Transforming mining residues to valuable products (Residue2Product) – Stage II

Presenter
Hesham Ahmed, Luleå University of Technology

Project leader
Hesham Ahmed, Luleå University of Technology

Partners
Boliden minerals AB and Heidelberg materials (fd Cementa)

Program Day 2023

SWEDISH MINING INNOVATION

Med stöd från
VINNOVA Sveriges innovationsmyndighet
Energimyndigheten
FORMAS
Strategiska innovationsprogram

Goals of the project

1. Develop and optimize a combined novel recycling process for waste gypsum and pyrite tailings.
    1.1. Study and optimize the decomposition of pyrite to pyrrhotite.
    1.2. Study and optimize the production of metallic iron from pyrrhotite using fossil-free reductant
    1.3. Study and maximize the conversion of gypsum to CaO.

2. Evaluate the utilization of different sources of pyrite and gypsum.
3. Characterize and evaluate the generated products.
4. Evaluate the potential recovery of additional valuable metals as e.g. cobalt.

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Project Implementation

WP 1, Project coordination

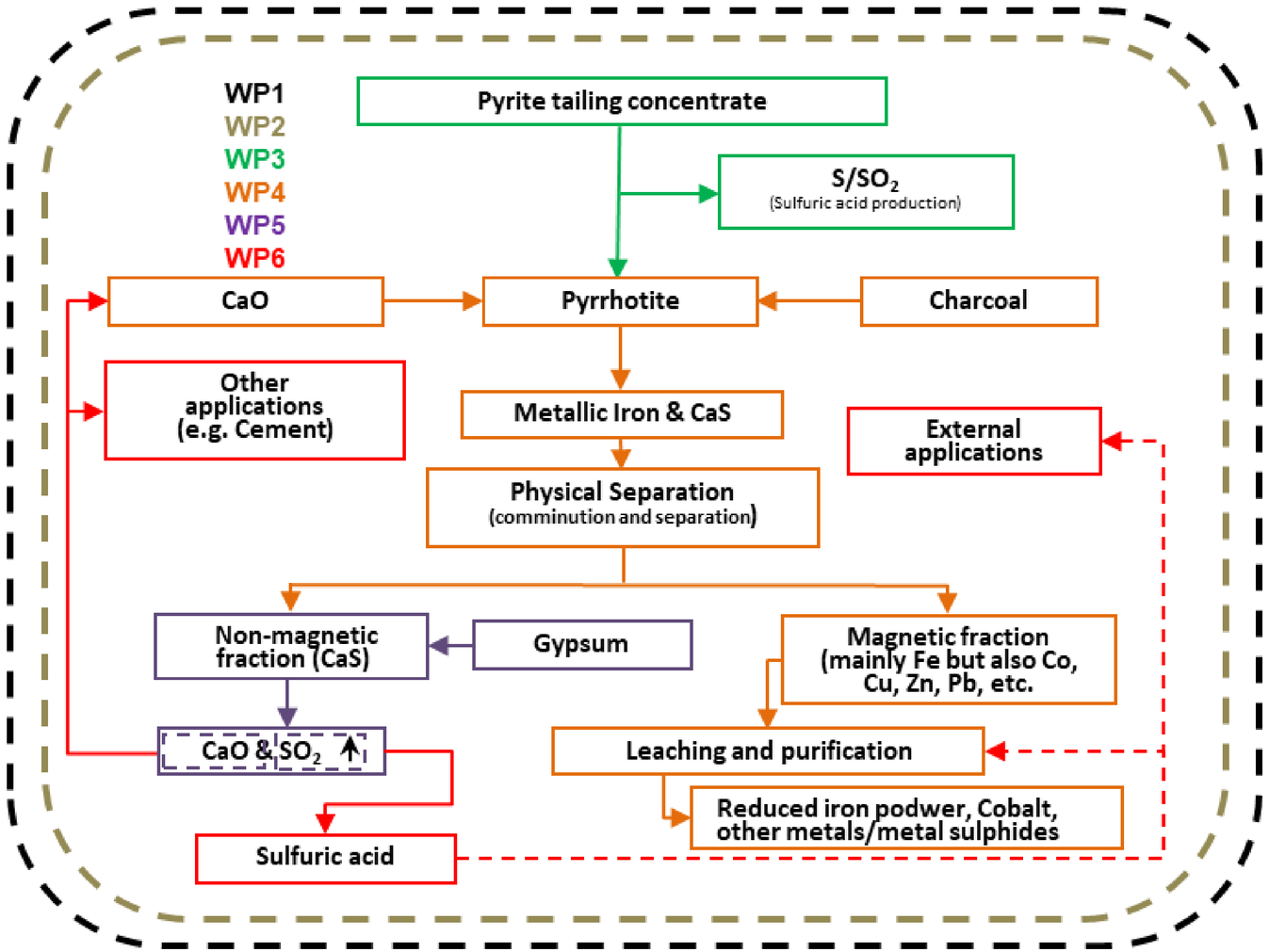
WP 2, Sampling and theoretical exploration

