Oakdene Hollins

ICSG: Study of By-Products of Copper, Lead, Zinc and Nickel

- Peter Willis

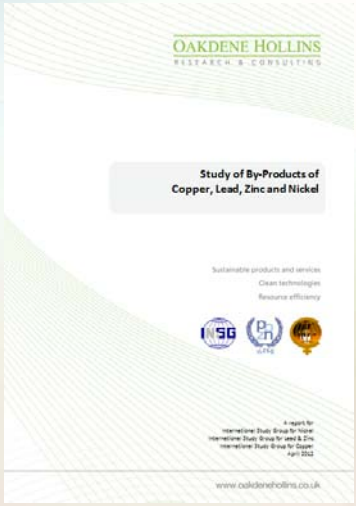
- 26th April 2012

Agenda

- Presentation of Draft Report
- Policy Context
- Scope
- Methodology
- Overview of Findings:
  - Molybdenum, Cobalt
  - Rhenium, Selenium, Tellurium, Bismuth
  - Rare Earth Elements
- General Conclusions
- Questions & Answers

Presentation of Draft Report

- Joint project between: ICSG, INSG, ILZSG
- Aim: produce in depth information on production, use and trade
- Comments and additional information are welcome
- Final report due for publication in June 2012
- Directory of producers



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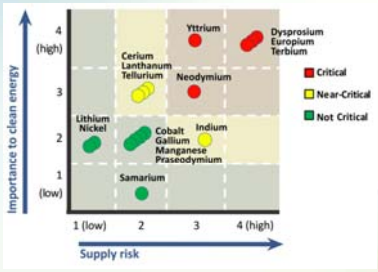
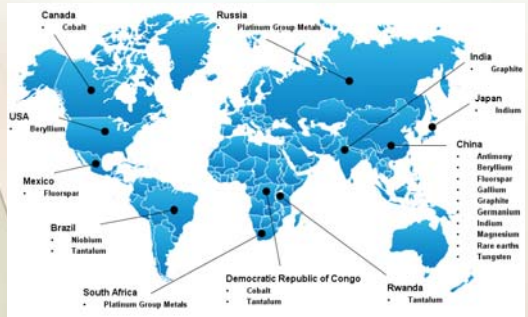
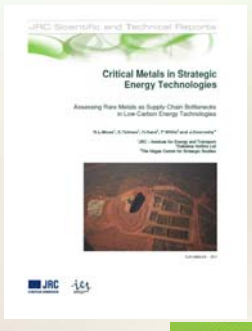
Policy Context







Sources: KITECH, US Dept. of Energy, EU RMI, EC JRC IET

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Project Scope

- Selection criteria of the by-product metals:
  - Linked to the production of study group metals
  - No or limited own-production infrastructure
  - Typically have high value
  - Increasing use in new technologies e.g. electronics, renewable energy
- Scope of the study:
  - Lead and Zinc: indium, germanium, bismuth, tellurium
  - Nickel: scandium, platinum group metals, cobalt
  - Copper: cobalt, rhenium, tellurium, selenium, rare earths, molybdenum

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Methodology

- Methodology:
  - Review of the literature
  - Web-based survey of producers, consumers, traders
  - Expert industry interviews
- Research conducted January-April 2012

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Overview of Findings

- Latest Production Statistics:

Principal Metal	Mine Production (tonnes)	By-product Metal	Production (tonnes)
Copper	16,100,000	Molybdenum	250,000
		Cobalt	98,000
		Rhenium	54
		Selenium	2,600
		Tellurium	450
		Bismuth	8,500
		Rare Earth Elements	130,000

Sources: USGS & Industry Estimates

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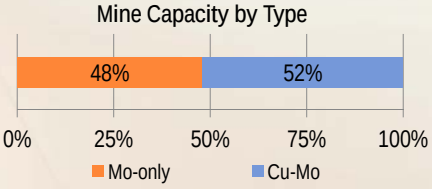
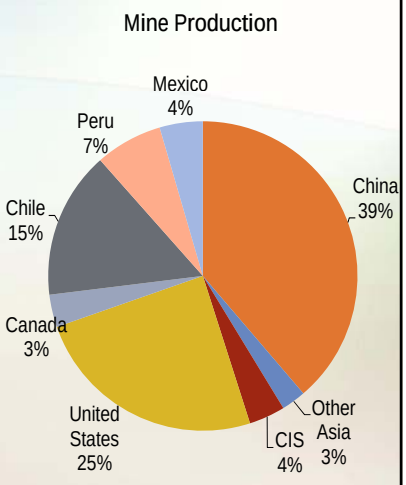
Molybdenum: Production

- Supply split between: Mo-only and Cu-Mo
- China and United States as major producers
- Some dislocation in mine and roasting capacity





Sources: USGS & Roskill

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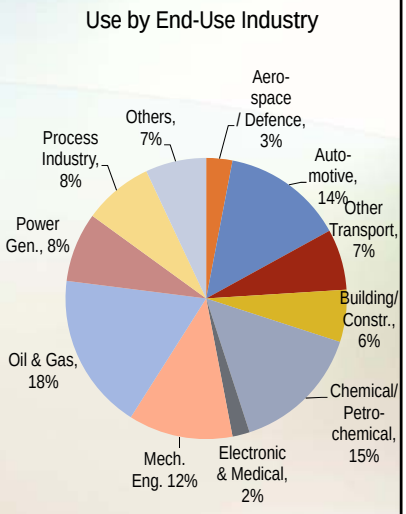
Molybdenum: Use

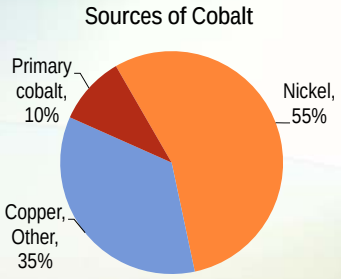
- Diverse end-markets: importance of steel alloys
- Growth of 3.6% p.a.to 2020
- LME traded; low volumes
- Export levies: China, Russia

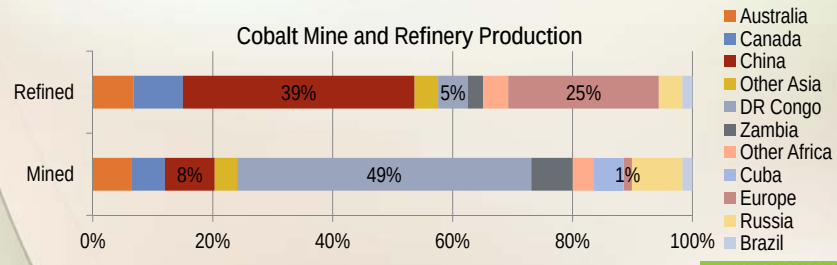


Sources: IMOA, Metal Pages

Cobalt: Production

- Cu, Ni & primary supply
- Trade of ores for refining
- Large number of pipeline projects – oversupply
- High recycling rate (68%)

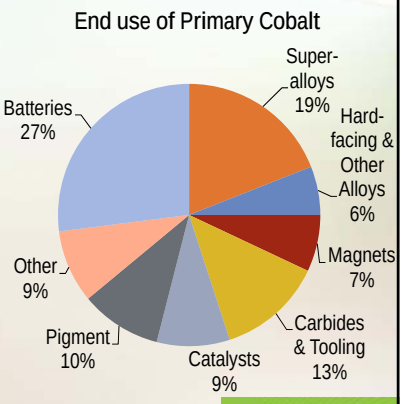




Sources: USGS, CDI

Cobalt: Use

- Diverse end-markets; recent growth in batteries
- Possible substitution in Li-ion batteries
- REACH Concerns (5 SVHCs)
- LME traded; low volumes



Sources: CDI, Metal Pages

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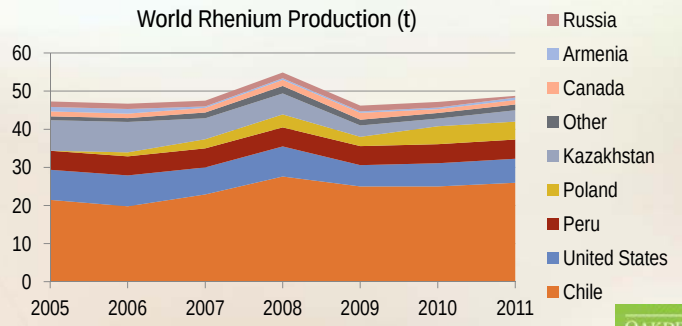
Rhenium: Production

- By-product from Copper Porphyry (Mo)
- Importance of Chile, emergence of Poland
- Limited pipeline of projects
- Efforts to improve recycling efficiency



Source: USGS

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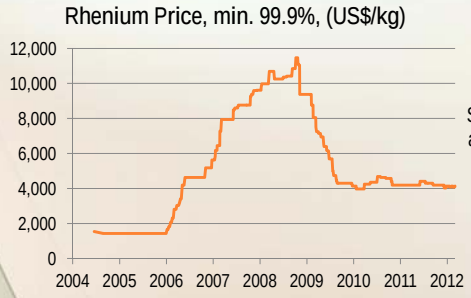
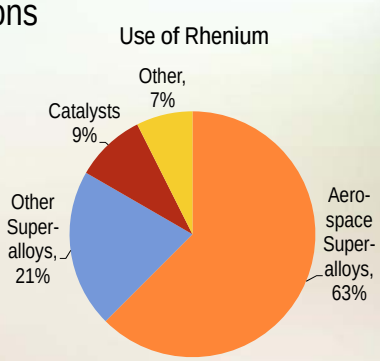
Rhenium: Use

- Importance of (aerospace) superalloys
- Growth in aerospace engines to result in rationing – substitution/reduction of rhenium content
- No major stockpiles or restrictions
- High and volatile prices





Sources: Lipmann Walton, Roskill, Metal Pages

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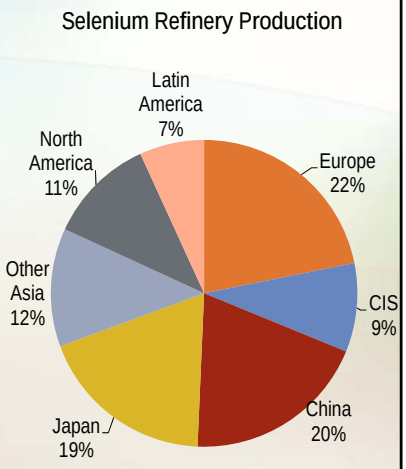
Selenium: Production

- By-product of copper, recoverable from slimes
- Incomplete official data – industry estimates
- Concentration varies – highest for refineries in Japan, Korea, CIS
- Often not recovered
- Technology shift to SE-EW may hurt recovery



Source: Industry Estimates

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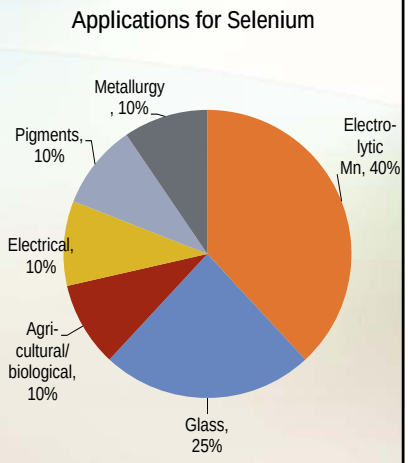
Selenium: Use

- China as main consumer: Electrolytic Mn production
- Uncertain short term outlook
- Some risk of substitution
- Modest use in solar



Sources: STDA, Metal Pages

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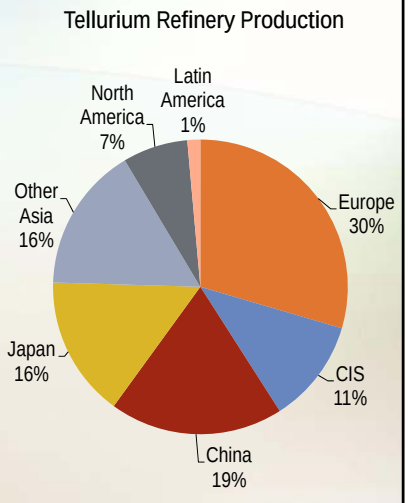
Tellurium: Production

- By-product of copper, recoverable from slimes
- Lack of official data
- Diverse supply, but fewer high purity refiners
- Often not recovered, or efficiency not high
- Technology shift to SE-EW may hurt recovery
- Gold as possible source



Source: Industry Estimates

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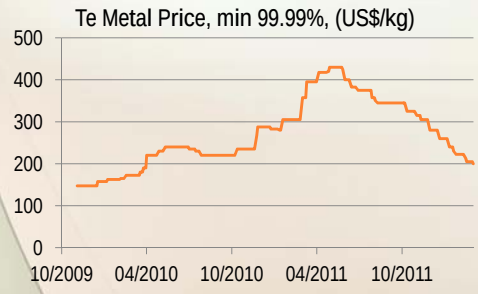
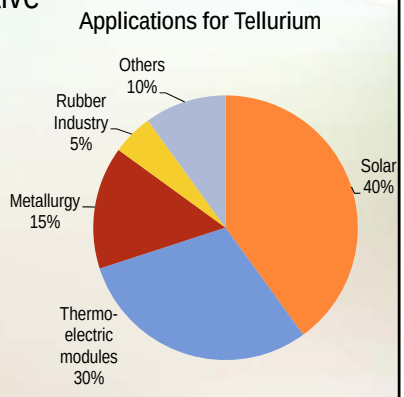
Tellurium: Use

- CdTe solar as major market:
  - Long term strong growth, short term weakness
- Some applications price sensitive or could be substituted
- Recent price falls





Sources: STDA, Metal Pages

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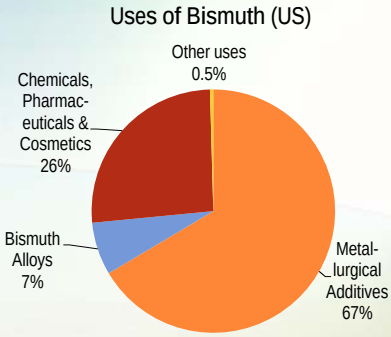
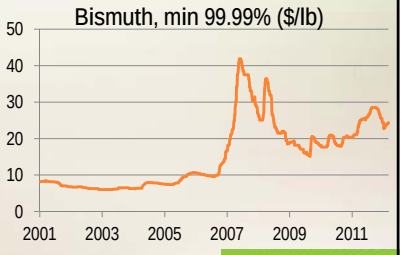
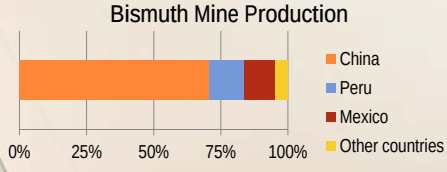
Bismuth

- Lead, tungsten as sources
- Limited production from Cu
- China, Peru and Mexico as largest suppliers
- Metal alloys, additives and chemicals as major markets
- Mature, slow growing







Sources: USGS, Metal Pages

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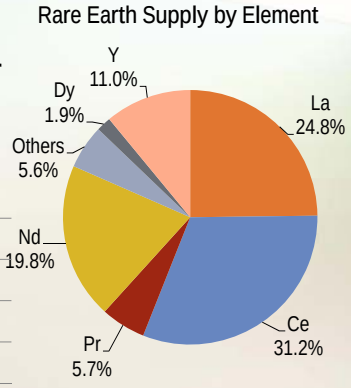
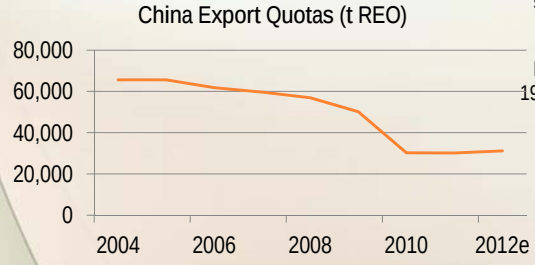
Rare Earth Elements: Production

- Dominance of China, large fall in quotas in 2010
- Tightening of China production
- Numerous pipeline projects
- Limited prospects from copper
- Development of recycling





Sources: US Dept. Energy , TMR, Lynas

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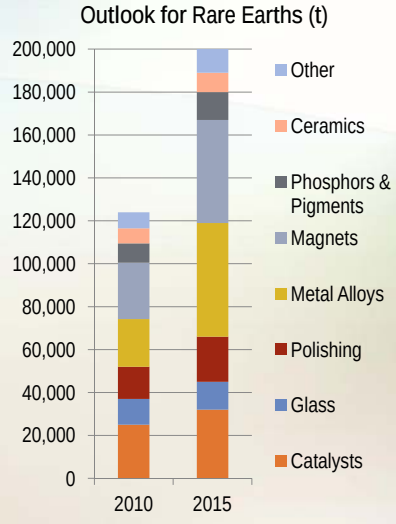
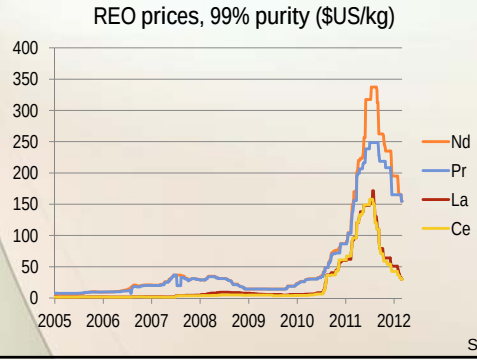
Rare Earth Elements: Use

- Strong market growth
- Deficits likely for HREEs
- Price ramp up in in 2010/11, now partially unwound





Sources: IMCOA, Metal Pages

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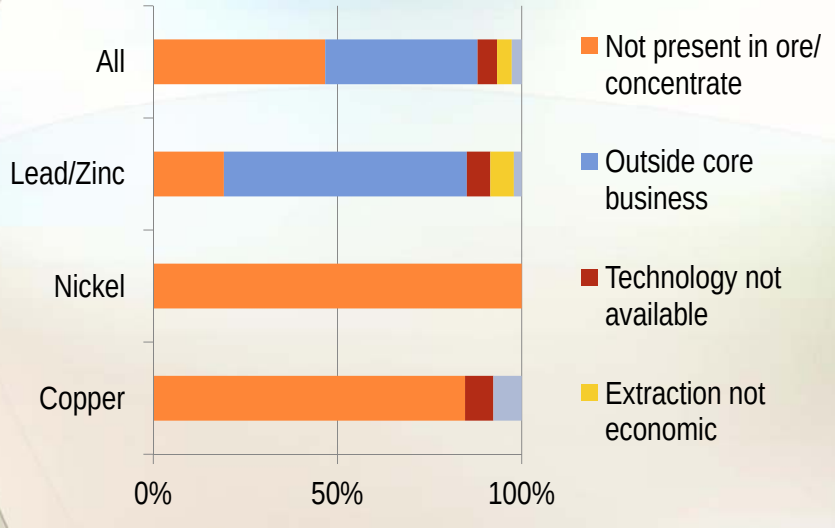
General Conclusions

- Spectrum of availability of data:
  - Government, industry could collaborate to improve it
  - Better trade statistics could be recorded
- Economics of by-production:
  - Mo, Co, REEs with primary production
  - Bi, Re, Se, Te solely as by-products
- Market outlook strongest for Te, REEs, Re
- Considerable opportunities to increase recovery of certain by-products or its efficiency
- Wastes could be sold on for by-product recovery

Barriers to By-Product Recovery



Sources: Oakdene Hollins Industry Survey

Questions & Answers

Thank-you for listening!

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ICSG Environmental and Economic Committee April 2012