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Battery metals from mine waste:

Our global opportunity

Dr. Helen Degeling

ASX: COB

CobaltBlue

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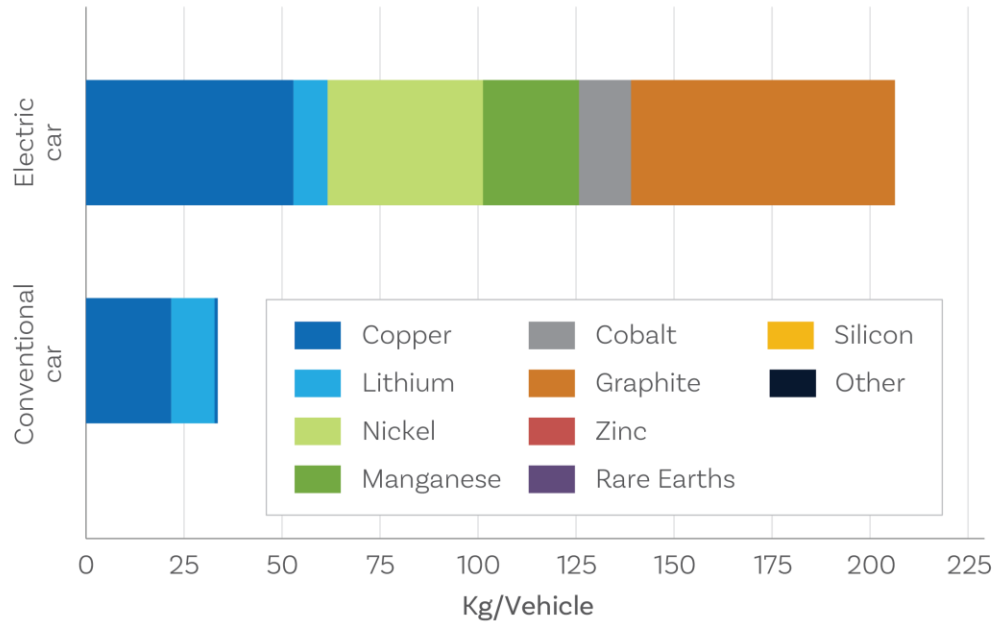
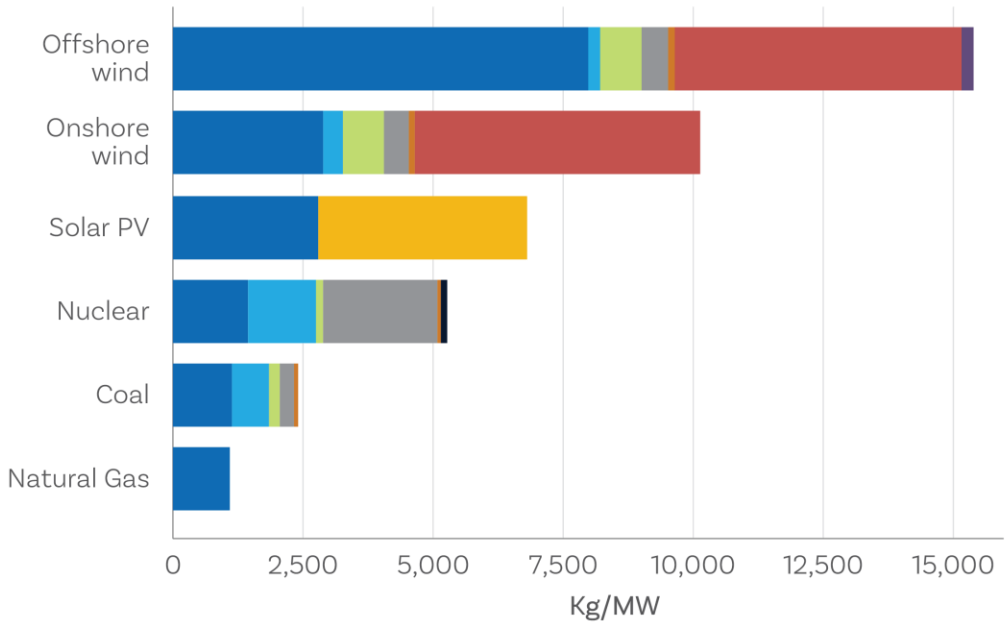
Metals and Mining for the Energy Transition





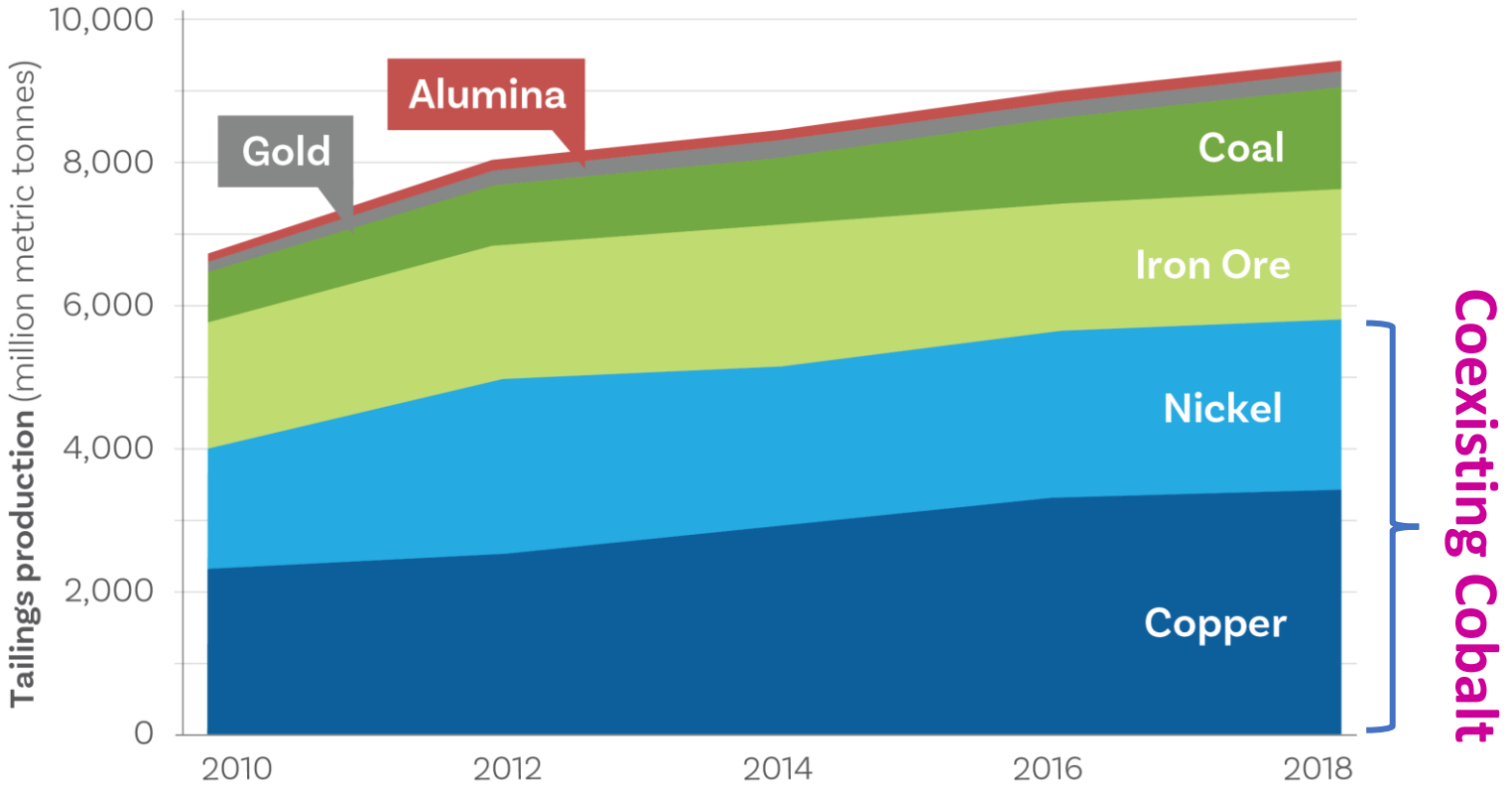
IEA, *Minerals used in electric cars compared to conventional cars*, IEA, Paris https://www.iea.org/data-and-statistics/charts/minerals-used-in-electric-cars-compared-to-conventional-cars, IEA. Licence: CC BY 4.0

