



# A responsible look at a resourceful planet

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# Metals and Sustainable Development

# Metals and Sustainable Development

- Reduction and smelting of iron ore in the blast furnace
  - > 1450 °C

Charcoal



**Massive Deforestation**

> *Unsustainable production of pig iron (Buffon, 1783)*



*Blast furnace in the region of Spa(1612) Jan Bruegel*

# Metals and Sustainable Development

- Modern steelmaking
  - John Cockerill (1817)

Coking coal



1,9 tons CO<sub>2</sub> per ton of steel  
> 5% of world GHG emissions in 2023



HFB Blast Furnace in Ougrée

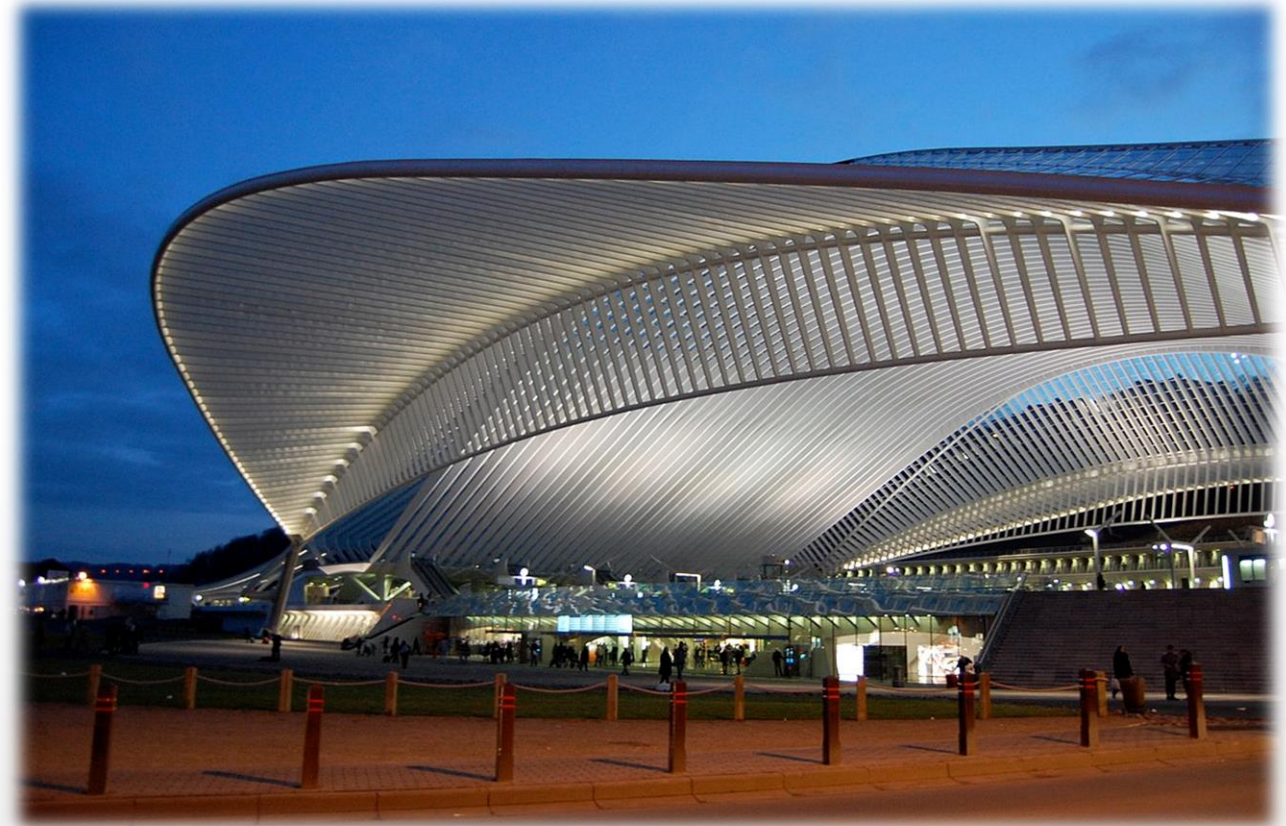
# Metals and Sustainable Development

- World production of 1,5 Gt steel
  - 450 kg steel/ pers yr (Europe)

Where to find hydrogen?



