Can we sustain Australia’s mining industry through exploration?

Neil Williams

Honorary Professorial Fellow, University of Wollongong
An elephant in the room!

Sabi Sabi Game Reserve, South Africa, Nov 2011
When it comes to resource sustainability there are two elephants in the room:

Sabi Sabi Game Reserve, South Africa, Nov 2011
Elephant No 1 (the little one): Increasing Population

Source: U.S. Census Bureau, International Data Base, December 2008 Update.

www.census.gov/ipc/www/idb/worldpopgraph.html
Elephant No 2 (the big one): Economic Growth

Sao Paulo – Brazil, September 2011
## Modern Society – Economic Growth

<table>
<thead>
<tr>
<th>Continent</th>
<th>Copper</th>
<th>Aluminium</th>
<th>Nickel</th>
<th>Lead</th>
<th>Zinc</th>
<th>Steel</th>
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<tbody>
<tr>
<td>USA</td>
<td>7.5</td>
<td>21.1</td>
<td>0.5</td>
<td>5.2</td>
<td>3.8</td>
<td>80</td>
</tr>
<tr>
<td>Europe</td>
<td>7.8</td>
<td>17.1</td>
<td>0.8</td>
<td>3.7</td>
<td>4.7</td>
<td>99</td>
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<tr>
<td>Latin America</td>
<td>1.0</td>
<td>3.0</td>
<td>0.1</td>
<td>0.1</td>
<td>1.1</td>
<td>N/A</td>
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<tr>
<td>Africa</td>
<td>0.2</td>
<td>0.4</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>N/A</td>
</tr>
<tr>
<td>Asia</td>
<td>2.3</td>
<td>3.0</td>
<td>0.2</td>
<td>0.9</td>
<td>1.5</td>
<td>N/A</td>
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</tbody>
</table>

Intensity of metal consumption 2005 (Kg per capita)

OUTLINE

- NEW ECONOMIC DISCOVERIES
- TECHNICAL INNOVATION
- THE CURRENT SITUATION
- THE FUTURE – ACTIONS REQUIRED
SUSTAINING THE MINING INDUSTRY

- NEW ECONOMIC DISCOVERIES
The importance of exploration

SIGNIFICANT AUSTRALIAN MINERAL DISCOVERIES 1946-2001

Commodity
- Bauxite
- Coal
- Cu/Pb/Zn
- Gold
- Iron/Manganese
- Mineral sands
- Nickel
- Other minerals
- Tin/Tungsten
- Uranium
### Australia’s mineral wealth – world ranking by production

<table>
<thead>
<tr>
<th>Commodity</th>
<th>World Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alumina</td>
<td>1</td>
</tr>
<tr>
<td>Bauxite</td>
<td>1</td>
</tr>
<tr>
<td>Pb</td>
<td>2</td>
</tr>
<tr>
<td>Zn</td>
<td>2</td>
</tr>
<tr>
<td>Au</td>
<td>2</td>
</tr>
<tr>
<td>Ni</td>
<td>2</td>
</tr>
<tr>
<td>Uranium Oxide</td>
<td>2</td>
</tr>
<tr>
<td>Iron Ore</td>
<td>3</td>
</tr>
<tr>
<td>Ag</td>
<td>4</td>
</tr>
<tr>
<td>Cu</td>
<td>5</td>
</tr>
</tbody>
</table>

Source: Australia’s Identified Mineral Resources 2009 – Geoscience Australia
SUSTAINING THE MINING INDUSTRY

- TECHNICAL INNOVATION
AN EXAMPLE OF INNOVATION: THE McARTHUR RIVER Zn MINE, NORTHERN TERRITORY
The HYC Zn-Pb DISCOVERY OUTCROP AT McARThUR RIVER

Photo taken in 1977

THE HYC DEPOSIT WAS DISCOVERED IN 1955
BENEATH THE DISCOVERY OUTCROP

THE McARTHUR MINE WAS OPENED IN 1995
THE McARTHUR CHALLENGE
THE McARTHUR MINE – A TESTAMENT TO INNOVATION

- Selective mining of layers with high zinc grades
- Fine grinding: IsaMills grinding technology
- Beneficiation: Jameson cell technology
- Today: 2.5Mt tonnes mined annually, yielding 200,000 t of Zn in concentrate. The mine workforce comprises 282 permanent employees & 162 contractors
- Discovery preceded technological innovation
SUSTAINING THE MINING INDUSTRY

- THE CURRENT SITUATION
Some recent conclusions regarding the state of Australia’s exploration and mining industry:
Schodde’s conclusions (1)

Estimated Remaining life for Major Australian Mines
(based on all operations mining >1 Mt ore in 2010. Excludes Bulk Minerals)

Half of Australia’s existing mines could close down within 5 to 16 years

Closure Date based on current Resources

Source: MinEx Consulting June 2011
Schodde’s conclusions (2):

- In spite of higher expenditures Australia’s discovery rate has declined in recent years
- Average discovery costs are rising
- Schodde and others take these trends as good evidence that the current near-surface Australian search space is now significantly depleted, leading to the important conclusion that *the next generation of discoveries will be under deeper cover*
“…as yet “undiscovered” world-class ore deposits are most probably concealed by barren soils or barren cover rock sequences”.