WP 3, Pyrite decomposition

WP 4, Pyrrhotite reduction and CaS formation

WP 5, Gypsum conversion

WP 6, Product and process evaluation



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Project plan

			2023			2024				2025				2026
			Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
WP1		***Project coordination***												
	1.1	Coordination				D1.1				D1.1				D1.1
	1.2	Reporting												D1.2
	1.3	Dissemination						D1.3	D1.4	D1.3	D1.5		D1.3/1.4	D1.5
WP2		**Sampling and Theoretical exploration**											D2.1	
	2.1	*Sampling*												
	2.2	*Characterization*												
	2.3	*Theoretical exploration*				D2.2								
	2.4	*Experimental design*												
WP3		**Pyrite Decomposition**				D3.1								
	3.1	*Roasting in inert atmosp*												
	3.2	*Roasting in oxidative atmosphere*												
	3.3	*Optimization and scale-up*				D3.2								
WP4		**Pyrrhotite reduction and CaS formation**								D4.1				
	4.1	*Define the experimental setup*												
	4.2	*Optimization and up-scaling*						D4.2						
	4.3	*Physical separation*						D4.3						
	4.4	*Leaching and purification*							D 4.4					
	4.5	*Integration and optimization*												
WP5		**Gypsum conversion**									D5.1			
	5.1	*Non-magnetic fraction characterization*												
	5.2	*Define the experimental setup*												
	5.3	*Define the optimum conditions*								D5.2				
	5.4	*Up-scaling*												
WP6		**Product and process evaluation**											D6.1	
	6.1	*Quality of the recovered materials*												
	6.2	*Environmental, economic and technical evaluation*											D6.2	
	6.3	*System Analysis*												D6.3

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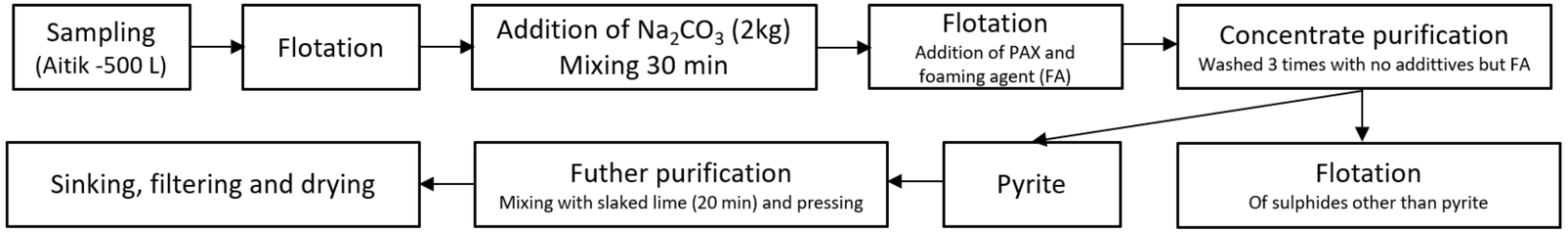
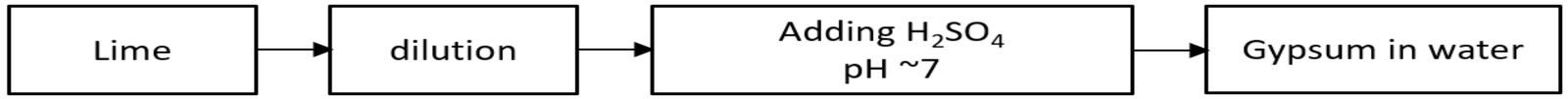
Project results so far

