Strengthening Efforts in Critical and Strategic Metals and Minerals Research and Innovation at Luleå University of Technology

Lena Sundqvist Öqvist

CAMMCRM
CENTRE OF ADVANCED MINING AND METALLURGY CRITICAL RAW MATERIALS

LULEÅ TEKNISKA UNIVERSITET

Process Metallurgy at LTU

- Group of approx. 35 researchers
- Applied research linked to mining, metallurgy and recycling.
  - extraction of metals from complex primary and secondary raw materials, heat treatments and production of alloys and metal salts
  - valorising by-products, slag to SCM (Supplementary Cementitious Material)
- Civil engineering program in Sustainable Process and Chemical Engineering

Pyro Metallurgy

Hydro Metallurgy

Main research Areas

Iron/steel

Strategic metals

Residues

Slag

CRM

On-going or recent projects related to Li, Ni, Co, Cu, Zn, Pb, Sb, Bi, As, Au, Ag, Ti, V, Cr, REE, P, $C_{Graphite}$

Increased need for elements

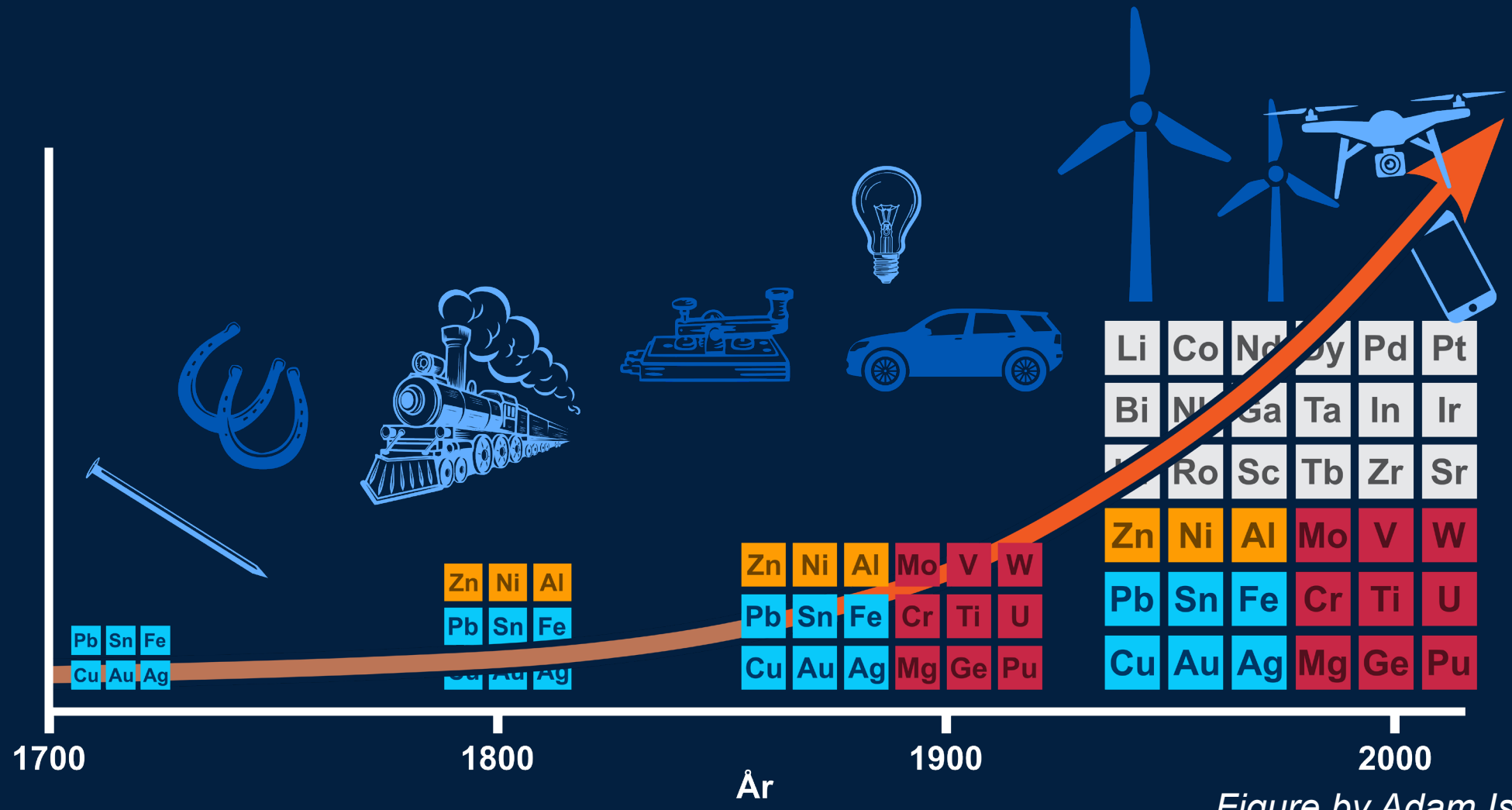


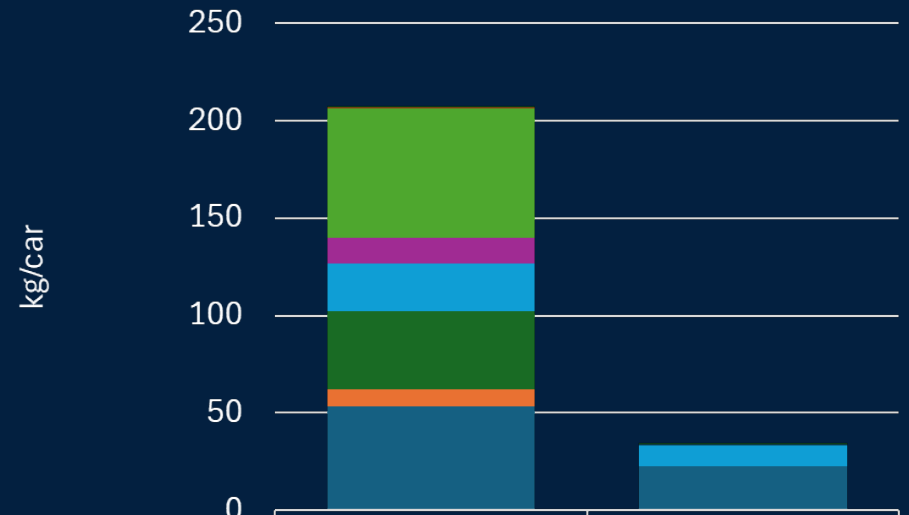
Figure by Adam Isaksson, LTU

EV compared to conventional

EV can be in average 340 kg heavier

It can require up to 6 times more metals to operate an EV than a conventional car.

- Cu in electrical wiring and stator if the vehicle uses an induction motor.
- Batteries use graphite in the anode and nickel, cobalt, lithium and manganese in the cathode.
- REEs in the permanent magnets of the electric motor.



	EV, kg/car	Conv. car, kg/car