Water vapour

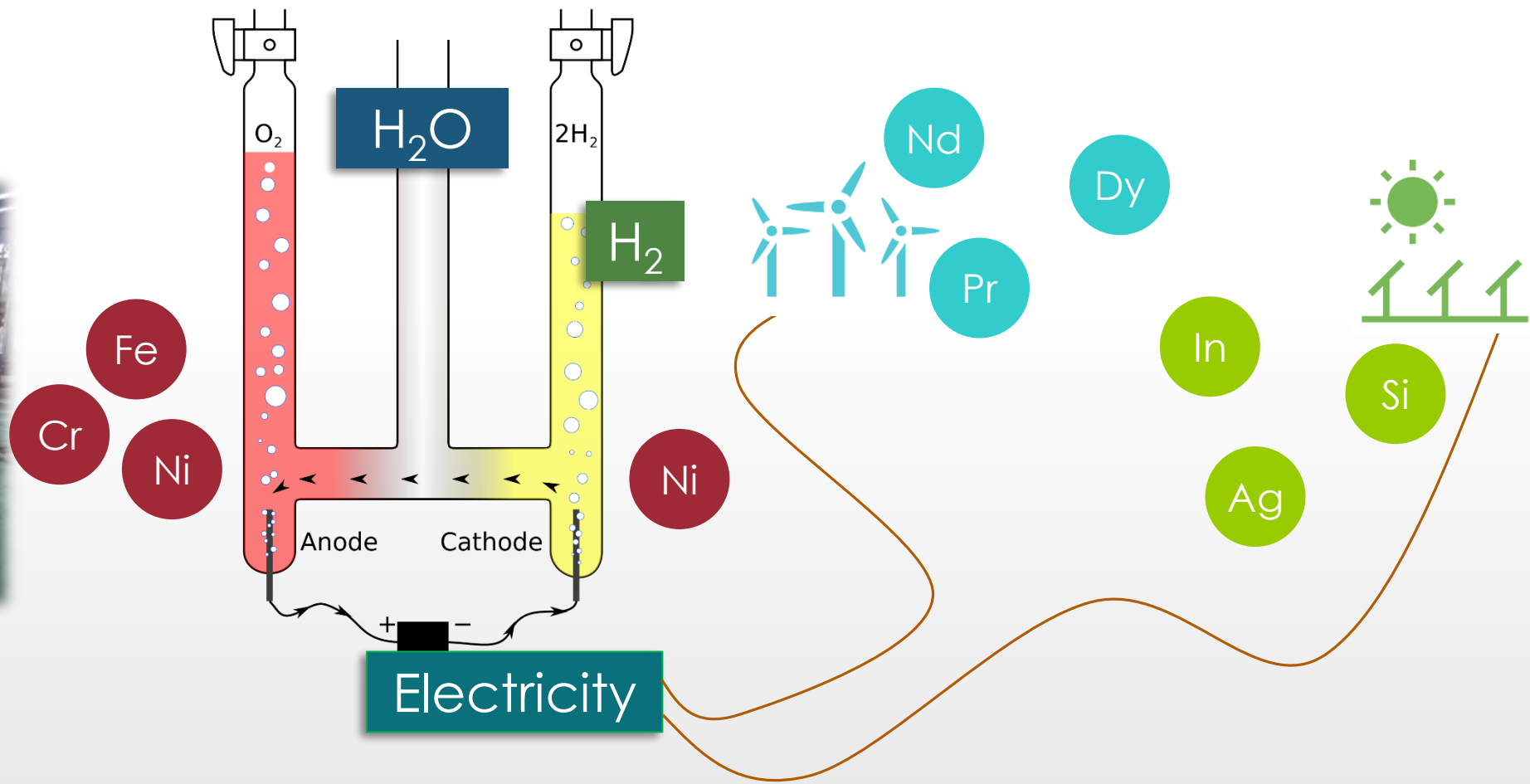


# Metals and Sustainable Development

- We need water and « green » electricity!

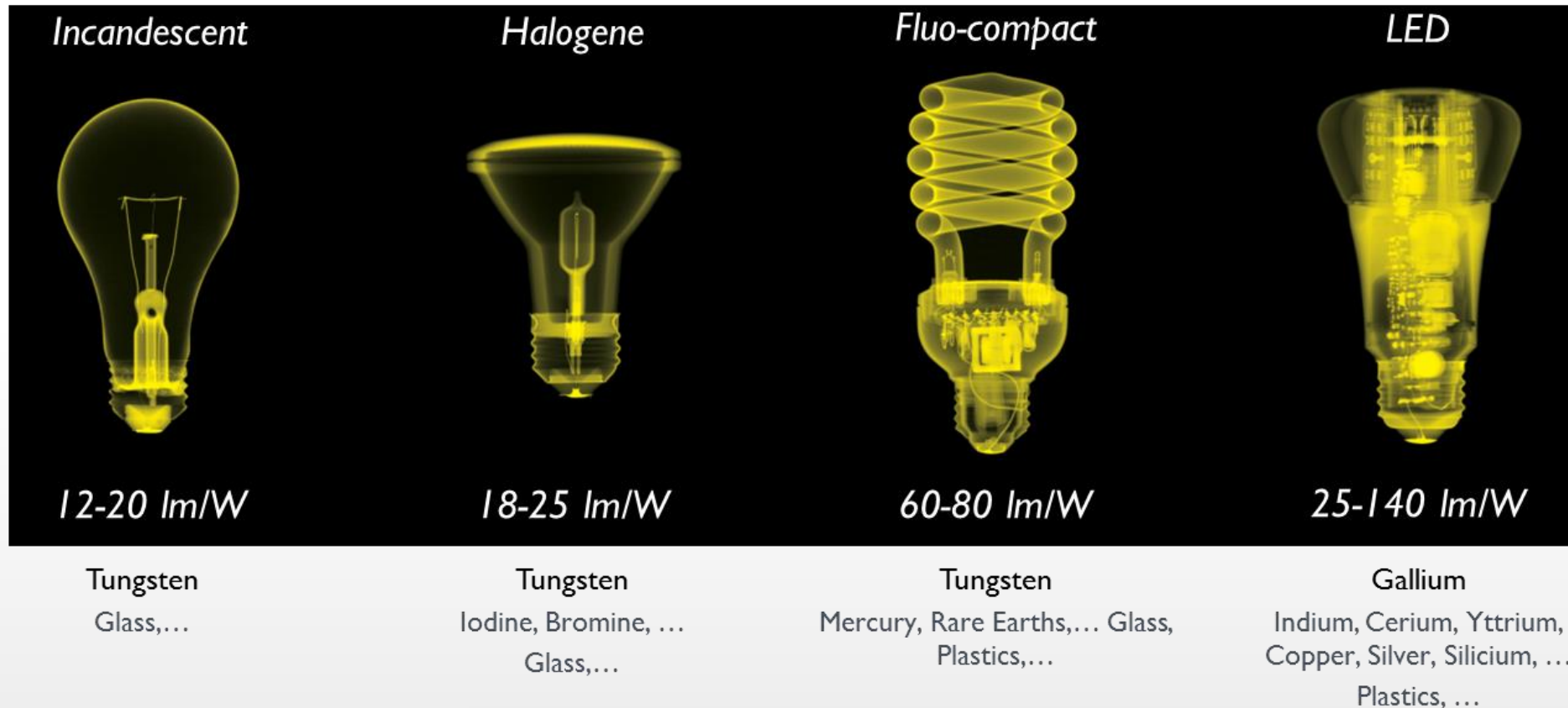


 John Cockerill



# Metals and Sustainable Development

- It is not just a question of CO<sub>2</sub>!



We have optimized **functionality** (and lowered in-use GHG emissions) at the expense of resource **extraction** and **recyclability**!

