Leveraging investment in the Earth Sciences to meet future mineral discovery challenges

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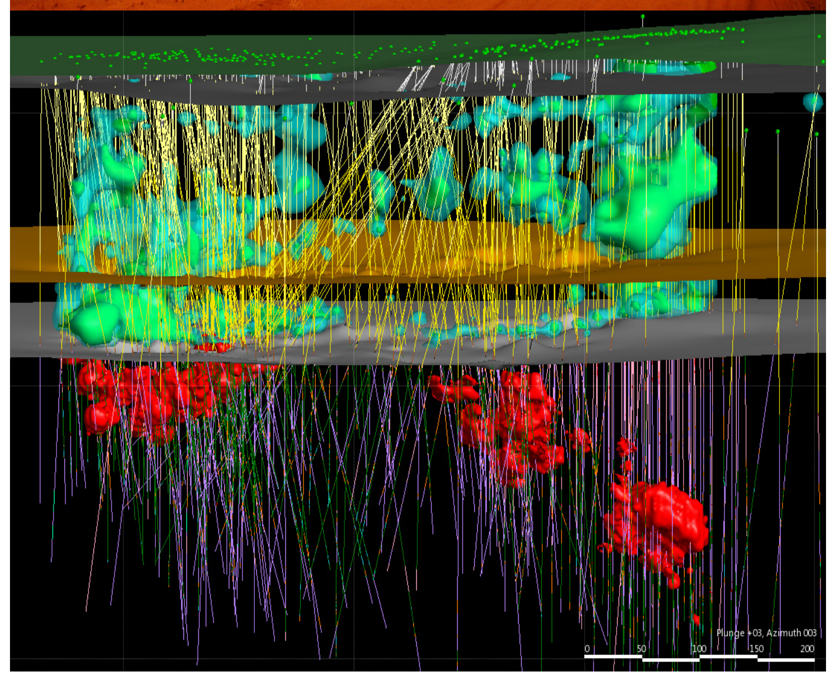
UNCOVER – Adelaide March 31st, 2014



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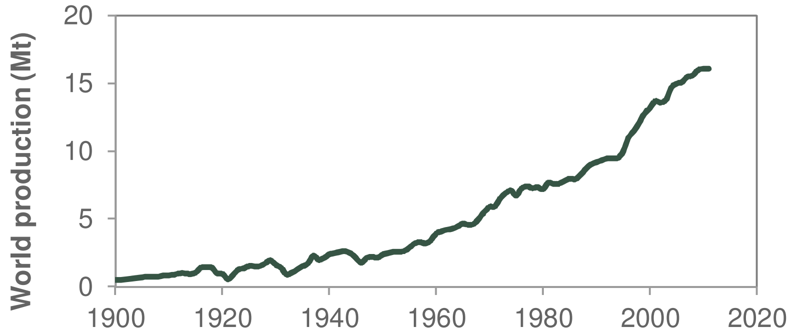
Global production trends

Why is exploration success so important?

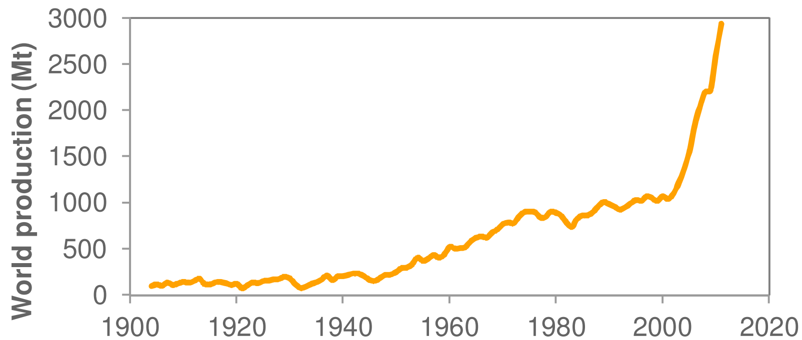
Copper



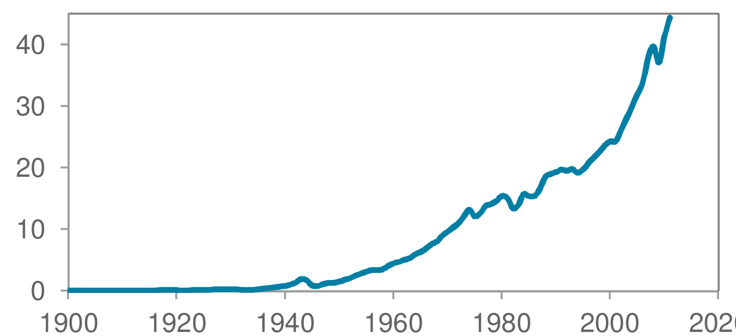
Historical CAGR in global production for minerals has been ~ 3.5%

- Increasing global population
- The ongoing urbanisation of society
- The industrialisation of production