IEA, *Minerals used in clean energy technologies compared to other power generation sources*, IEA, Paris https://www.iea.org/data-and-statistics/charts/minerals-used-in-clean-energy-technologies-compared-to-other-power-generation-sources, IEA. Licence: CC BY 4.0

Mine Waste: Size of the ~~Problem~~ OPPORTUNITY

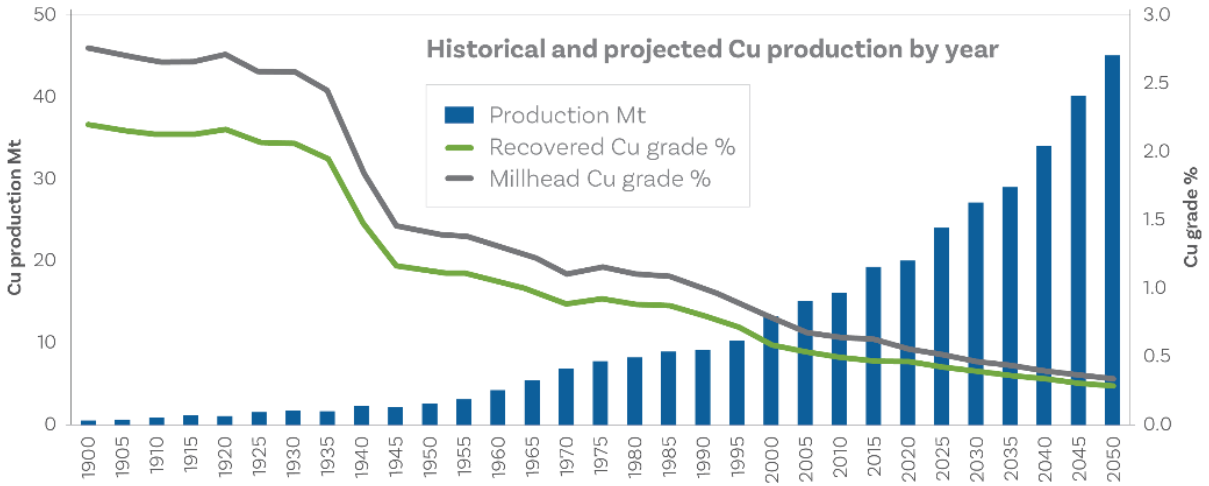
Estimate of global annual tailings production by commodity

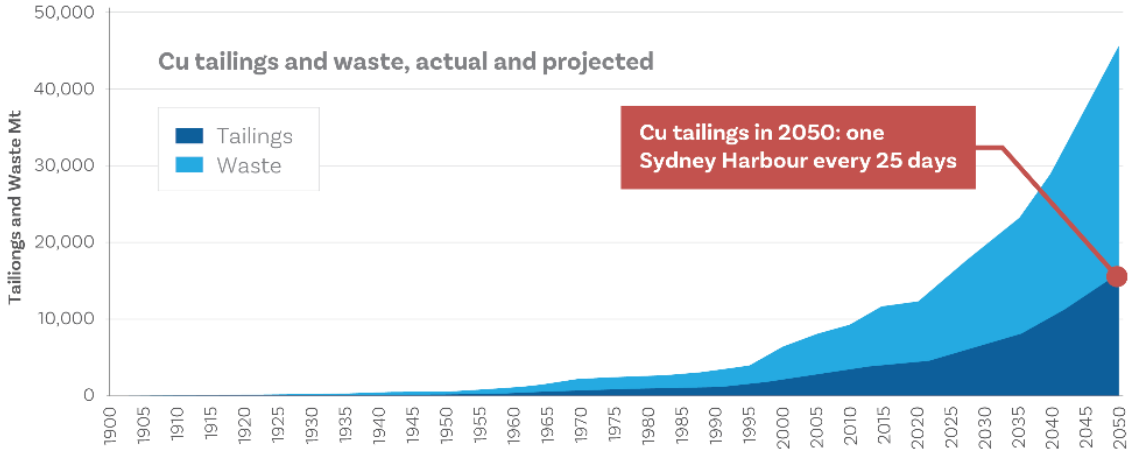
- 3.4 billion tonnes tailings produced annually from copper tailings in 2018.
- Copper by far the most.
- Declining grades, increasing demand, mean the volume of tails per tonne Cu produced is going up.
- Coexisting metals end up in waste – as much as 0.1 % Co could be present in an average Cu or Ni deposit (USGS)



Source: International Council on Mining and Metals; Roadmap for Tailings Reduction, 2022