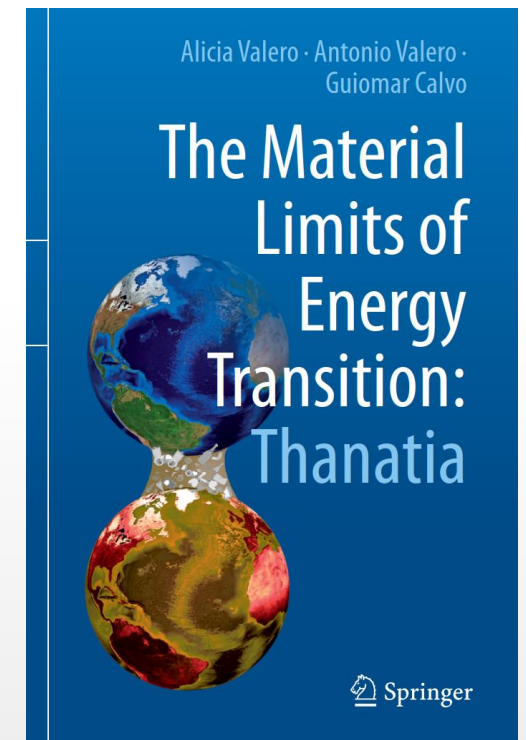
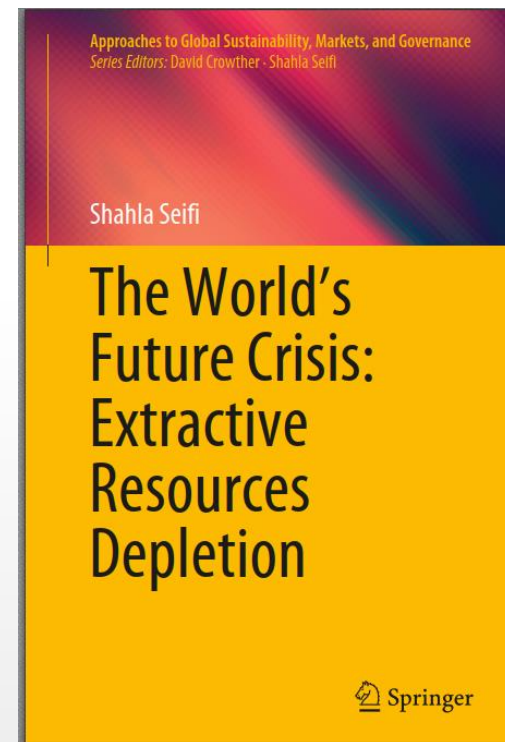
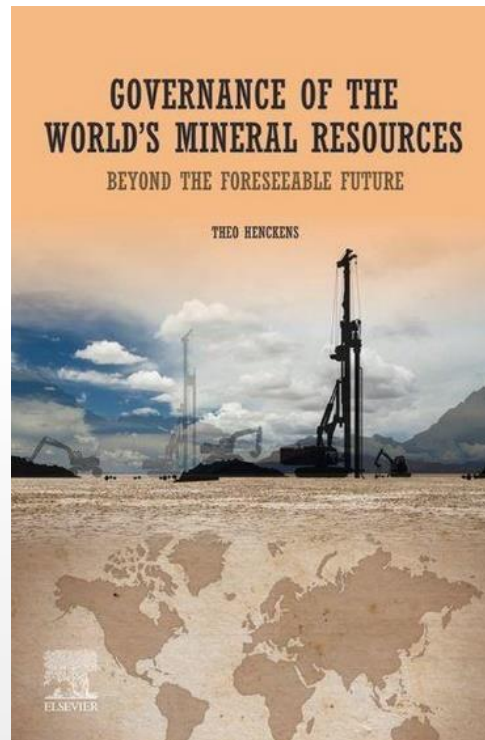
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Why metals suddenly became critical?



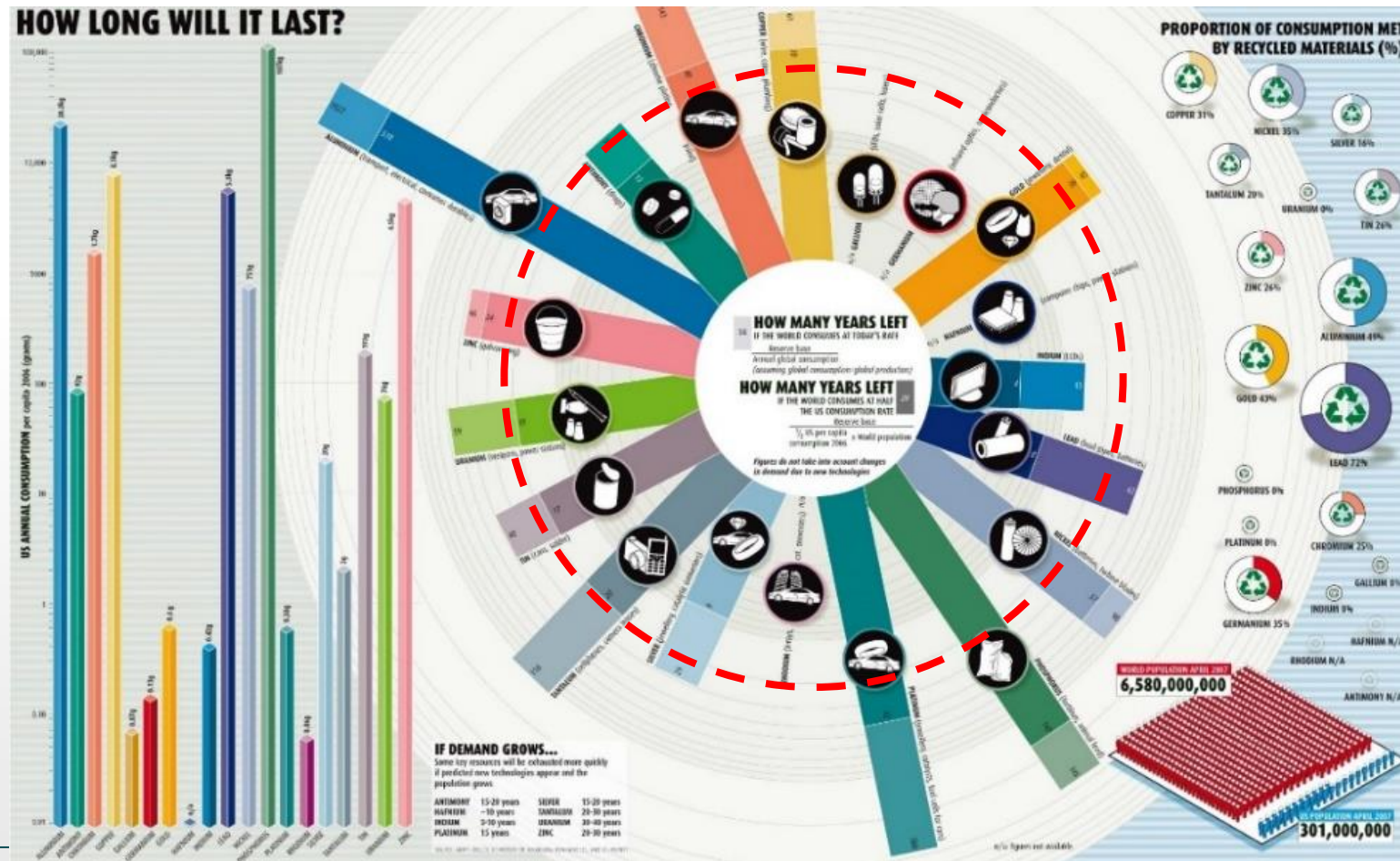
# Why metals suddenly became critical?

- Abundance of alarming messages about resource depletion
  - ... written (mostly) by non-geologists!?