Iron ore



Aluminium



Source: US Geological Survey, 2013

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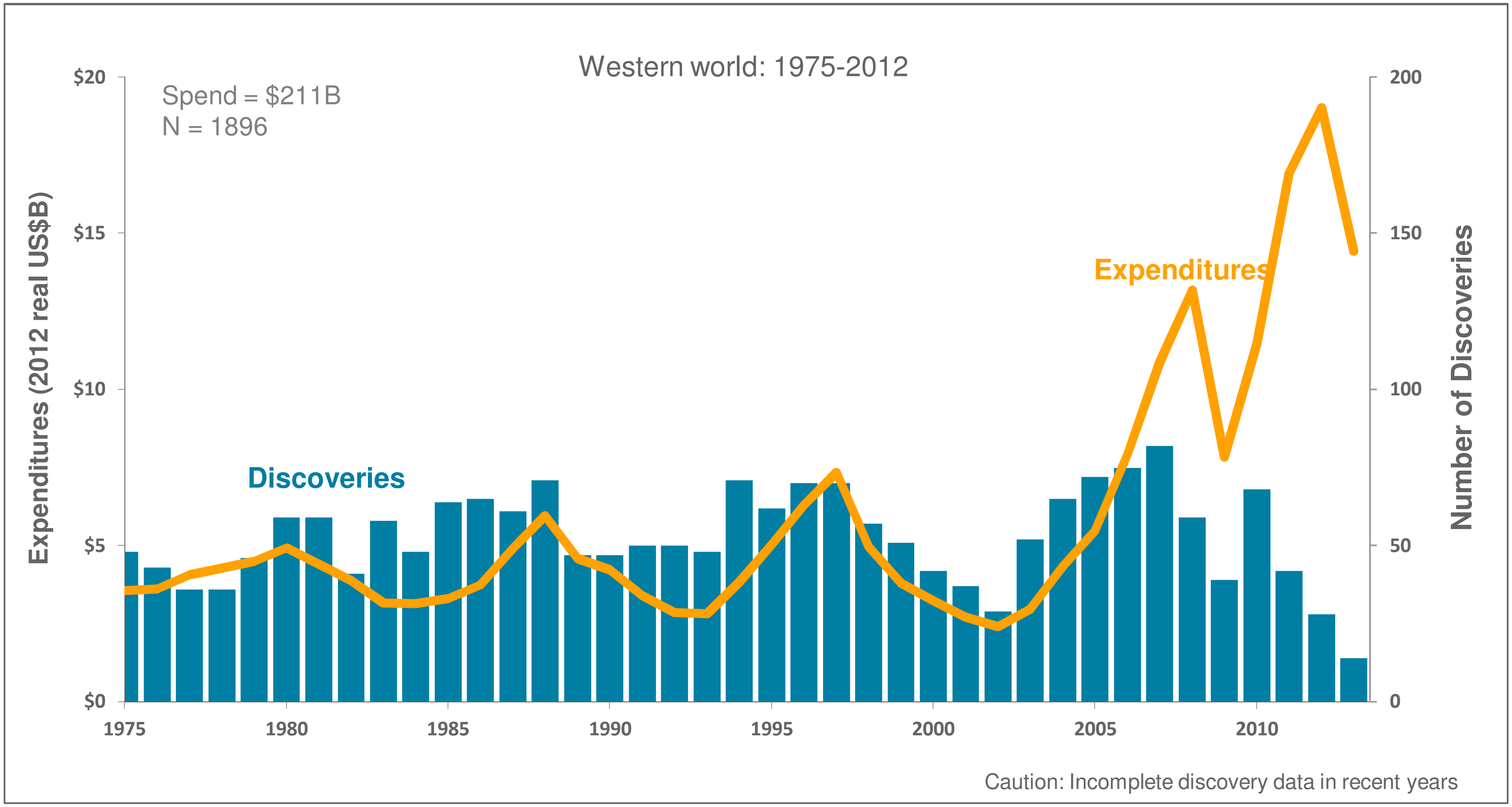
Exploration spend and historic discovery rates

The recent disconnect between spend & discovery rates

Significant* mineral discoveries (excluding bulks)



*Significant defined as >100Koz Au, >10Kt Ni, >100Kt Cu equiv, 250Kt Zn+Pb, >5Moz Ag, >5kt U_3O_8

Source: MinEx Consulting @ February 2014

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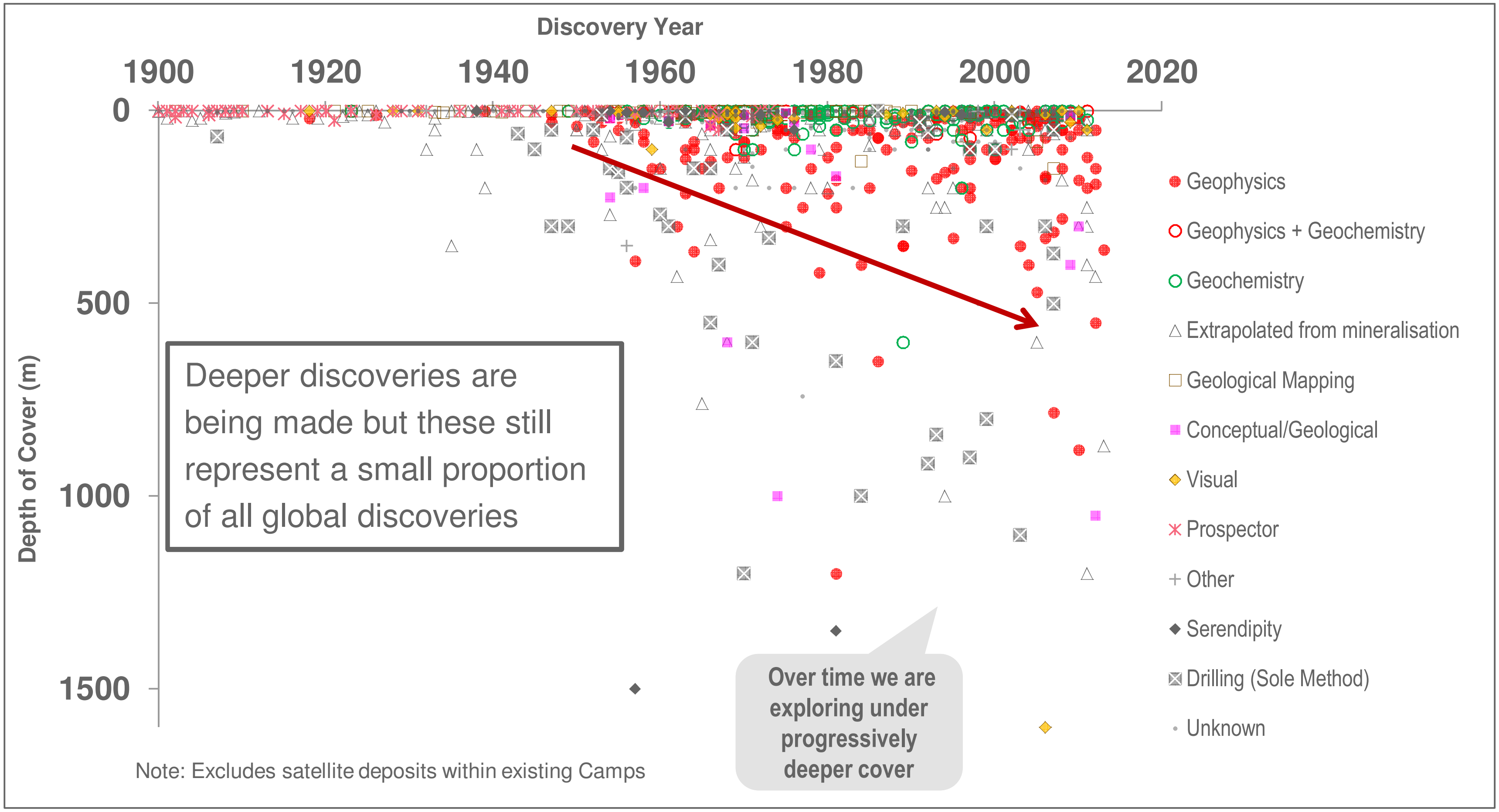
Global mineral discovery trends
Depth of cover and discovery method

