MINE WASTE AS AN ECONOMIC PROSPECT?

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SMI BRC
WH Bryan Mining & Geology Research Centre

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

CREATE CHANGE

Talk Overview

1 | **Motivation for change:** Risks in mining

2 | **Case study:** Savage River mine: Old Tailings Dam (OTD)- Co

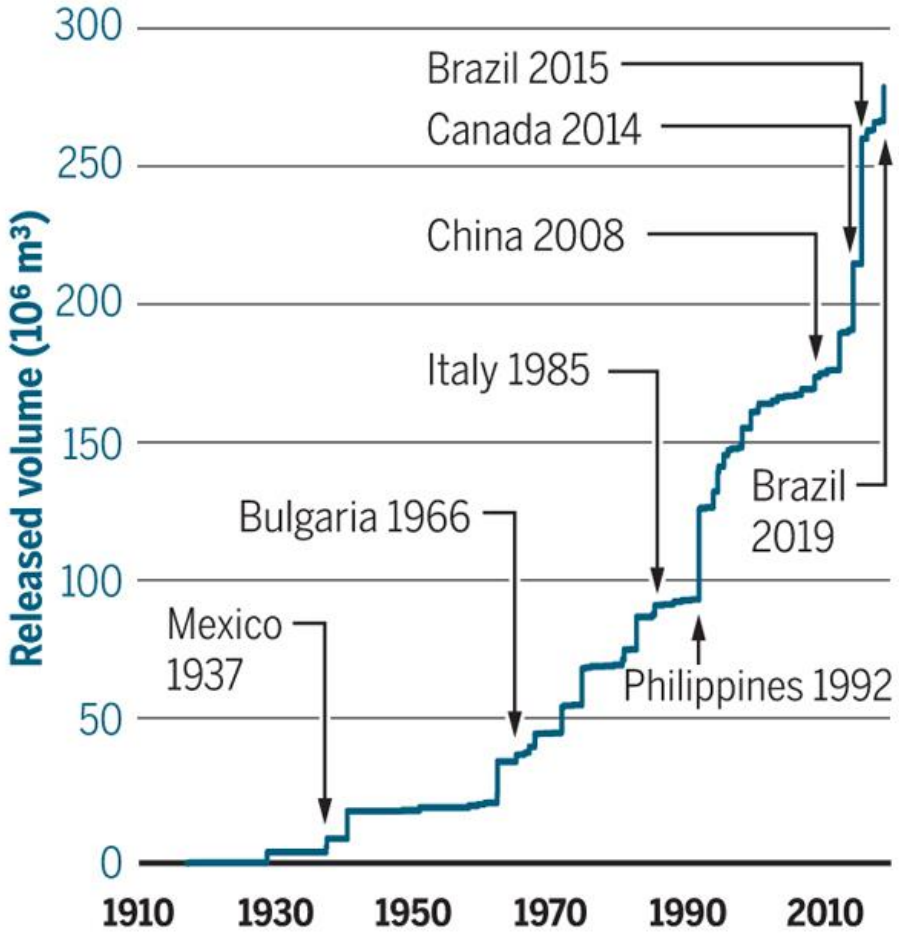
3 | **The Future:** New opportunities in Tasmania and Queensland

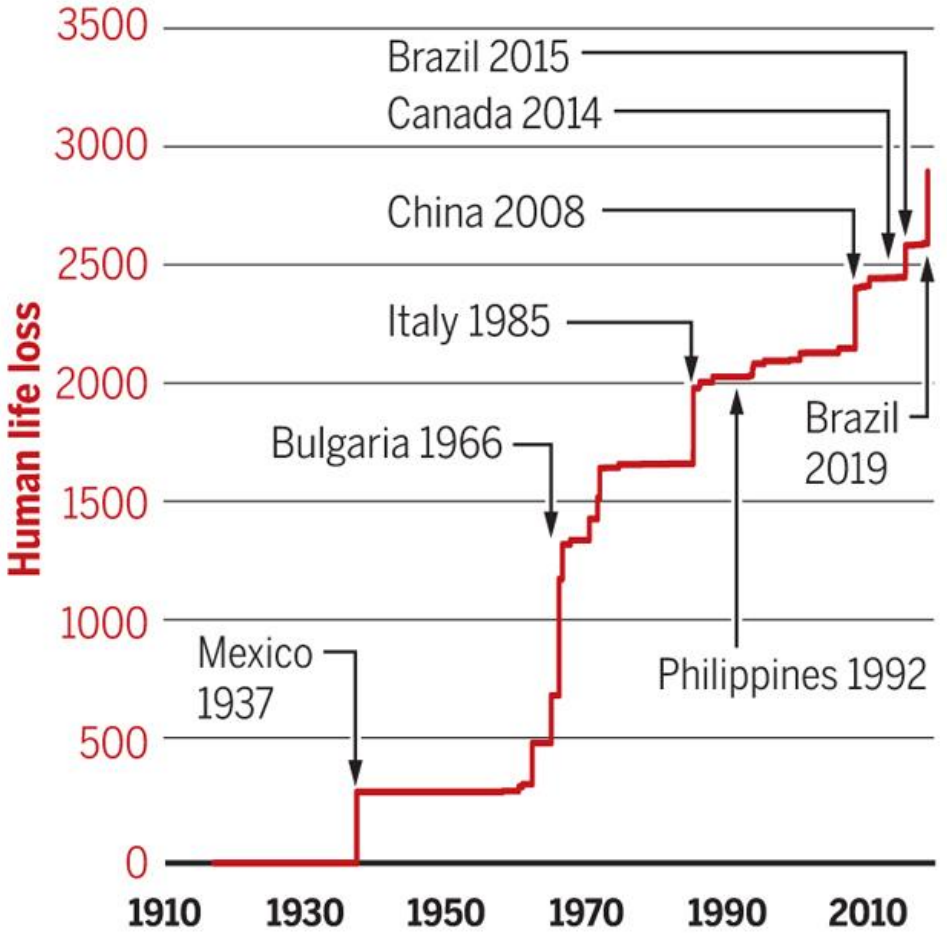
Brumadinho Dam, Córrego do Feijão iron ore mine, Brazil, 25/01/19

12 million cubic meters of tailings released
237 people lost their lives, ~33 still missing

Catastrophic dam failures

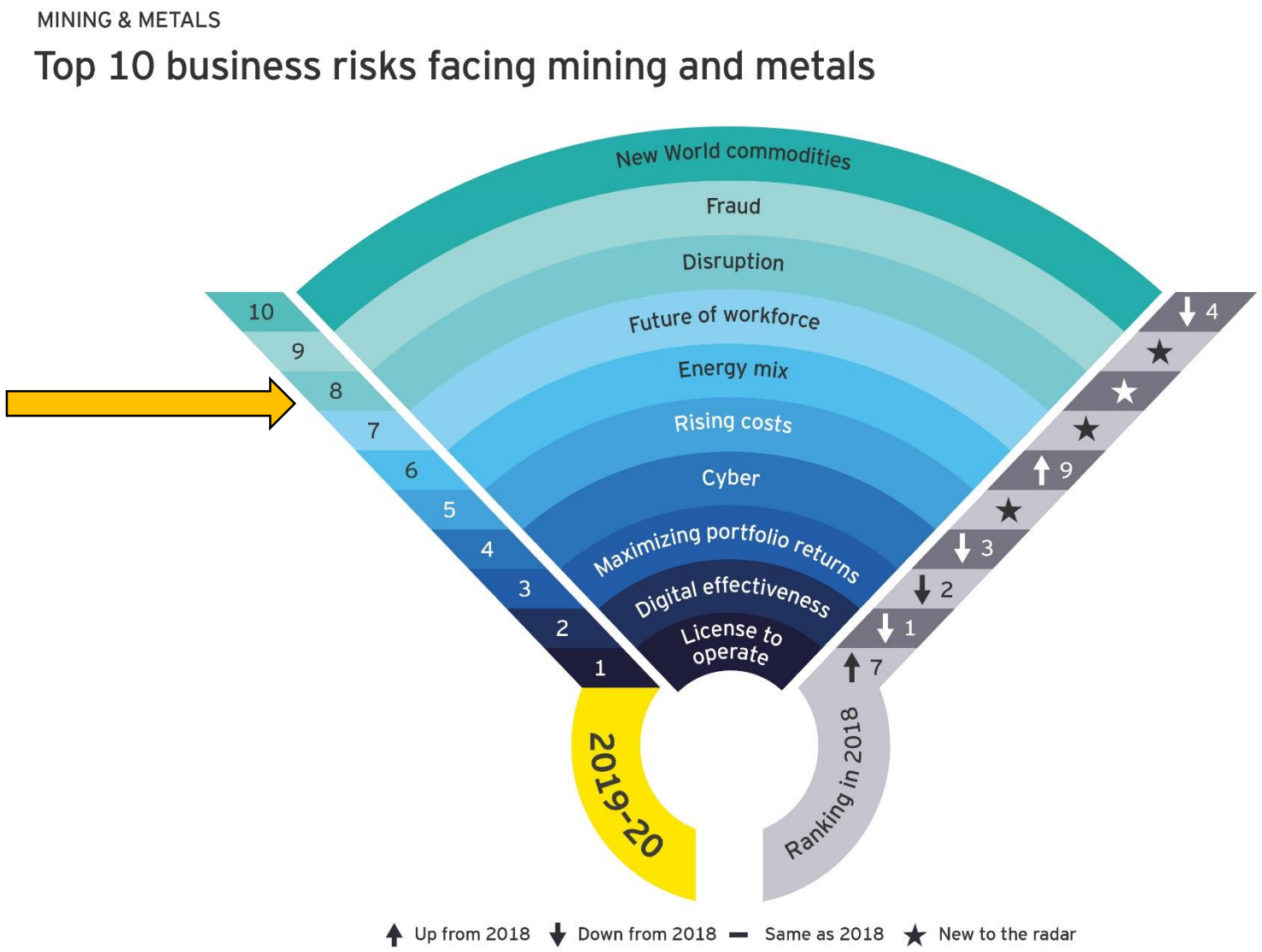
Over the past century, tailings dams and ash pond failures and the resulting fast-moving mudflows have led to a cumulative loss of almost 3,000 lives





https://science.sciencemag.org/content/364/6440/526/tab-figures-data

Risks in mining



The sector needs to redefine its image as a sustainable and responsible source of the world's minerals