Others	0.31	0.3
REE	0.5	0
Zinc	0.1	0.1
Graphite	66.3	0
Cobalt	13.3	0
Manganese	24.5	11.2
Nickel	39.9	0
Lithium	8.9	0
Copper	53.2	22.3

Data Source IEA, baserat på 75 kW NMC 622

CAMM
CENTRE OF ADVANCED MINING AND METALLURGY

CAMM-SFO Director: Saeed Chereh Chelgani
saeed.chelgani@ltu.se

Research center established in 2010 via a governmental *Strategic Research Area* grant (SFO).

Research along entire mining value chain

WP1 Exploration | **WP2 Mining** | **WP3 Mineral processing** | **WP4 Metallurgy** | **WP5 Environment**

Metallurgy involves research at LTU and Swerim

CAMM CRM

CAMM CRM is linked to CAMM SFO with common overarching governance, but separate management, budget, work plan and funding source

CAMM CRM funded by Ministry of Commerce vs. SFO by Ministry of Education.

Total budget: 145 MSEK (2025-2028)

Aim: Focused research on challenges for CRM supply along the value chain, from exploration to recycling.

CAMMCRM
CENTRE OF ADVANCED MINING AND METALLURGY CRITICAL RAW MATERIALS

Overarching goals

CAMM CRM activities should work towards:

- Reducing European dependency on imported CRMs.
- Strengthening collaboration between academia, industry, national and international initiatives.
- Developing environmentally responsible and socially acceptable exploration, resource extraction and recycling practices.
- Training the next generation of experts bridging geology, mineralogy, metallurgy, and processing

