

# Strategic Resources & the “New Economy”

Tony Knight  
Chief Government Geologist  
Geological Survey of Queensland, Australia





# Transition to the new economy

## Sustainable Prosperity



Global shifts in  
energy and  
sustainability



50% renewable  
target by 2030



Green hydrogen  
strategy 2019-2024



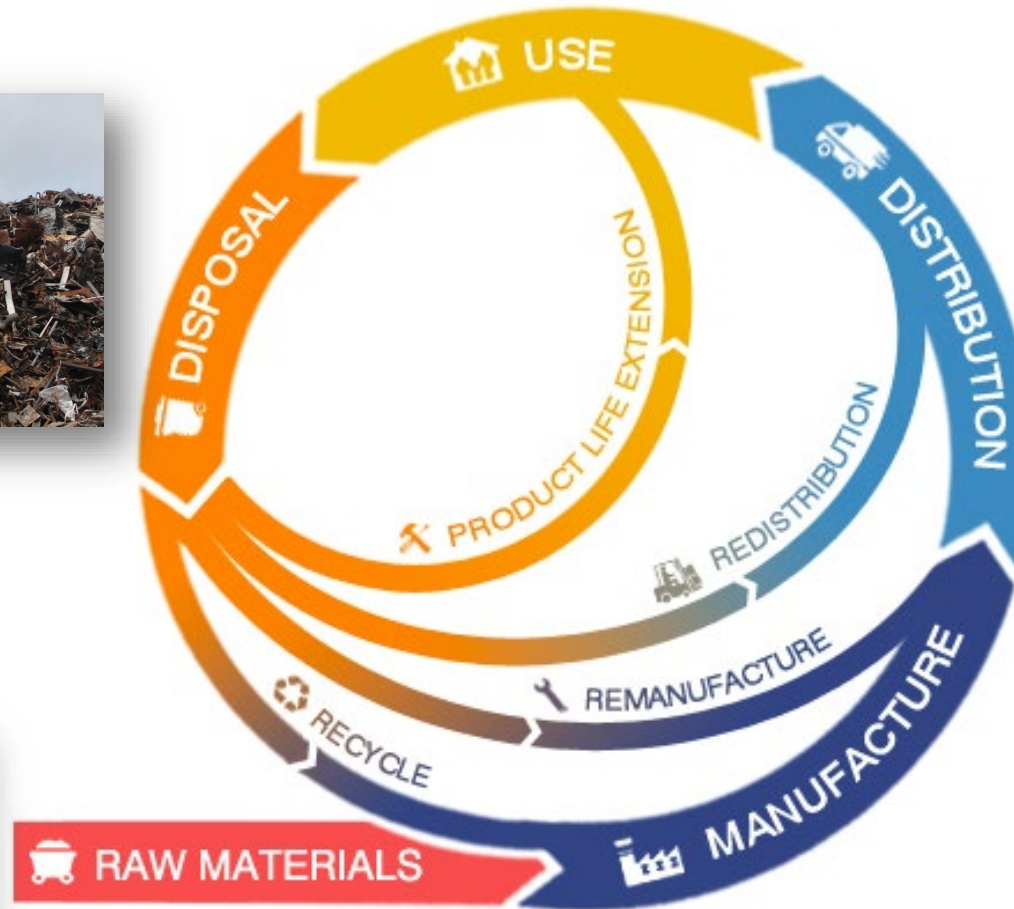
Not just *what* we  
supply but *how* we  
supply.



# The New Economy and Mineral Resources



**WASTE**



[HTTPS://CONNECT.INNOVATEUK.ORG/WEB/COLLABORATIONS-CIRCULAR-ECONOMY](https://connect.innovateuk.org/web/collaborations-circular-economy) © INNOVATE UK 2017. ALL RIGHTS RESERVED.

