M.; Perez-Lopez, R.; Ayora C., Nieto J.M. (2021) Geochemical behaviour and transport of technology critical metals (TCMs) by the Tinto River (SW Spain) to the Atlantic Ocean. Science Of The Total Environment, 764, DOI:10.1016/j.scitotenv.2020.143796.

Orden, S.; Macias, F.; Canovas, C.R.; Nieto, J.M.; Perez-Lopez, R.; Ayora, C. (2021) Eco-sustainable passive treatment for mine waters: Full-scale and long-term demonstration. Journal Of Environmental Management, 280, DOI:10.1016/j.jenvman.2020.111699

Ayora C., Carrero S., Bellés J., Basallote M.D., Cánovas C.R., Macías F. (2021) Partition of Rare Earth Elements Between Sulfate Salts Formed by the Evaporation of Acid Mine Drainage, Mine Water and the Environment, MWEN-D-20-00283R2, accepted.

León R, Macías F, Cánovas CR, Pérez-López R, Ayora C, Nieto JM & Olías M (2021). Mine waters as a secondary source of rare earth elements worldwide: the case of the Iberian Pyrite Belt. Journal of Geochemical Exploration 224, 106742. https://doi.org/10.1016/j.gexplo.2021.106742

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LABORATORY-SCALE TESTING

- The most interesting targets were further studied at the partners' laboratories for recovery potential
- Studied targets included:
  - *Ni and Co recovery from Hitura drainage and water treatment sludge*
  - *Nb and Ta recovery from the Keliber Li ore side stream, later also As removal from the waste and product*
  - *REE-rich drainage samples from Spain*
  - *P and REE recovery from Siilinjärvi gypsum and drainage*

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THE PILOTING CONTAINER

- Larger scale field piloting at Hitura based on UEF lab results
- Piloting equipment were installed in a 40’’ sea container
- Obtained equipment included oxidation, precipitation and sedimentation units, and general supplies (measurement, pumps, electricity, ventilation, etc.)

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LARGER-SCALE PILOTING AT CASE SITES

- In 2020 larger scale piloting done in Hitura, Finland
  - *Hitura Ni-Co recovery based on water treatment system*
- In 2021 larger scale piloting in Spain cancelled, larger lab-scale test done in Finland
  - *Element recovery from mine waters sent from Spain to Finland*

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SUMMARY

- During the project a modular recovery service package was created and tested, which will be offered by GTK and Savonia
- The service package includes: screening of potential test sites, sampling, further lab-scale tests, designing and construction of larger scale pilot plant, piloting at selected sites

GTK

THANK YOU

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