

Economic Perspectives on Seabed Mining

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Woods Hole, April 2, 2009



Three Perspectives

- Seabed Mining: Then and Now
- Metal Prices
 - The Recent Boom (and Bust)
 - The Longer Term
- The Prospects for Commercial Seabed Mining



Then and Now

- Late 1970s, early 1980s
 - Cobalt/copper/manganese/nickel nodules
 - International waters
 - Approx 5000 meters at depth
- Early 2000s
 - Copper/zinc/gold/silver massive sulfides
 - Territorial waters
 - Approx 1500 meters at depth

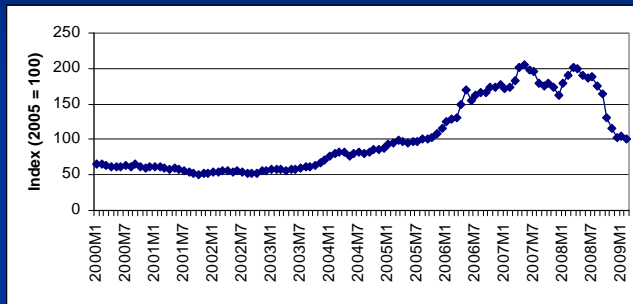


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Metal Prices, January 2000-February 2009 (US dollars)



Source: International Monetary Fund



How Did It Happen?

- Demand increased more than expected, production constrained by existing capacity
- Unexpected supply disruptions as production approached capacity
- Price increases exacerbated by lack of investment in 1980s and 1990s
- Of course, every market is slightly different—and more complicated



Averages of the Year-to-Year Rates of Consumption Growth (%)

	1990-2002	2003-2007	Difference
Aluminum	2.2	8.0	5.8
Copper	2.5	3.6	1.1
Iron ore (prod)	1.3	9.7	8.4
Lead	1.3	4.5	3.2
Nickel	2.9	3.7	0.8
Tin	1.4	4.1	2.7
Zinc	2.6	3.9	1.3

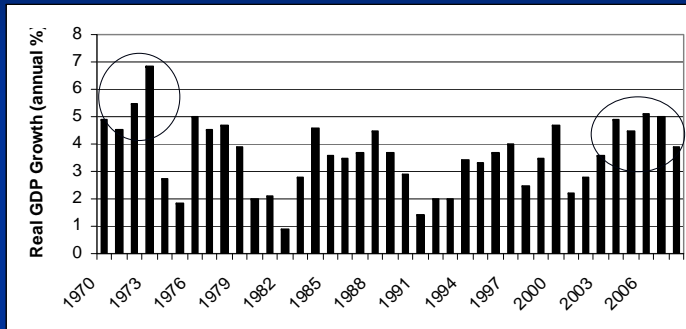
Sources: World Bureau of Metal Statistics, UNCTAD, US Geological Survey

What was different about the last 5 years?

- World GDP (real) up > 4% per year
 - 1st time since early 1970s
- China: became largest user and significant net importer of many minerals and metals
 - Investment, infrastructure, exports
 - Room for continued growth: domestic households



World GDP Growth, 1970-2008



Source: International Monetary Fund



Chinese Consumption (% of world)

	1980	1990	2000	2006
Steel	6	9	16	32
Al	3	5	13	25
Cu	5	7	12	23
Zn	4	8	15	30
Ni	2	4	6	18

Source: Macquarie, as reported by M. Wolf

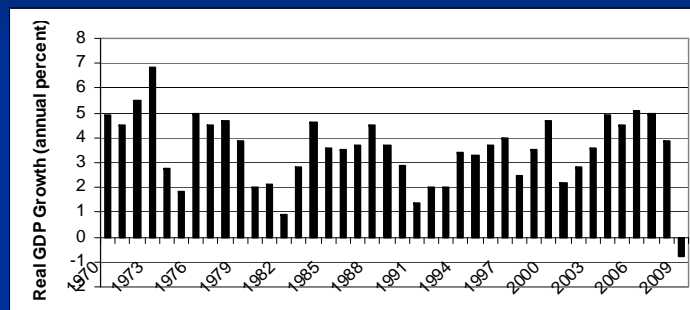


How Do Booms End?