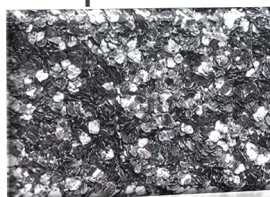


# Queensland's New Economy Minerals

Copper



Graphite



Indium



Scandium



Cobalt



Vanadium



Tungsten



Nickel



Silver



REEs



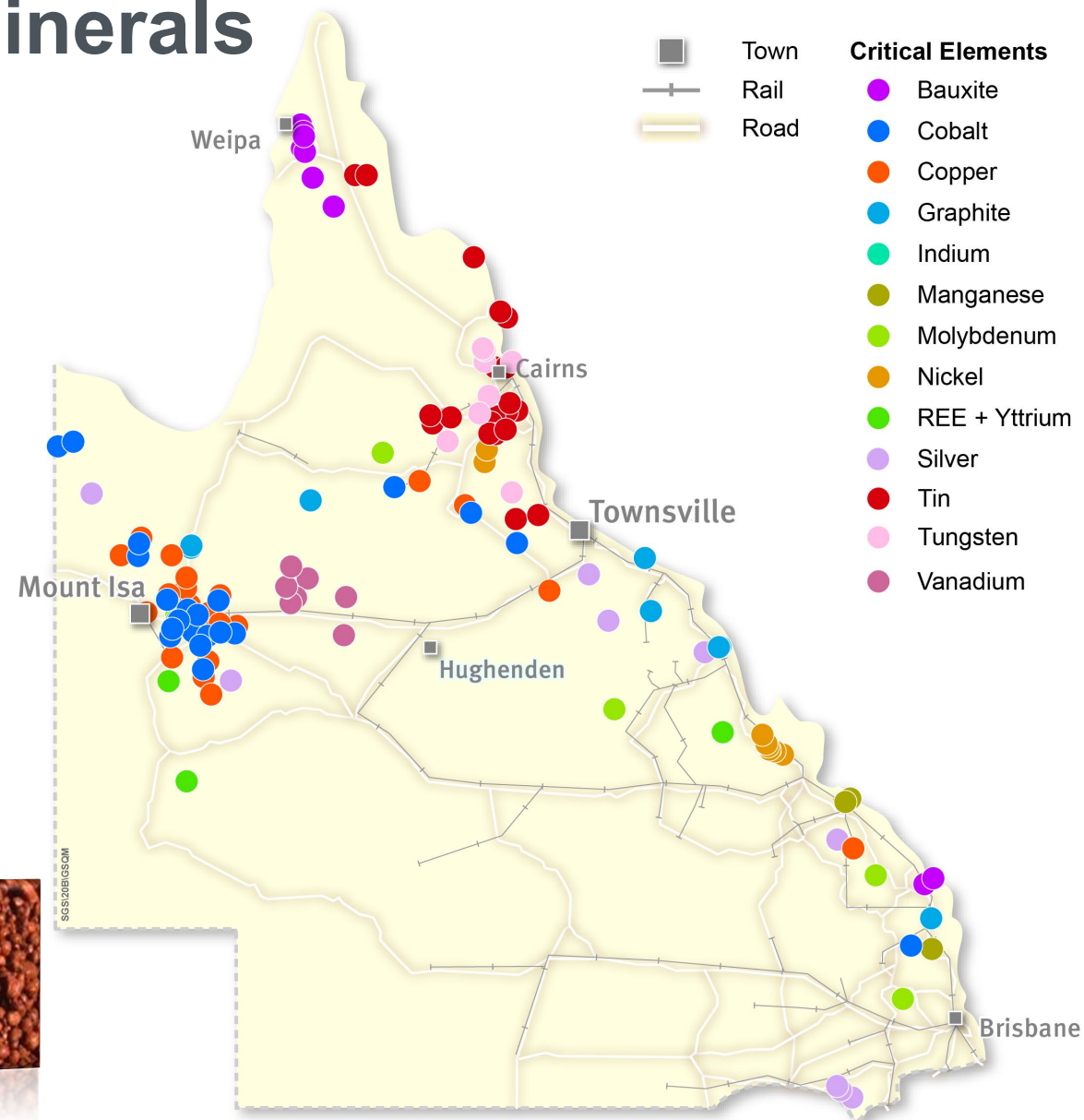
Tin



Uranium

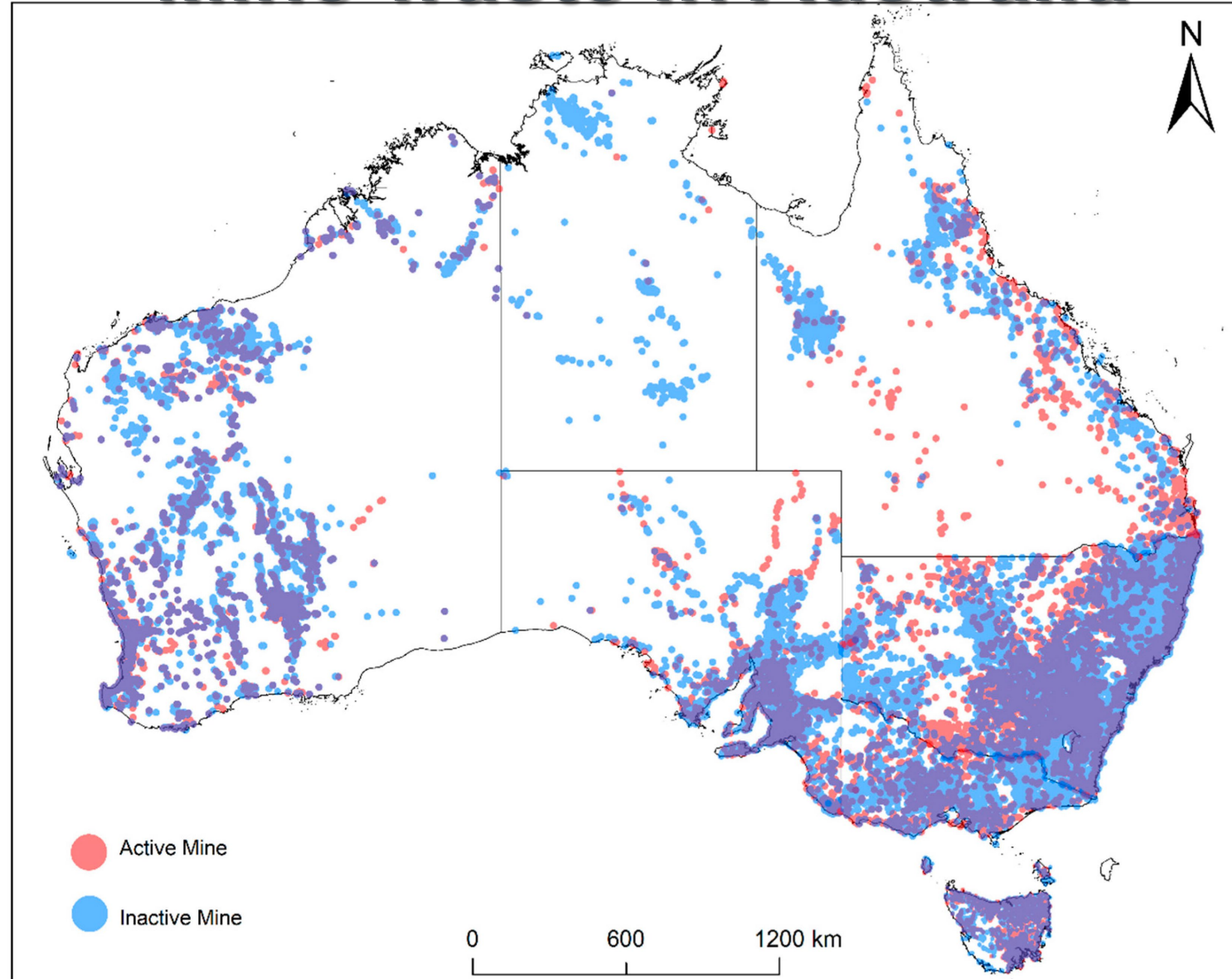


Bauxite





# Mine waste in Australia



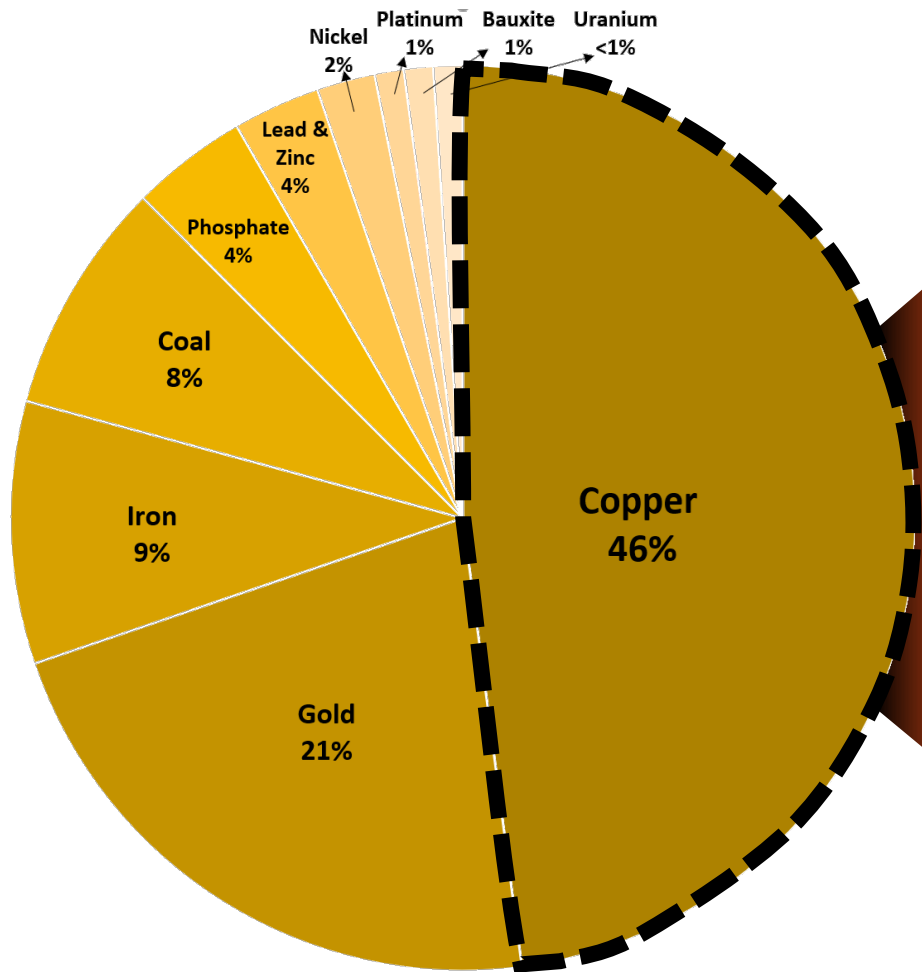
Werner et al, 2020



Government

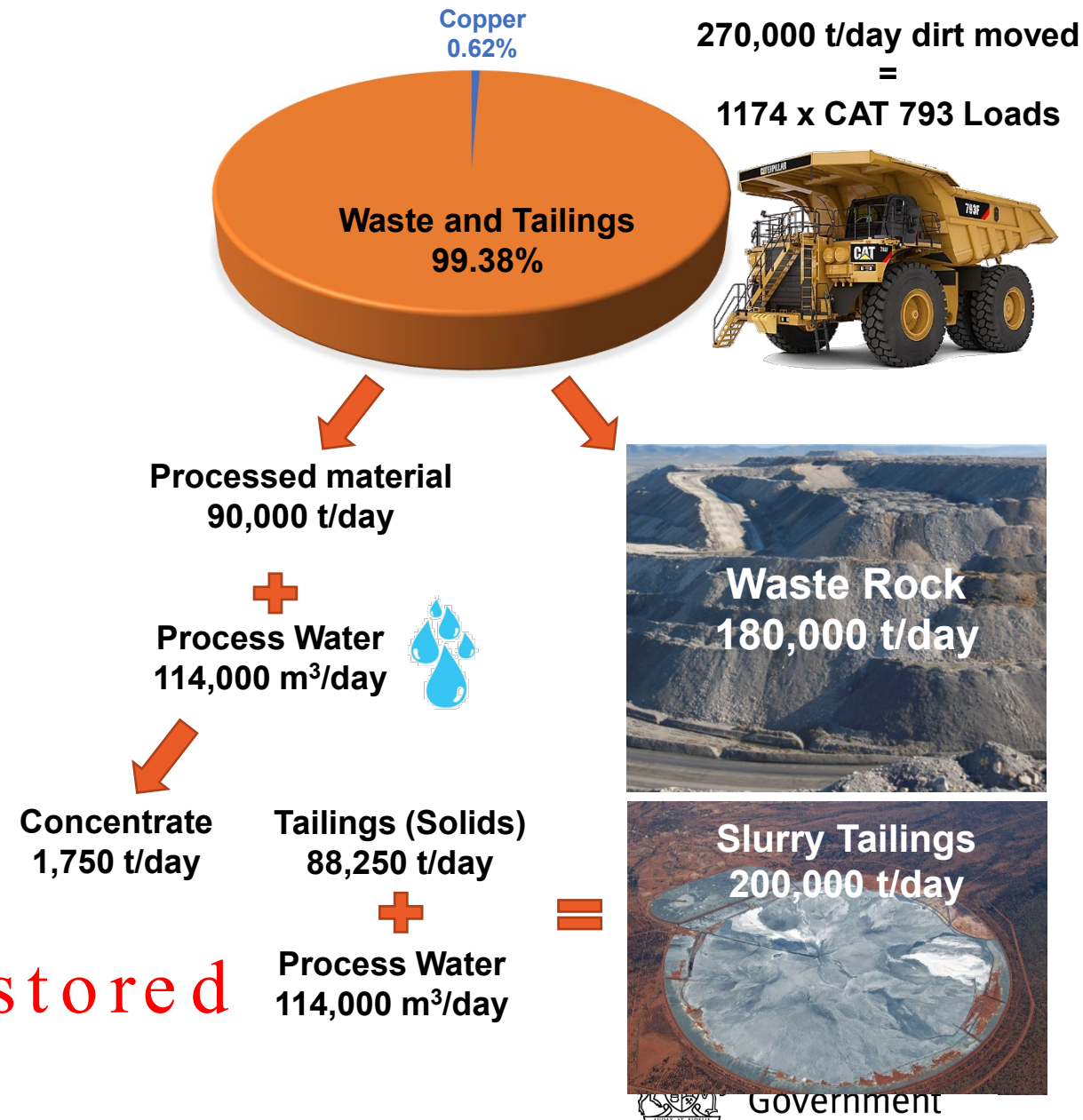


## Contribution to global tailings by commodity



217,330,652,000 m<sup>3</sup> tailings stored globally

## Average global copper grade

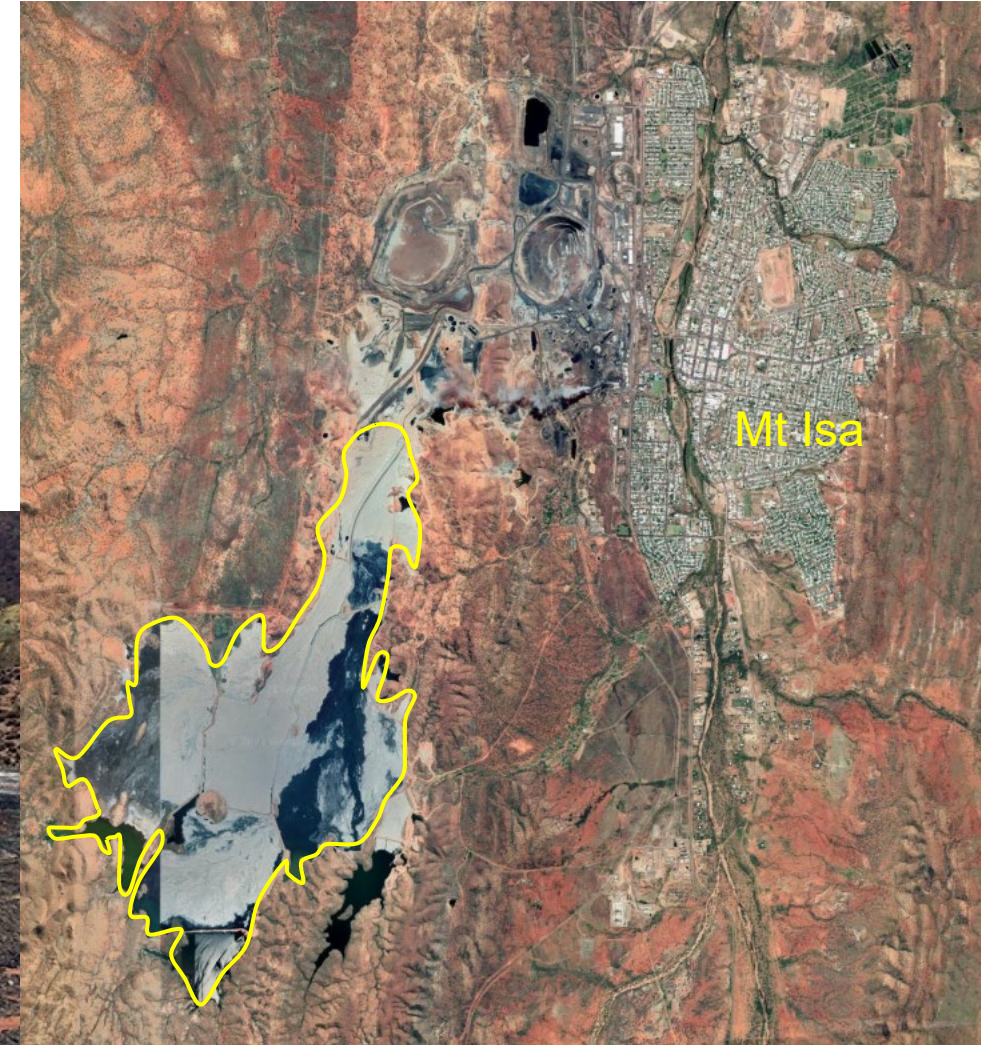




# The Opportunity of Secondary Prospectivity

Example - Mount Isa copper mine:

- Reported spot grades up to 9% Cobalt
- No cobalt production since 1990's
- Approx 15km<sup>2</sup> tailings





# Secondary Prospectivity - Cobalt and other critical minerals in mine waste



Collaborative Project through University of Queensland

- A/Prof Anita Parbhakar-Fox
- **Transforming Queensland's mine waste into green ore deposits:  
Exploration of new economy metals**
  - Examine mine waste sites across Queensland and identify economic deposits of new economy metals (in particular critical metals e.g., Co, In, W, REEs, Ga, Ge) to determine if mine waste is a viable resource





Son

# National Collaboration Framework

Collaborative Project Agreement

Mine Waste Sampling and Analysis

---

Geoscience Australia

University of Queensland

Geological Survey of Queensland



**Australian Government**

**Geoscience Australia**



**THE UNIVERSITY  
OF QUEENSLAND**  
AUSTRALIA



**Queensland  
Government**





## **Waste Rock**

Capricorn Copper    Baal Gammon  
Mount Oxide        Horn Island  
Pindora              Mary Kathleen  
Lady Annie



## **Tailings**

Capricorn Copper    Horn Island  
Rocklands            Mary Kathleen  
Herberton             Osborne  
Mount Garnet        Selwyn  
Century



## **Spent Heap Leach**

Mt Cuthbert        Lady Annie  
Pindora

## **Metallurgical Slimes**

Phosphate Hill



## **Metallurgical Slag**

Mount Morgan  
Mount Chalmers (upcoming)



