Solid Earth and Environment Grid
CANBERRA, July 2003

Liedeke Bosma
Chief Geologist – Knowledge Management
BHP Billiton Minerals Exploration

- Exploration : Setting the Scene [Todays Challenges, BHPB Mandate]
- Exploration : Imperatives – Key Drivers
  - Business
  - Commercial
  - Geoscientific [Geology - Geochemistry - Geophysics]
  - Knowledge and Collaboration
  - Information and Data
MINERAL EXPLORATION TODAY
Current State
Challenges for the Exploration Industry

- Discovery costs have risen dramatically over the last three decades (see next slide)
- Size of discoveries declines with terrain maturity
- A need to balance Risk Vs. Opportunity
- Inability to detect mineral deposits beneath cover is considered a major impediment to success
Challenges for the Exploration Industry – cont.

Challenges for exploration in Australia:

- Diminishing early-mover opportunities in areas of outcrop
- Extensive, complex transported cover
- Easier opportunities offshore
- Environmental Issues
- Native Title Issues
Discoveries Vs Exploration Spend

Annual Discoveries versus Exploration Expenditure

328 discoveries in total 1980 – 2001

Source: BHP Billiton, March 2003
Quality discoveries require more than money ....

World Class and Large Discoveries versus Exploration Expenditure

13 World Class and 130 Large Deposits

- World exploration spending
- Large discovery
- World Class discovery

Source: BHP Billiton, March 2003
World Class discoveries are becoming more expensive....

Exploration costs per discovery
(5 year rolling average)

World class discoveries x10

World class & large discoveries

All discoveries

Source: BHP Billiton, March 2003
MINERAL EXPLORATION MANDATE
MISSION
Discover 2 world class deposits by 2010 that will be profitable through the price cycle.

IMPERATIVES
New Areas > best ground
New Ideas > interpretation
New Technologies > innovation and distinctive capabilities

✔ Maximise number and quality of opportunities
✔ Minimise risk
✔ Minimise cost
✔ Minimise time / project life-cycles
MINERAL EXPLORATION IMPERATIVES

Key Drivers
Mineral Exploration Imperatives [Drivers]

1. Business Drivers
2. Commercial Drivers
3. Geoscientific Drivers
4. Knowledge & Collaboration Drivers
5. Information & Data Drivers
Mineral Exploration Imperatives [Drivers]

1. Business Drivers
Mineral Exploration Imperatives

**BUSINESS DRIVERS**

- **All activities need to Add Real Value**
  - Remain focused on finding world-class deposits

- **Identify and Manage Risk**
  - Increase the Probability of Success
  - Need to know our various portfolio’s [project, target, R&D]

- **Maximise the Value of our Budget / Expenditures**
  - Best projects get funded (global ranking)
  - Most needed R&D gets funded

- **Reduce Costs and Cycle Times**
  - Be more efficient > streamline processes > increase turnover of projects
  - Improve the utilization of all resources (people, technology, data etc)
  - Support rapid decision making

- **Improve Interaction with Key Customers and Partners**
  - Alliance – JV partners
  - R&D partners
  - Government agencies

---

“Portfolios”
“Processes”
“Workflows”
Mineral Exploration Imperatives

✨ BUSINESS DRIVERS [example – Workflow Processes]
Mineral Exploration Imperatives

BUSINESS DRIVERS [example – Portfolio Management]

- Project Portfolio Management System
Mineral Exploration Imperatives

 › BUSINESS DRIVERS [example – Technical Risk]

- Target Portfolio Management System
- Understanding Technical Risks
- Comparing Pre-Drill with Post-Drill results
- Capturing Key Learnings
Mineral Exploration Imperatives