Prospect-scale base metal discoveries in the World: 1900-2012



Source: MinEx Consulting @ February 2014

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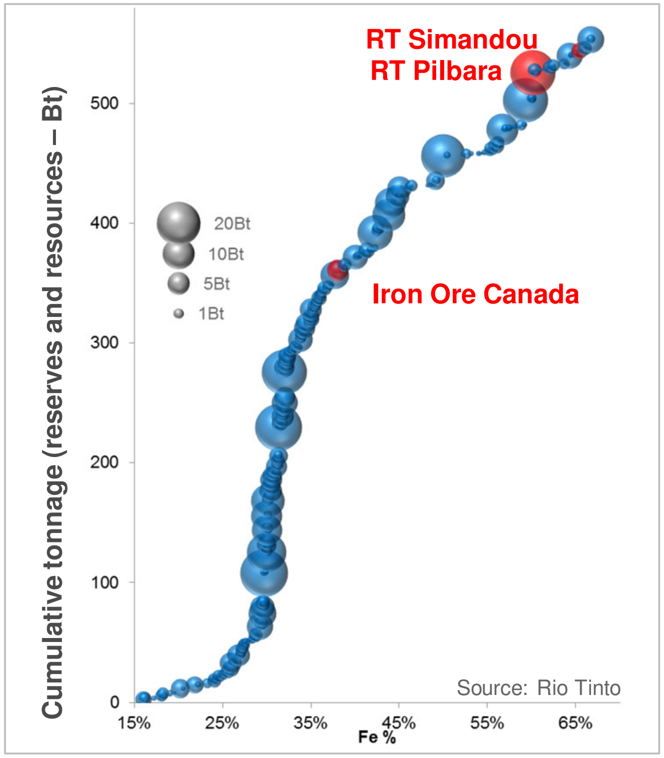
We are not running out of resources globally

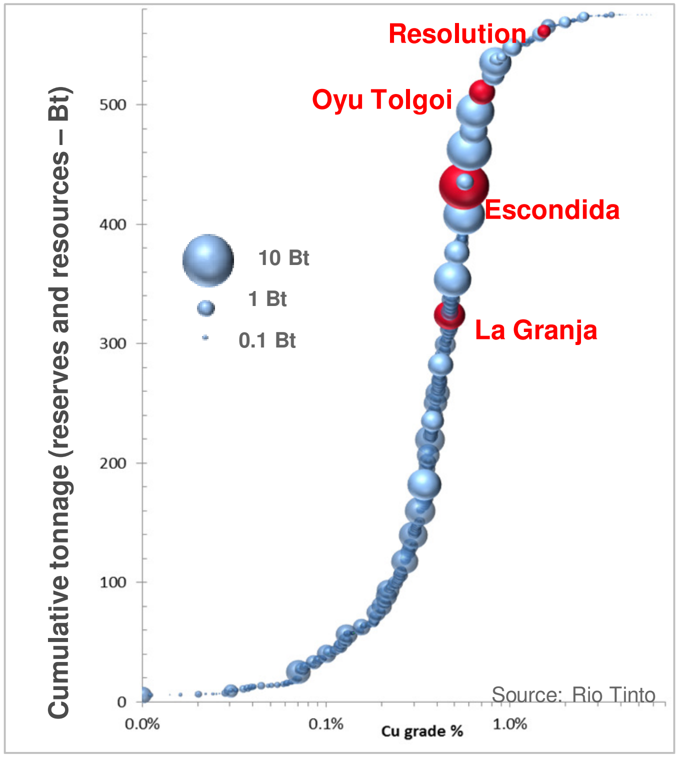
New discoveries from under cover will have to compete for their place

Iron ore



In-situ inventory of iron ore

Copper



In-situ inventory of copper

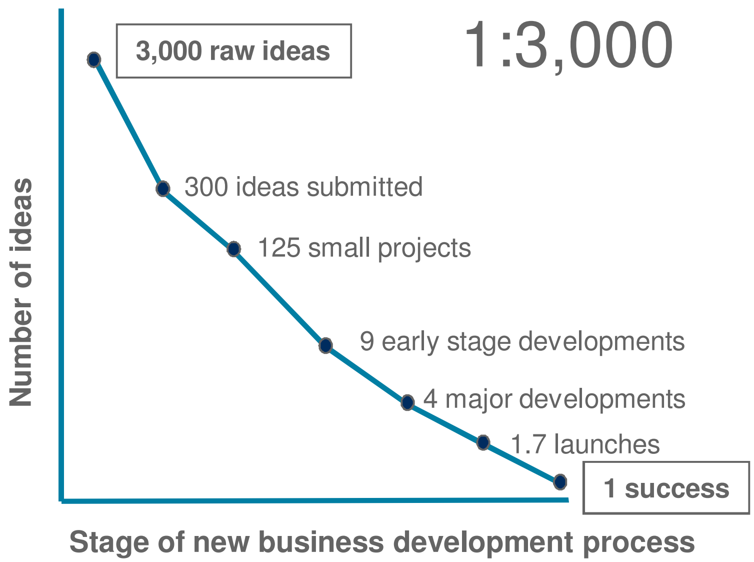
- Ample volumes of key resources so deeper discoveries will have to compete
- Discovery of new resources will need to be done more cost effectively
- New technologies to extract buried resources cost effectively need to be developed