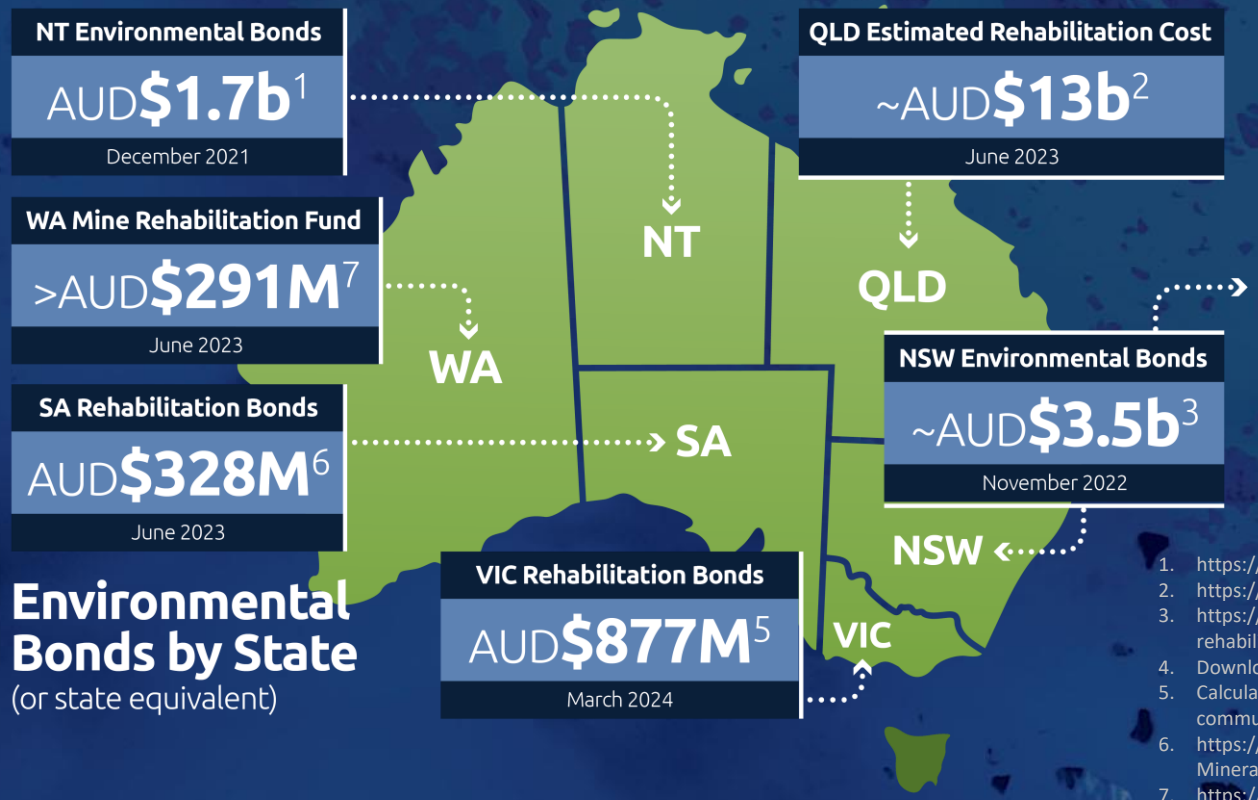
Cu tailings – 2050





Source: R. Valenta 2021

Environmental Bonds by State (or territory)



What is an environmental bond?

An environmental bond is a deposit to a government to cover potential damage from mining activities. Bonds vary by location and by project size and pollution risk.

Re-mining can reduce bond costs by lowering project size and risk, freeing up funds for rehabilitation and commercialisation of mine waste.

NSW Environmental Bonds

Using the NSW Rehabilitation Cost Estimation Tool[4], Re-mining tailings to remove sulphides could reduce an environmental bond from >AUD$800k/ha to AUD$82k/ha (excl. water management & waste water treatment costs)

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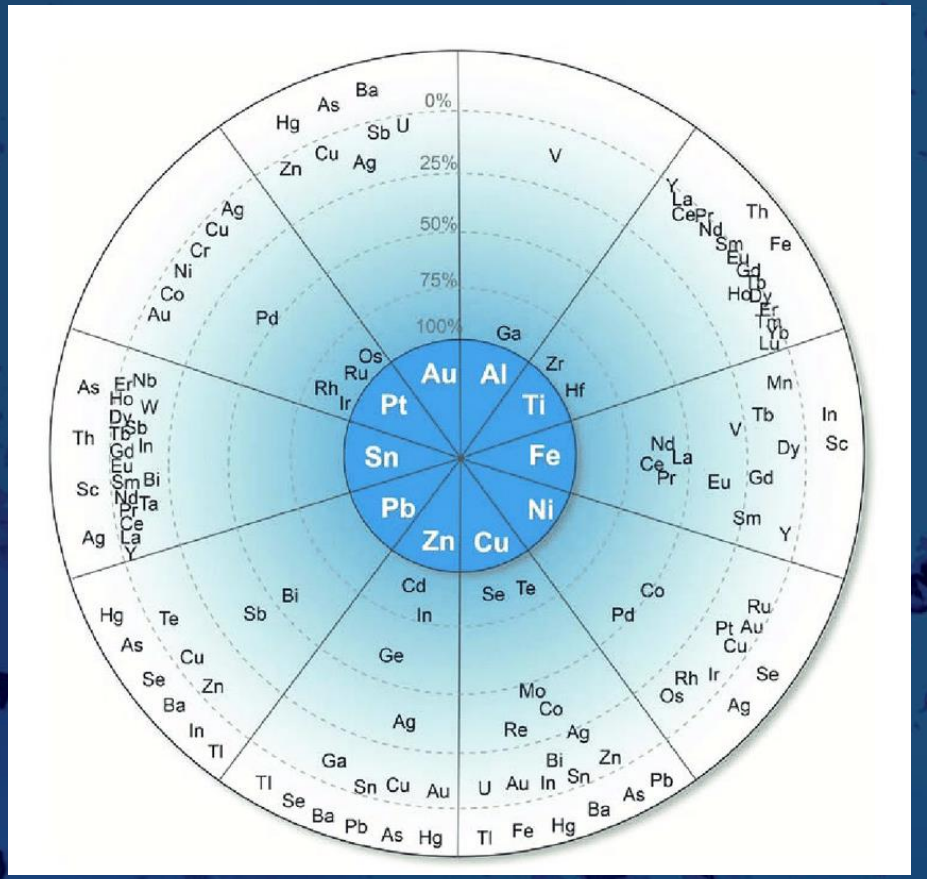
4. Downloaded from https://www.resourcesregulator.nsw.gov.au/rehabilitation/rehabilitation-security-deposits
5. Calculated from the Register of Rehabilitation Bonds https://resources.vic.gov.au/community-and-land-use/rehabilitation
6. https://www.energymining.sa.gov.au/industry/minerals-and-mining/mining/regulating-mining-activity/Mineral-resources-regulation-report/mine-rehabilitation-and-closure
7. https://www.dmp.wa.gov.au/Documents/Petroleum/MRF22-23-Yearly-Report.pdf

Predictive metal associations

- Natural ore deposits are a mix of commodities, though often with one dominant
- Mining operations focus on one or two commodities for efficiency of operation.
  - The remaining metals are sent to waste
- For example, cobalt is commonly associated with both nickel and copper ore. However the majority of mine operators have previously not extracted the cobalt.
  - It can therefore be predicted that many large copper and nickel mines will contain potentially economic concentrations of cobalt
- Other metals, many critical to the energy transition, may also be predicted to occur in mine waste based on their known ore associations



Source: https://www.nordicinnovation.org/2021/nordic-supply-potential-critical-metals-and-mineralsgreen-energy-transition

