The Case for a Greenfields Renaissance

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Acknowledgments

- WMS colleagues

- Richard Schodde (MinEx Consulting), who has compiled much of the underlying data
Global Greenfields Exploration for Metals now at an All-Time Low in Relative Terms

Percentage of total spend

Data Compiled by R. Schodde

Source: Derived from MEG

Note: Excludes exploration on Bulk Minerals, Coal & Uranium
Figure 1: Australian Mineral Exploration Expenditure in constant 2006-07 Dollars separating greenfields from brownfields expenditure. Source: Geoscience Australia (based on ABS survey data deflated by CPI)
Why the Greenfields Decline?

- Long term decline in discovery rates; few “easy to find” near-surface deposits left except in high risk places
- Short-term drivers for industry leadership mitigates against greenfields investment with long-term pay-off
- Perceived large inventory of known deposits available for development
  - Previous period of great Greenfields Success (1960s-1970s for base metals; 1980s for gold)
  - Fall of Communism (early 1989-91) opening up areas previously excluded
- Increasing volatility of global investment in exploration as risk capital market funding has become more important
Exploration effectiveness declining

Ratio of in-situ value of gold found per exploration dollar spent

5-year rolling average

i.e. $1 spent on exploration delivers about $11 of value in-the-ground

Decline in spite of a real gold price increase from ~$400/oz to ~$900/oz

Note: Based on primary gold deposits found in the western world versus associated expenditures on grassroots and late stage exploration

Source: GFL/MinEx Consulting
... but average discovery costs have been slowly increasing

Base metal found divided by exploration expenditures: western world

Unit discovery costs (2006 c/lb Cu-equiv)

5-Year Rolling Average

BASE METAL

See a similar trend of rising discovery costs for other commodities
McKeith (2009) - Exploration funding volatile

Western World Exploration Expenditures (2008 US$B)

- Average funding about US$2.5 billion per annum – but – very volatile
- Rise of the junior explorer in response to gold price and available risk capital

Gold Price (2008 US$/oz)

Sources: MinEx Consulting + MEG (from 1992 onwards)

Majors spend about $500 million to $1 billion p.a.
Mineral Supply and Global Prosperity

• The massive growth in global prosperity over the last 500 years has been fundamentally underpinned by a strong decrease in the **REAL COSTS** of the critical material inputs to our civilization:
  – Food
  – Fibre
  – Energy
  – Minerals
LONG TERM COPPER PRICES

Source: unpublished presentation-Greg McKelvey
What Does “Real Cost” Really Mean?

- Cost per unit of metal production
- Denominated in Constant Dollars
- Actually a PROXY for all of the inputs required to produce a unit of metal and increasingly, the externalities associated with that production:
  - Labour
  - Materials
  - Energy
  - Externalities (environmental, community impact etc)
- The fundamental measure of the quality of an ore deposit
Why the world needs to find more deposits
World copper production: 1900-2006

Mine Production (mtpa Cu metal)

World consumption over the next 25 years will exceed all of copper metal ever mined to date.

Copper consumption over the last 25 years accounted for half of all copper metal ever mined in the world.

Average 3.4% pa growth rate 1900-81
Average 2.0% pa 1982-2005
Average 3.2% pa 1986-2030

Sources: US Geological Survey (1900-83), Brook Hunt (1984 onwards)

(Hall, 2008; data compiled by R.Schodde)
DEMAND FROM CHINA WILL INCREASE

> Chinese demand for copper has a long way to go.

COPPER INTENSITY OF USE

Source: World Bank, CRU
We have a large global resource base but what about the quality?
Increasing Gap between Promised and Actual Production Performance: Declining Quality of Maturing Mines?

Source: Brook Hunt, Macquarie Research, June 2009
Next Generation of Copper Projects require significantly higher prices to justify Development
Trend 2: Quality of resources declining

Average resource grade for all primary gold discoveries >1Moz in the world

Driven by technological improvements (economies of scale, CIL, heap leaching)

Note: Excludes deposits where gold is a by-product (<50% of mine revenue)

Source: GFL/MinEx Consulting

Are these grades sustainable in an energy constrained world?

Trend to Declining Grade of New Gold Discoveries
McKeith (2009) No - it’s worse than we think ….

Historic average to 1995 is that 75% of discovered ounces are mined

Industry is being sustained by maturing mines discovered many years ago

Primary gold deposits > 0.1 Moz found in the world

Current gold mine production is about 75 Mozpa

Increasing Proportion of Gold Discoveries Staying in the Ground
A Declining Quality Global Resource Base?