# Why metals suddenly became critical?

- The mirage of a twenty years horizon
  - Non-sense of dividing currently known reserves by annual production

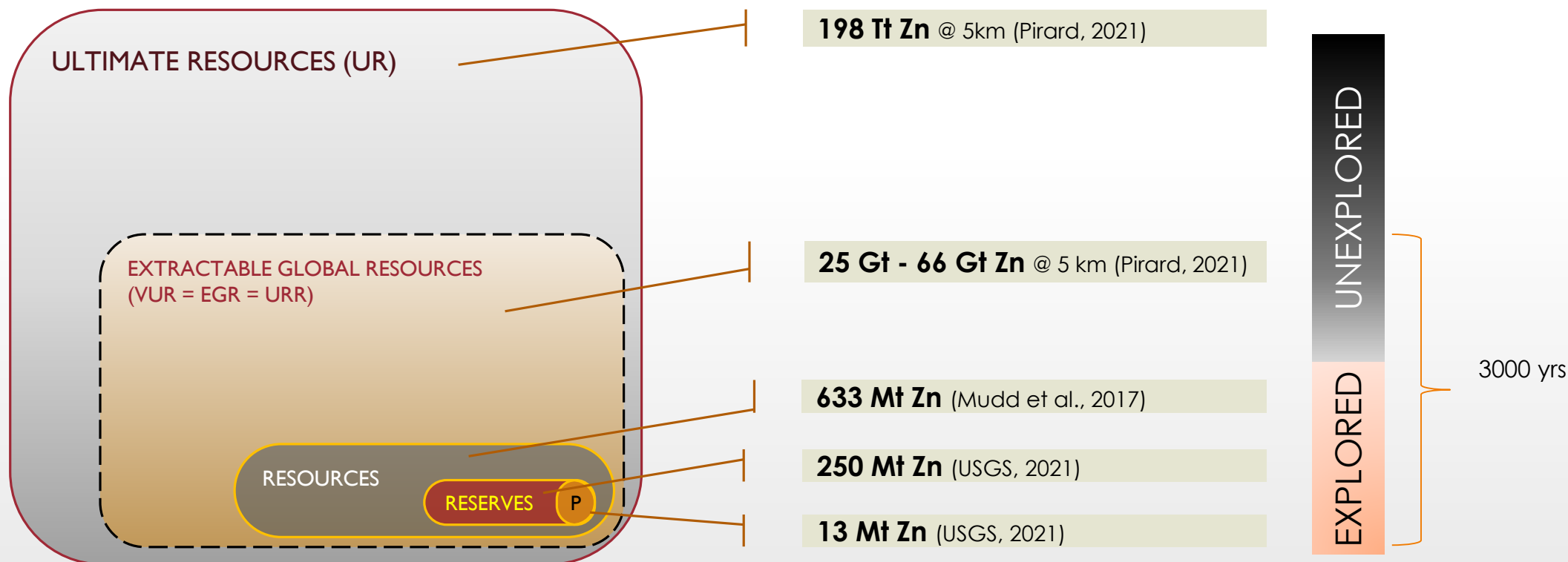


A. Reller & T. Graedel, 2007

# Why metals suddenly became critical?

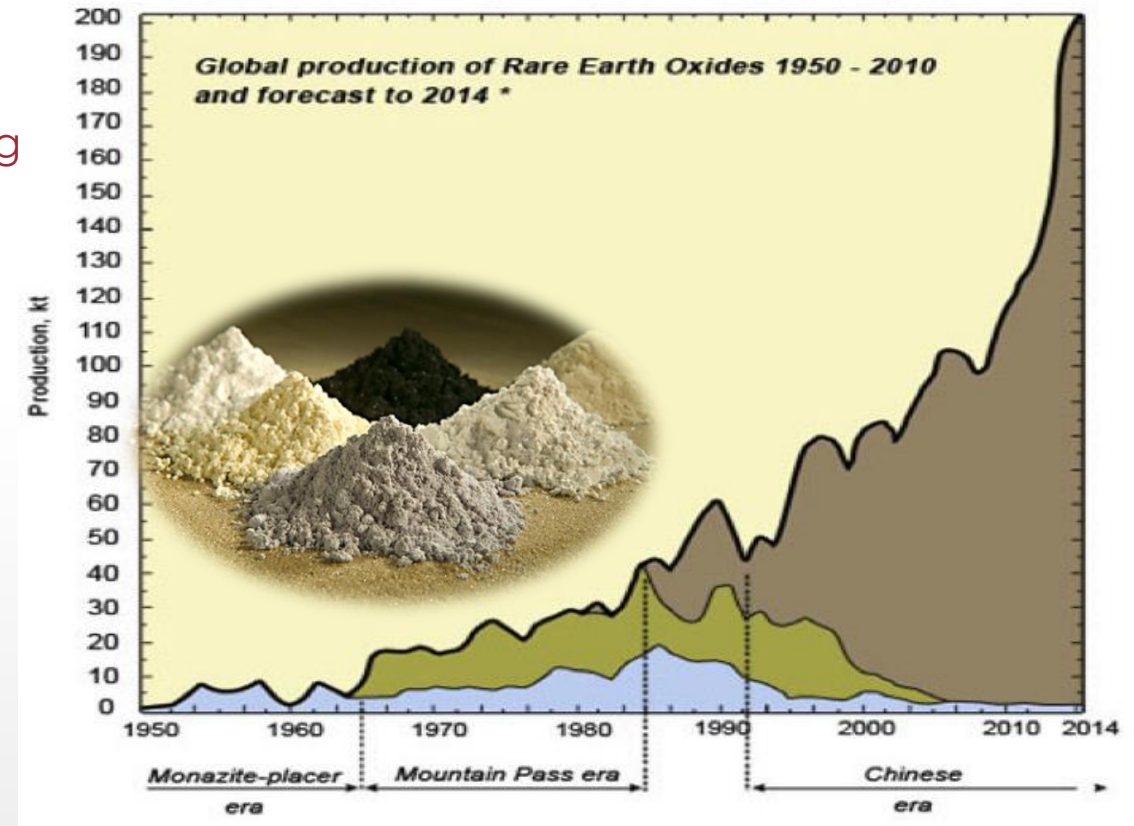
- Criticality does not mean scarcity!
  - Relying on reasonable technical innovation
    - robotics, deep exploration tools, ...
  - Based on demonstrated « discovery factors »

**Thousands of years left** for mining similar deposits at similar grades (but greater depth)



# Why metals suddenly became critical?

- Criticality is a geopolitical question
  - **NIMCO** - NOT IN MY CONTINENT
  - China's monopoly on Rare Earth mining and processing is exactly what we wanted...
  - 1985
    - **US** is a significant player in mining
    - **FR** has unique know-how in refining
  - 2000 – today
    - Mining is in **China**
    - Processing is in **China**