Sampling – ”Pure” pyrite tailings and Gypsum ”synthetic gypsum”

Pyrite tailings



Synthetic gypsum



Characterization

Pyrite tailings

Elements	Iron	Sulfur	Sodium	Magnesium	Aluminum	Silicon	Calcium	Cobalt	Nickel
wt.%	36.06	32.30	1.85	0.26	0.79	1.38	0.11	0.12	0.03

Synthetic gypsum

Elements	CaSO4	Na2O	MgO	Al2O3	SiO2	Others			
wt.%	94.00	1.80	0.50	0.80	1.00	1.90			

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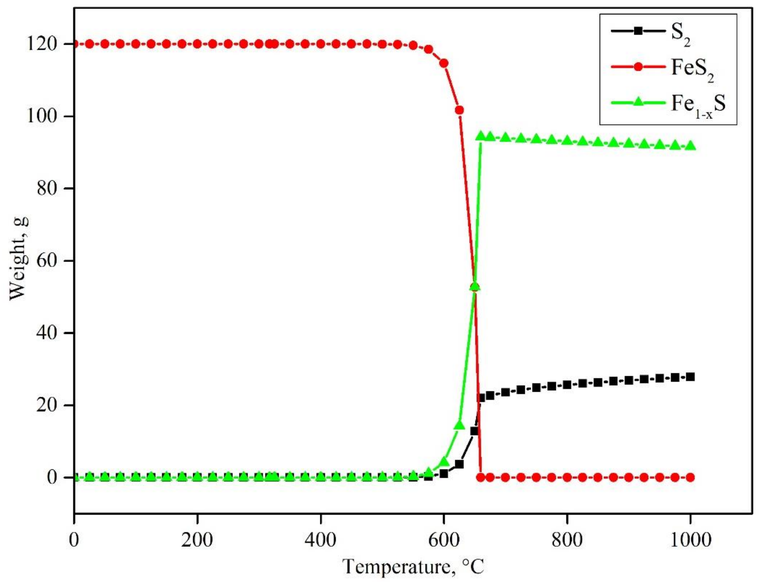
Project results so far

Theoretical exploration – FactSage (pure systems)