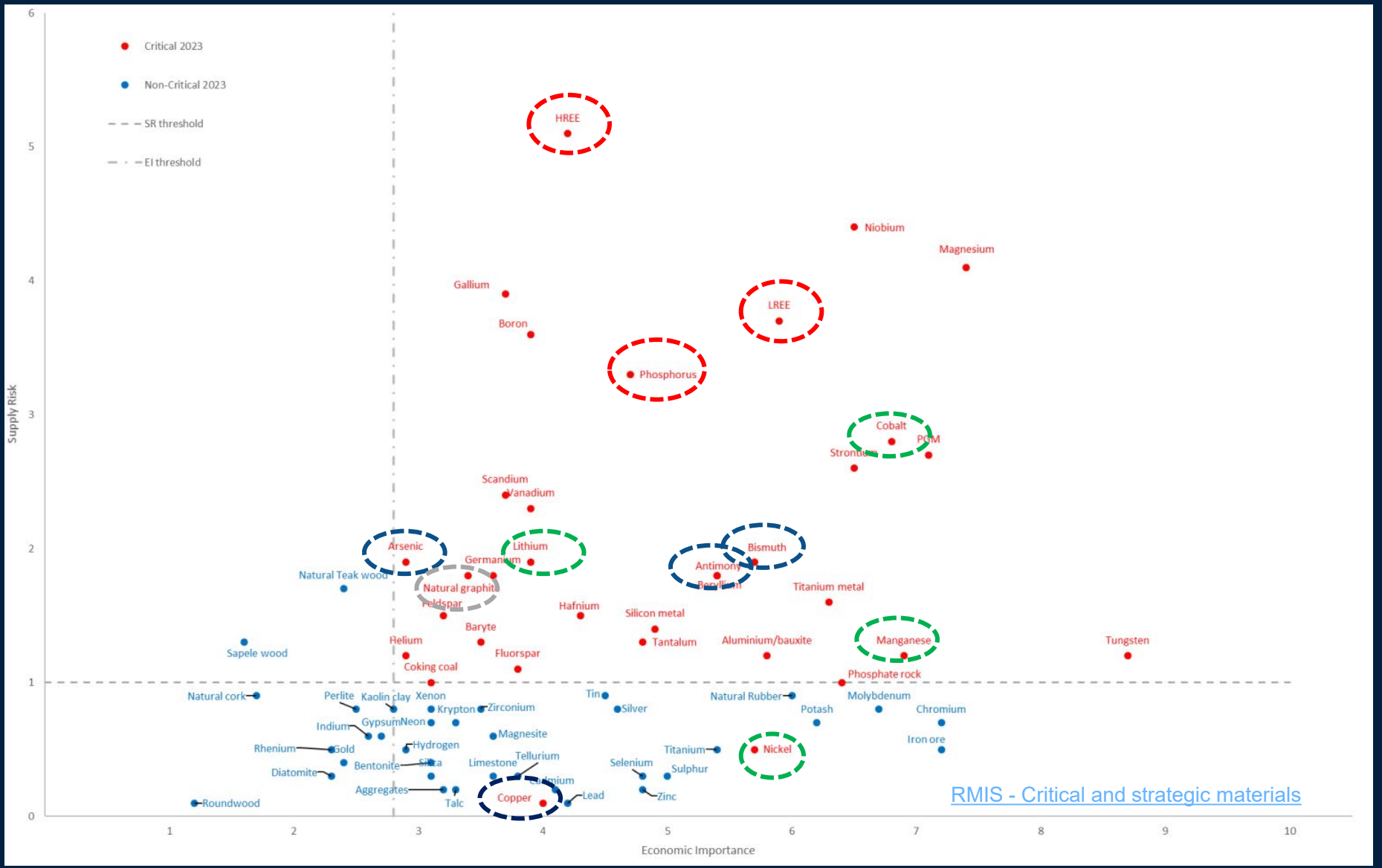
CAMM CRM

A strong tailored research agenda aims to put Sweden at the international forefront of CRM research.

- Opportunities in resources and technologies
- Industrial interest

Academic and industry stakeholders collaborate and contribute to national and EU goals

Existing CRM supply chains are transformed and new CRM supply chains established



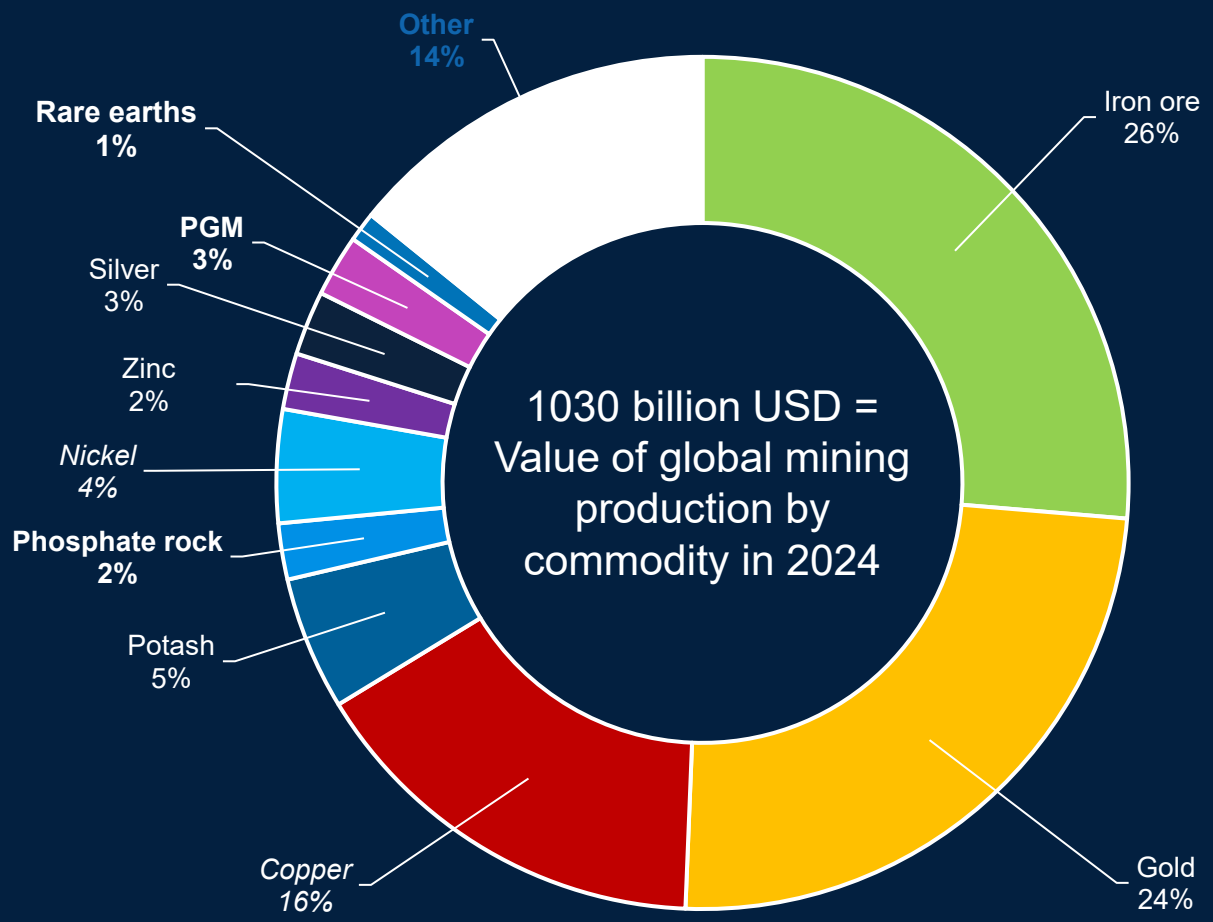
RMIS - Critical and strategic materials

Critical raw materials

Critical for modern technologies important to the digital and green transitions and for defence