World production of rare earths by country since 1950

# Why metals suddenly became critical?

- Same story for almost all commodities
  - Cobalt processing routes

Ores & concentrates

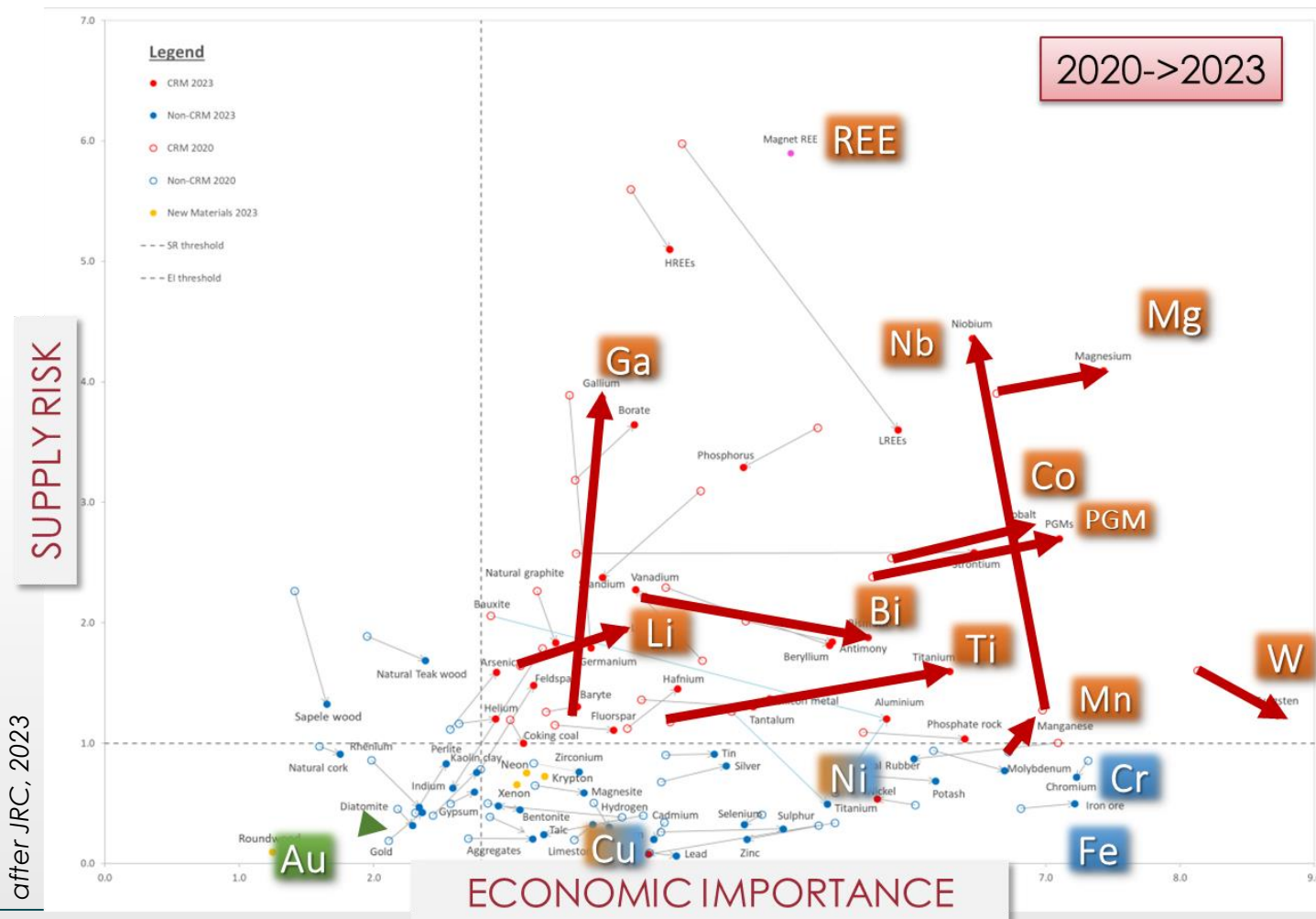
Mattes & other intermediates



# Why metals suddenly became critical?

- 30+ critical and strategic elements for the EU in 2023 ... and counting

- Supply risk
  - concentration within a few hands
- Economic importance
  - limited diversity of uses



# Why metals suddenly became critical?

- So what ?
  - Critical Raw Materials **ACT** (Mar 23)
    - Recycling and Mining = **REINDUSTRIALISATION**

## SETTING 2030 BENCHMARKS FOR STRATEGIC RAW MATERIALS



### EU EXTRACTION

At least **10%** of the EU's annual consumption for extraction



### EU PROCESSING

At least **40%** of the EU's annual consumption for processing



### EU RECYCLING

At least **15%** of the EU's annual consumption for recycling



### EXTERNAL SOURCES

Not more than **65%** of the EU's annual consumption of **each strategic raw material at any relevant stage of processing** from a single third country



*Brownfields in EU*

*Unique opportunity for a **circular reindustrialisation***

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# Objective Earth!



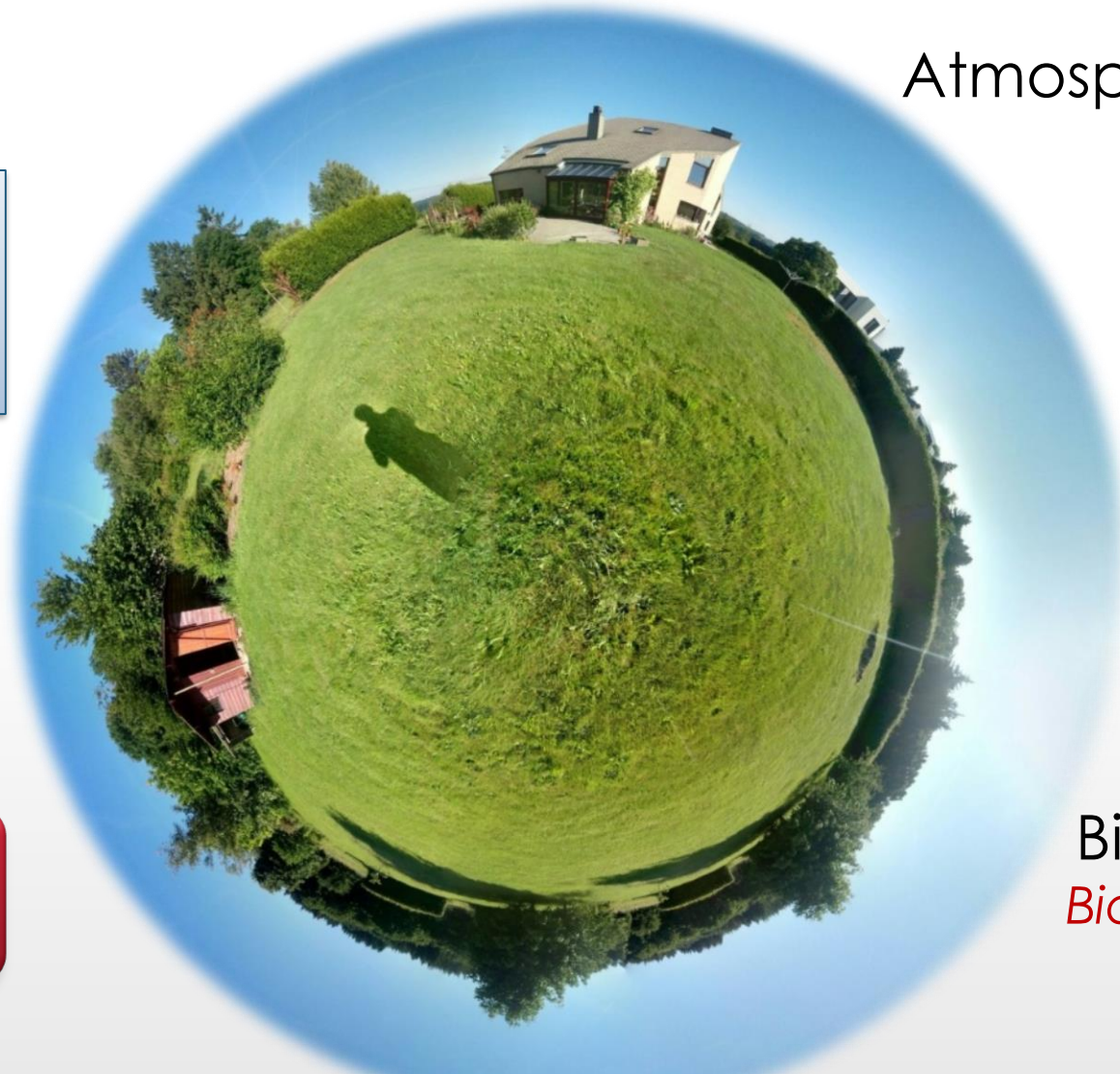
# Objective Earth!