Source: Internal Rio Tinto databases @ February 2014

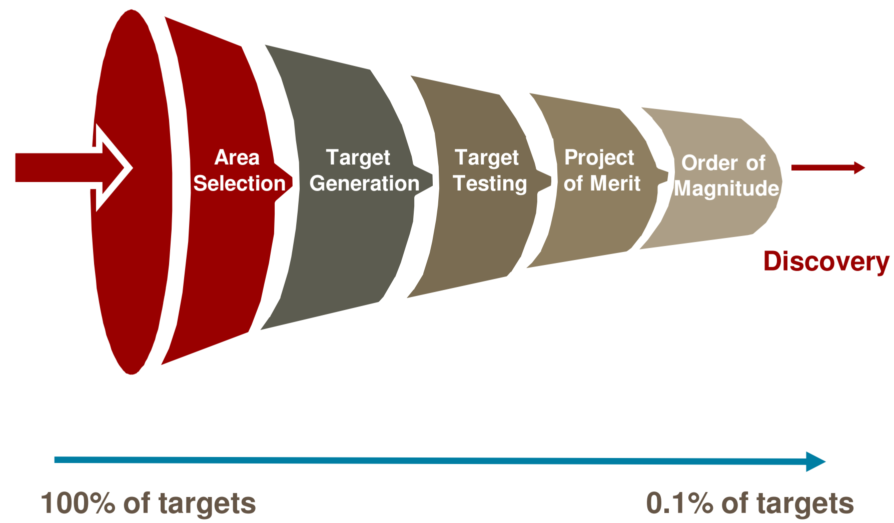
Exploration Industry

Risks and value just like other R&D sectors

Universal industrial success curve



Exploration process



- Exploration is similar to generic R&D, as only around 1 in 1,000 prospects becomes a mine
- The science community supporting us must make this connection
- The move under cover exposes the industry to increased technical risk

Source: Stevens and Burley,
Plotting the rocket of radical innovation, 2003

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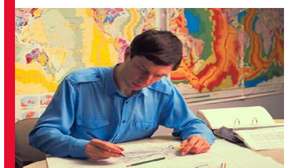
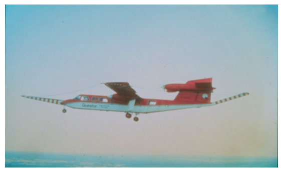
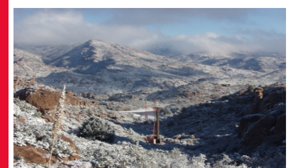
The exploration process

The most critical steps are the first three set out below

	Area selection	Target generation	Target testing	Resource delineation	Resource evaluation	DISCOVERY
						
Geologists view of the discovery process	Deciding where to explore by desktop evaluations of various data	Mapping and surveying to determine whether a deposit may exist	Assessing the nature of mineralisation by sub-surface evaluation	Determining deposit size, grade and metallurgy to estimate the extent of mineralisation	Judging whether a deposit will be economical by additional studies	Final feasibility and then construction and operation
Company view of the milestones required to advance	✓ Land acquisition ✓ Acceptable political, regulatory, security, sovereign risk ✓ Conceptual viability	Plus…. ✓ Identifiable drill targets ✓ Access rights ✓ Third party agreements ✓ Permits ✓ Stakeholder mapping	Plus…. ✓ Ore grade width intersection ✓ Critical issues identified ✓ Stakeholder engagement	Plus…. ✓ Inferred resource ✓ Order of Magnitude Study budget ✓ Major project risk analysis ✓ Stakeholder engagement	Plus…. ✓ Positive OoM economic impact study ✓ Detailed major project risk analysis with key stakeholders	Plus…. ✓ Economic viability ✓ Feasibility and construction budget ✓ Ongoing stakeholder engagement

The primary focus for this audience today

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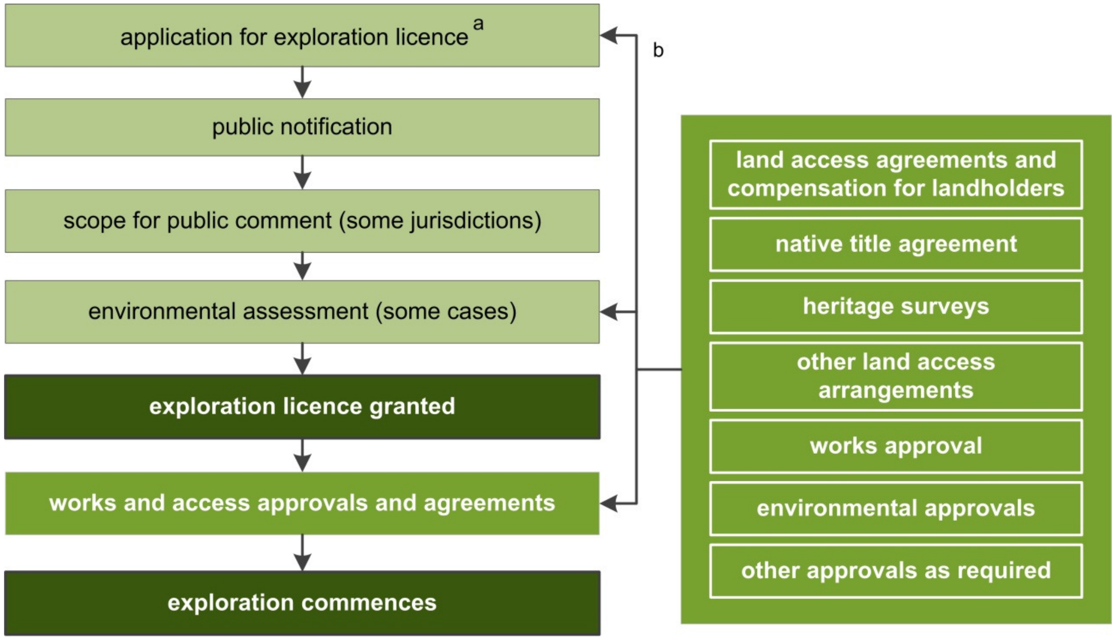
Non-technical barriers to exploration
(Australian Government Productivity Commission Inquiry – 2013)

- Increasingly longer time frames from concept to testing are impacting success rates
- In many instances, the first year of a licence period can be exhausted by the need to gain the necessary regulatory approvals truncating the time left for actual exploration activity



a A work program must be submitted with the application, but may not be part of the decision-making process.
b Jurisdictions require different environmental, heritage and land access agreements to be completed at different stages of the exploration licence approval process.