Predictive metal associations

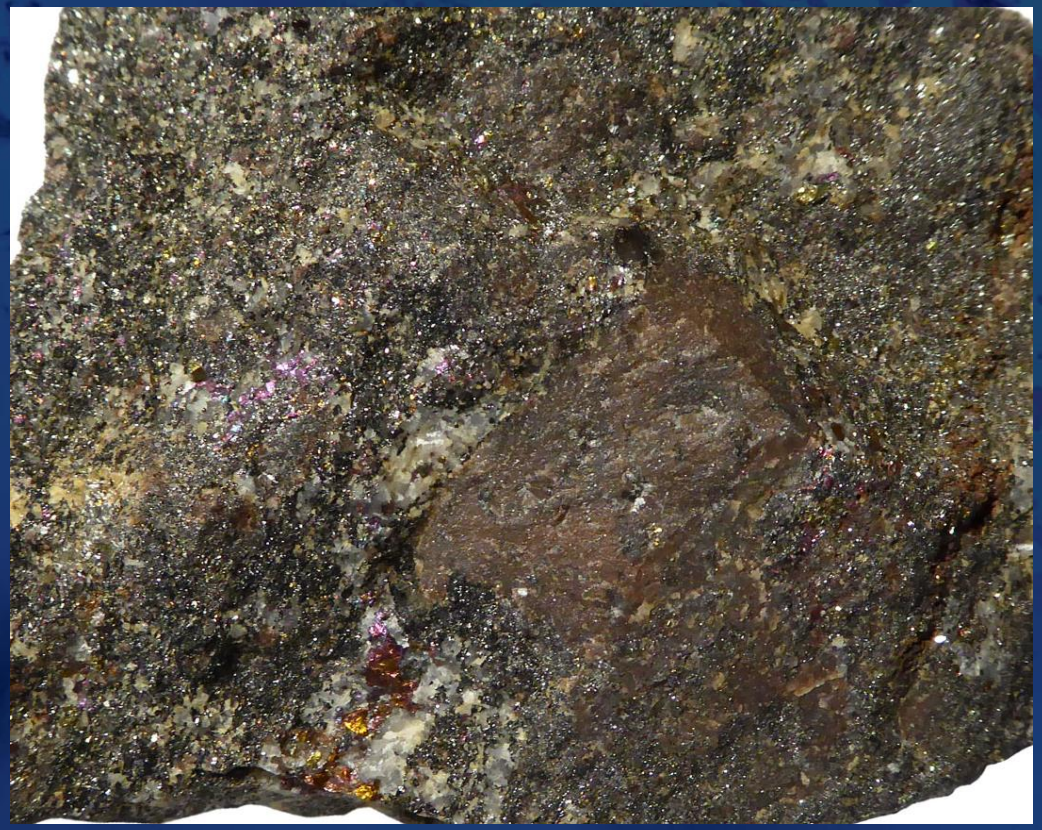
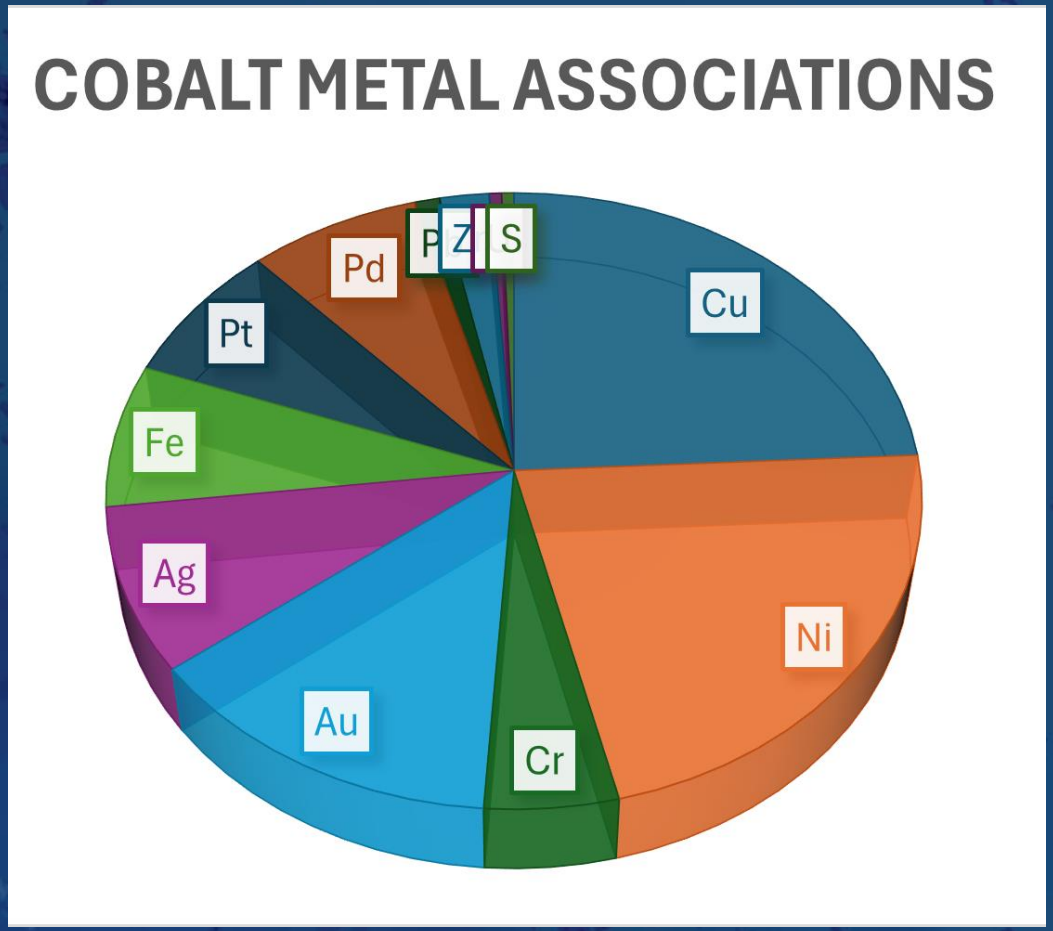