- Spherical Economy

The art of administering an asset (a planet!) by prudent and wise management in order to obtain (for all and for future generations) the best return by using the least resources.

Geosphere  
*Georesources*

Biosphere  
*Bioresources*



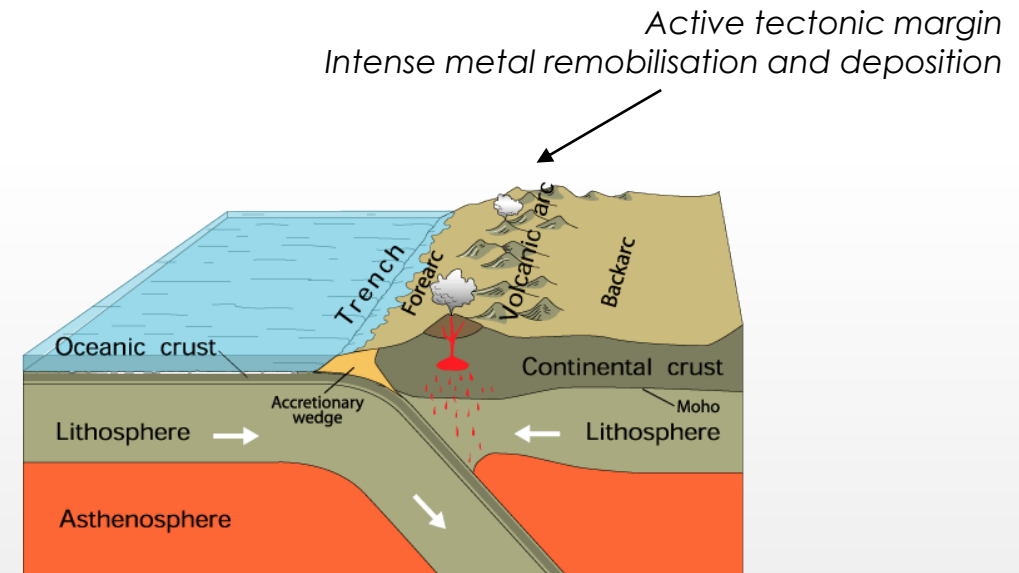
**NOT** a single reference to **metals** and minerals in the thousand pages on **Sustainable Development Goals (SDG)**!

# Objective Earth!



- Geology of the earth
  - **Oceanic Crust** 300 Mkm<sup>2</sup> (60%)
    - Very well known (homogeneous, young)
    - Limited potential (nodules, crust) Ni, Co, Cr, Cu...
  - **Continental Crust** 210 Mkm<sup>2</sup> (40%)
    - Only superficially known (300m)
    - Hosts most metal deposits (strong diversity)