- Renewable energy
- Digital technologies
- Electrification of transport
- Aerospace and defences
- Construction at industry

Cost-efficient, reliable and scalable technologies are needed



SOURCE: Olof Löf, RMG Consulting 2025

Italics = Strategic raw materials, not critical

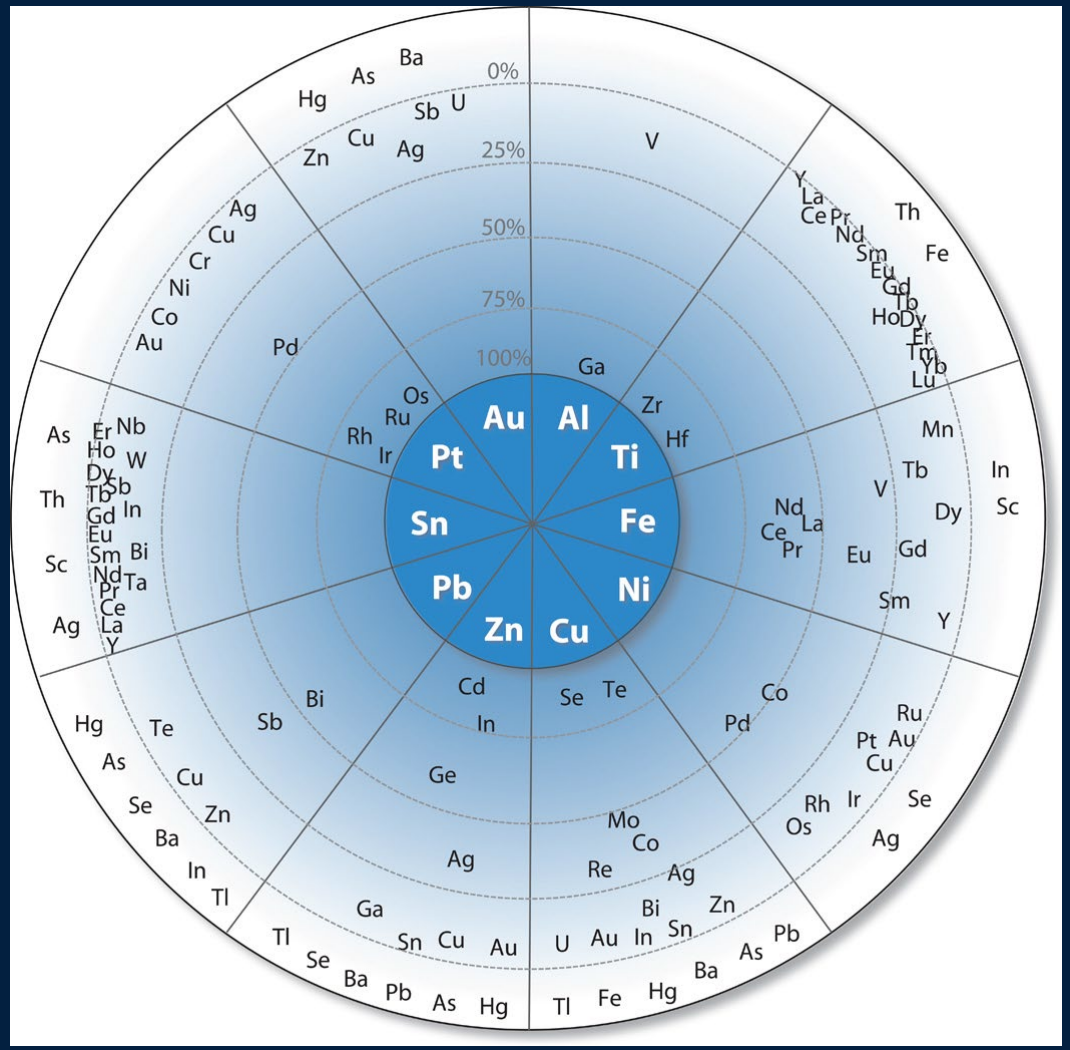
CRMs are <19% of the global mining value (<10% if including coal)

Many are niche industries built on volatile prices, unclear exploration targets and are commonly high-risk projects

Complicates realization of new supply chains

CAMM CRM aims at de-risking development by focused research on critical knowledge gaps