- Significant evidence for a decline in the overall quality of the global resource base for precious and base metals
- Existing major mines tend to be old – although they will continue to produce for decades, real costs will tend to increase (and therefore production rates will tend to stagnate or decline)
- If current trends continue, real costs will rise just when the world (particularly the developing world) needs exactly the opposite
- Supply shortages will be a consequence
But aren’t rising metal prices a Panacea?

- Supply shortages will lead to higher metal prices
- Surely this alone will encourage new investment in metal production via the development of known, previously sub-economic resources?
- Not necessarily! – investment is motivated by margin not price
- In a resource-constrained world, the costs of metal production tend to increase as fast as metal prices
- Margins can only be sustainable if real costs can be continually driven down
- Sustainable margins for the global mining industry are required to motivate the required investment in production capacity
Marginal deposits will not fill the gap
...once a dog, always a dog...

Pre-boom, subeconomic
Early boom, economic
Late boom, marginal
Crash, very subeconomic

Commodity Price
Production cost

Time

McCuaig (2009)
Australia's copper exports
metal equivalent

Negligible Production Response to Higher Prices

Source: ABARE
No Production Response to Higher Prices
Limited Production Response to Higher Prices

Source: ABARE
But We have heard all this before!

“The world will run out of gold in 2001” (assuming we haven’t killed/starved/poisoned ourselves beforehand)

*Limits to Growth, 1972 (Club of Rome)*

“The US could be short of coal by 1975”

*President's Materials Policy Commission, 1952 (Paley Report)*

“Am worried that Chile’s copper mines will not survive”

*Report in Sociedad de Minería 1884*

“The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race.”

*Thomas Malthus, 1798 (an essay on the principle of population)*

Gordon Conference July 2008

Hall (2008)
The Economist’s answer to the Club of Rome

Perception of Supply Shortage

Higher Prices provide incentive for Innovation

The critical step!

Innovative Success

Discovery of New Sources of High-quality Supply

New Period of Supply Security
The Innovation Response

- Key to the global mineral supply problem and the reason why we have not “run out” before

- Two parts:
  - new extraction technologies
  - discovery of new low cost resources by Greenfields Exploration

- A big driver of cost reduction in recent decades has been increasing economies of scale – these now seem to have reached their limit

- Current industry underinvestment in Greenfields Exploration totally incompatible with contemporary Global Challenge

- A “Greenfields Renaissance” is required!
The Mineral Exploration Opportunity

• Since the dawn of time, humans have found mineral deposits because they were exposed at the surface

• Those days are nearly over – most significant new deposits will be “blind”

• A major transition for the Minerals industry: Petroleum went through this almost a century ago

• Innovative science and technology: the absolute key to the next generation of Greenfields mineral discovery
Barrels of oil equivalent (BOE) in millions, includes natural gas

Active lease

Scale varies in this perspective. Distance from Houston to New Orleans is 316 miles (509 kilometers).


1961
80 million BOE
415 active leases

Gulf of Mexico

North
If we can find Deep High-Quality Orebodies we can mine them

Modelling for a Voisey’s Bay style orebody in remote WA
(30 Mt @ 2.5% Ni, 2.0% Cu; 20m thick 60 degree dip)
Understanding the Difference between Risk and Uncertainty

- A common confusion that can lead to poor strategic decision making in our industry

- **Risk** = probability of an economically positive outcome for a particular project

- **Uncertainty** = level of knowledge concerning key parameters relating to a project

- A project with highly uncertain outcomes (eg a Greenfields program) is not necessarily higher risk than a more certain one (eg developing a marginal deposit)
Comparative Sensitivity to Increasing Exploration Expenditure: High and Very High Risk Exploration Scenarios

Greenfields: No Short-term Levers!
Need for Stable Greenfields Funding

Goodyear (2006)

BROWNFIELDS
Episodic - Driven by need / opportunity

GREENFIELDS EXPLORATION
Persistent, stable funding at critical mass level

TIME
Greenfields: Key Success Factors

- Greenfields cannot be turned on when it is needed – requires a long-term effort sustained at critical mass levels

- The key to Greenfields is technical excellence, particularly at the Project Generation stage, leading to the creation of new search spaces
  - Much more about the quality of the thinking than the dollars spent

- To pay for itself, Greenfields must focus on those high-value opportunities with long-term option value
Remember:

“We don’t explore to find more ore, we explore to find better quality ore!”