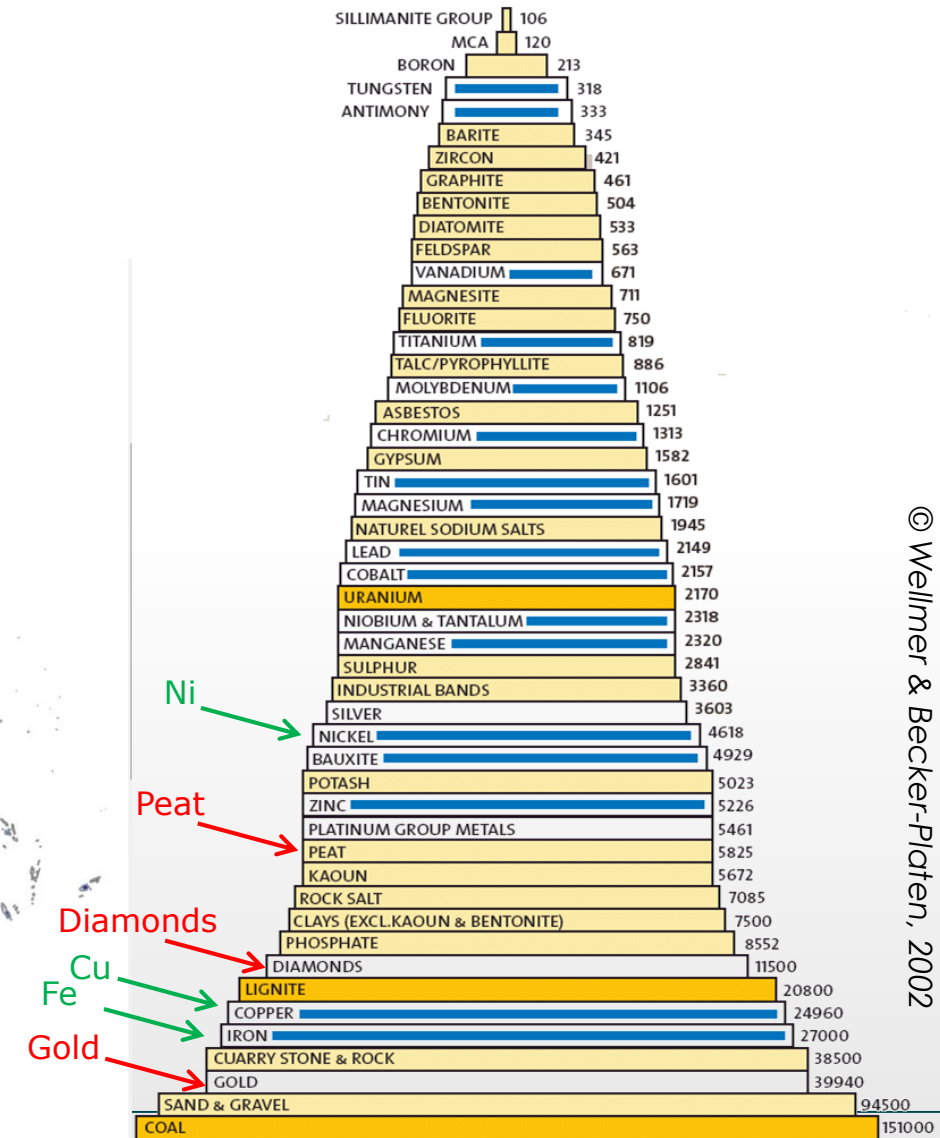
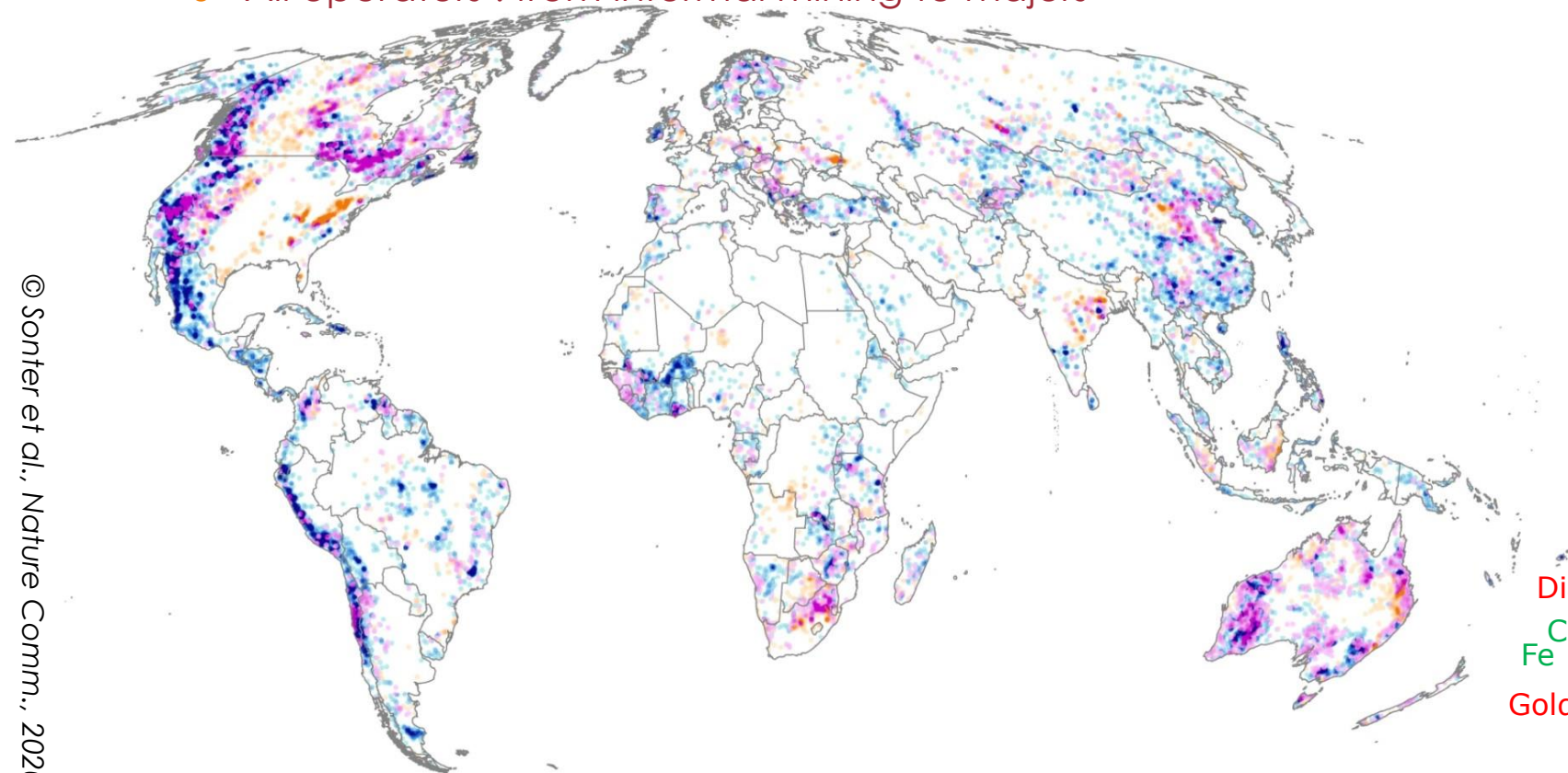
Newly formed oceanic crust  
Ocean floor (- 5000m)



A perfect **Understanding** of the Earth mineral resources should be a preliminary to a **Responsible Management**

# Objective Earth!

- (Ir)Responsible Mining ?
  - No world governance
  - No socio-environmental prioritisation
  - All operators : from informal mining to majors



# Objective Earth!

- The Future is a More Responsible Mining

- Technology & Environment

- Safer Tailings Management
    - Water Recycling
    - Acid Mine Drainage
    - Site Remediation
    - Clean Energy Sources
    - Digitisation, Robotics, ...



© Anglo



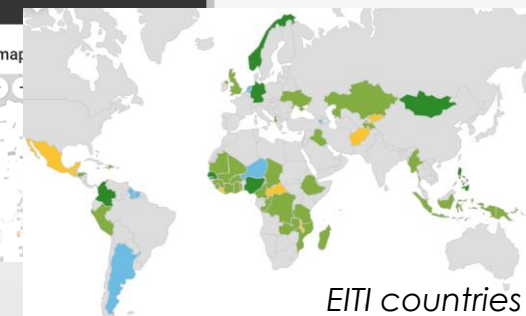
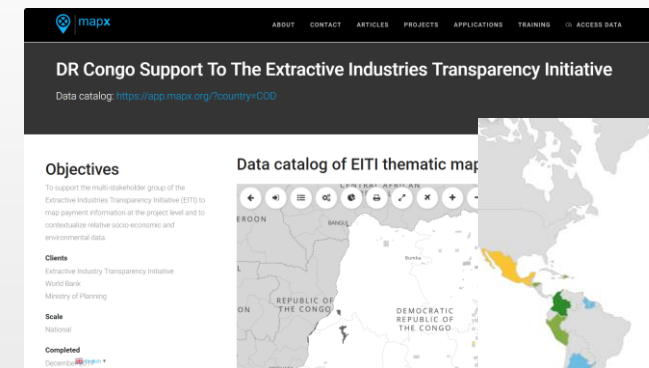
© Rio Tinto