*: BUSINESS DRIVERS [example – R&D]*

- Best R&D is getting supported and funded
- R&D is aligned to Exploration strategy
- R&D Portfolio is transparent
  - we know how much we spend
  - we know where we are spending it
    (commodity focus, geographic focus, geoscientific focus)
  - we have identified the key deliverables
  - we have exposed the risks
- Competitive Advantage is measured against current Key Performance Indicators
- Forum exists to review R&D submissions
  - Process is fast, effective, and focused
Mineral Exploration Imperatives

**COMMERCIAL DRIVERS**

- Build strong alliance **partnerships** that deliver value
- Develop innovative and effective commercial **deals**
- Be responsive to new commercial **opportunities**
- **Leverage** technologies eg. FALCON
- **Mitigate** Exploration Success Risk
  - Gain access to ‘other peoples’ money
  - Gain access to ‘other peoples’ concepts and projects
  - Increase Alliance partnerships to share exploration risk
    - consequence: Junior Partners utilise low cost exploration techniques to generate new projects
3. Geoscientific Drivers

a. Geology
b. Geophysics
c. Geochemistry
Mineral Exploration Imperatives

✓ GEOSCIENTIFIC DRIVERS [GEOLOGY]

- More Targeting exercises like the NWQLD study.
- Focus on fundamental controls at the belt / terrane-scale, as opposed to microscope studies
  - Precambrian tectonic reconstructions
- Produce quantifiable field tested exploration models [ground truthing]
  - Enhanced mineral chemistry mapping
  - Dating of ore minerals and host rocks
  - Regolith research
- Deliver more baseline geological, geophysical, geochemical and drilling data to discriminate and select best terranes at the regional scale
- Deliver Physical Property Databases of lithology, alteration etc. with special reference to regions, ore-deposits and any other logical classification there may be available.
- Develop more effective easy to use data processing techniques (e.g. weights of evidence, fuzzy logic, neural networks)
- Drilling undercover > targets large features of interest
- Alteration mapping (Mt Isa and Broken Hill)
Mineral Exploration Imperatives

**GEOSCIENTIFIC DRIVERS [GEOPHYSICS]**

- **Identify BEST Terrains**
  - Long seismic traverses across craton boundaries and other significant geological areas > new/better understanding of tectonics and structure of continent

- **Identify NEW Terrains**
  - Improved seismic velocity model of the crust and lithosphere > better seismic network across the country

- **Generate New Projects**
  - Ready access to all Open File Geophysics incl. State geophysical airborne databases (including DEM etc) and any other geophysical data such as seismic > pay for what you need

- **Generate Higher Quality Projects**
  - 3-D visualization and geophysical inversion tools that permit constraining the interpretation based on hard (drilled or mapped) geologic data

- **Delineate New Targets**
  - Improved Geophysical detection / discrimination technologies i.e. for lithologies and ore
    - AGG and ATMG <300m depth
    - Electromagnetic technologies > true 3D (3 component) broad band data to map from surface to 1000m at resolutions only limited by physics of EM (incl Y)
Mineral Exploration Imperatives

GEOSCIENTIFIC DRIVERS [target detection under cover]

Prominent Hill
South Australia

Ground Gravity data mostly 400m x 800m station intervals with some patches of 100m x 100m. $g_0$ (above), $G_{DD}$ (below)

Falcon AGG data at 200m line spacing, 100m clearance, $g_0$ (above), $G_{DD}$ (below)
Identify BEST Terrains
Identify NEW Terrains
Generate New Projects
Generate Higher Quality Projects
Delineate New Targets

- Improved analytical methods to interpret all historical and new geoscience data i.e. compilation and levelling
- Innovative geochemical detection technologies
  - Airborne Chemistry, Soil Gas
  - Partial / Selective Extraction Soil Geochemistry
    - compile all known data and case studies
    - trial over buried features
    - try and understand base lines
- Advanced Regolith Methods
  - Understanding 3D dispersion processes in relation to selective extraction
  - Improvement through the understanding of processes
- Alteration litho-geochemistry in metamorphosed rocks i.e. unraveling pre-metamorphic alteration
- Regolith characterisation - case studies defining what is a significant level of anomalism in target and pathfinder elements for various selex geochem techniques