To do this, organizations need to:

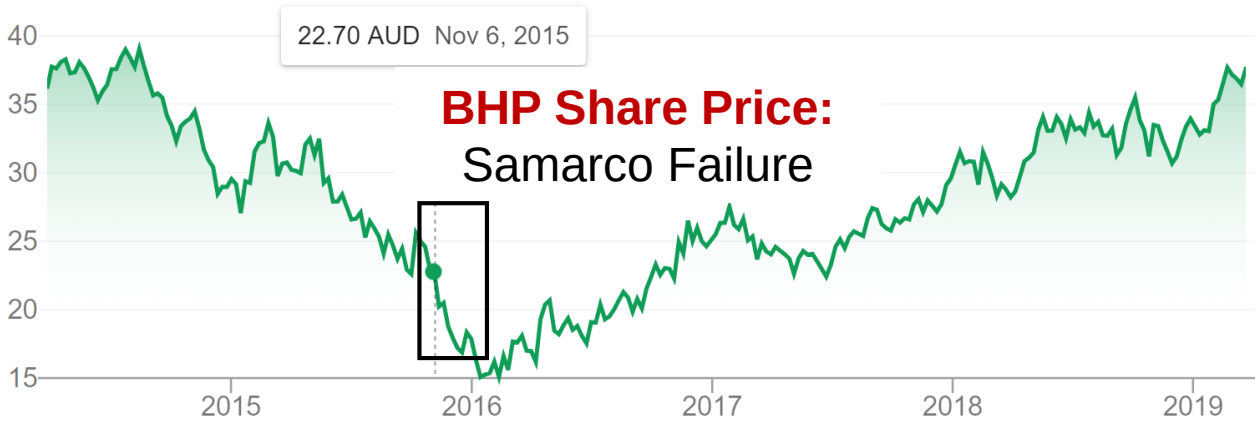
- Take a whole of business approach to license to operate driven from the top down
- Commit and contribute to community, government, employees and environment needs beyond life of mine
- **Walk the talk! Make it part of the company's DNA**

Source: ***https://www.ey.com/en_gl/mining-metals/10-business-risks-facing-mining-and-metals***

Risks in mining

Imperial Metals Share Price:
Mt. Polley Failure

CAN $37.3 Million loss

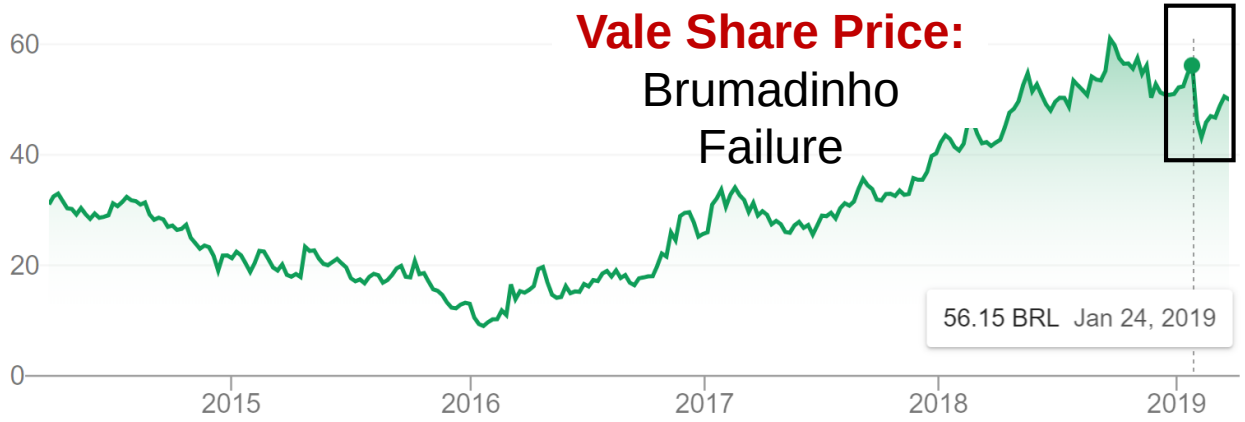


BHP Share Price:
Samarco Failure

Aug 2016: AUD $6.4 billion loss

Vale Share Price:
Samarco Failure

7% drop within 24 hours; billions lost



Vale Share Price:
Brumadinho Failure

28 Jan '19: 24% drop, US $19 Billion loss

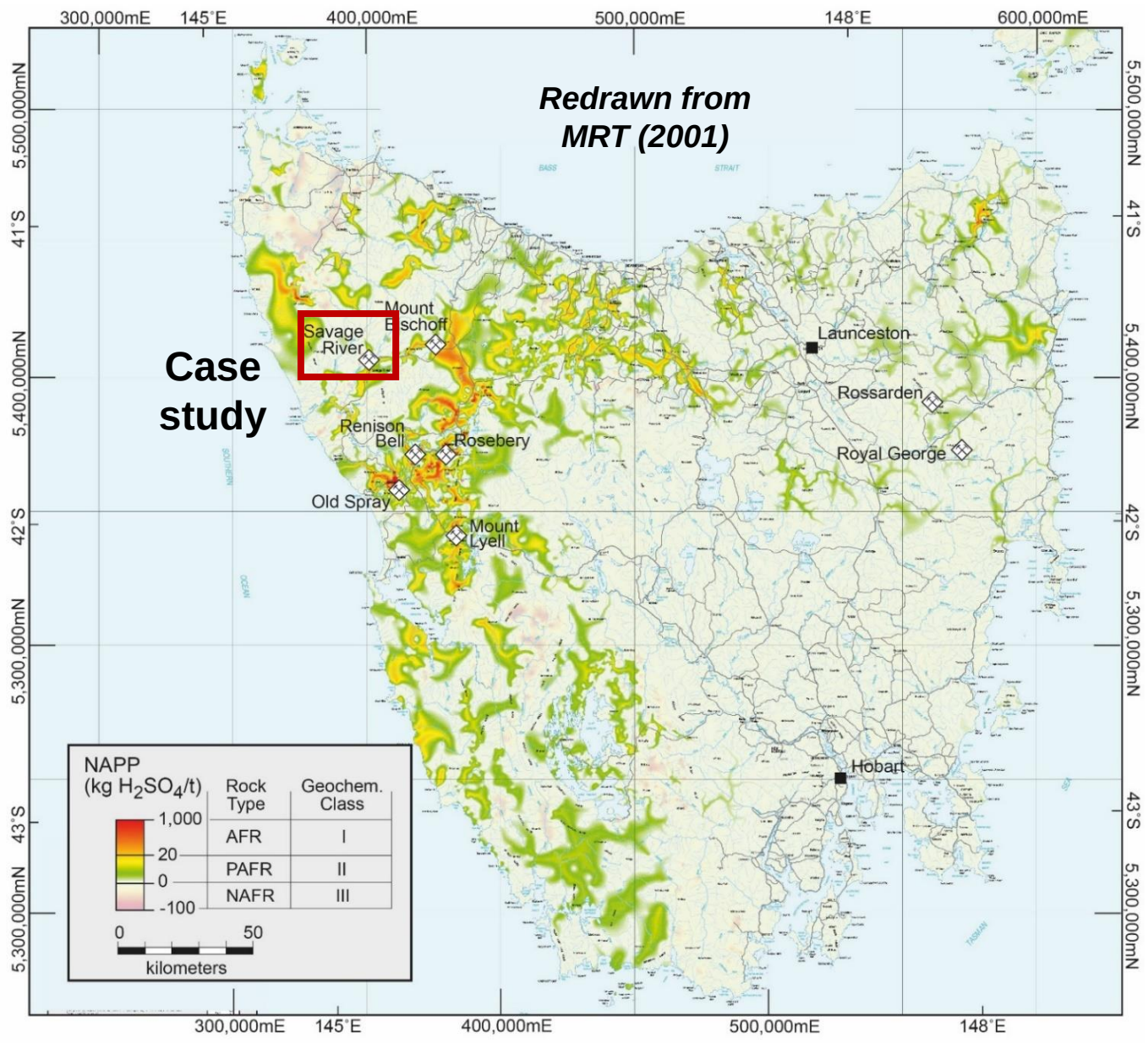
Pollution linkage chain

Source → **Pathway** → **Receptor**

Characterise materials, identify recommercialisation opportunities, reduce risk & liabilities (increase profits?)