## **Bauxite Residues**

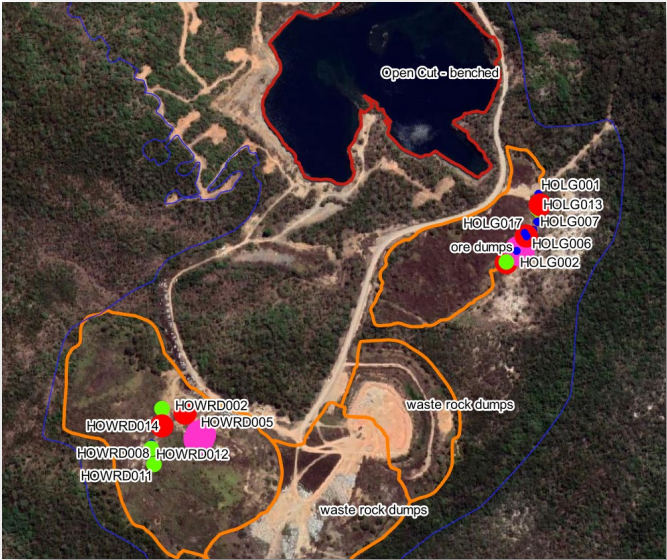
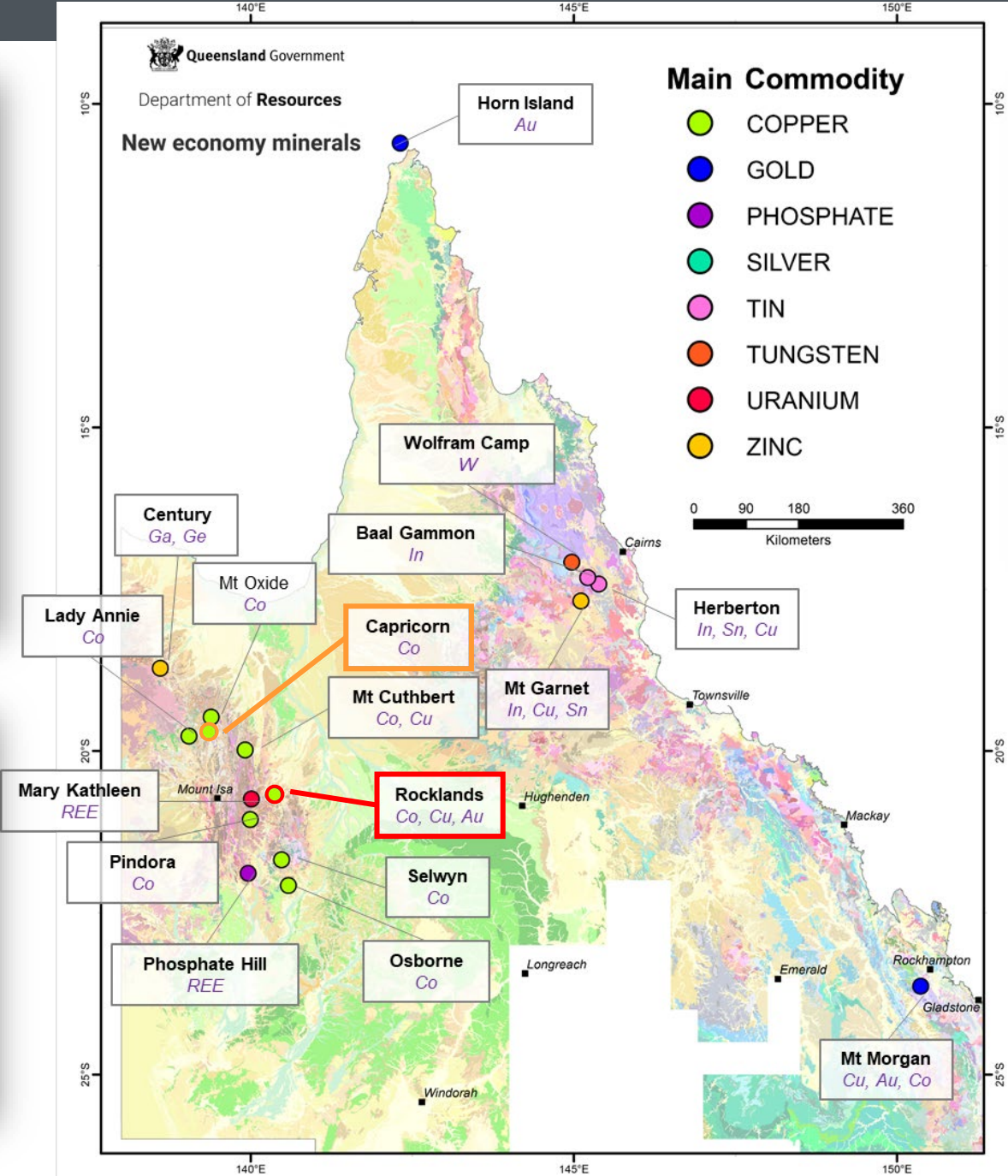
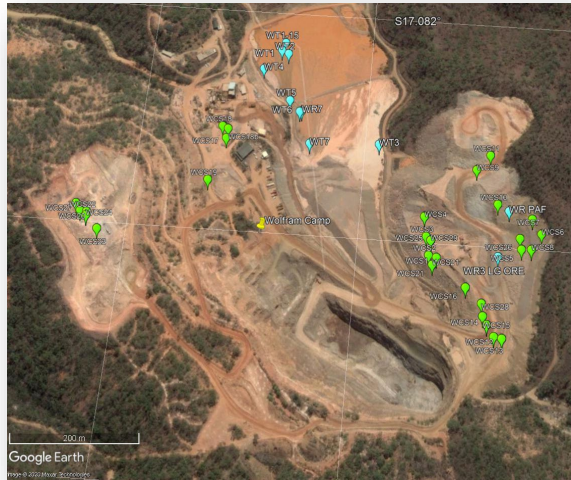
Target in next campaign  
Search for REEs, Ga, Ge



## **Coal Wash & Fly Ash**

Target in next campaign  
Search for REEs, Ga, Ge, Se





17 sites sampled  
thus far

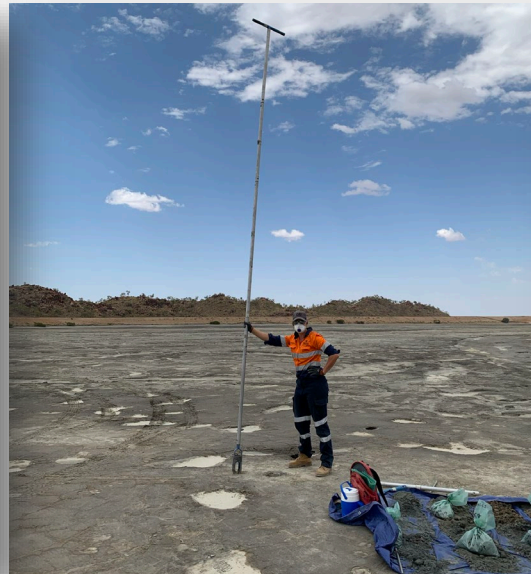
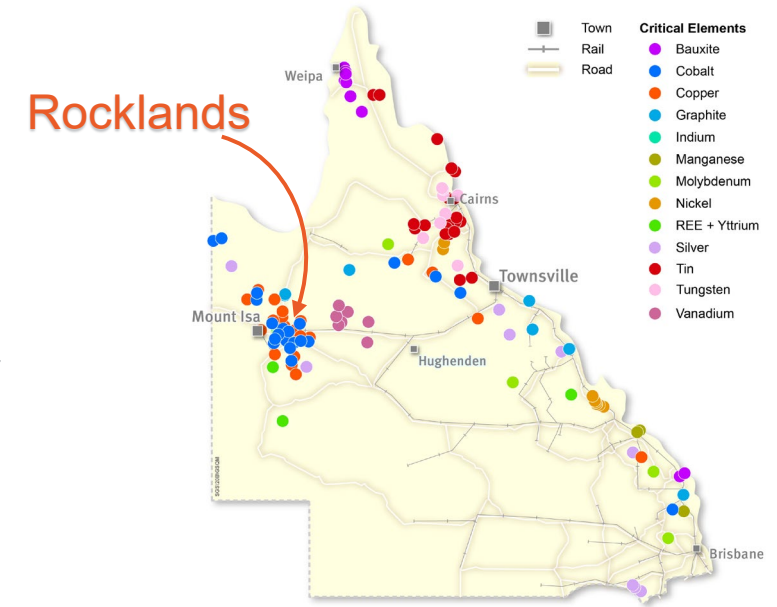
Goal: ~6 sites/year



# Cobalt Opportunity



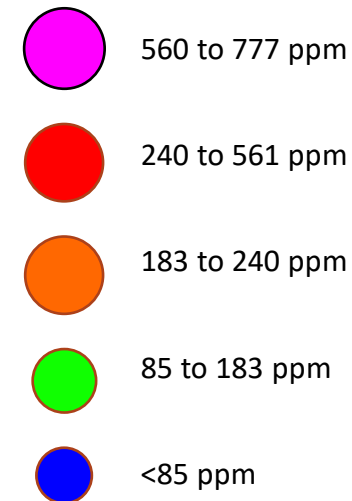
- GSQ
- JOGMEC
- UQ





# Average Cobalt – All sites Whole Rock (assay)

## Mean Co (ppm)



Concentration of Co  
in NW Qld – endowed  
in IOCG, sediment-  
hosted and  
epigenetic Cu  
systems