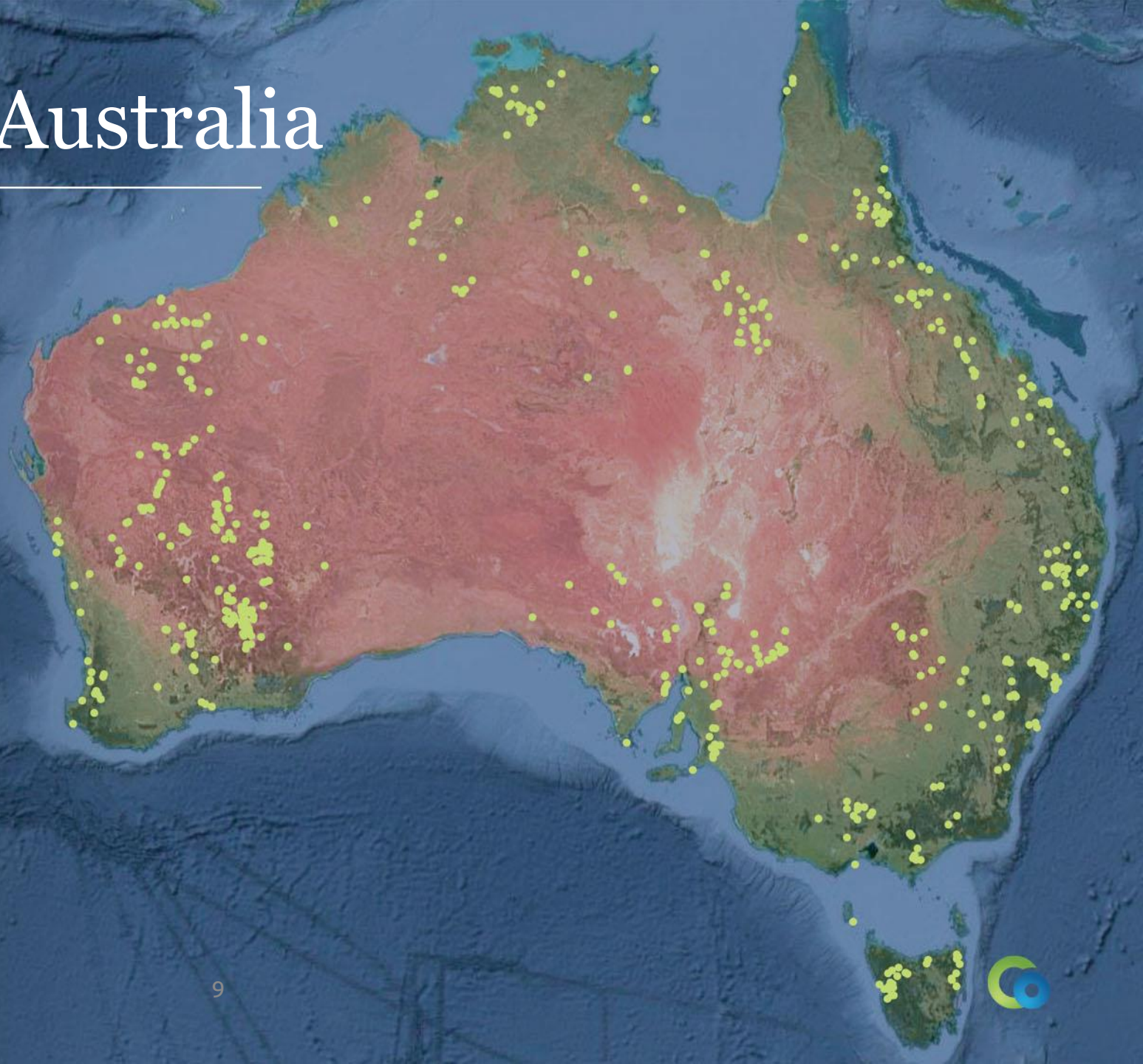
Image credit: Mike Porter



Derived from USGS Cobalt occurrence data
https://mrdata.usgs.gov/deposit/

Mine Waste in Australia

- >3,500 active and inactive sites on GA portal, 10's thousands estimated by other studies



Mine waste in Europe

- Very long history of mining
- >30,000 active and inactive sites

Mine Waste in the United States

- >100,000 active and inactive sites

https://mrdata.usgs.gov/usmin/map-us.html#home

Mine Waste in Canada

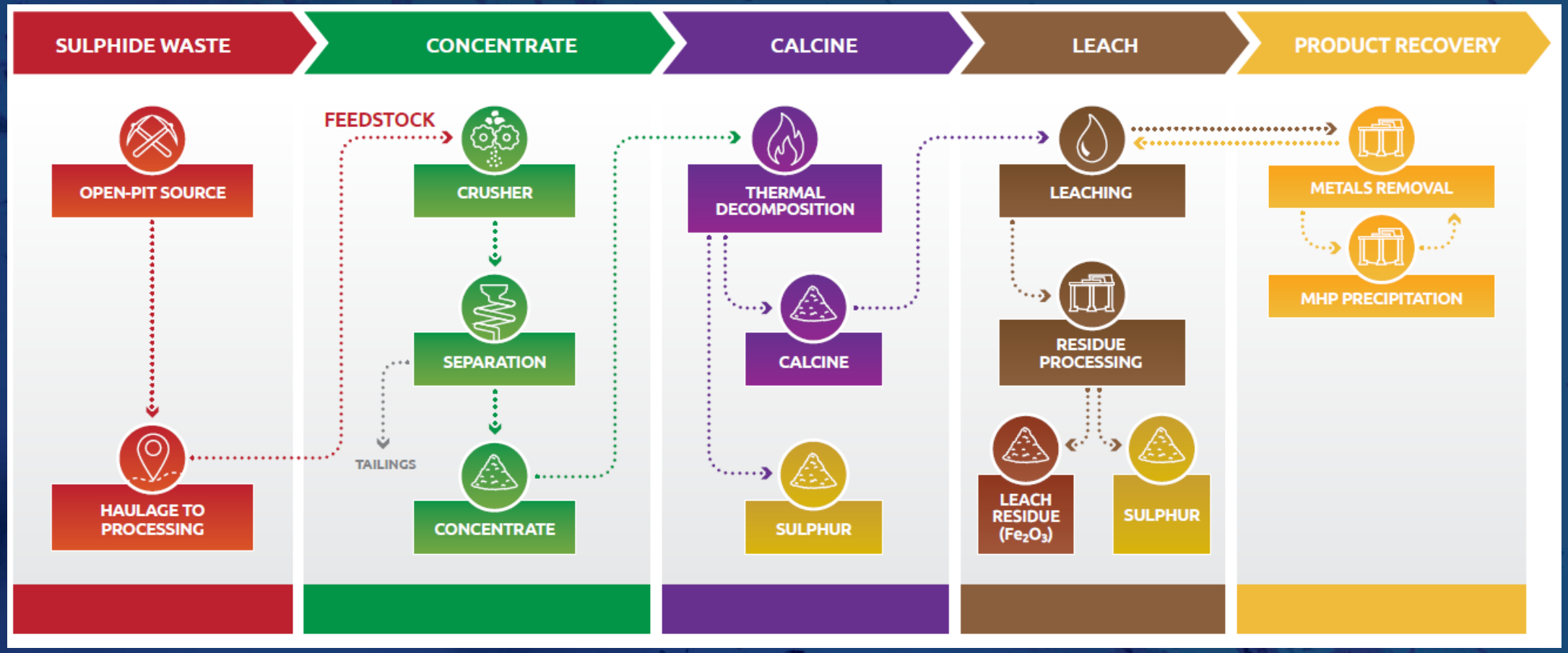
- >14,000 active and inactive sites

https://spatialsk.maps.arcgis.com/apps/dashboards/780a4bc0aa524cc38e10a4699bc3511e

Cobalt Blue: metals for positive impact

Our *'mine-to-battery-markets'* strategy aims to provide a reliable supply of responsibly sourced battery metals that are essential to the Global Energy Transition.