CRM-valorization from existing streams



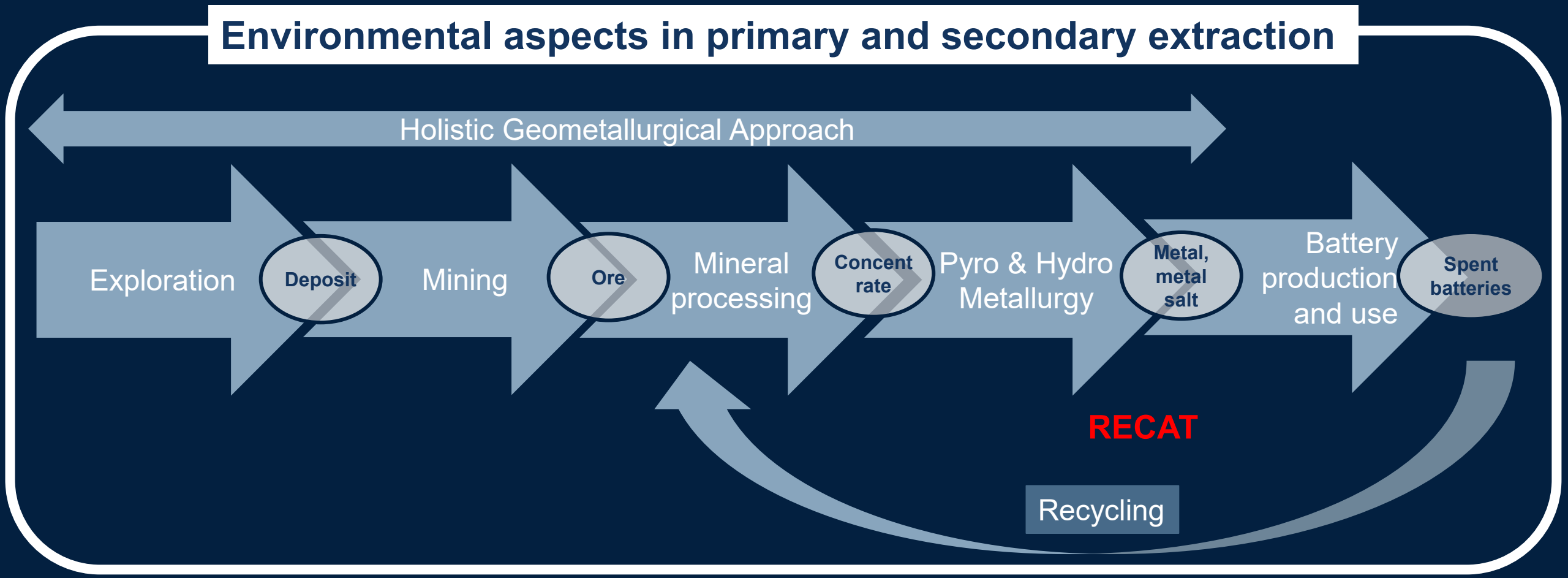
Many CRMs are almost exclusively derived as by-products from mining and smelting of ferrous, base and precious metals

Many are currently not recovered due to insufficient technologies and/or feasibility

Targeted CRM exploration will not be sufficient to meet current and future demands

Valorization of ’problem elements’ (e.g. Sb) can unlock metallurgically problematic mineral exploration targets

Integrated value chain approach to CRMs, example



RECAT= Research Center for Advanced Battery Technology,
https://www.ltu.se/en/research/centres-of-excellence-and-collaborations/recat

CRM act identified strategic projects in Sweden

European Commission

Strategic Projects under the Critical Raw Materials Act

STRATEGIC PROJECT

REEMap project

Description of project

The ReeMAP project is an extraction and processing project in Sweden. It aims at further expanding LKAB's businesses model by starting production of critical and strategical raw materials, as by-products from the iron ore production. The project spans three key locations in northern Sweden. At Malmberget, mine tailings from the ongoing underground operation will be further processed to produce a concentrate containing rare earth elements. In Kiruna, the Per Geijer deposit, contributes substantial reserves of iron ore containing rare earth elements to the ReeMAP project. At the planned Luleå Industrial Park, the concentrates are refined into commercial products, including rare earth oxides.

Benefit for the EU

The ReeMAP project effectively integrates various stages of the value chain from extraction to processing, to reduce the EU's reliance on imports of rare earth elements from 3rd countries. By producing materials essential for strategic technologies, such as electric vehicles and wind turbines, the project will also help to reduce vulnerability to external supply disruptions and strengthen EU's supply chains for these important technologies.

Project Name:
ReeMAP project

Project Type:
Integrated: Extraction and Processing

Strategic Raw Material:
Rare Earth Elements for Magnets (Nd, Pr, Tb, Dy, Gd, Sm, and Ce)

Project Promoter:
Luossavaara-Kirunavaara AB (LKAB)

Project Country:
Sweden

Estimated Starting Date of Production:
2026

UNFC Classification: Malmberget: E2 // F2.1 // G3 Lulea Industrial Park: E2 // F2.1 // G3 Per Geijer: E2 // F2.1 // G3

Website of the Strategic Project:
https://www.lkab.com

Luxembourg: Publications Office of the European Union, 2025
PDF ISBN 978-92-68-26257-3 doi: 10.2873/0012054 ET-01-25-085-EN-N

European Commission

Strategic Projects under the Critical Raw Materials Act

STRATEGIC PROJECT

Talga Natural Graphite ONE Project

Description of project

The Talga Natural Graphite ONE Project is an extraction project located in Sweden. The project entails a greenfield development consisting of a natural graphite mine and concentrator. The project will have natural graphite concentrate as an output, which can be used for further processing into natural graphite anode material. The project is particularly suitable for lithium-ion batteries, separating it from other graphite miners some of which are unsuitable for lithium-ion battery material.