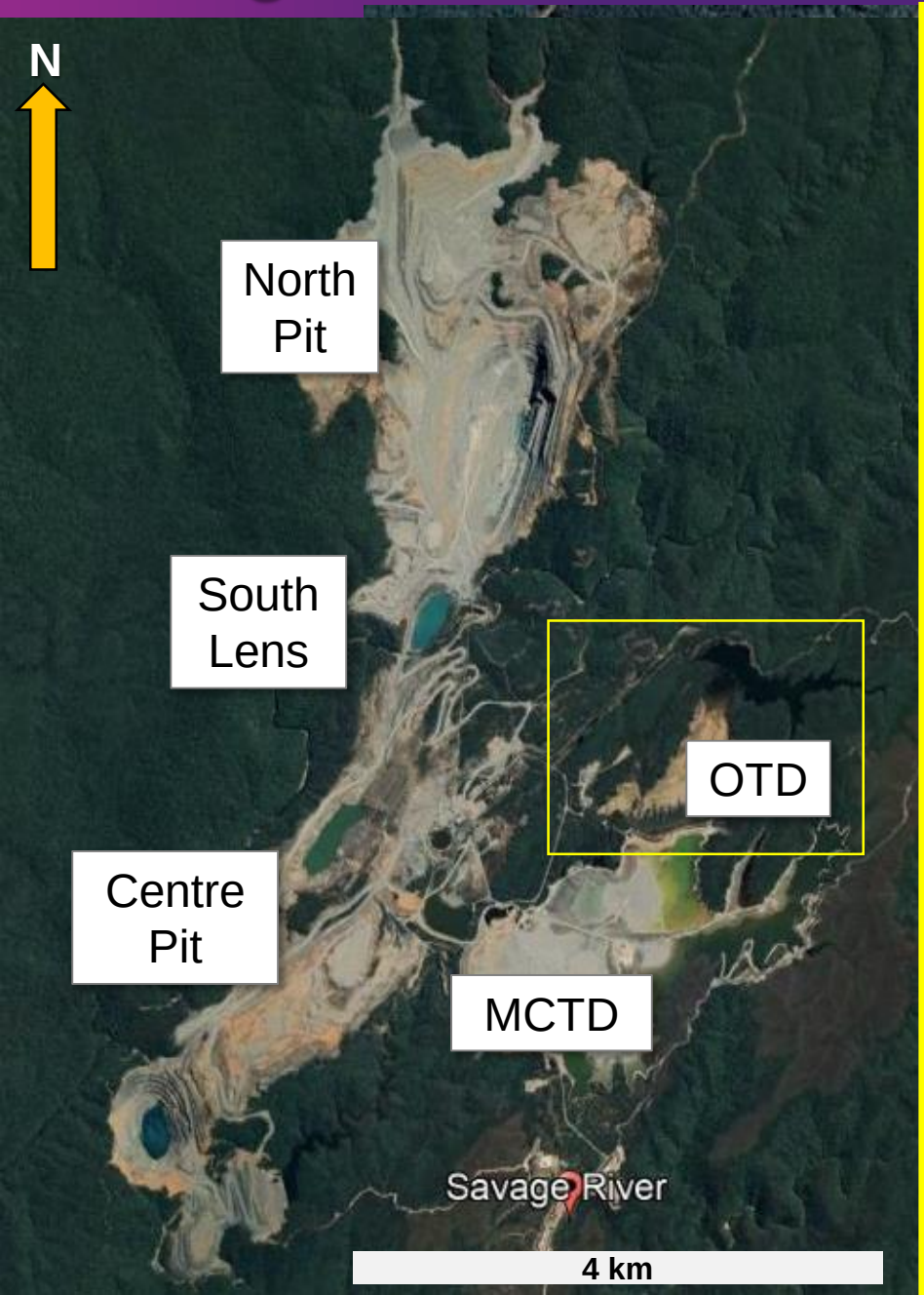
Bobadil tailings storage facility, Rosebery, Tasmania (MMG)

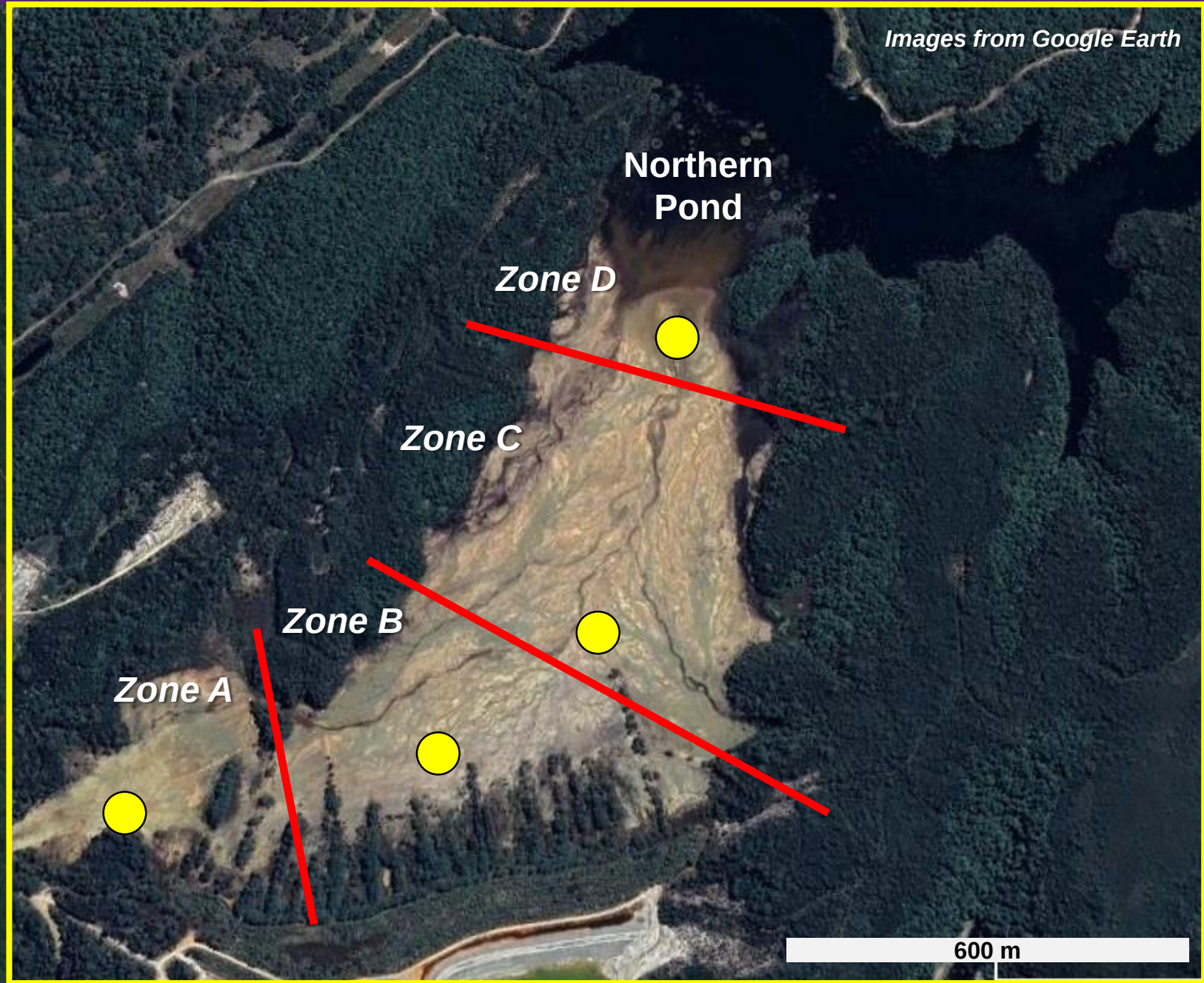
Tasmania: AMD distribution



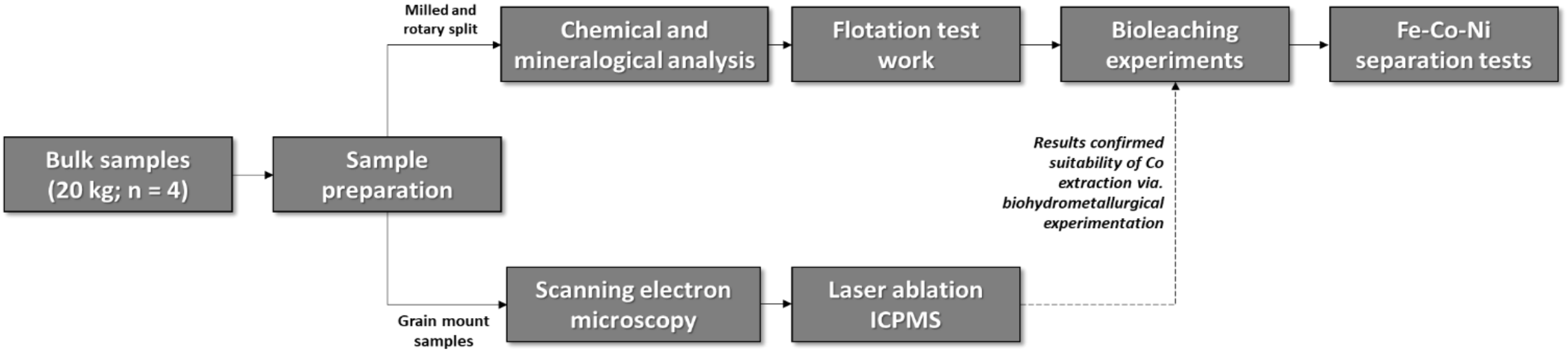
Savage River mine: Old Tailings Dam

The University Of Queensland AUSTRALIA





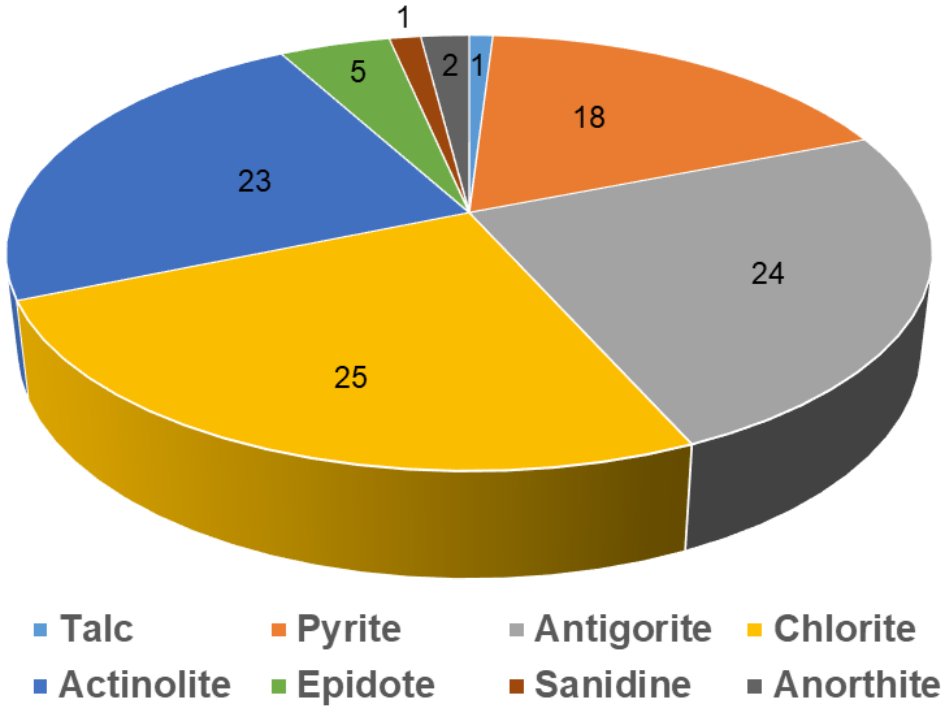
Geometallurgical characterisation approach