The Cobalt Blue flow sheet



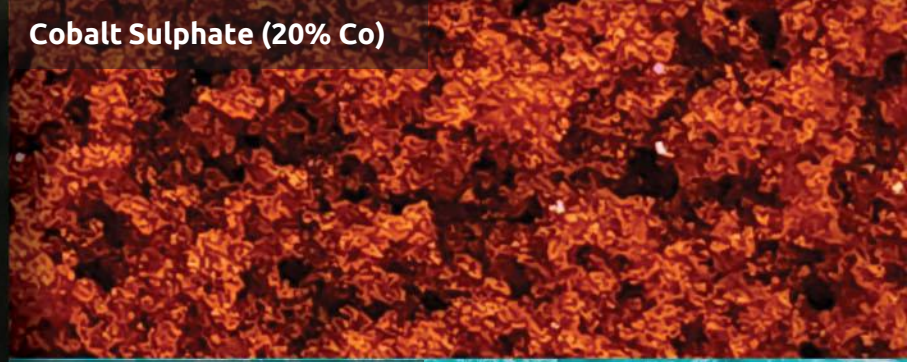
Cobalt Blue Products

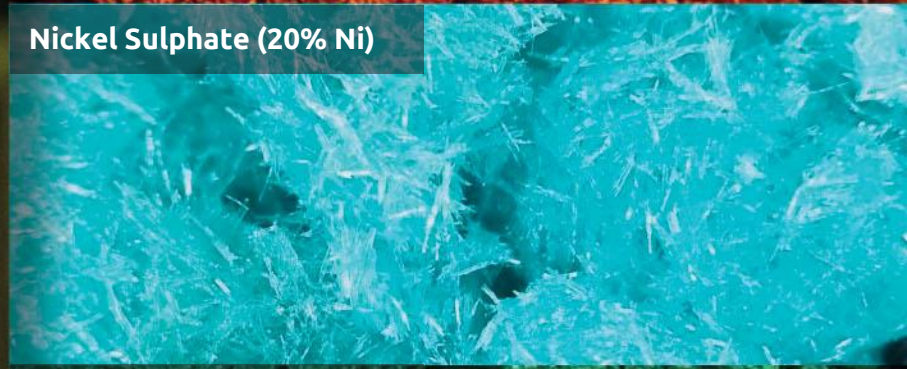
Our processing technology is unique by design but based on some the most commonly used refining techniques used around the world. We can tailor the product to end-users' requirements

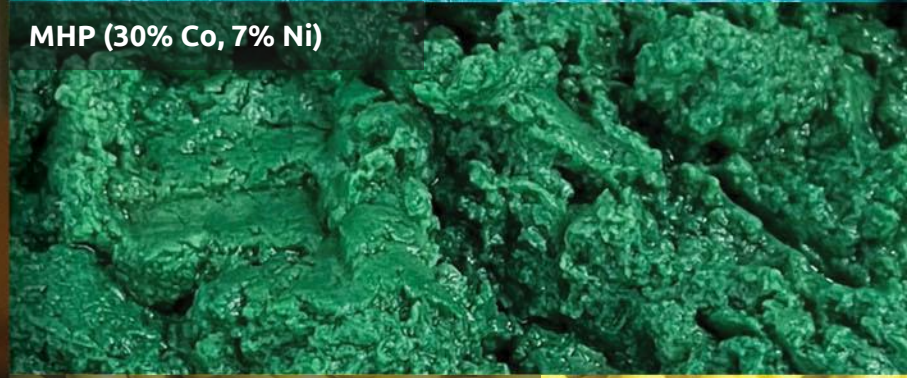
Products for Broken Hill Cobalt Project

- Elemental Sulphur
- Mixed Hydroxide Precipitate (Cobalt and Nickel hydroxide)
- Refining step produces cobalt and nickel sulphate

Outputs from leach step can be varied depending on ore composition and target commodities







Source: Cobalt Blue Holdings Limited

Example: Osborne Testwork

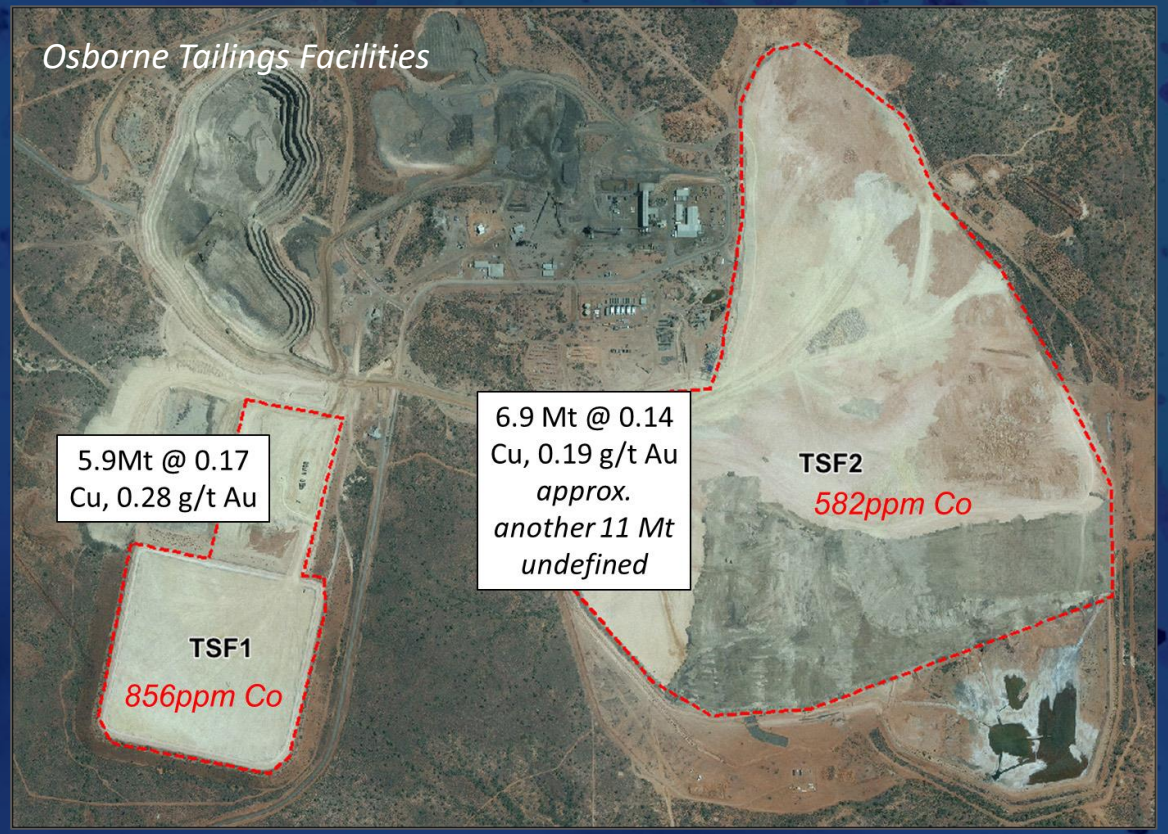


Image credit and sampling data: A. Parbhakar-Fox, University of Queensland.

Two flowsheets tested:

Tails → float → POX
Tails → kiln → POX (COB Process)

	Float	POX	TOTAL recovery
Cobalt	90%	46%	41.4%
Copper	74%	98%	72.5%

	Kiln	POX	TOTAL recovery
COBALT	99%	90%	89.1%
COPPER	99%	90%	89.1%

Further recovery of cobalt and copper required from leach solutions.

Flin Flon Tailings Project

Site: Flin Flon TSF

Location: Manitoba, Canada

Commodities: Zn-Cu-Ag

Status: initial testwork completed. Confirms >90% conversion of pyrite to pyrrhotite from tailings sample, with capture/removal of elemental sulphur

Estimated >100 million tonnes contained in tailings dam at Flin Flon. Tailings contains Zn, Cu, Ag and Au.

HUDBAY

Cobalt Blue and Hudbay Minerals collaborating to apply Cobalt Blue's processing technology to the Flin Flon tailings facility, Manitoba.

Testwork results to date have achieved >90% conversion of pyrite to pyrrhotite + sulphur.