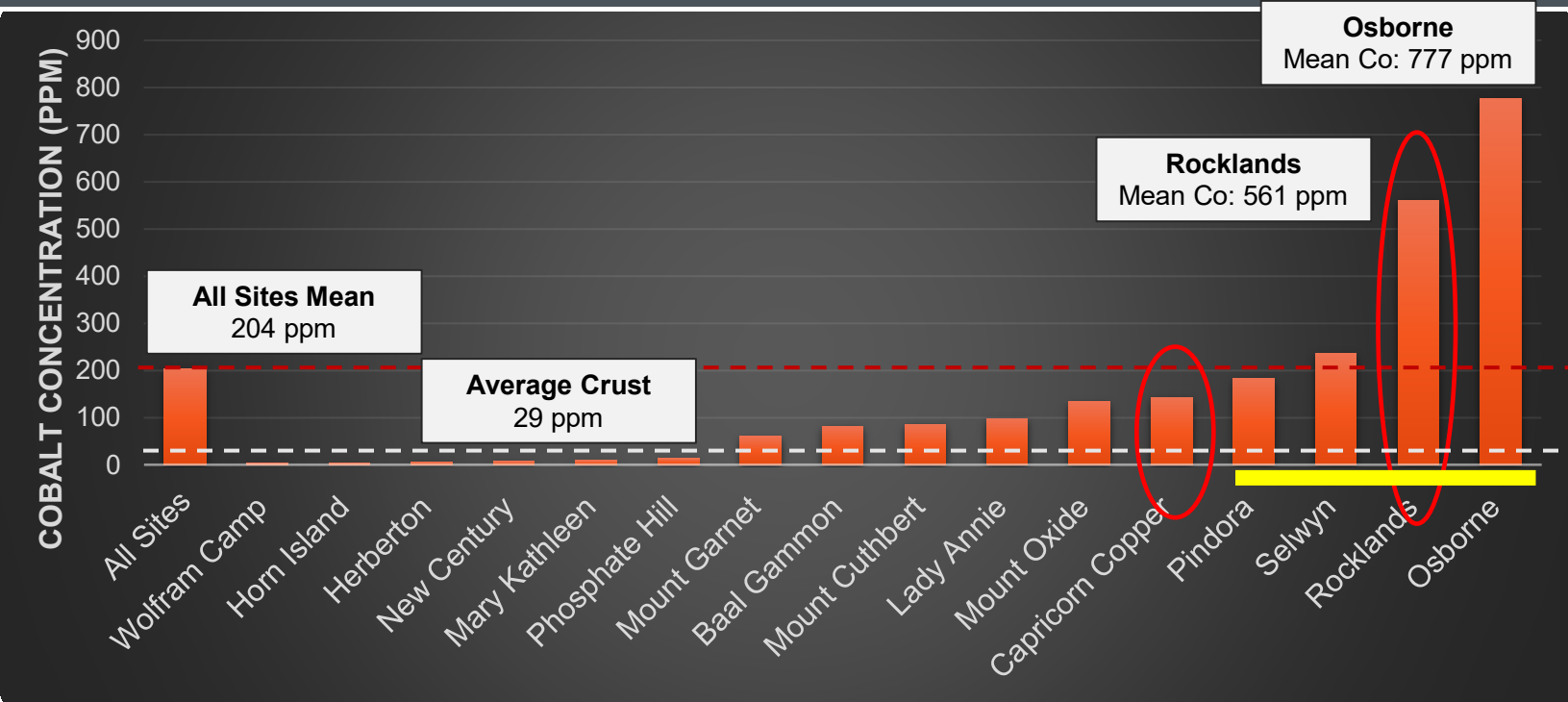
Google Earth

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image Landsat / Copernicus

QUEENSLAND

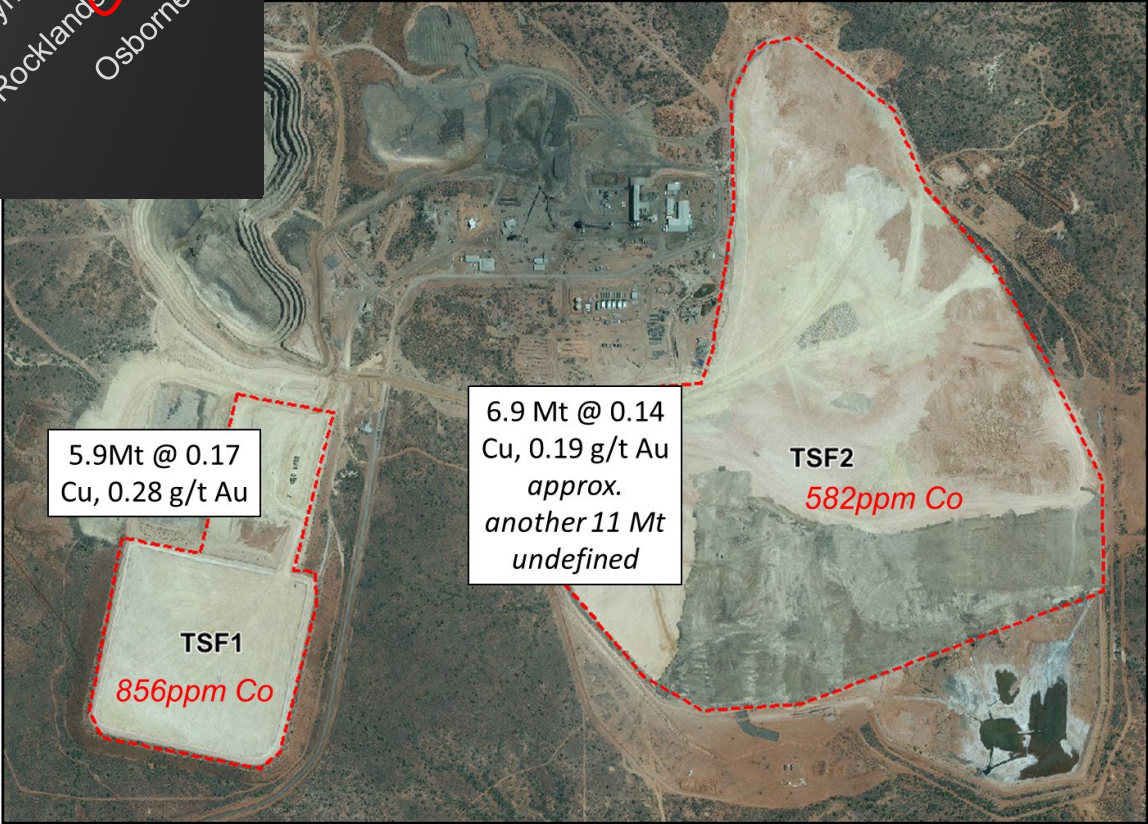
300 km



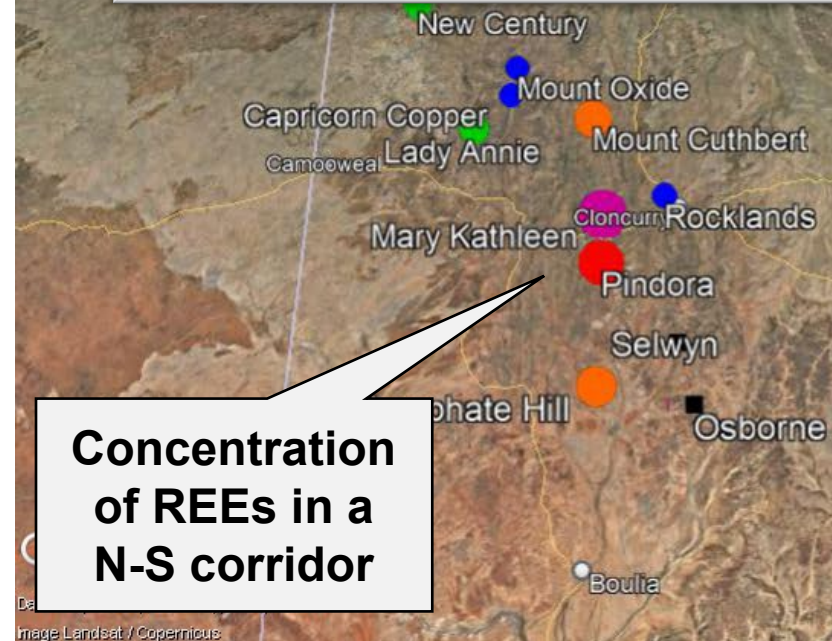
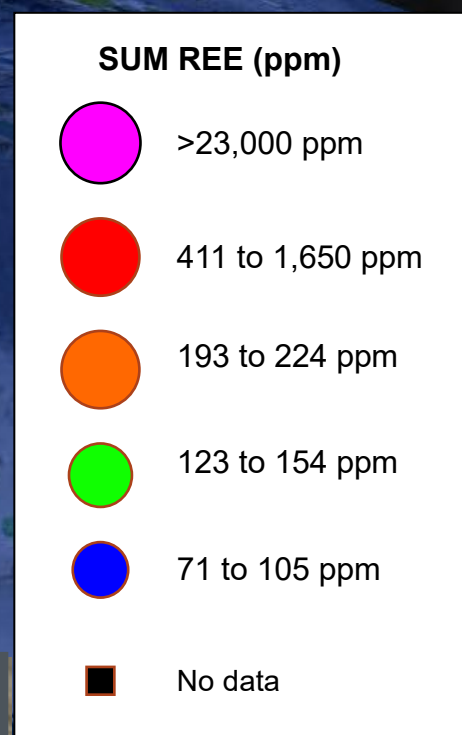
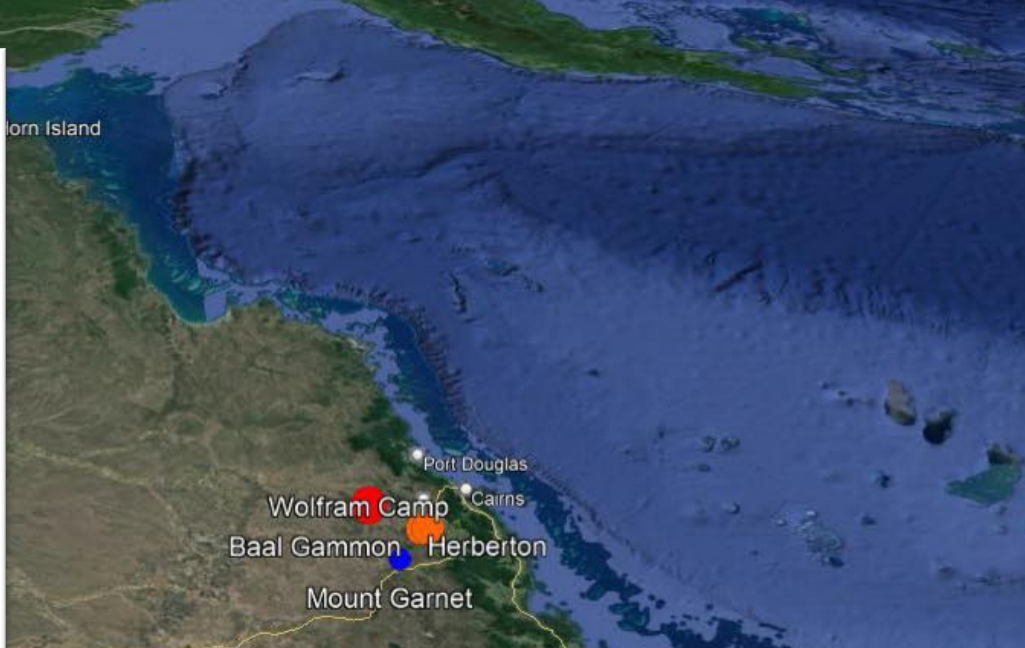