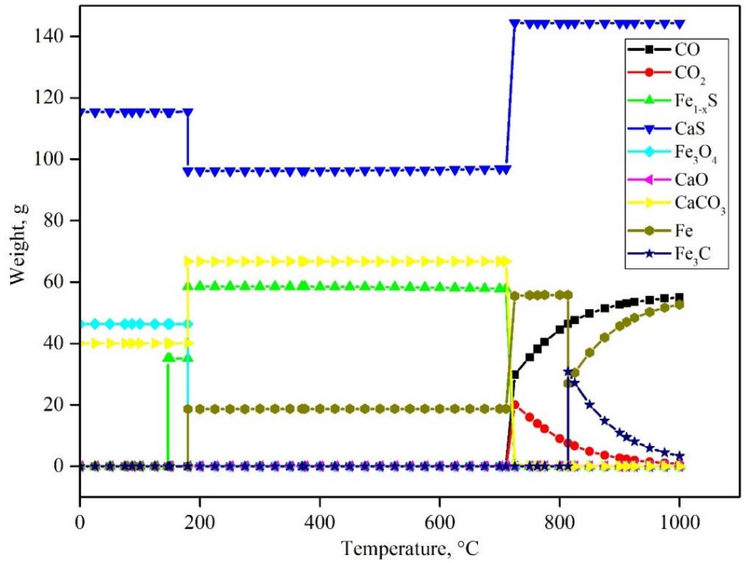
Pyrite pyrolysis

$$2FeS_{2(S)} \leftrightharpoons 2FeS_{(S)} + S_{2(g)}$$



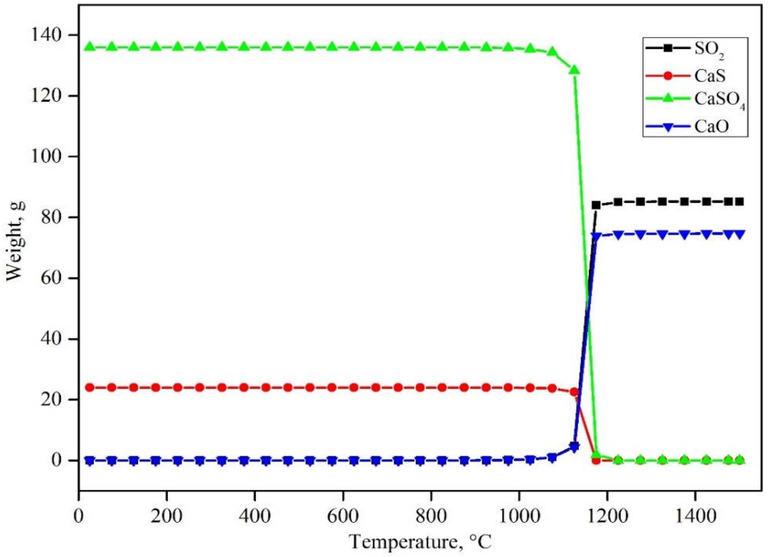
Carbothermic reduction of pyrrhotite

$$FeS_{(s)} + CaO_{(s)} + C_{(s)} \rightarrow Fe_{(s)} + CaS_{(s)} + CO_{(g)}$$



Gypsum conversion

$$3CaSO_{4(s)} + CaS_{(s)} \rightarrow 4CaO_{(s)} + 4SO_{2(g)}$$



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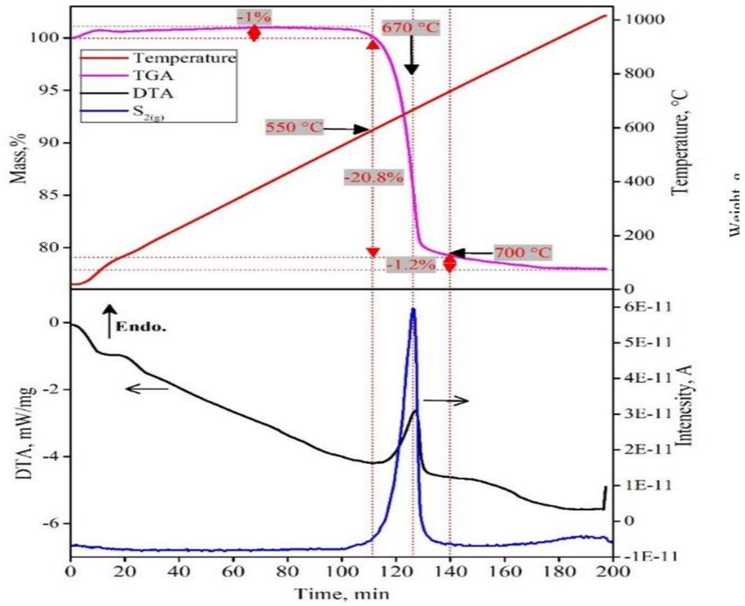
Project results so far