© NGI

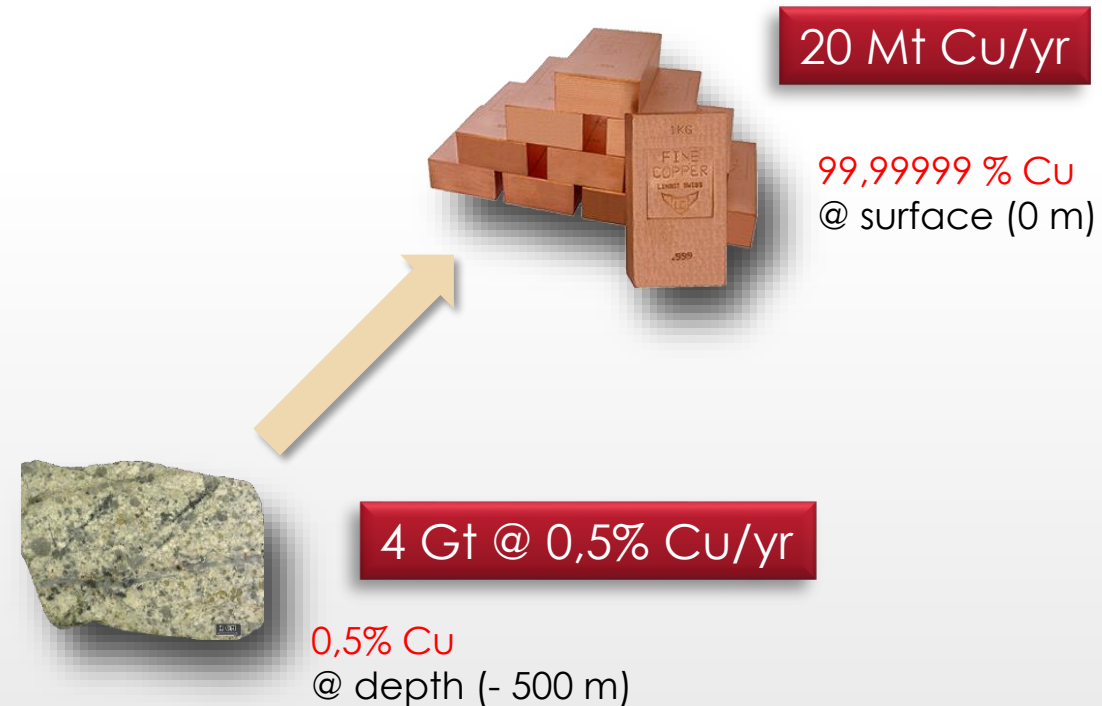
- Social Responsibility

- Corporate Governance
    - Social Responsibility
    - Transparency
    - Due Diligence of Supply Chains



# Objective Earth!

- There is no Sustainable Mining
  - Mining is about **EXTRACTION** (making resources accessible)
  - Minins is about **FUNCTIONALIZATION** (making raw materials useful to society)
  - Mining is a major **UPCYCLING** step



# Objective Earth!



- The Four Challenges of a Circular Economy
  - Nothing gets lost, nothing is created, everything is transformed, **BUT...**

- Compromising actions:
  - Dispersion, hoarding, ...

- Waste at all stages

- Dissipation during collection/recycling

$$(80\%)^3 = 51\%$$



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# Mining for Europe

# Mining for Europe

- Relocating Mines in Europe
  - Is a **political** decision
    - The end of globalisation?
  - Is key in a **circular economy** strategy
    - Feed the Loop
  - Implies **reindustrialisation**
    - Relocation of the whole value chain (from lithium to EV)
  - Could **stimulate innovation** and **responsible** mining practices
    - Internalise socio-environmental impacts



Belgium opens the world's first unmanned mine!



# Mining for Europe

- Alternatives ?
  - **Zero mining** is not an option
    - Metal-based transition
  - **Recycling** will never supplement mining
    - Will contribute at best 10 % - 30 % of needs
  - Sign Ambitious **International Partnerships**
    - Equitable sharing of the value chain
    - Fair Mining

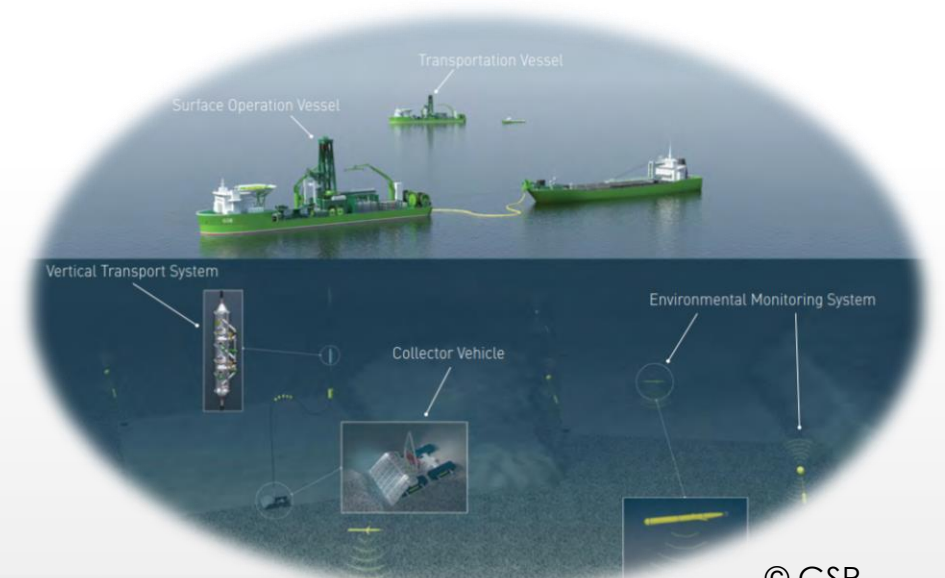


Proudly sourced in the DR Congo!

© Glencore

# Mining for Europe

- Deep Sea Mining
  - Strengthen leadership in **engineering**
    - Support innovation
  - Access resources placed under an **international authority**
    - Transparency
    - Responsible governance
  - Shorter **discovery to production** potential
    - Land based mining averages 15,7 years
  - Limited **environmental impact** (dust, tailings, water, land-use, biodiversity)
    - Compared to surface mining of Ni, Co



Responsibly collected on the ocean floor

© GSR

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The End

# Anthropy or Entropy

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- Let's cooperate to postpone the end!



What is **critical** is not so much the long-term availability of raw materials as the short-term **use** we make of it!