Source: Australian Government Productivity Commission Inquiry Report September 2013

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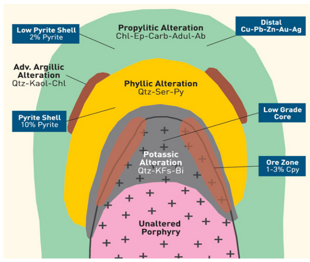
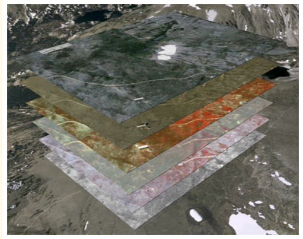
The role of technology is evolving

Correlation of discovery rates with new technology in decline since 90's

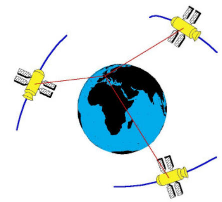
1950's
Prospector led discovery until late 1950's*



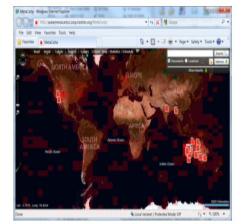
1960's
Understanding mineral systems



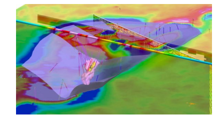
1970's
Remote sensing & airborne geophysics

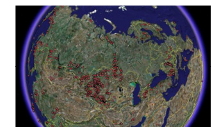


Early 1990's
Useful GPS positioning arrives



2000's
Even faster PC's & ever larger datasets





From ~2010
Big data & the Cloud emerge as key drivers

1950 — 1960 — 1970 — 1980 — 1990 — 2000 — 2010 — 2013

Post WWII
New technologies emerged (magnetics, EM etc)

1960's
Role of Plate Tectonics emerged

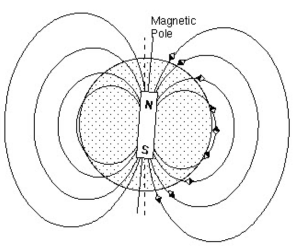
1970's
Improved geochemical capabilities (AAS/ICP)

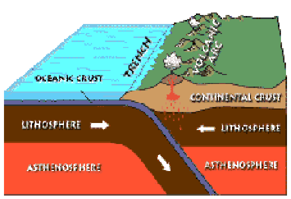
1980's
The PC arrives, computing in the field now possible

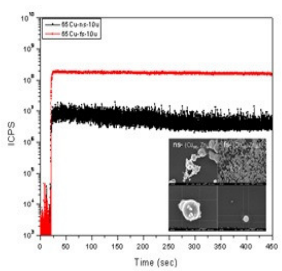
Mid 1990's
Forward & inverse modelling routines delivered

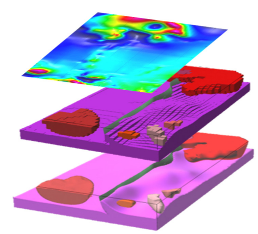
2000's
More powerful transmitters, greater bandwidth receivers

2000's
Airborne gravity gradiometers









* Gold prospectors in Australia doing it the old-fashioned way in 1851.
(Three Lions/Getty Images)

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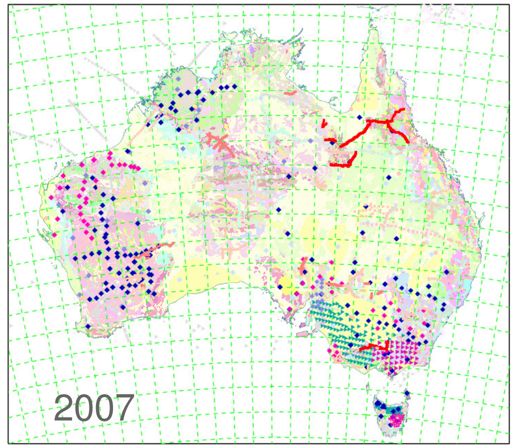
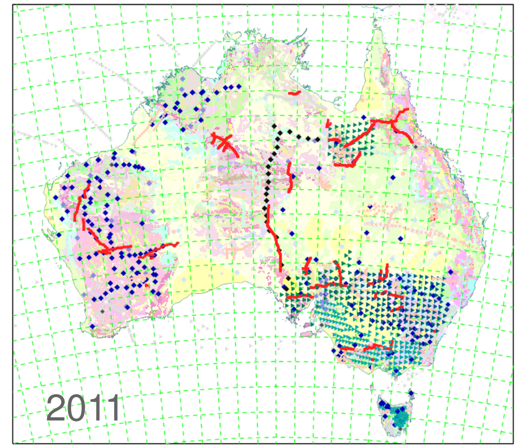
Improving understanding of crustal architecture

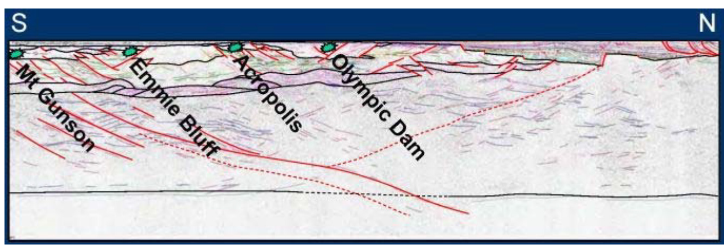
Gross controls but usually only relevant in hindsight

Comparison of seismic deployments across Australia (GA/Surveys/AuScope). Red lines represent reflection transects, diamonds broad-band recorders, triangles short-period recorders. Some small deployments in Tasmania and coastal NSW are omitted to avoid clutter