Experimental results – Thermogravimetric analysis

Pyrite pyrolysis

$$2FeS_{2(S)} \leftrightharpoons 2FeS_{(S)} + S_{2(g)}$$



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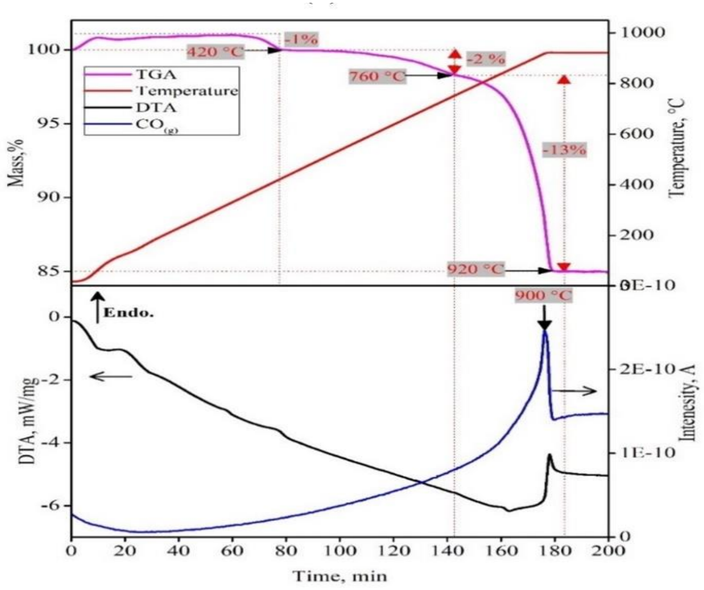

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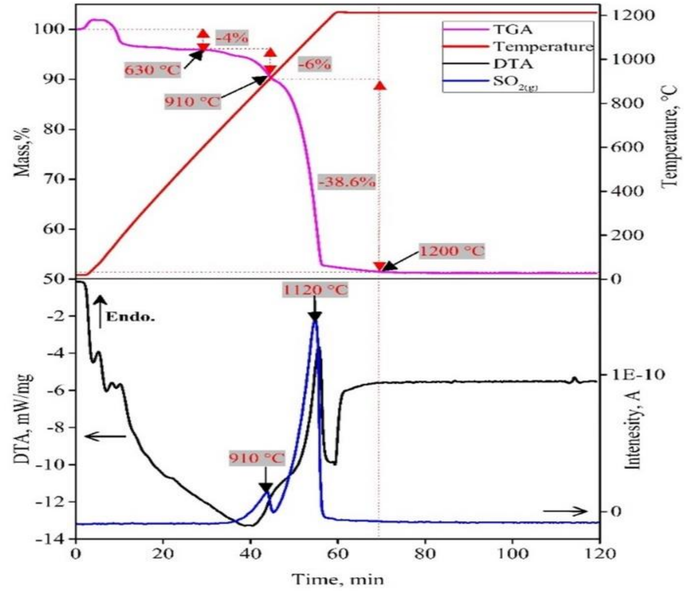

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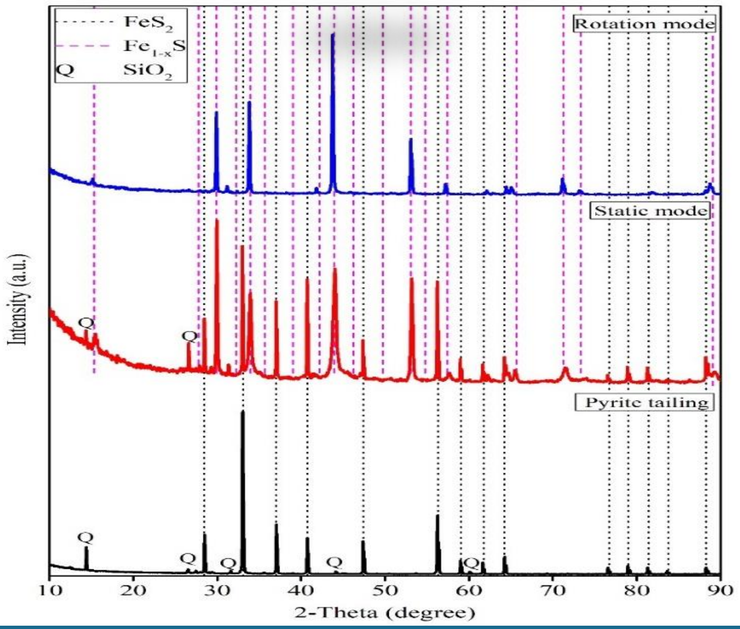
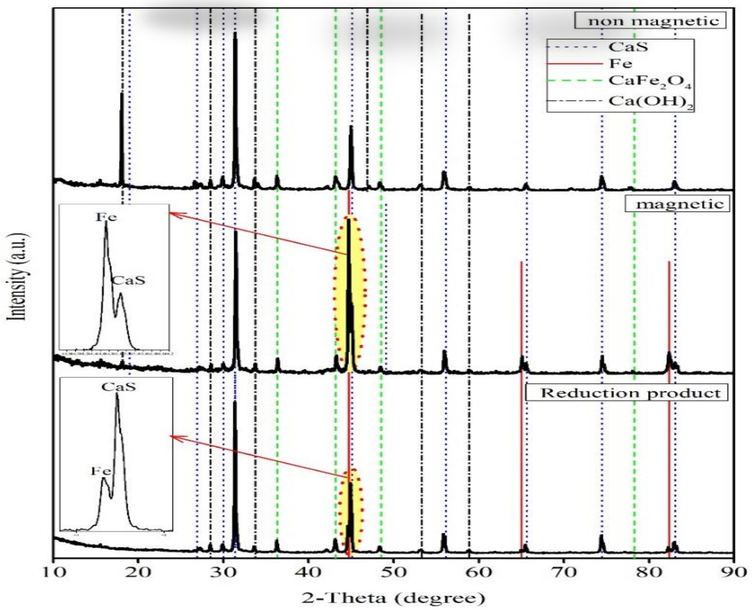
Project results so far