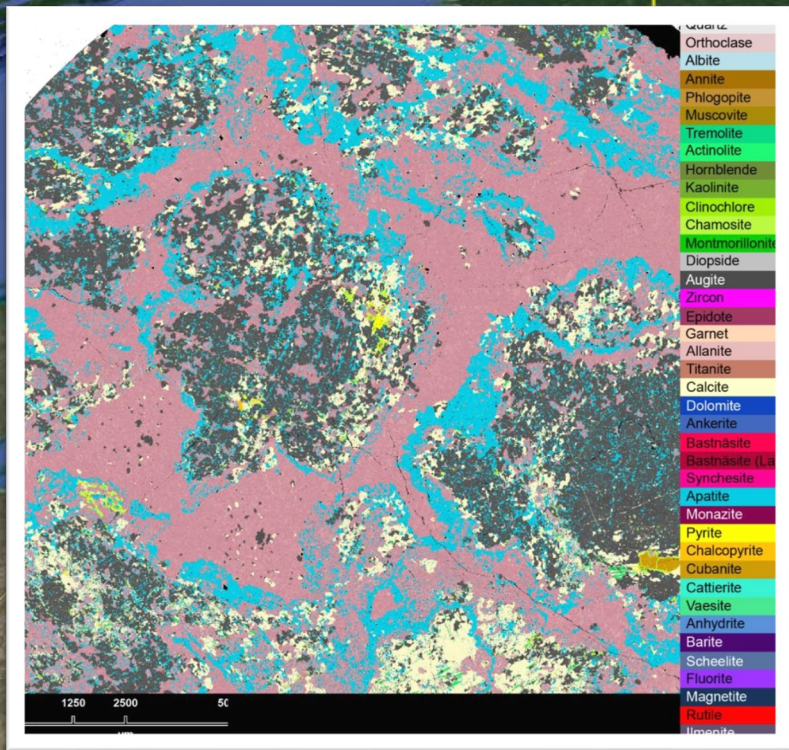


# Cobalt

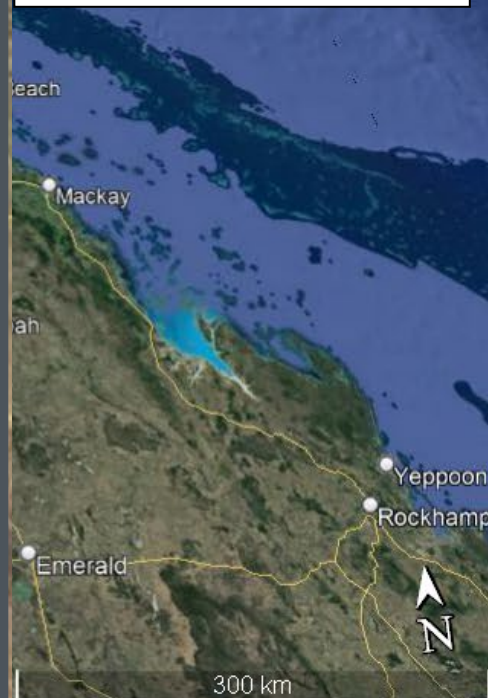
Osborne Tailings Facilities







**Concentration  
of REEs in a  
N-S corridor**





# Mary Kathleen REE metallurgy solutions

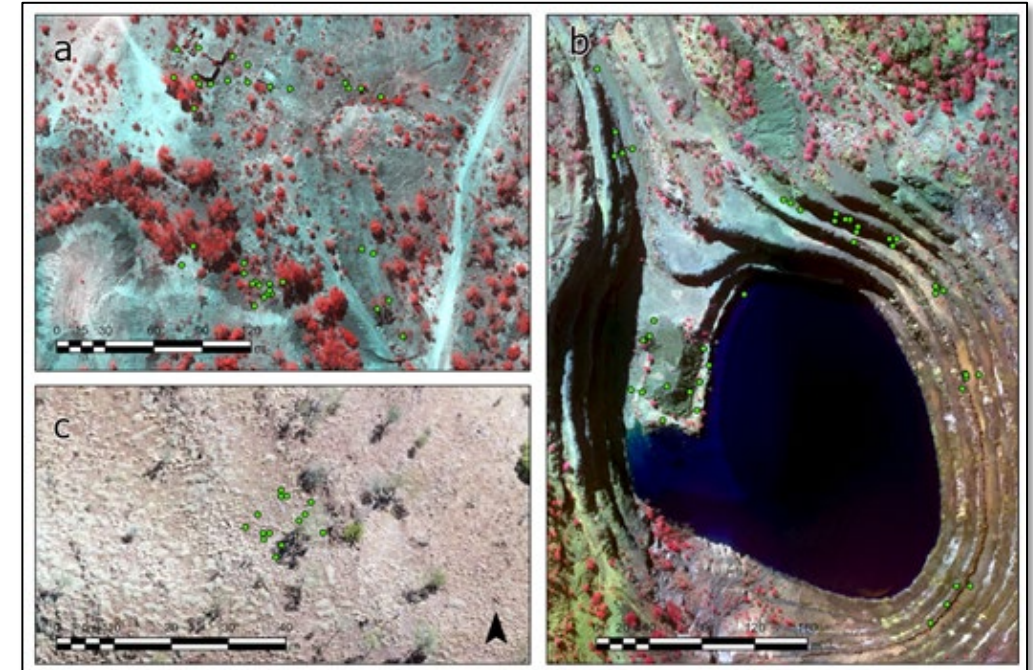
## Bioleaching (bacteria)