An overall flowsheet is now being designed for the final step of testwork.

The Case for Tailings Re-Processing

The problem

Traditionally, mine waste such as tailings is considered a liability. Employing circular economy principles redefines the liability into a valuable asset which can be recycled, repurposed or reprocessed and reduced.

The opportunity

Re-processing sulphide mine waste allows discarded metals to be recovered, leading to ethically sourced metal and sulphur products whilst reducing the potential for environmental harm.
In addition, international legislation such as the IRA and CRMA mandate domestic production of a variety of critical minerals, many of which can be found in the mine waste of traditional operations, making this an ideal source of much needed material for the energy transition

Our know-how

Our extensive experience and proven ability to think outside the box ensures we can create value from waste through bespoke solutions, whilst optimizing for positive environmental outcomes.

Creating value

Concepts of value are evolving from traditional economic philosophies, to include the importance of the natural environment. We can extract metal whilst also de-sulfidising the remaining material, leading to restoration of habitats and waterways and reducing environmental liabilities.

The Case for Tailings Re-Processing

Valuable Metals

Cost of mining/processing (capex/opex)

-$

Sale of metals

+$

Environmental Bond

-$

AMD risk reduction

+$

Volume reduction

+$

Economics of project

Wholistic economics of project

Acid Reduction

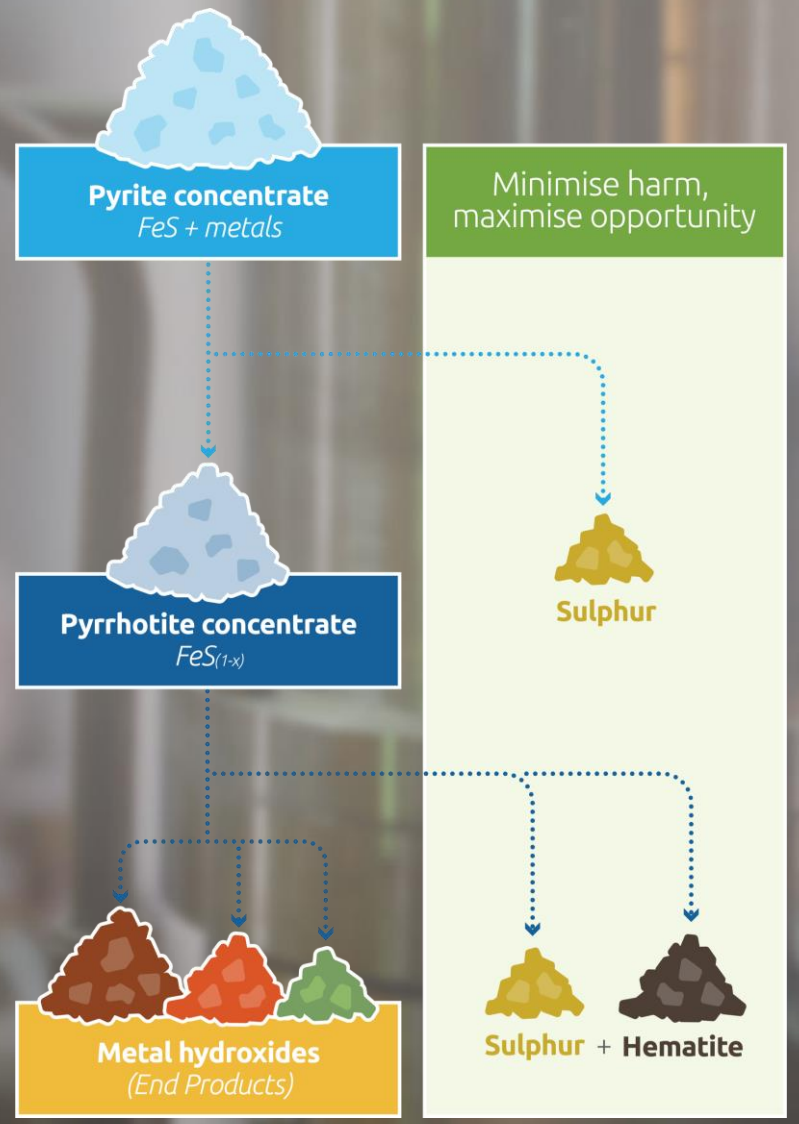
Cobalt Blue's patented process mitigates potential environmental harm and produces saleable elemental sulphur

A key step in the Cobalt Blue process is to convert pyrite (FeS) to the mineral pyrrhotite ($FeS_{(1-x)}$).

Pyrrhotite contains less sulphur than pyrite, and the rejected sulphur is captured as a gas and cooled to crystallise as elemental sulphur.

A second sulphur extraction step is achieved during leaching, during which the pyrrhotite molecules are oxidized to make hematite (Fe_2O_3). This process liberates sulphur, as well as any other metals (such as Co, Ni, Co, Ag and others) that may be contained in the pyrrhotite lattice.

By capturing the sulphur at each stage, any additional waste therefore has a much lower ability to form sulphuric acid; the main culprit in acid mine drainage.



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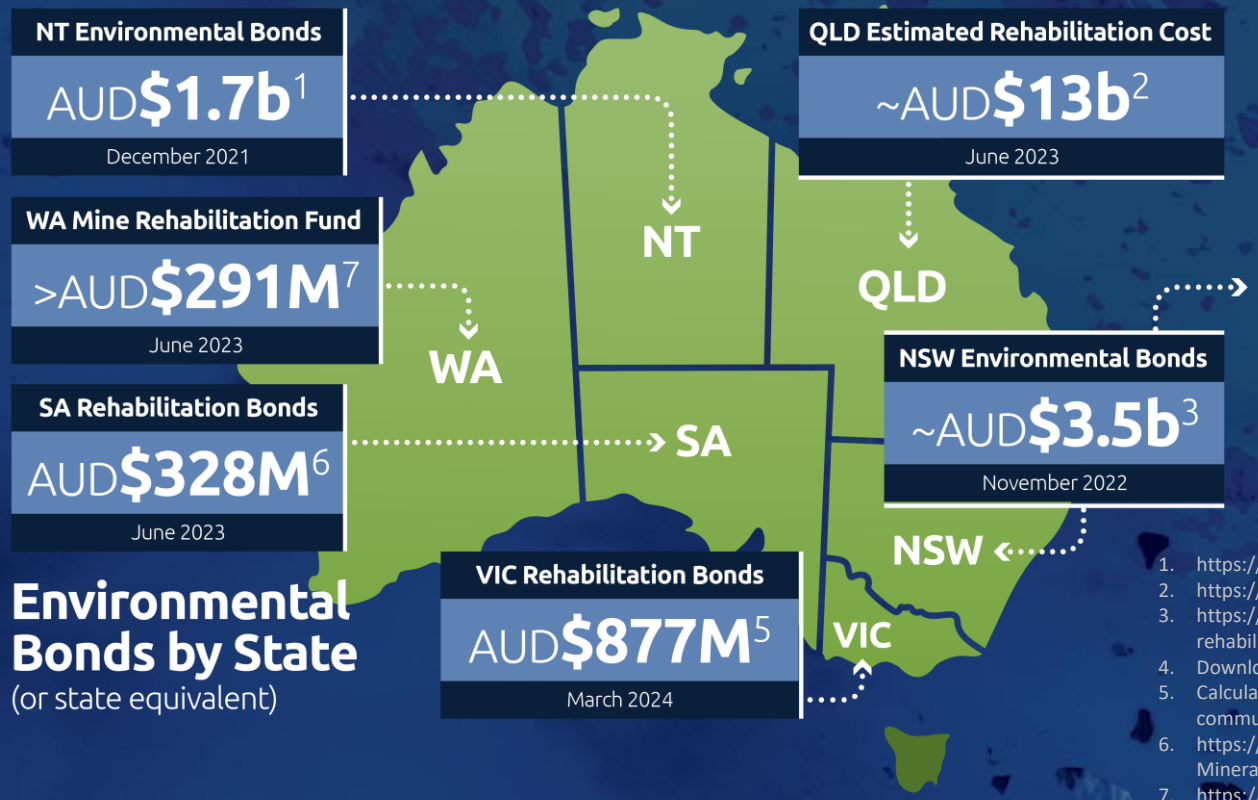