- Macroeconomic recession and demand collapse
 - Can happen quickly
- Lagged supply response to higher prices
 - 5-10 years



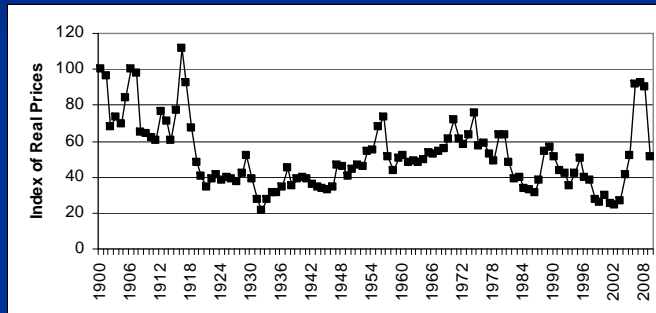
World GDP Growth, 1970-2008 & Forecast for 2009



Source: International Monetary Fund



Real Copper Prices, 1900-2009 (US dollars)



Source: P. Hoagland, *Mining Journal*



The last 6 years: cyclical behavior or structural change?

- Of course, no one knows
- The case for structural change
 - Continued economic growth likely in developing nations; metal-intensive goods
 - Increasing technical costs of production (e.g., declining grades, more remote locations)
 - Increasing environmental, political, and social costs of production

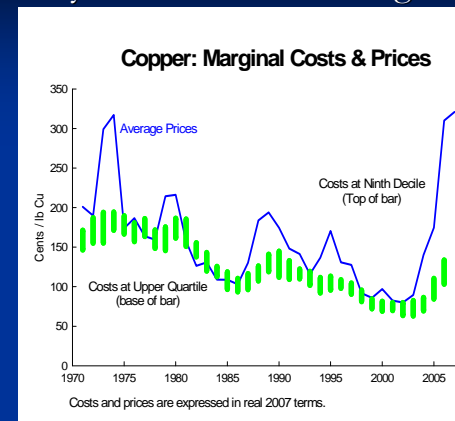


Cyclical or Structural?

- The case against structural change
 - Stalled economic growth for the foreseeable future
 - Recent cost increases arguably were largely cyclical
 - Continued cost-reducing technological innovation
 - Substitution will limit price increases
 - Material for material
 - Resource saving



Eventually Prices Revert to Marginal Costs



Source: V. Tulpule, Rio Tinto, Sept. 2007



But which costs?

- Cyclical variations in costs
 - During booms, input prices surge
 - During recessions, input prices fall
- Longer term
 - How do the various dimensions of availability influence costs?
 - My biases

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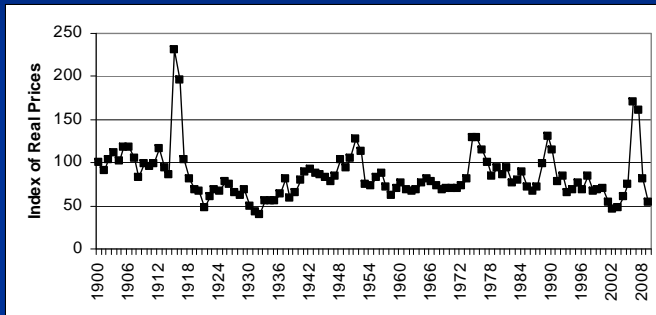
Thinking About Commercialization

- Expected revenues and costs, appropriately adjusted for time and risks
- Now: largely uneconomic
- Possible reasons to invest now for the future
 - Social (public)
 - Environmental & social considerations
 - Security of supply
 - Strategic (corporate)
 - Option value
 - Technology development
 - Anticipate future environmental & social constraints on land-based mining

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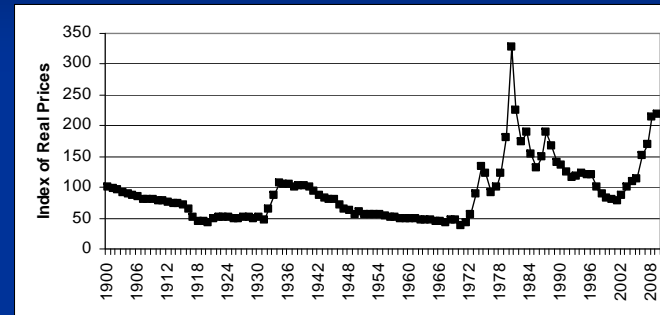
Real Zinc Prices, 1900-2009 (US dollars)



Source: P. Hoagland, *Mining Journal*



Real Gold Prices, 1900-2009 (US dollars)



Source: P. Hoagland, *Mining Journal*