Bioleaching experiments currently underway using Mary Kathleen ore



## Phytomining (hyperaccumulator plants)

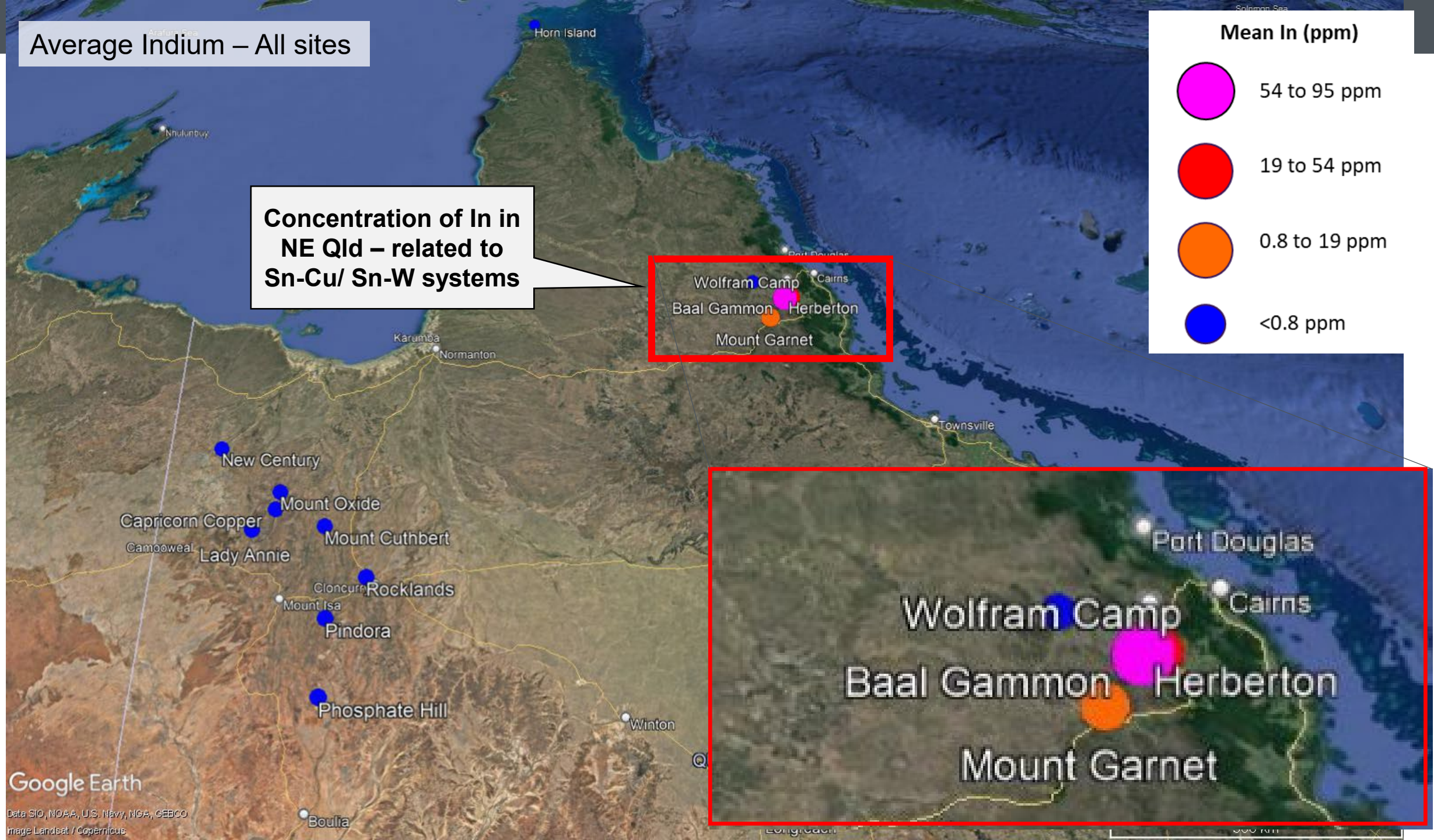
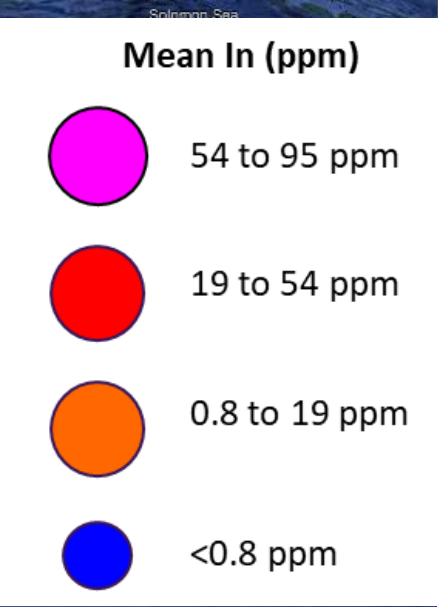