Benefit for the EU

The Talga Natural Graphite ONE Project addresses strategic dependencies of the EU through the establishment of a secure supply of natural graphite concentrate. According to the project promoter, the project is forecasted to meet 2% of the demand for battery grade natural graphite in the EU by 2030. Thus, this project would contribute to the targets outlined in the Critical Raw Materials Act and enables domestic production of sustainable lithium-ion batteries, further enhancing the strategic autonomy and resilience of the EU. Furthermore, the project would entail a significant reduction in emissions of carbon dioxide compared to imported synthetic anode material used in lithium-ion batteries today.

Project Name:
Talga Natural Graphite ONE

Project Type:
Extraction

Strategic Raw Material:
Graphite (battery grade)

Project Promoter:
Talga AB

Project Country:
Sweden

Estimated Starting Date of Production:
2027

UNFC Classification:
E1.2 // F1.3 // G2

Website of the Strategic Project:
https://www.talgagroup.com/

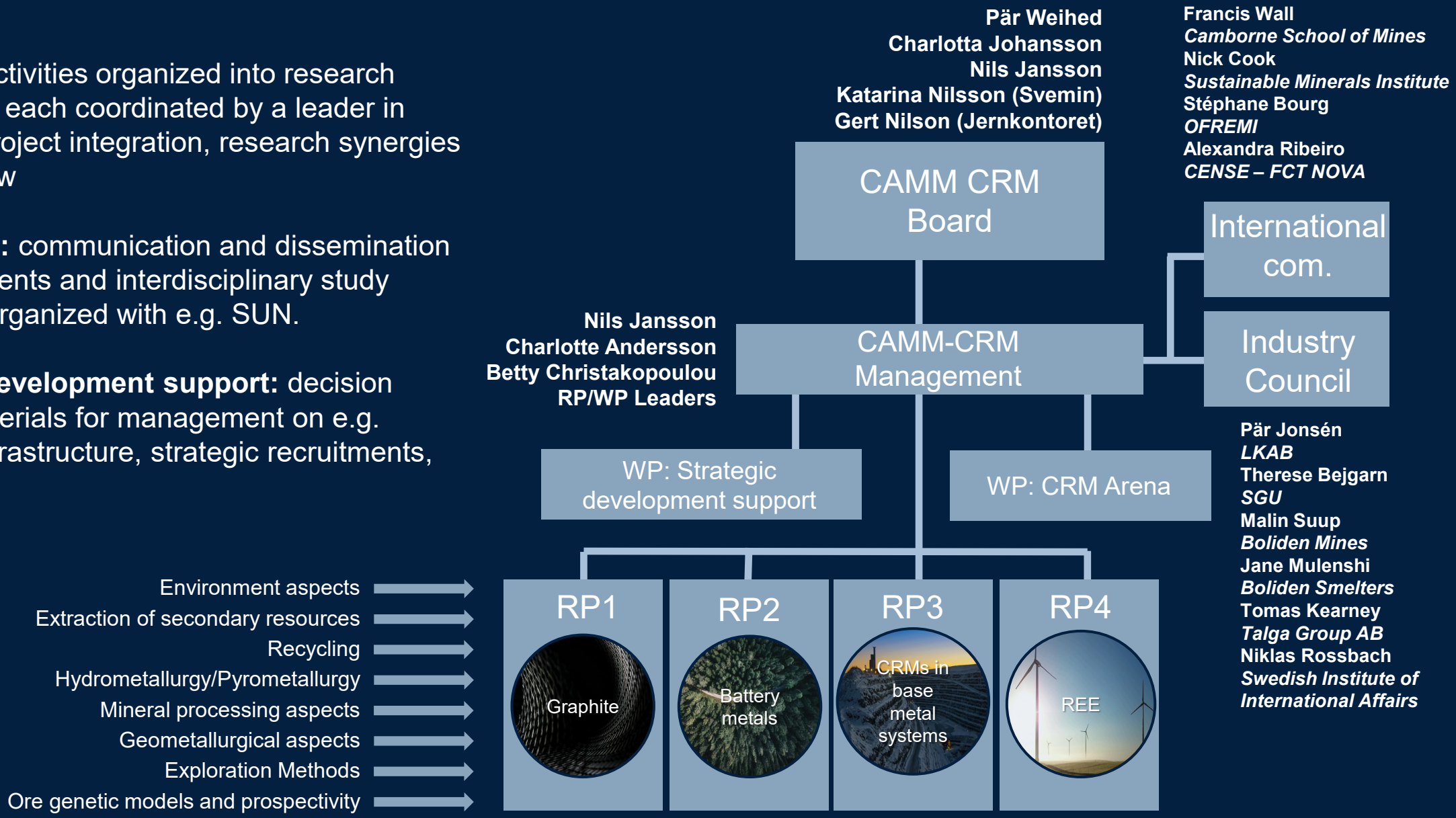
Luxembourg: Publications Office of the European Union, 2025
PDF ISBN 978-92-68-26151-4 doi: 10.2873/1636549 ET-01-25-054-EN-N

Organization and structure

Research activities organized into research pillars (RP), each coordinated by a leader in charge of project integration, research synergies and overview

CRM Arena: communication and dissemination platform, events and interdisciplinary study groups co-organized with e.g. SUN.