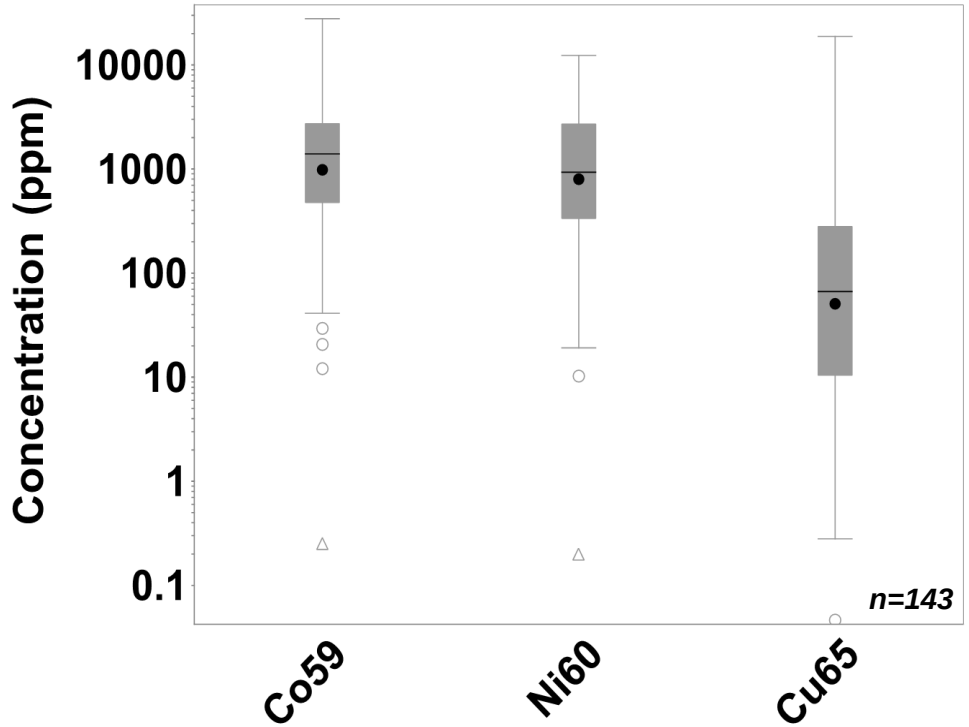


Parbhakar-Fox et al. (2018): https://www.mdpi.com/2075-163X/8/10/454

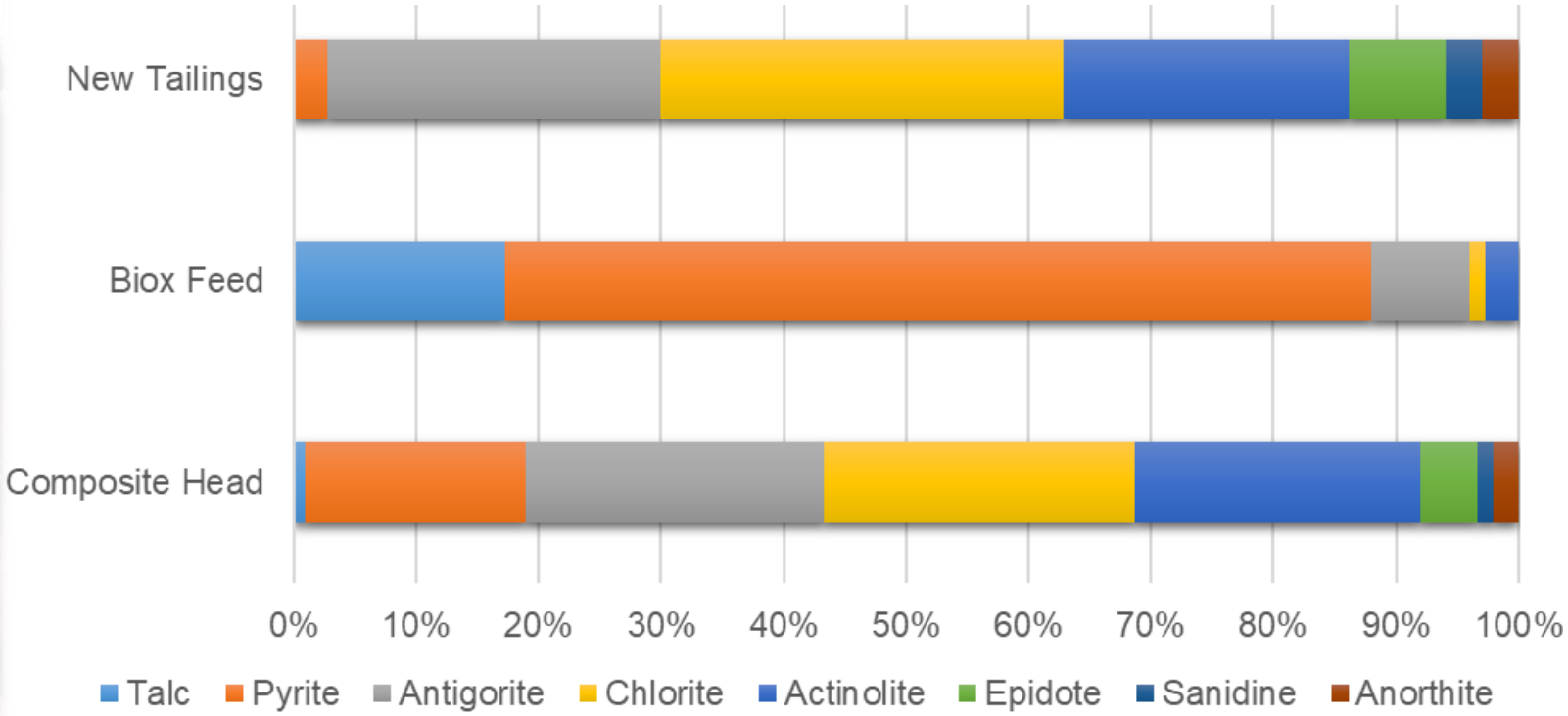
Composite head characteristics

	S	S^{2-}	Fe	Cu	Co	Zn	Ni	Pb
	%	%	%	ppm	ppm	ppm	ppm	ppm
Zone A Head	0.72	0.56	9.38	98	**60**	32	75	15
Zone B Head	15.9	14.2	18.1	2120	**580**	88	595	25
Zone C Head	10.6	9.54	14.1	1480	**440**	102	375	30
Zone D Head	9.54	8.62	13.6	1640	**380**	76	305	35
Composite Head	9.16	8.22	14.0	1400	**360**	74	325	30