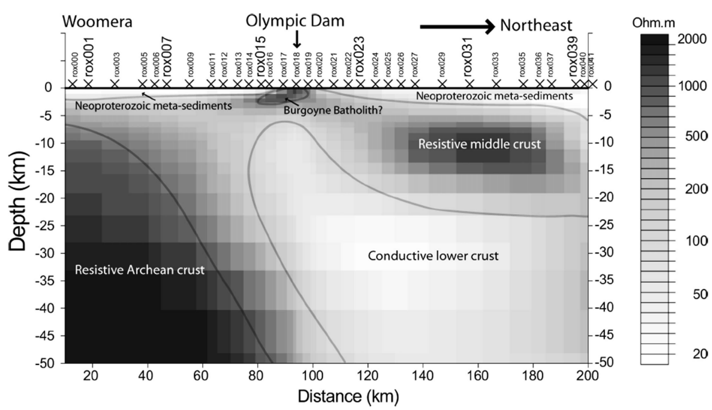




Gawler Craton seismic transect structural interpretation (Geoscience Australia Gawler Mineral Promotion Project)



2-D Inversion of magnetotelluric (MT) over Olympic Dam (Rodi & Mackie, 2001)



- Fundamental crustal architecture provides large-scale controls on the distribution of mineral resources
- Understanding this architecture is especially important for covered area exploration
- As continental-scale data are progressively collected the controls to mineralisation on known mining camps will become clearer

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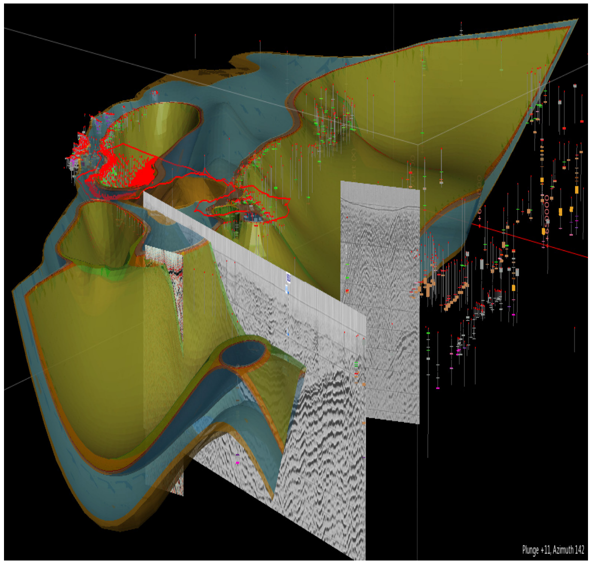
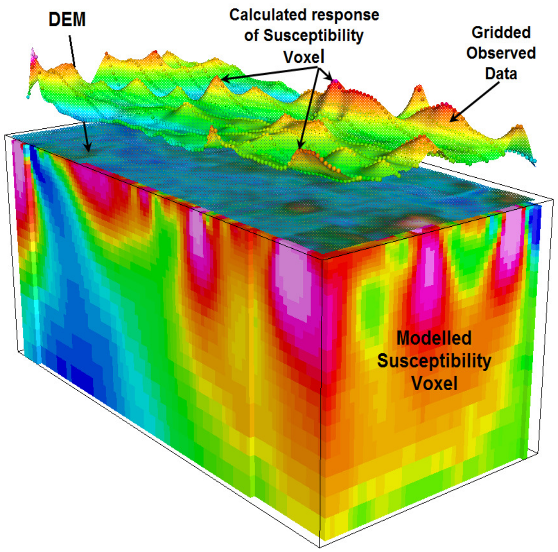
Modelling, inversion and 3D targeting

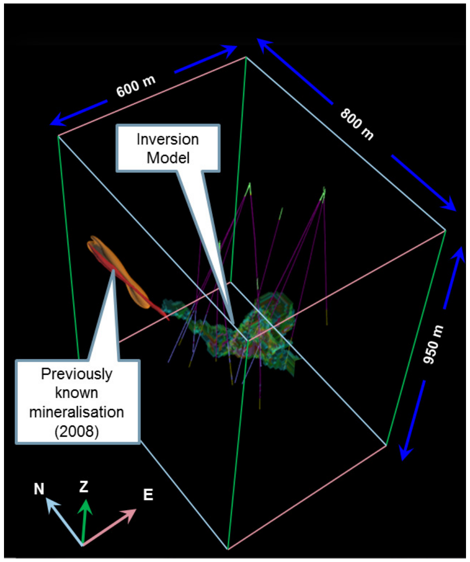
The scale of observation & quality of control becomes key here



Stratigraphic Model of Bowen Basin coal measures



Source: Geosoft 2013



RTX down-hole 3-D inversion model

- Basin scale geological modelling will become critically important
- The lowest technical risk will be to move from relatively data rich areas where we have control as we head out under cover
- 3D models and 3D inversions will play an increasingly important role in target generation and target selection
- Very large scale, multiple parameter data integrations and data inversions utilising huge volumes of data are required BUT they need to be constrained (real data + petrophysics)