Up-scalling

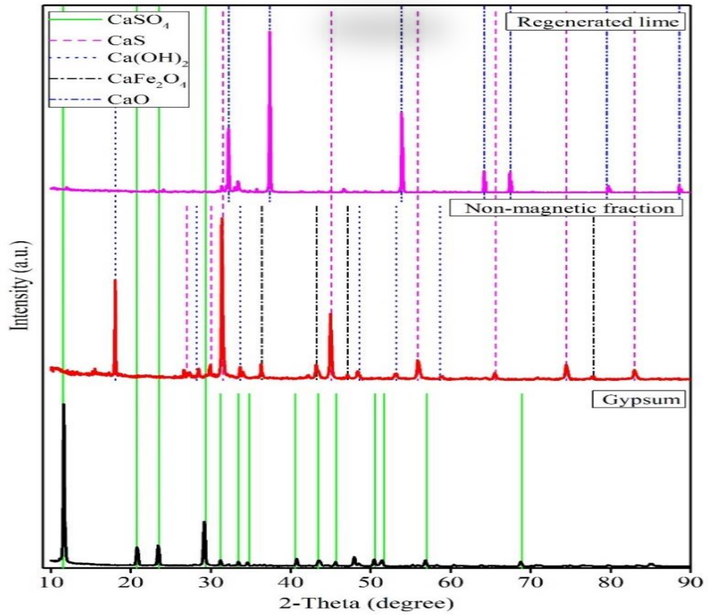
Pyrite pyrolysis



Carbothermic reduction of pyrrhotite



Gypsum conversion



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Dissemination

Hesham Ahmed • You
Industry-driven research on #Metallurgy toward #sustainability #green a...
5mo • Edited •

The implementation of our recently approved full-scale research project, Residue2Product-II, has practically commenced following our kickoff meeting held on May 10th. The project focuses on transforming mining residues into valuable products. The meeting brought together our dedicated team of talented researchers (**Anders Sand**, **Tommy Karlkvist**, **Erik Viggh**, **Lena Sundqvist**, **Mohammad Khoshkhoo**, **Malin Suup**, **Vitalis Chipakwe**) who will be working collaboratively to drive this project forward. During the kickoff meeting, we established a solid foundation for the project's success. We discussed the project's objectives, deliverables, and timelines.

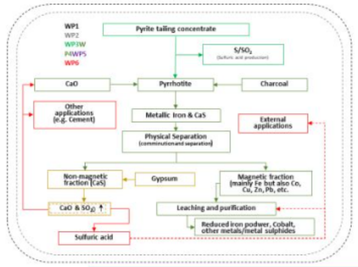
The project aims at developing and optimizing a novel combined recycling process for pyrite tailings and waste gypsum. Products such as lime, sulphur/sulphur dioxide and iron powder are produced.