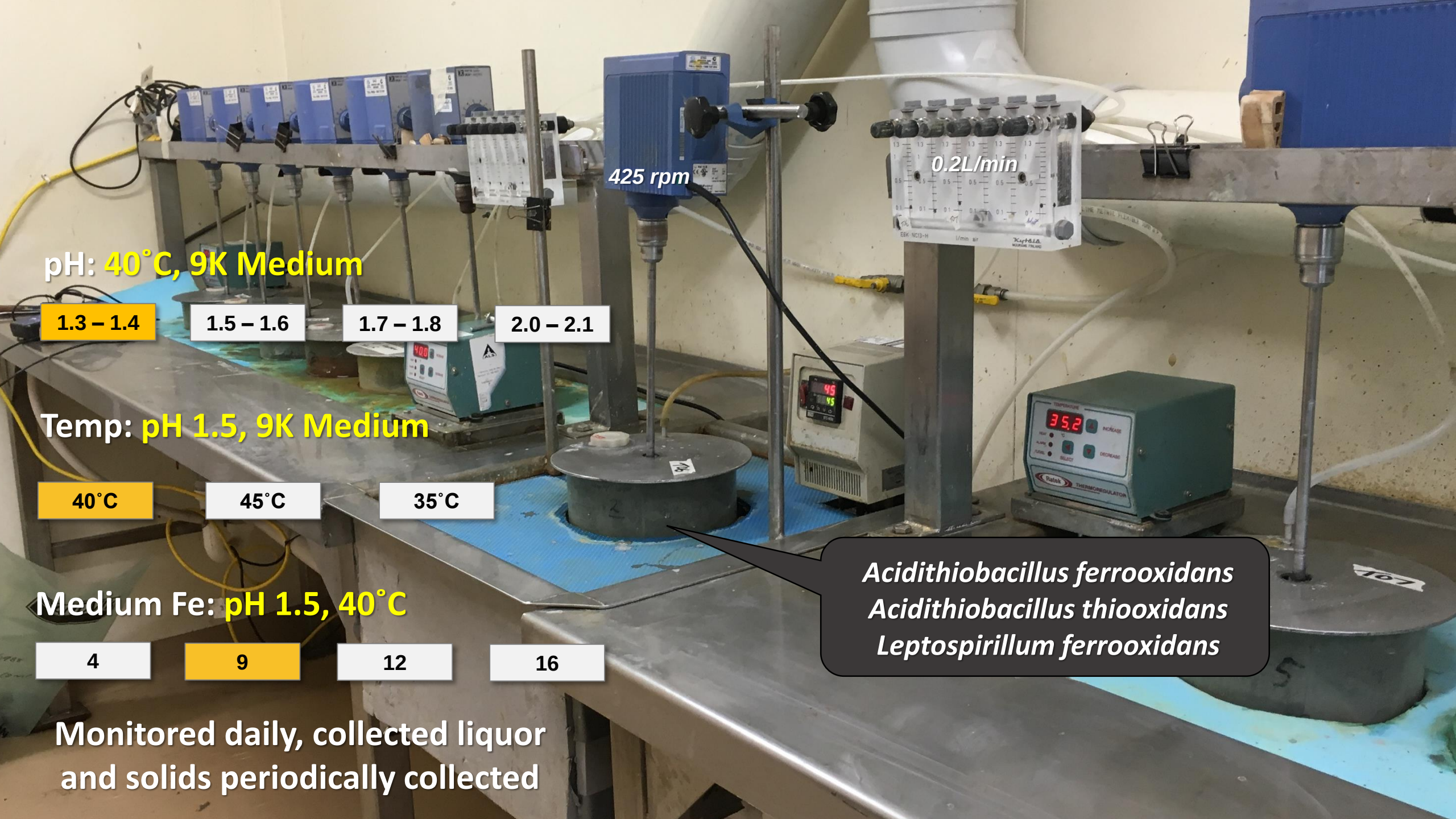


Flotation results: Mineralogy

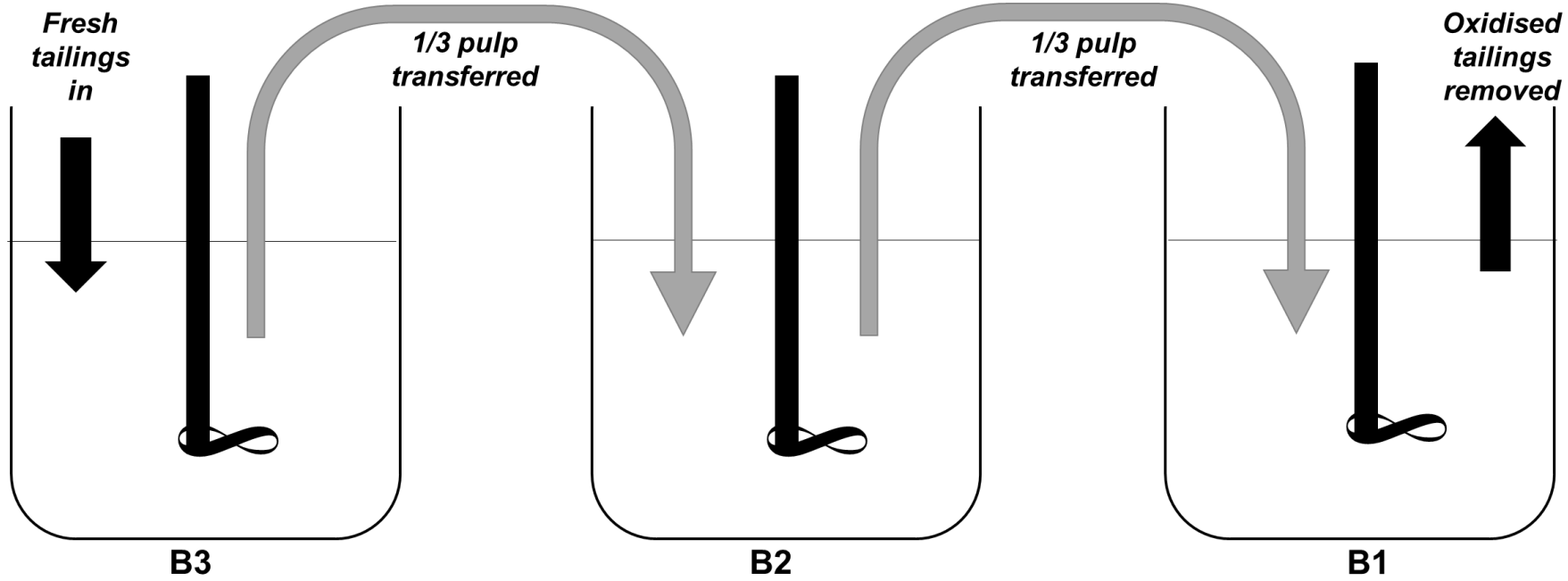


Flotation results: Chemistry

Parameter	Unit	Composite head	Biox feed	New Tailings
Fe	%	14	37	9.5
Cu	ppm	1100	5910	452
Co	**ppm**	**360**	**1840**	**70**
Ni	ppm	350	1385	170
Pb	ppm	30	80	5
Zn	ppm	114	166	80
S	%	7.53	44.9	1.09
Neutralising characteristics				
Fizz Rating	-	1	0	1
ANC (Sobek)	Kg H_2SO_4/t	14	0	22
Acid generating characteristics				
MPA	Kg H_2SO_4/t	230	1374	33
NAPP	**Kg H_2SO_4/t**	**216**	**1374**	**11**
NAG*	Kg H_2SO_4/t	45	115	15
NAGpH	-	2.3	2.1	2.6
ARD Classification		PAF	PAF	PAF

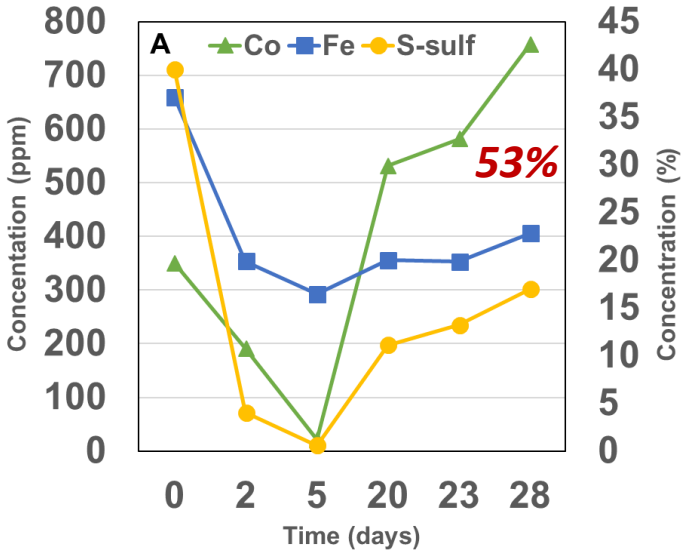

425 rpm
0.2L/min
pH: 40˚C, 9K Medium
1.3 – 1.4
1.5 – 1.6
1.7 – 1.8
2.0 – 2.1
Temp: pH 1.5, 9K Medium
40˚C
45˚C
35˚C
Medium Fe: pH 1.5, 40˚C
4
9
12
16
Monitored daily, collected liquor and solids periodically collected
Acidithiobacillus ferrooxidans
Acidithiobacillus thiooxidans
Leptospirillum ferrooxidans