Strategic development support: decision support materials for management on e.g. research infrastructure, strategic recruitments, calls



Challenges

Volatile business cases

- High processing costs and volatile commodity prices.
- Market sensitivity due to low total volumes of specific raw materials within the EU.
- Example: In the battery sector, a significant gap emerged between forecasted and realized capacity. EV adoption progressed more slowly than expected, and shifts in battery chemistry influenced the ramp-up of cell manufacturing.

Constraints in the EU value chain

- For example, around **98%** of rare-earth magnets and compounds used in the EU are imported from China*.
- If primary supply of REEs is developed within the EU, **downstream production capacity** must also be established.
- Existing and emerging EU producers
  - **VACUUMSCHMELZE (VAC)** plants in Germany, Slovakia and Finland
  - New sintered **NdFeB** plant in Narva, Estonia

**ASCII Policy Brief*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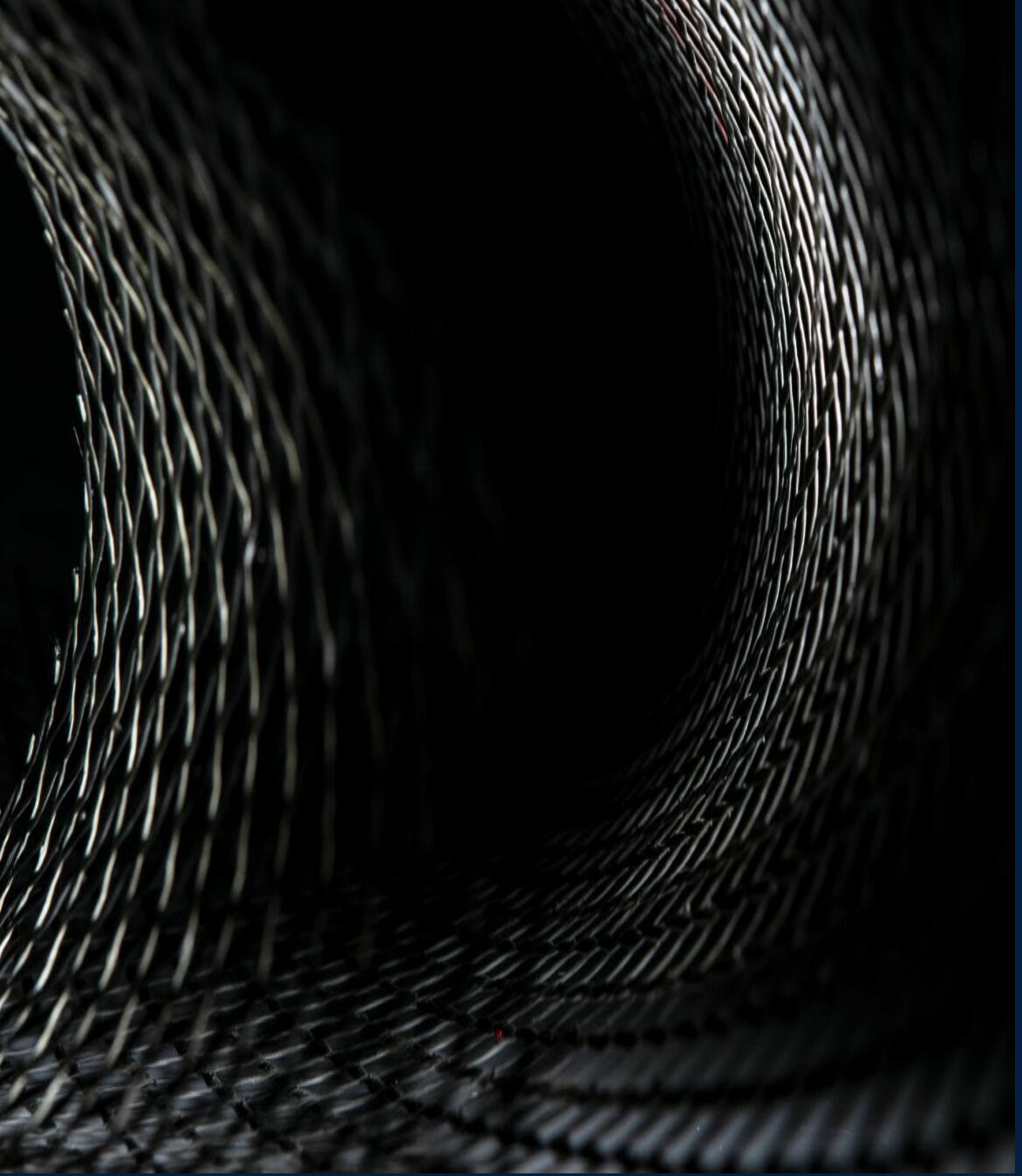


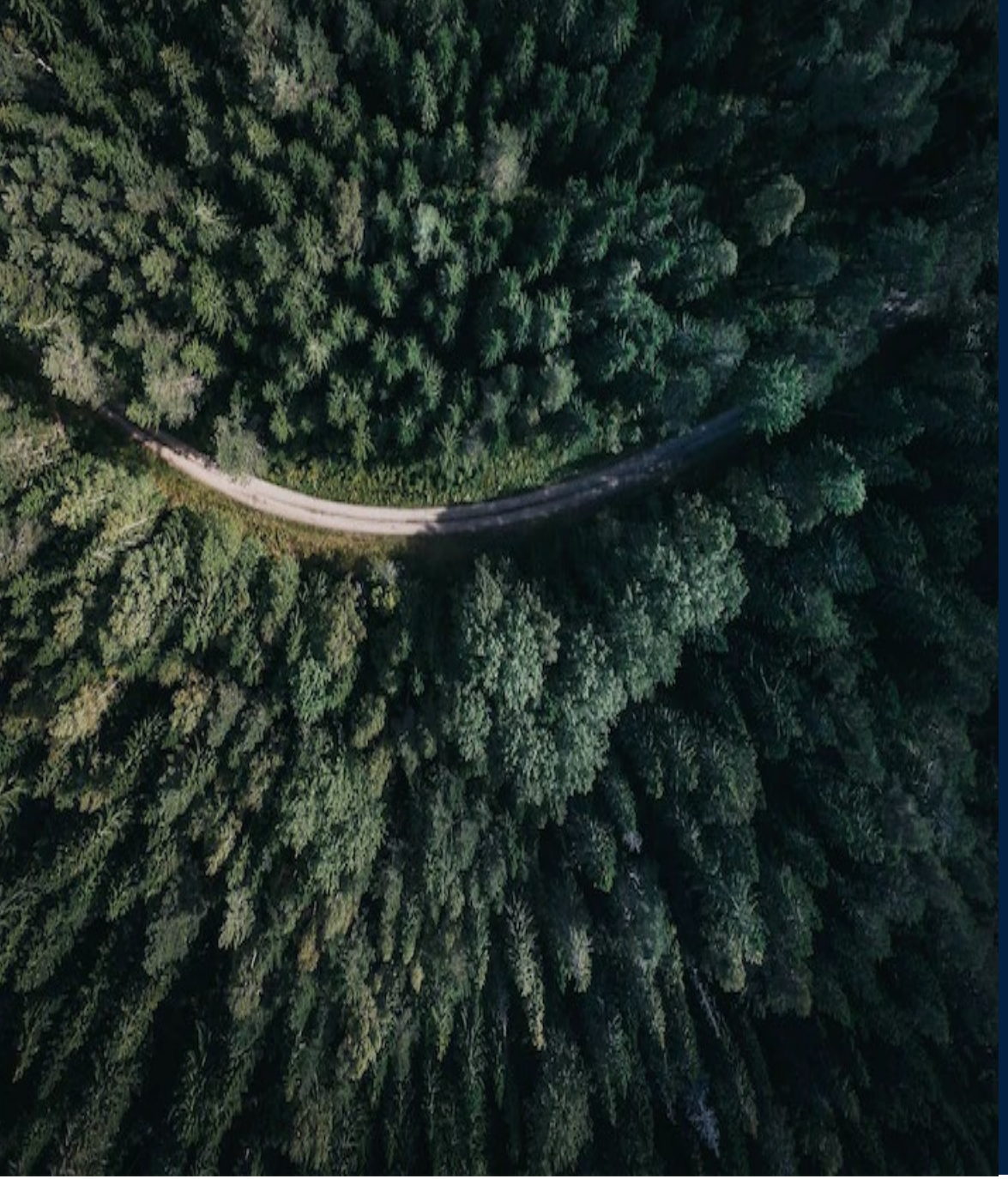
RP1 - Graphite

RP Leader: Mehdi Parian
Associate Professor
Mineral Processing

Overarching goals

1. Reduce European graphite dependency
2. Contributing to building a sustainable graphite value chain in Sweden, spanning exploration, beneficiation, refining, and recycling.