The residue2product-II is a collaborative project between **Luleå University of Technology**, **Boliden** and **Cementa**. Products such as lime, sulphur/sulphur dioxide and iron powder are produced.

The project is funded through the strategic innovation program **Swedish Mining Innovation**, a joint venture by **Vinnova**, **Formas, a Swedish Research Council for Sustainable Development** and **Swedish Energy Agency**.

Further information can be found through this link, **https://lnkd.in/dyHJp3Xr**

Residue2Product



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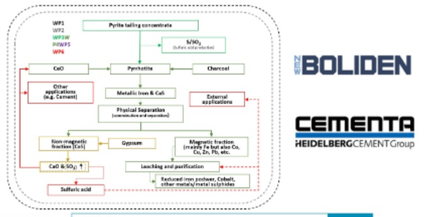

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Residue2Product-II

Published: 16 May 2023

Transforming mining residues to valuable products (stage II) or Residue2Product-II project aims at developing and optimizing a novel combined recycling process for pyrite tailings and waste gypsum. Products such as lime, sulphur/sulphur dioxide and iron powder are produced.

Products such as lime, sulphur/sulphur dioxide and iron powder are produced. The specific project objectives are to; 1) integrate and optimize a combined recycling process for waste gypsum and pyrite tailings, 2) identify the factors that affect/optimize the conversion of pyrite and gypsum to lime, sulphur/sulphur dioxide and iron powder, 3) evaluate generated products and identify the plausible separation techniques for the potential use of lime in cement industry and metallic iron in the steel industry, and 4) evaluate the potential recovery of additional valuable metals as e.g. cobalt.

Wastes from the mining of sulphidic ores for Cu, Zn, Pb, etc. represent the largest volume of waste generated in the European mining industry. Weathering of pyrite tailings can lead to the formation of acidic water known as acid mine drainage (AMD). Neutralization of AMD with limestone/lime addition results in high production of gypsum residue ($CaSO_4 \cdot 2H_2O$). Gypsum residues are by-products of many other processes, e.g. phosphoric acid production. Pyrite tailings and waste gypsum are fed into the new process, which will ensure mining sustainability, decrease the environmental burden from the generated wastes, and reduce the generated CO_2.

The project results will strengthen the Swedish mining and metallurgical industry, by providing improved management of the residues. The results can be implemented in any extraction of base metals from sulphidic ore and chemical manufacturing industry, etc.

The project is funded through the strategic innovation program Swedish Mining Innovation, a joint venture by Vinnova, Formas and Energimyndigheten.

The residue2product-II is a a collaborative project between LTU, Boliden minerals and Cementa.

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Hesham Ahmed, Associate Professor
Phone: +46 (0)920 491309
Email: hesham.ahmed@ltu.se
Organisation: Process Metallurgy, Minerals and Metallurgical Engineering, Department of Civil, Environmental and Natural Resources Engineering

ELSEVIER

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Recycling of pyrite and gypsum mining residues through thermochemical conversion into valuable products

Mohamed Elsadek [a b], Hesham Ahmed [a b], Malin Suup [c], Anders Sand [c], Eetu Heikkinen [d], Mohammad Khoshkhoo [c], Lena Sundqvist-Öqvist [a]

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Researchers turn tailings into chemical, construction materials

A new study has found a way to use thermochemical conversion to recycle mining waste into valuable chemicals and construction products.

Pyrite tailings ar

Future Of Mining > Sustainability

The study, which was conducted by researchers at Luleå University of Technology in Sweden, focused on the recycling of pyrite tailings and gypsum residues from the Boliden Aitik mine.

20 October 2023

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Next Steps

- Postdoc arrival (expected early 2024)
- Continue with Thermodynamic modeling including impurity minerals
- Study the effect of different parameters on each of the proposed steps
- Optimization
- Study more complicated pyrite tailings and waste gypsum
- Product and process evaluation

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Mining innovation for a sustainable future

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