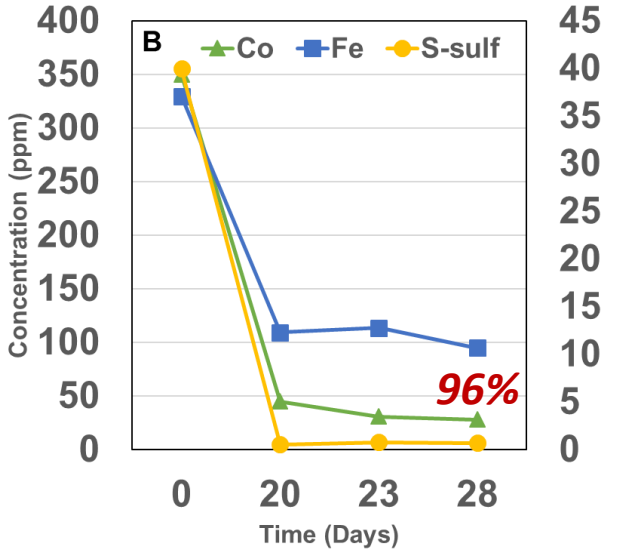
Bioleaching results: Co leached

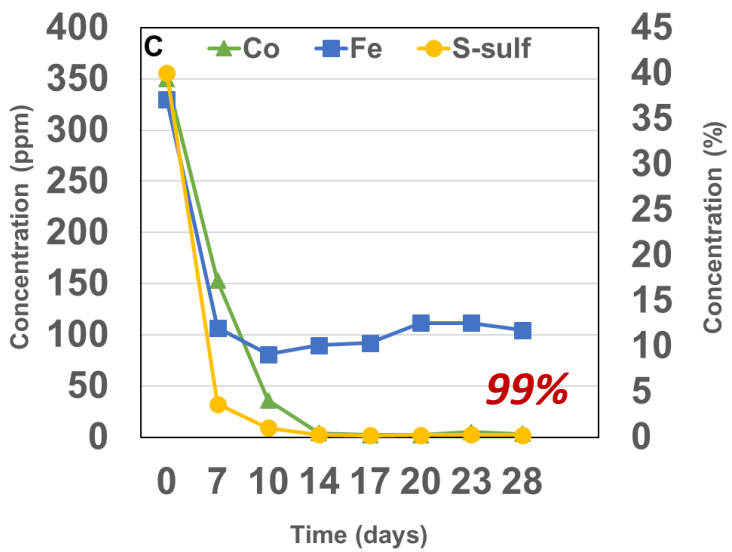


7 days reaction, fresh con. added

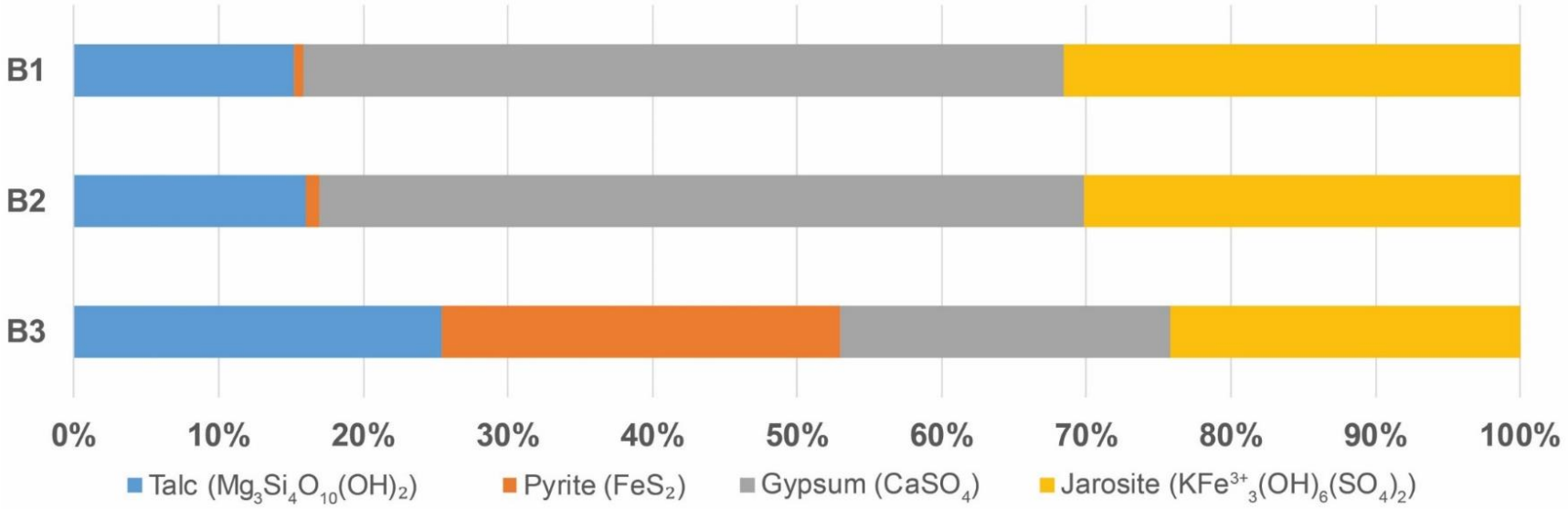
Final exit solid: < 5 ppm Co

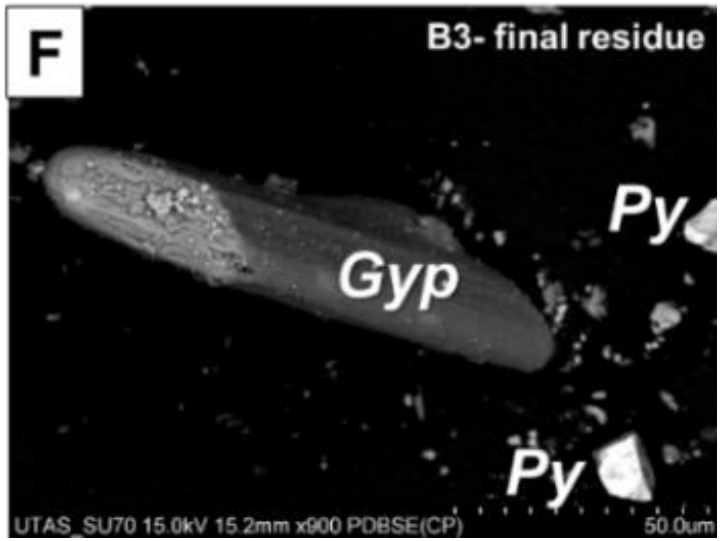


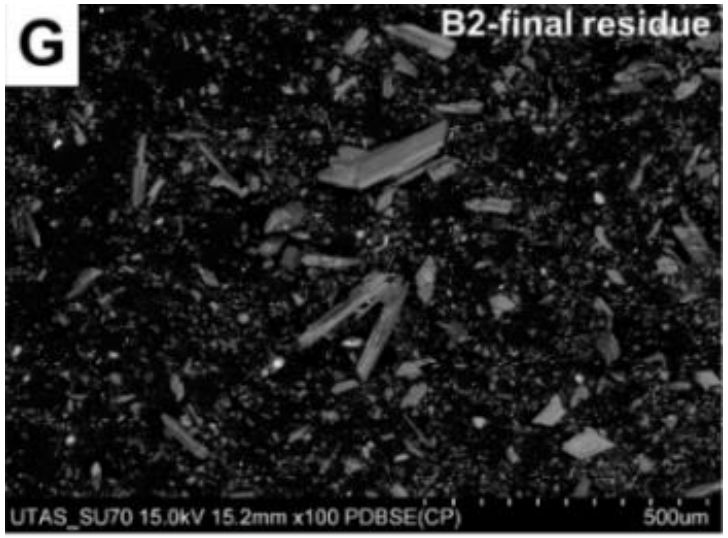


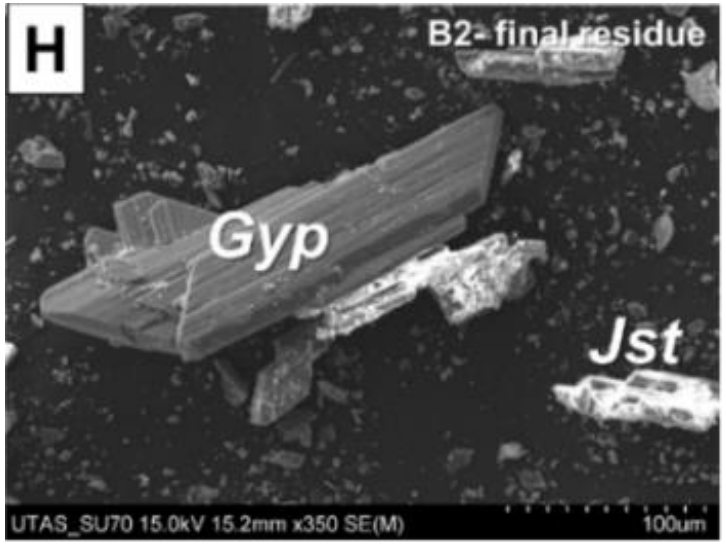


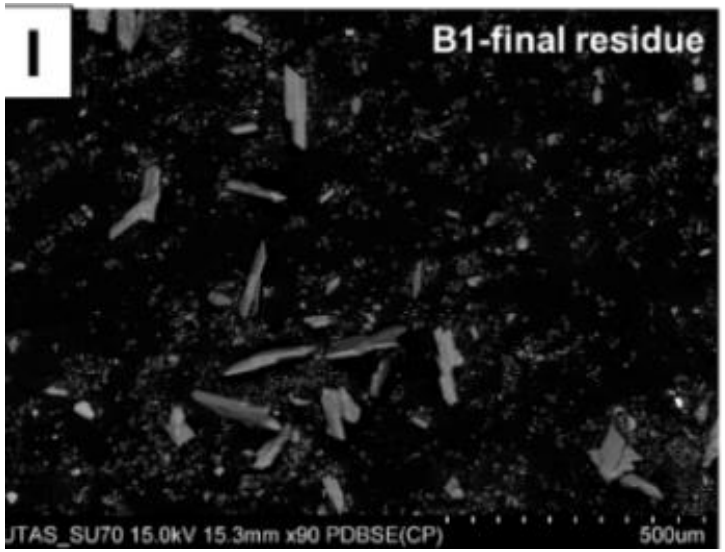
Bioleaching results: Solid mineralogy



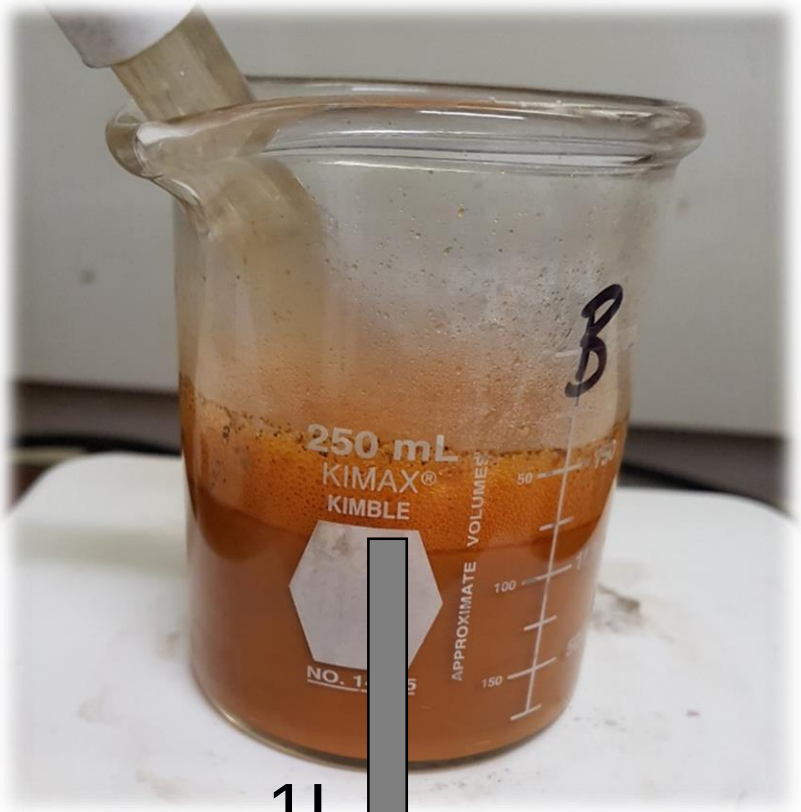








Co precipitation tests



	pH	Fe	Co	Cu	Ni	As
Experiment		mg/L	mg/L	mg/L	mg/L	mg/L
Test A	2.18	9730	135.5	275	96.7	3.6
Test B	3	124	135.5	218	96.3	1.7
Test C	3.8	93.6	126	38.2	86.2	1.8
Test D	4.86	20.6	64.9	0.9	30	0.7
Test E	6.3	0.80	1	<0.2	0.6	3.5
Feed Liquor		19,950	127	267	90.8	6.8

1L

+ NaOCl (15% 5 ml)

to pH 4.5

+ NaOH (5% 8 ml)

