

Critical mineral resources

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Increasing metal use and complexity

- ▶ Electric cars: 2-4 x copper in regular cars (~50Kg) + Al, Li, Co, Ni, Ti, B, Au ... and buses, trains, planes, ferries
- ▶ Wind turbine: ~185t steel (+coal), ~3t Cu, ~0.5kg Nd
- ▶ Solar PV: Si, Cd, Ga, Te, Se, In, Zn, Mo, REE
- ▶ LED lighting: Si, As, Ga, In, Te, Se, Ba, B, REE



Copper – technology and infrastructure

Global copper provinces

Chile-Peru: ~35% of global copper

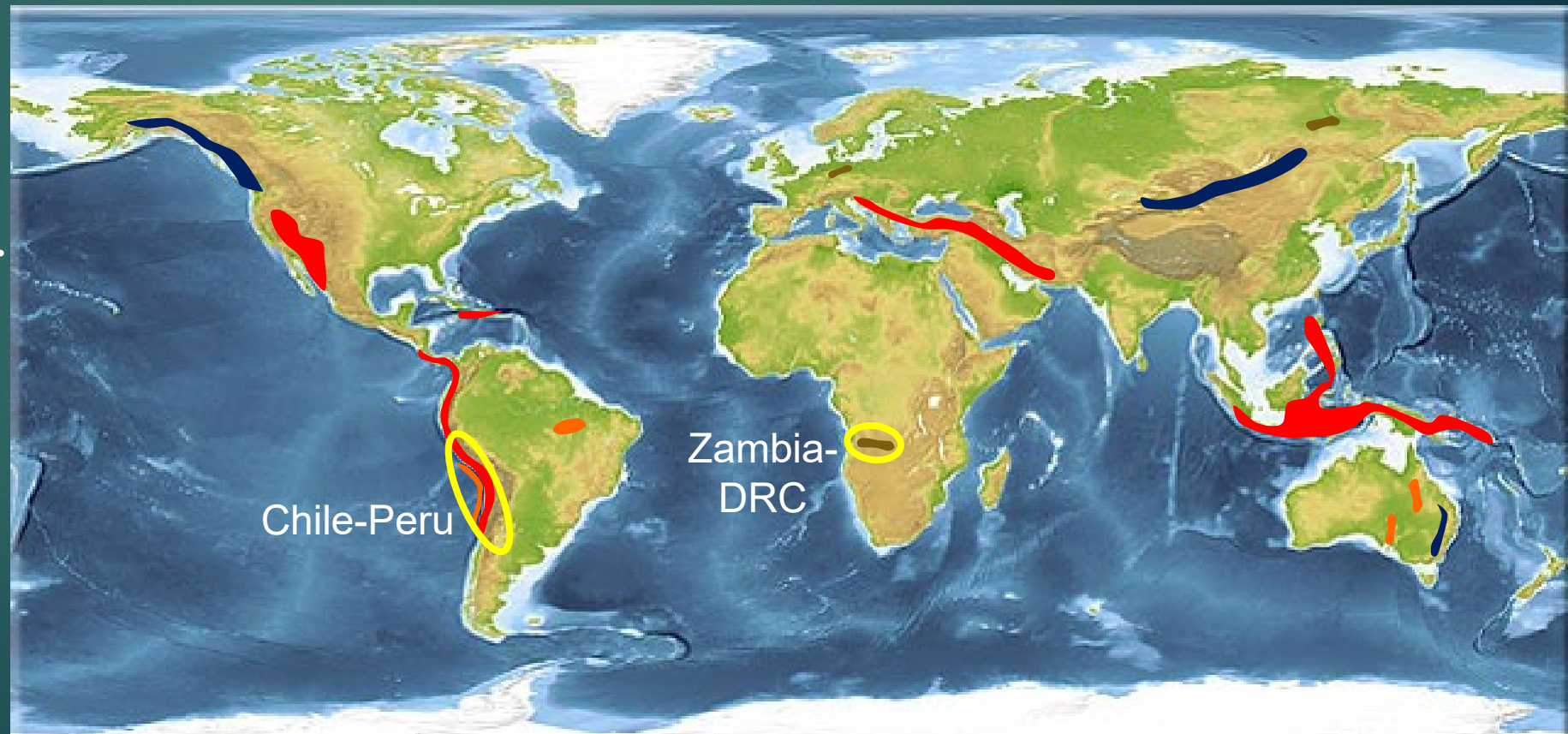
Zambia-DRC: ~ 25% of global copper

- ▶ Expansions
- ▶ New discoveries

Supply growth but...