Understanding geological processes using geochemistry is not of primary interest to mineral exploration geochemists.
Mineral Exploration Imperatives [Drivers]

Knowledge & Collaboration Drivers
Mineral Exploration Imperatives

**KNOWLEDGE SHARING DRIVERS**

- **Access to innovative thinking, new ideas and interpretation through effective collaboration and knowledge sharing initiatives**
  - Internet based Virtual Data Analysis environments – real time collaboration
  - Empower geoscientists (minimise support interaction) via web solutions
  - Access to new collaborative tools eg. netmeeting, web conferencing, data streaming, data and metadata harvesting

- **Need to access-integrate-manipulate data more effectively**
  - Live (web enabled) 3D modeling, advanced processing and visualisation
  - Access to supercomputers > web enabled access to public processing and research software or the ability to use proprietary software
  - Seamless access to large amounts of data with fast display speeds.

- **Access to Researchers and Specialists**
  - Researchers timelines are not always aligned with Exploration requirements
  - Establishment of portals such as *Innocentive* which bring industry and key researchers, consultants together more effectively
  - One-on-One research collaboration is becoming more popular
  - Need to focus on mineral discovery, not mineral genesis
GIS 3D Visualisation and Analysis  eg. ArcGLOBE

- Easy-to-use 3D visualization application
- Ability to view and analyze large amounts of multi-scale GIS data seamlessly with extremely fast display speeds.
- Out of the box solution
- Adding new data is straightforward
  - Able to support all common geoscientific data formats
  - Data is dynamically transformed to its appropriate location on the globe
  - Multiple data sets at varying resolutions can be transparently combined
- Offers advanced indexing facilities
Mineral Exploration Imperatives

KNOWLEDGE SHARING DRIVERS [example – collaboration]
Mineral Exploration Imperatives

KNOWLEDGE SHARING DRIVERS [Virtual Environment]

Seamless operability to a complex global infrastructure and its resources

Various Devices (Portability)
Multiple Interfaces
Fast Performance

Global coverage
Secure Environment
Real time access (more effective use of idle resources)

WAP / WAN / LAN / Wireless / Bluetooth / Infrared
Mineral Exploration Imperatives [Drivers]

5 Information & Data Drivers
Mineral Exploration Imperatives

DATA & INFORMATION DRIVERS

✓ Straightforward access to data:

- Online
- Up-to-date
- High quality
- Cheap
- Consolidated – Integrated – Rationalized
  - Web-based data portals – simple, seamless, single point entry
  - Integration utilising XML technologies

NSDI
A GIS catalog portal is a one-stop Web application that references numerous GIS holdings.

A network of GIS catalog portals forms a Spatial Data Infrastructure (SDI) for both national (NSDI) and global use.

**Key Features**

- **Search a GIS catalog portal** for various geoscientific data sets in real time.
- **Register for notification** when new or updated data has been added.
- **View metadata** records to determine if a data set is suitable for the intended use.
- **Access and view** geoscientific data through a web browser.
- **Download** geoscientific data from various providers through feature streaming or FTP services for large data sets.
- **Publish (register)** various data sets, activities or events to share with others through submission of online forms within a GIS catalog portal. Data providers will have the ability to update their metadata submissions.
Mineral Exploration Imperatives

DATA & INFORMATION DRIVERS [example – GIS Portals]
Mineral Exploration Imperatives

DATA & INFORMATION DRIVERS [example – GIS Portals]

gedata.gov is a web-based portal for one-stop access to maps, data and other geospatial services that will simplify the ability of all levels of government and citizens to find geospatial data and learn more about geospatial projects underway.

gedata.gov is part of the Geospatial One-Stop Initiative, one of the 24 OMB electronic government initiatives that will enhance government efficiency. The geodata.gov portal will accelerate the development and implementation of the National Spatial Data Infrastructure (NSDI) and includes state, local and tribal governments along with the private sector and academia as participants. In order to get started, please use our Quick Start Guide.