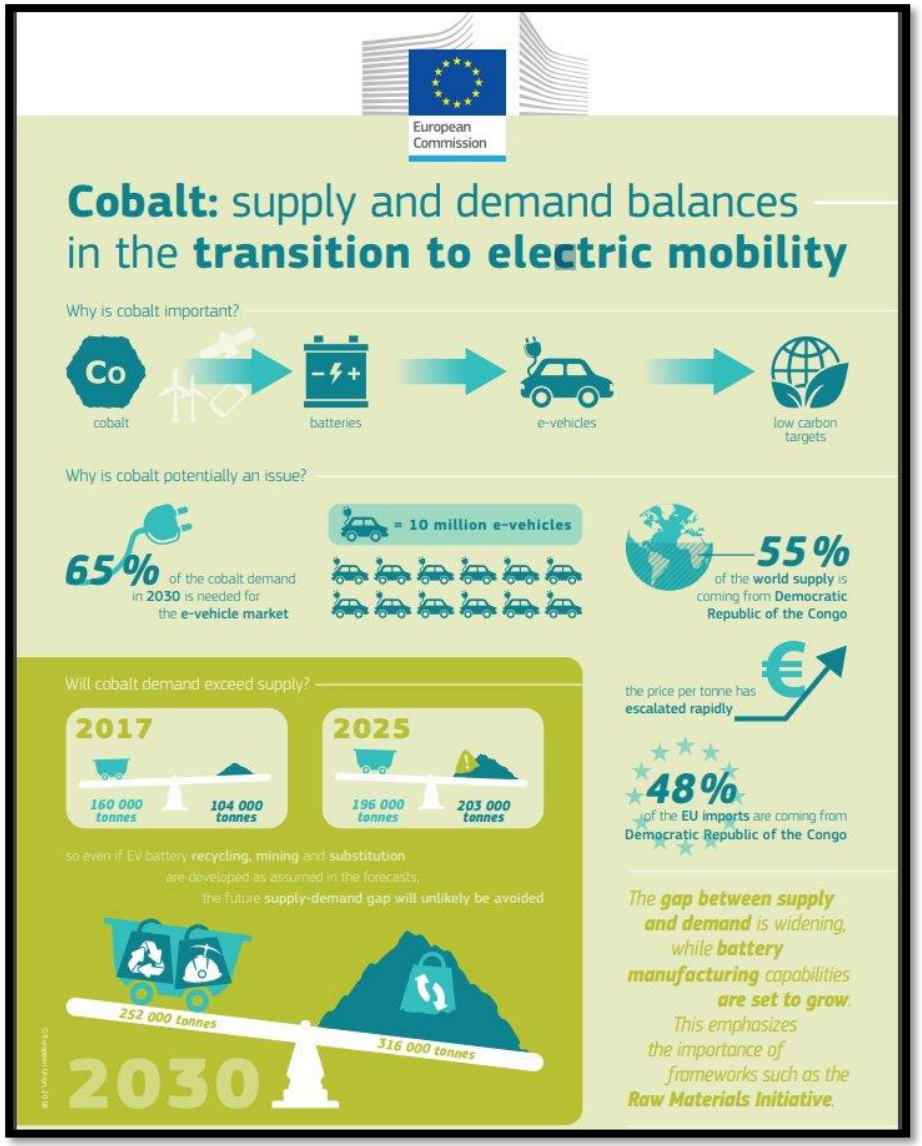
Intermediate saleable product

$Co(OH)_2$

A potential business case?

38 Mt tailings → *7 % pyrite* → 2.66 Mt pyrite → *0.1 % Co* → 2,660 t cobalt

LME Co = US $34,250/t → *90 % recovery* → Value = US ~$81 million



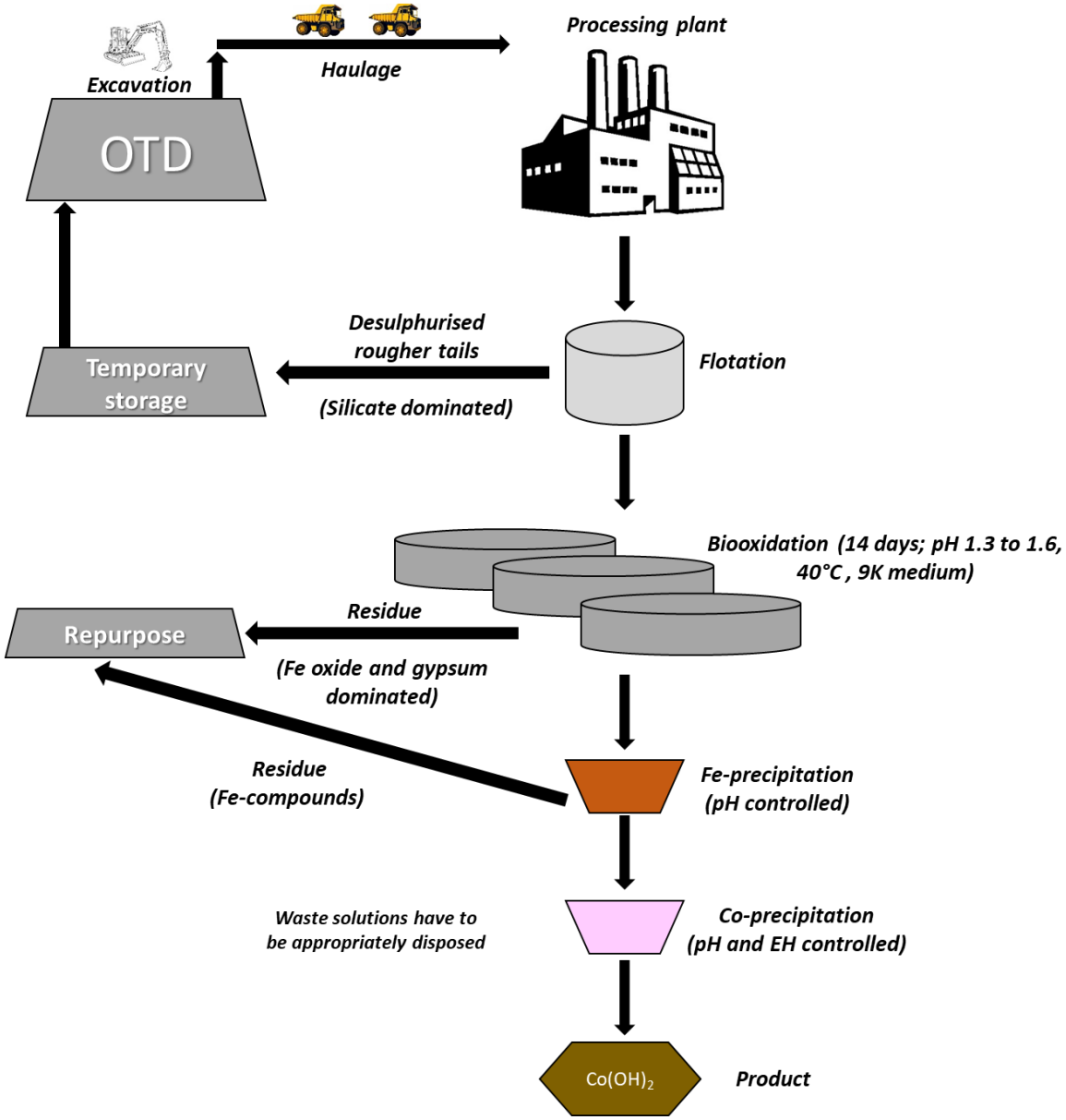
Future implications for the OTD

Mining
- Tailings mining
- Mechanical excavation
- Transportation to the mineral processing plant

Processing
- Grinding (*p80* of 84 µm)
- Flotation (polyscaccharide, PAX, MIBC)
- Regrinding (<38 µm)
- Biooxidation
- Iron and Cobalt precipitation (pH controlled)

Disposal
- Relining and engineering maintenance of the OTD
- Emplacement of a vegetation (or hard engineering) cover

Reclamation
- Passive treatment
- Maintenance of the cover
- Monitoring of any water seepages from the new tailings



New 2019 geomet. program commissioned by SRRP and Grange

Optimise flotation by finer grind (< 33 µm) and introducing polysaccharides

Refine bioleaching by increasing O_2 into the tanks

Tasmania: Recommercialisation opportunities

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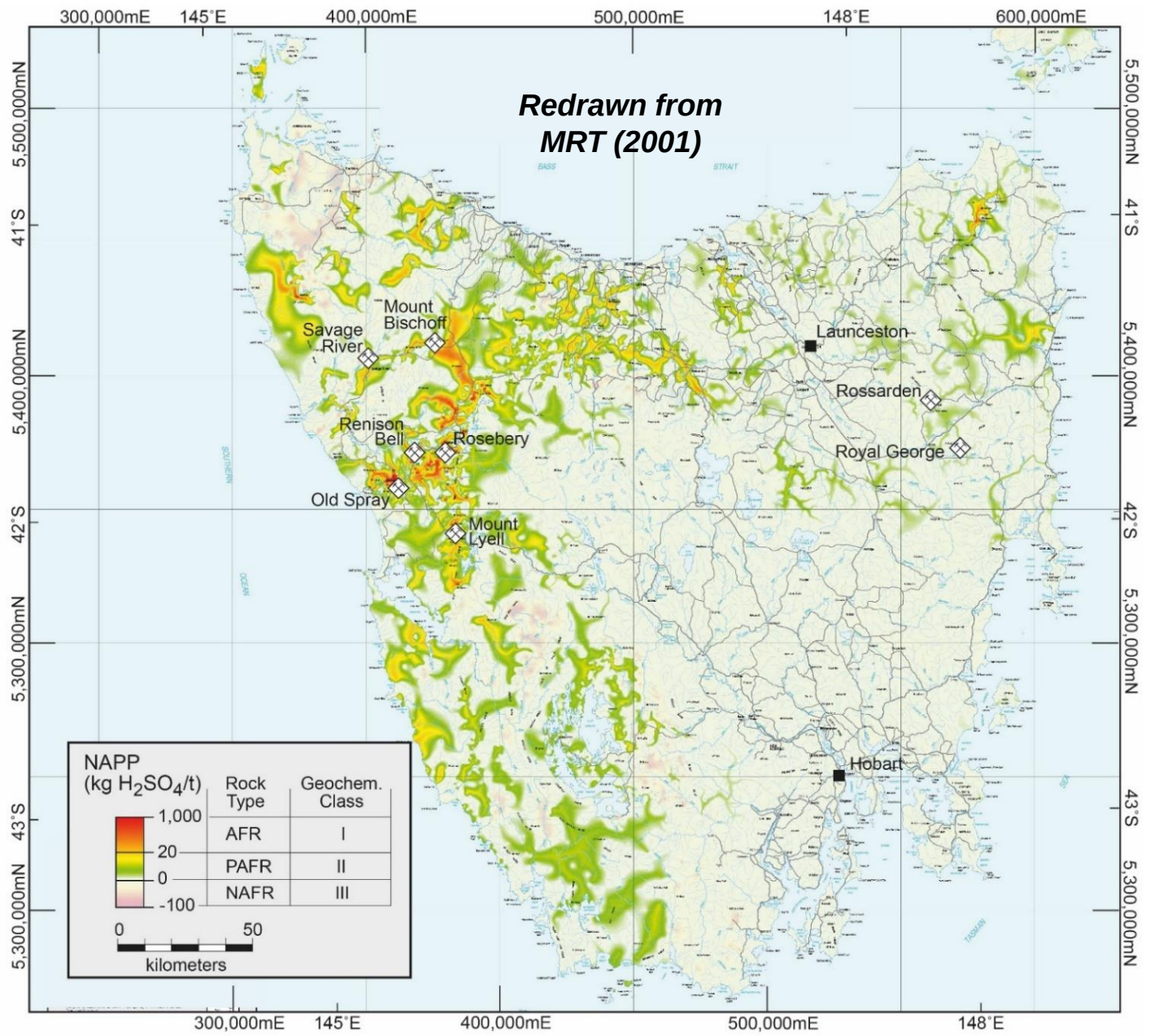
New cobalt resources

Tin and gold from historic tailings

Zinc from slag

New indium resources?