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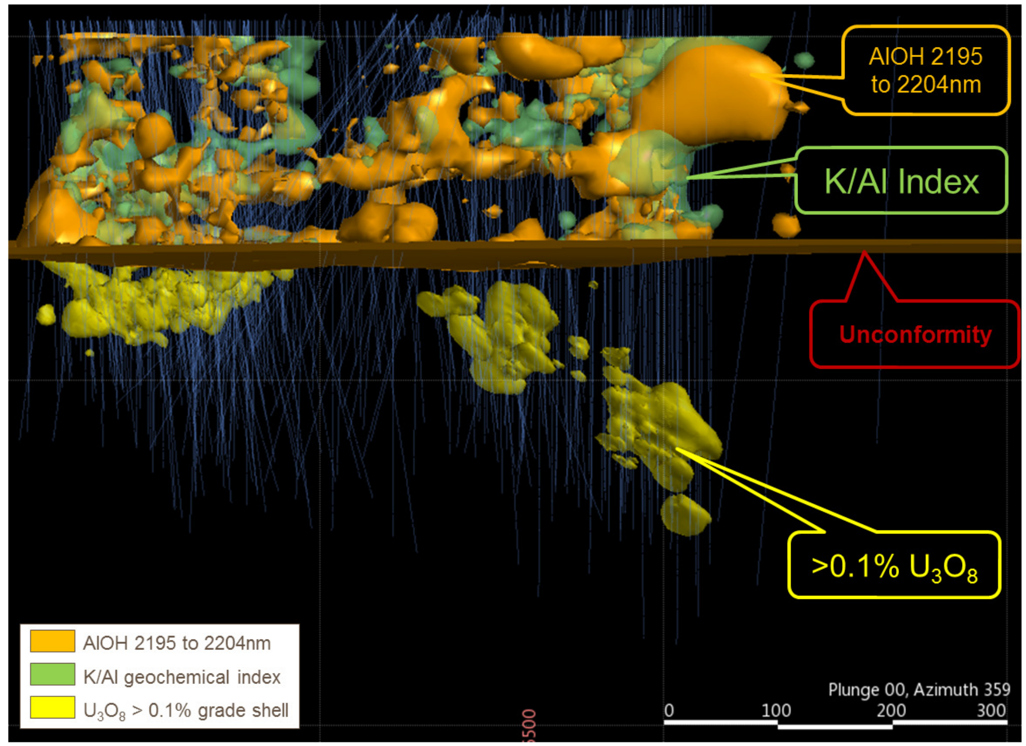
Predicting the mineral system footprint
Maximising the effective search area

- Increasing the spatial extent of recognisable alteration halos is a high priority for the minerals industry
- Understanding the alteration characteristics and spatial relationships around ore bodies is a key exploration tool
- Predictive alteration models are today critically important for porphyry copper, unconformity uranium, iron ore, gold and other commodities

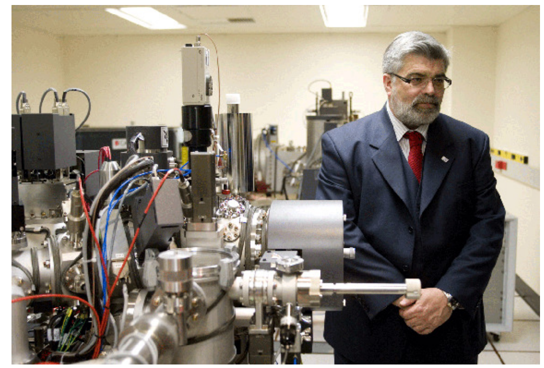


3-D Modelling of spectral mineralogy associated with unconformity U mineralisation

Leveraging micro-analytical capability

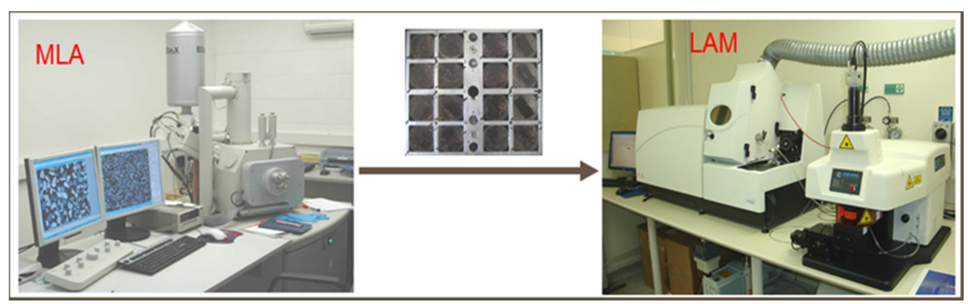
Aiding in fertility assessment and direct detection

- Academia and Industry are entering an era of unprecedented micro-analytical capability
- Federal spending has delivered state-of-the art micro-analytical facilities to numerous Australian institutions
- Rio Tinto and other Companies are actively leveraging micro-analytical technologies for geometallurgy and for the development of new exploration techniques
- Each Rio Tinto system has the capacity to generate >800,000 major and >50,000 trace element analyses a year



Centre for Microscopy, Characterisation and Analysis at UWA. Opened August 2009 by the Hon Kim Carr, Minister for innovation.

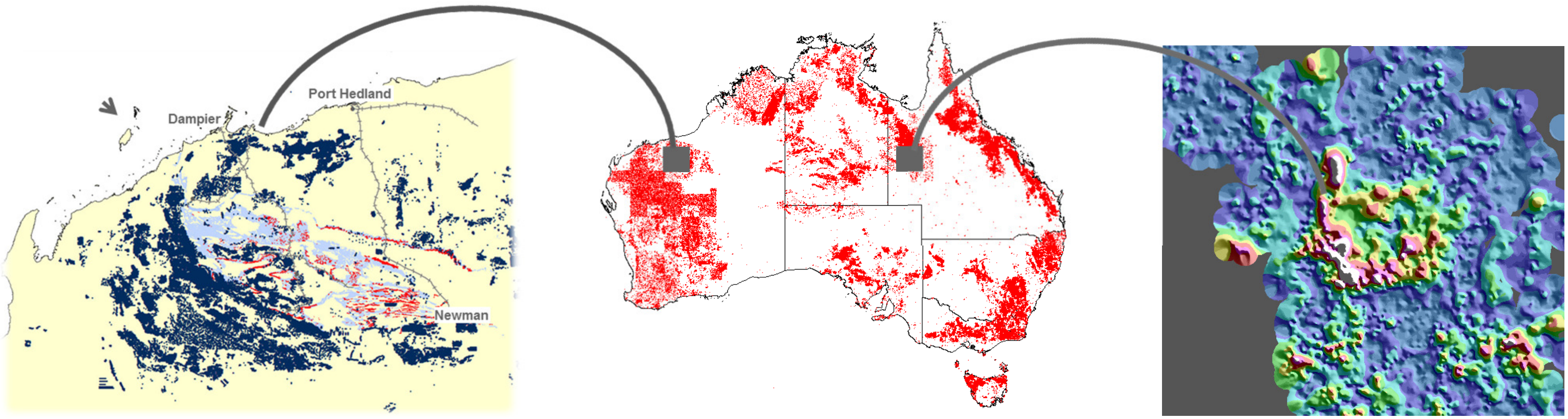
16 block mount holder



Rio Tinto's Bundoora RIMs Facility

Vast quantities of offline Geoscientific data

Must deliver improved accessibility using Portal interfaces



Pilbara public data capture >570,000 surface samples; >60,000 drillholes

RTX Public Surficial Geochemistry, Australia n > 3,300,000 samples (Mar 2014)