Industry partners: Talga Group, Woxna, Georeality



RP2 – Battery metals

RP leader: Edward Lynch
Associate Senior Lecturer
Ore Geology

Overarching goals

1. Secure sustainable supply of battery metals for Europe.
2. Reduce import dependency for Li, Co, Ni, Mn, and emerging battery metals (V, La, Zr, Ta, P, S, Ge).
3. Enable Europe to meet EU Battery Directive recovery targets.

Industry partners: Talga Group, Boliden, Asera Mining, Greenavance Tech Global AB

RP3 – CRMs in base metal system

RP leader: Lina Hällström
Associate Senior Lecturer
Applied Geochemistry

Overarching goals

1. Increase supply chain resilience and resource efficiency.
2. Strengthen Europe's CRM access by valorizing existing base metal operations.
3. Support industry in diversifying revenue and reducing penalty risks from "problem elements."

Industry partners: Boliden

RP4 – REE

RP leader: Lena Sundqvist-Öqvist
Professor
Process Metallurgy

Overarching goals

- Secure a sustainable REE supply chain for Europe
- Reduce near-total dependence on imports.
- Position Sweden as a leader in REE production and recycling.
- Strengthen Europe’s renewable energy, electrification, and defense security through REE supply resilience.

Industry partners: LKAB, Leading Edge, District Metals