Data Categories

- Administrative and Political Boundaries
- Agriculture and Farming
- Atmosphere and Climatic
- Biology and Ecology
- Business and Economic
- Cadastral
- Cultural, Society, and Demographic
- Elevation and Derived Products
- Environment and Conservation
- Geospatial and Geophysical
  - Human Health and Disease
  - Imagery and Base Maps
  - Inland Water Resources
  - Locations and Geodetic Networks
  - Oceans and Estuaries
  - Transportation Networks
  - Utilities and Communication
Technical Barriers

- Data storage options confusing to geoscientists [Coverages vs Relational vs Objects]
- Specialised software packages are very expensive ~A$5K+
- Too many specialised software packages eg. 3D industry booming
- Data conversion can be very time consuming
- Data conversion often requires expert knowledge
- Maintaining public domain data is costly, time consuming and an unnecessary duplication
  - Although disc space is cheap, backups are labour intensive
Mineral Exploration Imperatives

DATA & INFORMATION DRIVERS  [current state]

<table>
<thead>
<tr>
<th>Government Group</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geoscience Australia (AGSO, Auslig)</td>
<td>Best</td>
<td>Download a lot of data. Have to pay for 250K topo, AUD54 sheet layer. More specific data usually needs to be ordered on CD, AUD99 each. Poor quality raster 250k Geodata, not scanned at sufficient DPI, or resolution lost through conversion to ecw (2000 release).</td>
</tr>
<tr>
<td>SA</td>
<td>Pretty Good</td>
<td>Good online view, download most state-wide datasets. Can order region datasets CDs (~AUD50)</td>
</tr>
<tr>
<td>VIC</td>
<td>Pretty Good</td>
<td>Order Free CDs, can download 1:250K geology. Insufficient DPI, 125dpi should increase to 200dpi.</td>
</tr>
<tr>
<td>NSW</td>
<td>Good</td>
<td>On line viewer MinView. Order CDs (~AUD110) &gt; no download facility</td>
</tr>
<tr>
<td>NT</td>
<td>Good</td>
<td>You can download most of what they have, and order what you can't.</td>
</tr>
<tr>
<td>TAS</td>
<td>OK</td>
<td>Good data - no download of geoscientific data, order CDs. ~AUD55.</td>
</tr>
<tr>
<td>QLD</td>
<td>OK</td>
<td>Order CDs (~AUD113), no download facility.</td>
</tr>
<tr>
<td>WA</td>
<td>OK</td>
<td>Good online viewer, no download facilities.</td>
</tr>
</tbody>
</table>

Issues: Variable quality > Various coverage > Various delivery methods
Recommendation: National initiative to integrate all data resources
Mineral Exploration Imperatives

DATA & INFORMATION DRIVERS [data types and needs]

- Physical Property Databases of lithology, alteration, downhole geochem/geol etc. with special reference to regions, ore-deposits and any other logical classification there may be available.

- Deliver more baseline geological, geophysical, geochemical and drilling data to discriminate and select best terranes at the regional scale.

- In-house Acquired Sampling Analytical Geophysics

- R&D / University Open File - Restricted

- Newswire and Stock Exchange Services

- Bibliographic Open File
  - Gov. Pubs
  - Journals
  - Books
  - Theses

- Government Geoscientific Open File
  - 2D, 3D, GIS,
  - Geophysical, Geochemical,
  - Drill Hole Survey Data

- More consistency and integration via XML and portal technologies

- Demise of AESIS > decentralisation of publications

- Easier Tools that allow integration of public domain and inhouse data eg. 3D visual.

- Identification/integration of common data sets eg. Selective Extraction

- More

- Plethora of the same information
- End -

QUESTIONS?