- ▶ Complexity
- ▶ Grade challenges
- ▶ ESG

Belts with distinct types of copper deposits concentrated in different countries



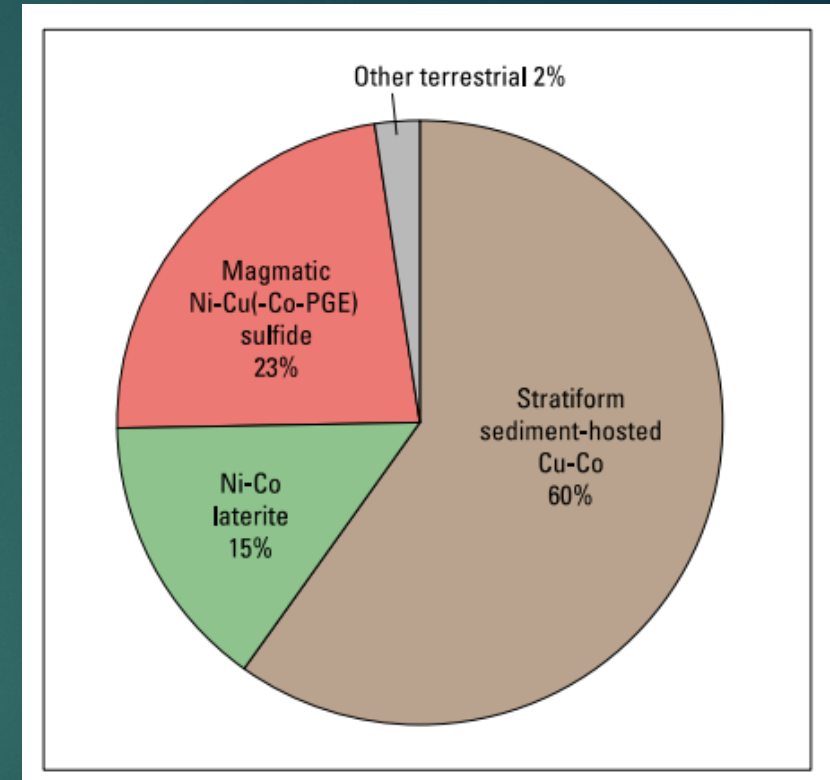
Li ion batteries – sufficient lithium?

- ▶ Mine production: ~85,000 tonnes in 2018 (~60% from Australia)
- ▶ Global reserves: 14 million tonnes (~70% in the Andes)
- ▶ Global resources: ~55 million tonnes (~60% in the Andes)
- ▶ Supply
 - ▶ Current supply: pegmatites (Australia, Canada, Zimbabwe) and brines (Chile, Argentina, USA) – 80% of supply: 7 producers (5 in Australia, 2 in Chile)
 - ▶ Resources (future supply): dominantly brines in Argentina, Chile and Bolivia – but production, quality, water use and community challenges

*All data for Li metal
USGS Mineral Summaries 2019

Co – LiMO_2 cathodes in Li ion batteries – Supply issues

- ▶ DRC: ~60% of current supply
- ▶ Sovereign risk: socio-political uncertainty
- ▶ 10-30% of Co supply from informal small miners (ASM) – 12M people
 - ▶ Issues: safety, child labour, human rights, environment- ~5 child deaths/month
 - ▶ Mine heterogenite – Co-rich mineral, weathering product + U (Decrée et al., 2014)



USGS 2017

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- ▶ Clean energy, technology, human development
 ➡ increasing demand for metals
 - ▶ Global resource availability – not a major issue
 - ▶ Challenges:
 - ▶ Discovery + quality, managing complexity
 - ▶ Knowledge gaps
 - ▶ Sustainability, clean/efficient mining
 - ▶ Environment, social, governance – ESG
 - ▶ Volatility

Cobalt price

- ▶ Volatile – price peaks in 1979 and early 2018
- ▶ Current price: US\$16.10/lb or US\$35,460/tonne