MMG

GRANGE RESOURCES

METALS X LIMITED

vedanta transforming elements

ELEMENTOS LIMITED

nq minerals

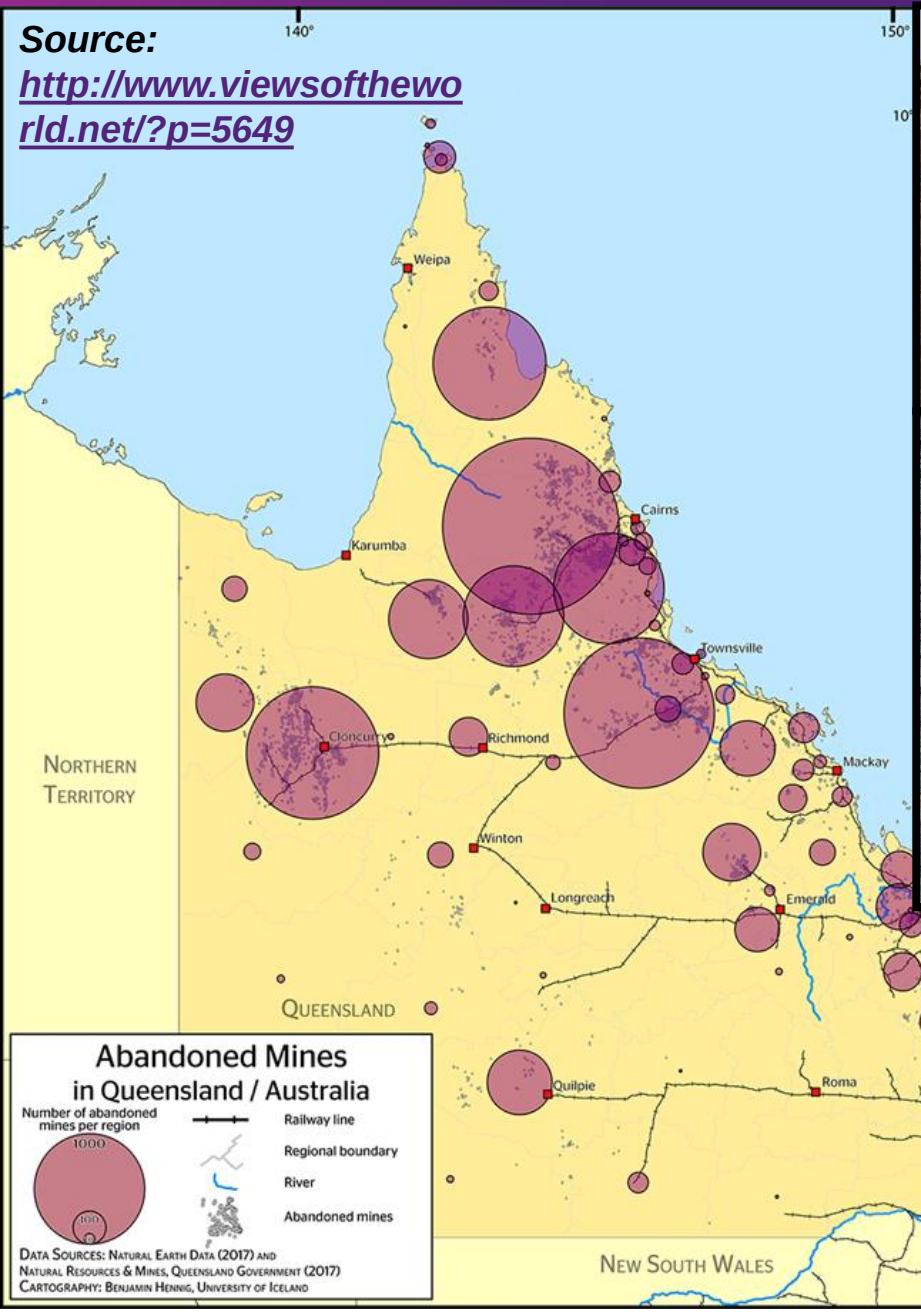
TARTANA RESOURCES LIMITED

Tasmania: Recommercialisation opportunities

Queensland: Recommercialisation opportunities

The University Of Queensland
AUSTRALIA

Source:
http://www.viewsoftheworld.net/?p=5649




Ernest Henry- Fe recovery

Mt Carbine, W recovery

Mary Kathleen, REE recovery


New Century- Zn recovery

Mt Morgan, Au recovery

Mine waste as a resource: Research programs

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NEAR-ZERO-WASTE RECYCLING OF LOW-GRADE SULPHIDIC MINING WASTE
FOR CRITICAL-METAL, MINERAL AND CONSTRUCTION RAW-MATERIAL PRODUCTION IN A CIRCULAR ECONOMY

NRC·CNRC

minerals to metals

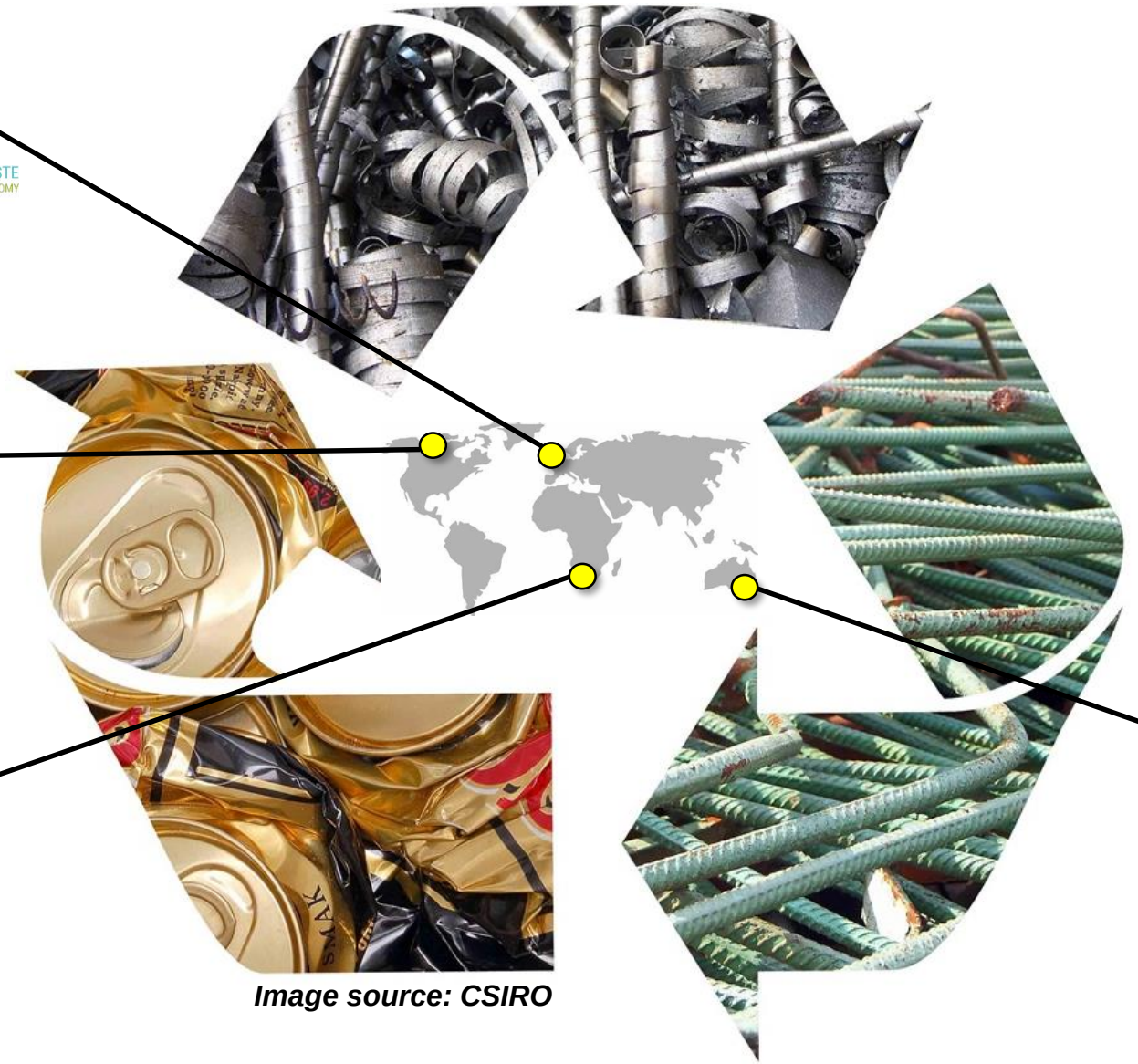

Image source: CSIRO

Focused on improving metal recovery from (sulphidic) mine waste


Thank you for your attention…
Questions?