Para. 4.5
SUSTAINING THE MINING INDUSTRY

- THE FUTURE – ACTIONS REQUIRED
THE CHALLENGE

✔ FINDING NEW MINES UNDER LANDSCAPES LIKE THIS
THE SHALLOW TO DEEP PARADIGM SHIFT

Depth (m)

0

250

500

Time

2010

2020

2030

Shallow exploration

Deep exploration

FROM SHALLOW TO DEEP
# FROM SHALLOW TO DEEP
## IMPLICATIONS FOR INDUSTRY

<table>
<thead>
<tr>
<th>SHALLOW</th>
<th>DEEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juniors dominant today – boom &amp; bust/hire &amp; fire cycles</td>
<td>Majors &amp; consortia – long-term persistent exploration</td>
</tr>
<tr>
<td>Conservatively managed brown-fields exploration</td>
<td>Risk managed green-fields exploration</td>
</tr>
<tr>
<td>Target: various grades &amp; tonnages. Many ore types</td>
<td>Target: high grades &amp; tonnages. Few ore types</td>
</tr>
<tr>
<td>Many drill holes</td>
<td>Fewer drill holes – more down-hole logging</td>
</tr>
<tr>
<td>Descriptive exploration models – orebody based</td>
<td>Predictive exploration models – systems based</td>
</tr>
</tbody>
</table>
# FROM SHALLOW TO DEEP

## IMPLICATIONS FOR SERVICE COMPANIES

<table>
<thead>
<tr>
<th>SHALLOW</th>
<th>DEEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific exploration techniques emphasised</td>
<td>Integration of exploration techniques emphasised</td>
</tr>
<tr>
<td>Focus on 2D and 3D visualisation</td>
<td>Focus on 3D and &gt;3D visualisation</td>
</tr>
<tr>
<td>Weak focus on drilling technologies</td>
<td>Strong focus on new drilling technologies</td>
</tr>
<tr>
<td>Focus on laboratory- and field-based tools</td>
<td>Focus on remote-sensing and down-hole tools</td>
</tr>
</tbody>
</table>

*AusIMM April 2012*
## FROM SHALLOW TO DEEP
### IMPLICATIONS FOR UNIVERSITIES

<table>
<thead>
<tr>
<th>SHALLOW</th>
<th>DEEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate geology and geophysics programs</td>
<td>Integrated geoscience programs</td>
</tr>
<tr>
<td>Emphasis on descriptive activities</td>
<td>Emphasis on integrative and predictive activities</td>
</tr>
<tr>
<td>Rock types important</td>
<td>Rock properties important</td>
</tr>
<tr>
<td>Isolated components of earth systems emphasised</td>
<td>Holistic approach to earth systems</td>
</tr>
<tr>
<td><em>Descriptive</em> mineral deposit models – ore-body based</td>
<td>Mineral-system models based on regional-scale observations and processes</td>
</tr>
</tbody>
</table>
FROM SHALLOW TO DEEP
IMPLICATIONS FOR THE GEOLOGICAL SURVEYS

<table>
<thead>
<tr>
<th>SHALLOW</th>
<th>DEEP</th>
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</thead>
<tbody>
<tr>
<td>Field mapping of surface geology</td>
<td>Remote mapping of subsurface geology</td>
</tr>
<tr>
<td>2D and 3D outputs</td>
<td>3D and time outputs</td>
</tr>
<tr>
<td>Focus on systematic coverage</td>
<td>Focus on subsurface frontier areas</td>
</tr>
<tr>
<td>Focus on rock types</td>
<td>Focus on rock properties</td>
</tr>
<tr>
<td>Focus on controls on location of ore deposits</td>
<td>Focus on controls on location of mineral systems</td>
</tr>
</tbody>
</table>
FROM SHALLOW TO DEEP

IMPLICATIONS FOR CSIRO

- NEW TOOLS AND TECHNIQUES FOR MAPPING SUBSURFACE GEOLOGY TO GREAT DEPTH

- NEW TOOLS AND TECHNIQUES FOR DIRECTLY DETECTING MINERAL SYSTEMS AND MINERAL DEPOSITS AT DEPTH – both from the surface, and from drill holes by way of down hole probes

- NEW TOOLS AND TECHNIQUES FOR ECONOMICALLY MINING & BENEFICIATING DEEPLY BURIED ORE DEPOSITS
FROM SHALLOW TO DEEP
IMPLICATIONS FOR GOVERNMENTS

- TAXATION POLICIES etc
- LAND ACCESS
- SUPPORT for CSIRO and Geological Surveys
SUBSURFACE MAPPING WILL BE DEPENDENT ON GEOPHYSICS
MEDICAL IMAGING – THE HUMAN HEART
- will we ever be able to do this well with the Earth’s crust?
Size and distribution of exploration leases and known oil fields in the Gulf of Mexico in 2001.

THANK YOU