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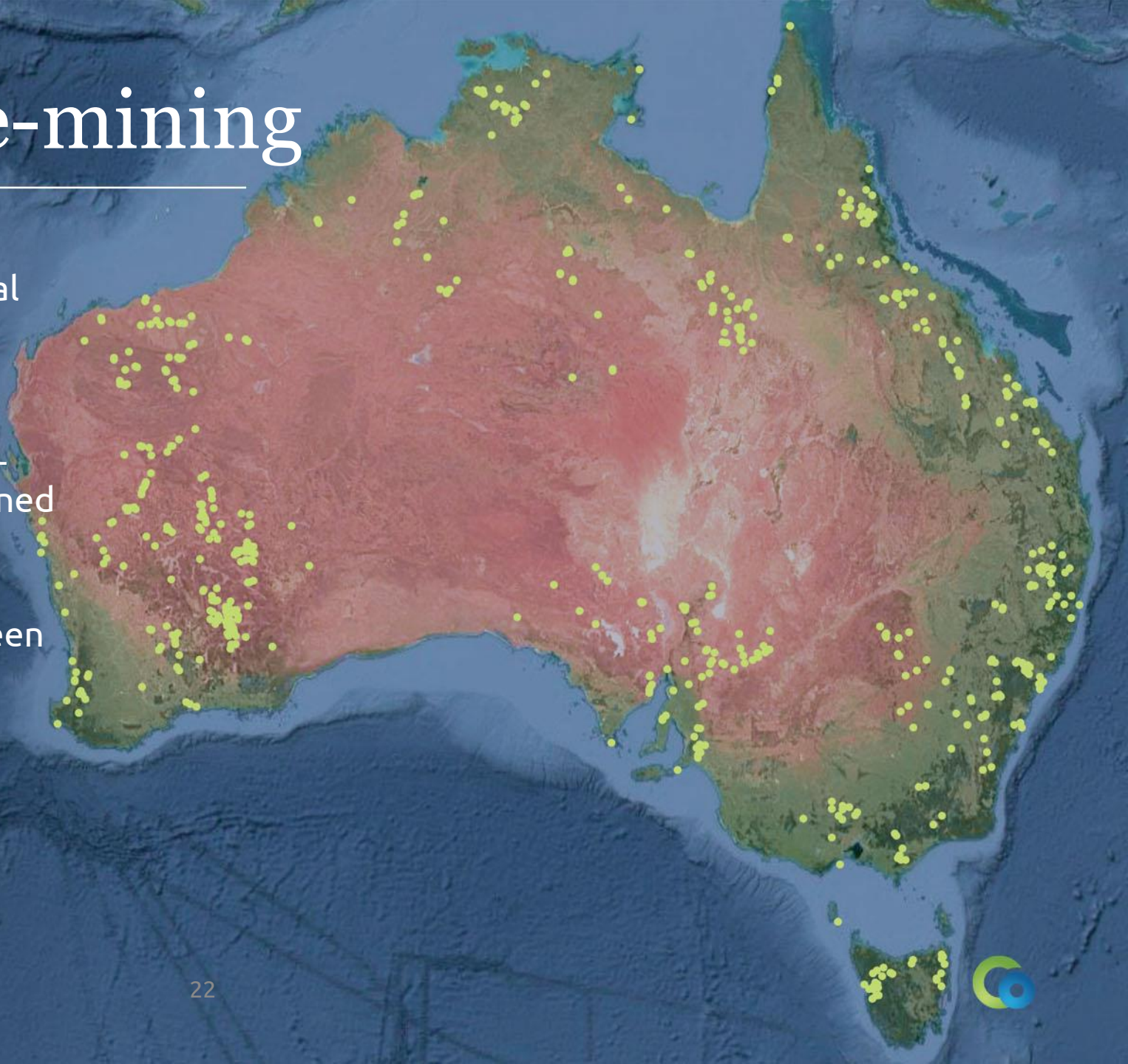
4. Downloaded from https://www.resourcesregulator.nsw.gov.au/rehabilitation/rehabilitation-security-deposits
5. Calculated from the Register of Rehabilitation Bonds https://resources.vic.gov.au/community-and-land-use/rehabilitation
6. https://www.energymining.sa.gov.au/industry/minerals-and-mining/mining/regulating-mining-activity/Mineral-resources-regulation-report/mine-rehabilitation-and-closure
7. https://www.dmp.wa.gov.au/Documents/Petroleum/MRF22-23-Yearly-Report.pdf

Challenges to re-mining

- Scale of liability for environmental bonds prohibitive for junior companies
- Regulatory frameworks have not kept up with modern desire to re-mine waste, especially at abandoned sites
- Low grades mean traditional economic models don’t work (green premiums)
- Challenging metallurgy



Positive Impact Re-Mining

CRITICAL METALS FOR THE ENERGY TRANSITION

Many critical metals occur in the waste streams of traditional mines. Rescuing these stranded assets contributes ethically and sustainably sourced material to battery and clean energy industries.

ENVIRONMENT

A reduction in acid forming potential as well as overall waste volume means more positive environmental outcomes for mined areas.

CWSP
Cobalt in Waste Streams Projects

COMMUNITY AND FIRST NATIONS PEOPLES

Contributing to better environmental and economic outcomes for a region positively impacts local communities and First Nations Peoples.

FERTILIZER INDUSTRY (ELEMENTAL SULPHUR)

Co-production of elemental sulphur helps meet sulphuric acid demand for the fertilizer industry; helping to combat the global food shortage.

EMPLOYMENT

Re-processing mine waste creates new jobs for mine sites, and both prolongs and expands the employment opportunities for local communities.

REGIONAL ECONOMIC BENEFIT

The combination of improved liveability, a healthier environment, more jobs and longer-lived, more diverse mining operations lead to an overall increase in regional economic benefit for many remote communities, including investment in local services and infrastructure.

Thankyou

Dr Helen Degeling

Project Acquisition Manager

E: helen.Degeling@cobaltblueholdings.com

Ph: +61 429 001 310

W: www.cobaltblueholdings.com/projects/cwsp

For more information: