Peak Minerals v Sustainable Mining

December 2008

3rd Int. Conf. on Sustainability Engineering & Science, Auckland, New Zealand

eng.monash.edu.au/enveng
Loy Yang brown coal mine, Australia
Sustainable Mining v Peak Minerals?

• Mining a ‘finite’ mineral resources is almost universally accepted as ‘unsustainable’:
  – yet mineral & metal production is bigger today than ever and still growing

• Typically two dominant views – “Limits to Growth” (ie. unsustainable) or “technology-markets-demand = solutions” (‘sustainable’)

• Easy to find good evidence for both sides …

  But what about ‘PEAK OIL’ → “PEAK MINERALS” too?
PEAK OIL … ‘101’

- Widespread debate about ‘Peak Oil’:
  - will it occur, has it occurred, if not when, or never …

- M King Hubbert first applied systematic analyses of oil production to US mainland in the 1950’s – & (correctly) predicted production would peak around 1970

- Based on simple assumptions of a finite resource and all oil wells following a basic bell curve: \(\text{cumulative country} = \text{same}\)
Hubbert’s (in)famous 1956 Curve

- Hubbert’s 1956 prediction of mainland US oil production, including historical data
- Some key assumptions … but assumes “finite” oil
Production...
**Trends in Ore Grades ...**

![Graph showing trends in ore grades for various metals and minerals from 1840 to 2005.](image)

**Axes:**
- X-axis: Years from 1840 to 2005
- Y-axis: Ore Grades (Cu, Pb, Zn, Au, Ni, U, Diamonds)

**Legend:**
- Copper (%Cu)
- Gold (g/t)
- Lead (%Pb)
- Zinc (%Zn)
- Uranium (kg/t U₃O₈)
- Nickel (%Ni)
- Diamonds (carats/t)
- Silver (g/t)

**Trends:**
- Ore grades for various metals and minerals show a general downward trend over time.
- Some metals, like silver, show a more fluctuating trend.
- The chart highlights specific years with notable changes in ore grades.
Sustainable Mining ...

- Unlike previous mining booms, the current boom is not only unprecedented in scale but is also claimed to be ‘sustainable’

- But can we assume the patterns of the past will continue into the future –
  - ie. can mining a ‘finite’ resource ever truly be ‘sustainable’ ????

- Ultimately, the world may not run out of mineral/metal resources – but energy, water, wastes etc. will lead to limits …
Sustainable Mining ...

Saudi’s Ahmed Zaki Yamani:

“The Stone Age came to an end not for the lack of stones and the oil age will end, but not for the lack of oil”

(Yamani was Saudi Arabia’s Oil Minister from 1962 to 1986)
Peak Minerals v Sustainability Limits

• Given the urgent multiple prongs of development, population, climate change and environmental degradation, it is clear that the patterns of the past are not sustainable into the future …

• But how do we combine bell curves & sustainability limits ?

• Through linking energy, water & costs to mineral production, we can develop scenarios for the future mining industry …
Hubbert Peak Curves: Au & Cu

GOLD

??

COPPER

ok?
Gold: CO₂ v Mining

• As gold ore grades decline, there is an increasing environmental cost (GJ, CO₂, ...)

\[
y = 156.27x^{-0.2793} \\
R^2 = 0.1493
\]

Note, excludes points:
(82.39, 21.9; 77.1, 22.9)
(0.64, 1,075.6; 5.3; 630.6)

\[
y = 15.591x^{-0.4379} \\
R^2 = 0.2248
\]

Note, excludes points:
(82.39, 0.2; 77.1, 0.2)
(0.64, 74.6; 2.3; 64.3)
Mining Susty Peaks v Troughs ...
Ongoing Thoughts … (TI&B?)

• For many countries, there remains reasonably abundant mineral resources, though of gradually declining quality
• To meet future global development demands, mining looks set to continue to grow for some time
• Some key assumptions vary between ‘Peak Oil’ and ‘Peak Minerals’ – particularly between minerals & metals …
• Future impacts of climate change … ???
Acknowledgements

• Numerous Colleagues (Monash, Zaragoza, UNSW, NGO’s, government, industry, …)
• Mineral Policy Institute (MPI)
• Vicky – the legend – Adin