Phytomining experiments currently underway using Mary Kathleen ore

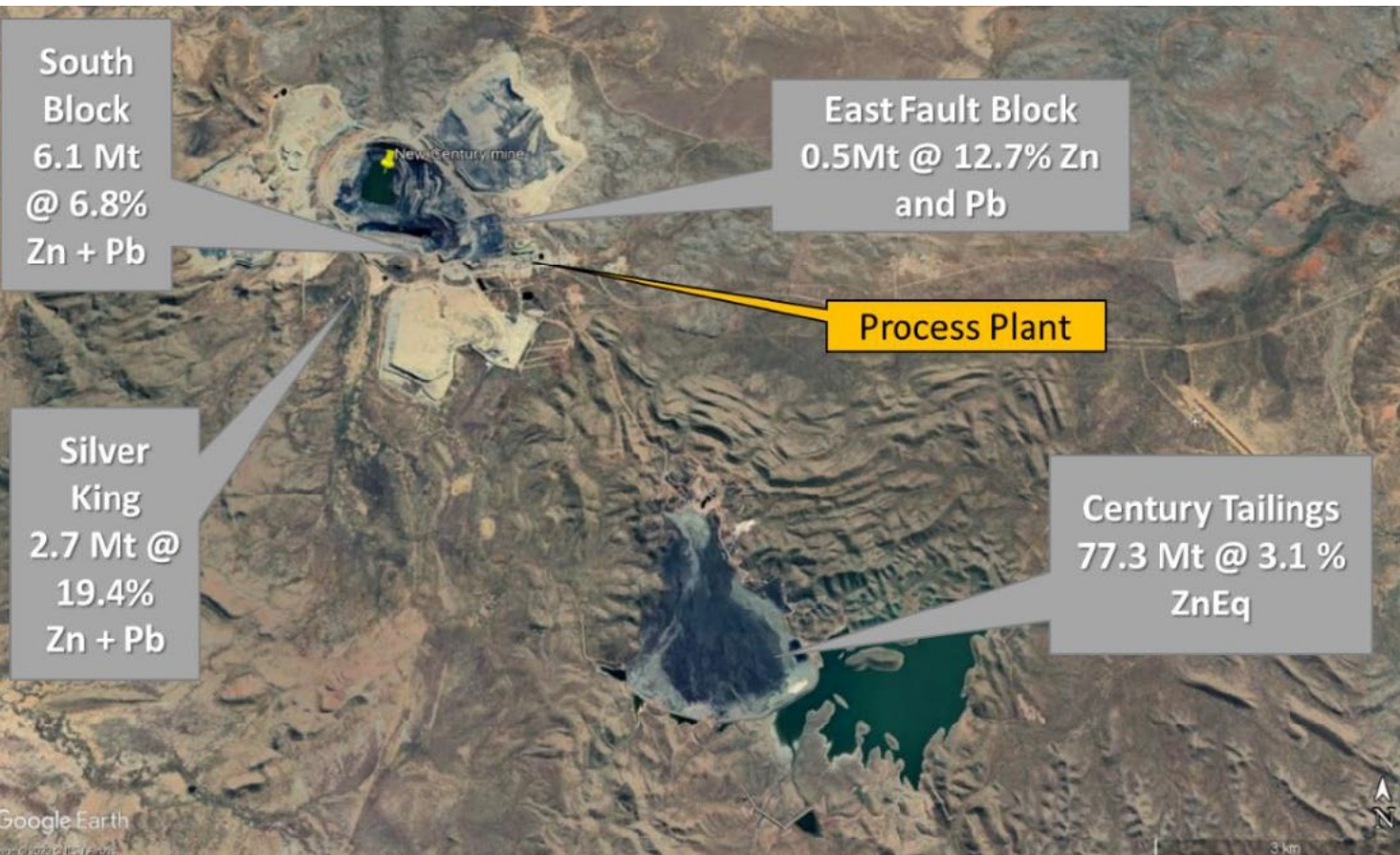


Average Indium – All sites

Concentration of In in  
NE Qld – related to  
Sn-Cu/ Sn-W systems







# Industry Examples:

## New Century Resources

Century Zinc Mine  
Tailings: 77MT @ 3.1% Zneq

Images from New Century Resources







## EQ Resources and Cronimet

Mt Carbine Tungsten Mine  
Low grade stockpiles and waste:  
12MT @ 0.07%  $\text{WO}_3$



Images courtesy EQ Resources





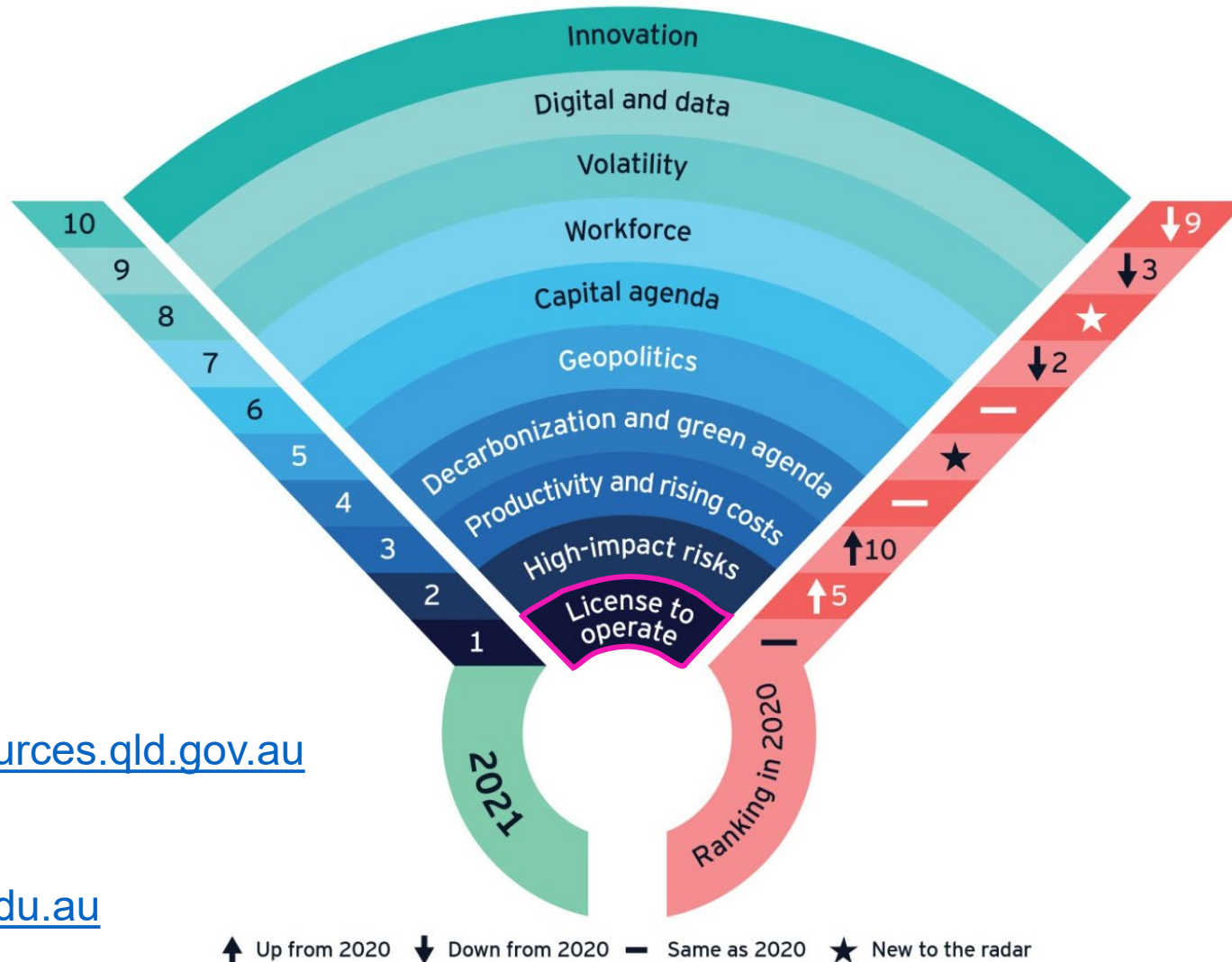
Metal	2019 Production and Reserves Worldwide (USGS 2020)	Main Deposit Types (Primary sources)	Main Waste Types (Secondary sources)
Cobalt	Production: 140 kt (3.4 kt in Aus) Reserve: 7 Mt	Stratiform sediment hosted Cu-Co, Ni-Co laterite, magmatic Ni-Cu-sulphides	Ni-Co laterites, Ni-Cu-Co sulphides and Cu-Co oxides
Indium	Production: 760 tonnes Reserve: unknown	VMS, SEDEX, skarn, epithermal Pb-Zn	Zinc sulphides in residues, Sn-Cu, Sn-W deposits
Nickel	Production: 2.7 Mt Reserve: 89 Mt	Nickel laterites, magmatic sulphides	Ni-Cu sulphides, Ni oxides
Rhenium	Production: 49 tonnes Reserve: 2.4 kt	Porphyry copper, sediment-hosted strata bound	Re-bearing sulphides (e.g., molybdenite) and perrhenate (ReO <sub>4</sub> <sup>-</sup> )
Tungsten	Production: 85 kt Reserve: 3.2 Mt	Calcic skarn, vein/stockwork, porphyry, greisen, stratabound	W oxide
Gallium	Production: 320 tonnes Reserve: unknown	Bauxite, sediment-hosted Pb-Zn	Bauxite residue, zinc sulphides (concentrates)
Germanium	Production: 130 tonnes Reserve: unknown	Volcanogenic massive sulphides (VMS), sedimentary exhalative (SEDEX), Mississippi Valley Type (MVT) Pb-Zn, coal	Zinc sulphides (concentrates), coal fly ash
REE	Production: 210 kt Reserve: 120 Mt	Ion adsorption clay, IOCG, carbonatite, skarn, heavy mineral sands	Bauxite residue, phosphogypsum, rare earth oxides (tailing, coal ash)

Source: Whitworth (2021)



# Top 10 risks and opportunities for mining and metals

Ernst and Young 2021



Contacts:

Helen Degeling

[Helen.degeling@resources.qld.gov.au](mailto:Helen.degeling@resources.qld.gov.au)

Anita Parbhakar-Fox

[a.parbhakarfox@uq.edu.au](mailto:a.parbhakarfox@uq.edu.au)



Queensland  
Government