Gridded stream sediment Zn geochemistry

- Enormous volumes of geoscience data are already available from governments & research organisations (airborne geophysics etc.)
- However equally large volumes of historic, corporate and academic data have never enter the public domain
- These data are fragmented, multi-format and often undiscoverable. A “Google-like” search experience to make data discoverable is key to unlocking value
- Federated nationally distributed data sets and tools to manipulate large data volumes is of immediate value to the exploration industry (AuScope Portal a good first step)

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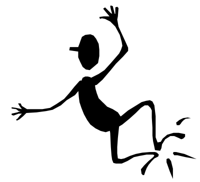
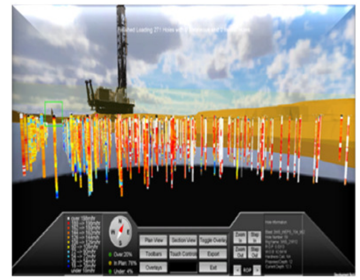
Improving discovery rates

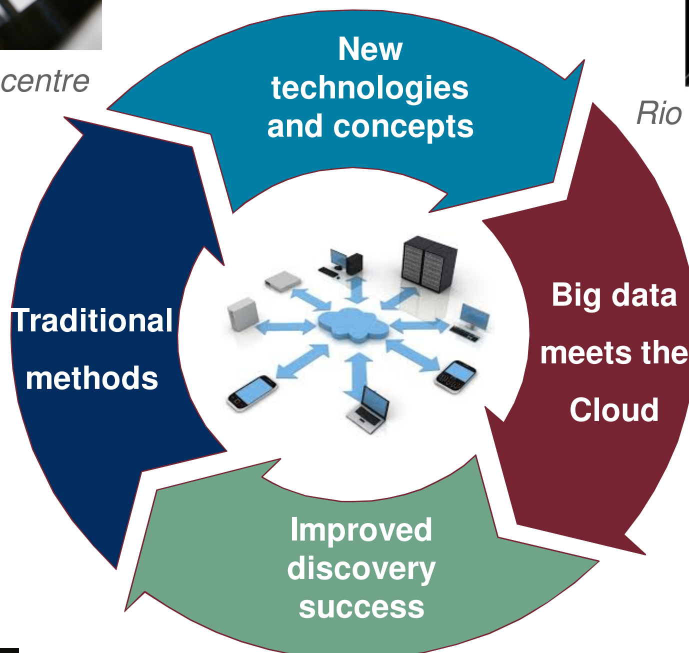
Combination of old and new technologies and effective data integration yielding knowledge

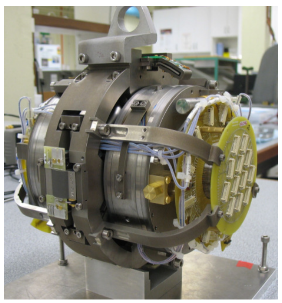
RTX mineralogy centre



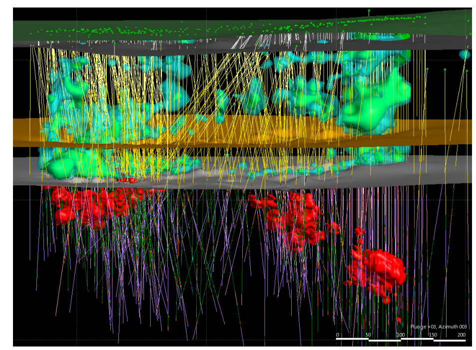


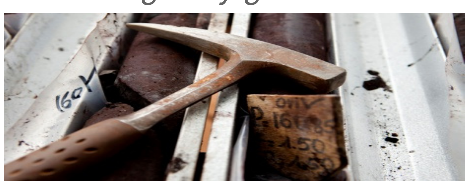
Rio Tinto automated drill console

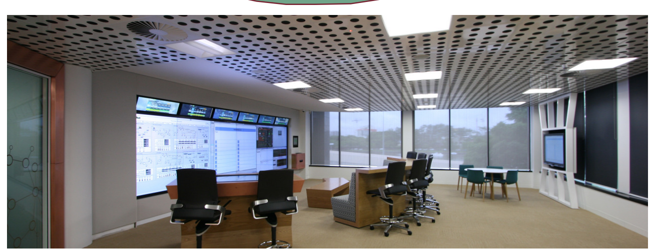




VK1 gravity gradiometer







Rio Tinto processing excellence centre

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The Industry & government context

The exploration industry faces numerous challenges today, including:

- A global declining discovery rate (yielding increasing cost per discovery)
- An unsustainably high level of exploration expenditure globally
- Largely ineffective predictive discovery tools
- An ocean of data to deal with (information versus knowledge)
- Even higher technical risk when exploring under cover
- Some commodities are precluded – e.g. those generated by surficial processes
- The need for new discoveries to compete for capital globally
- Land access restrictions and delays – years from concept to test
- Social and environmental “licence to operate” issues continue to grow

Ongoing engagement with government and academia is fundamental to developing the tools and processes to address these challenges

- Australia is uniquely placed to drive this breakthrough
- Australia has today a strong industry; strong government institutions and strong academic institutions underpinned by a can-do attitude
- However, all levels of government are facing a funding squeeze
- States must ensure Federally funded infrastructure is adequately resourced to extract full value.
- A long term commitment to common infrastructure use and its maintenance (to achieve full leverage of sunk investment) is needed

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Delivering on the UNCOVER promise Conclusion

To improve discovery rates, in particular in areas of post mineral cover, we need to:

- *Increase the search radius by targeting overall alteration footprints*
- *Effectively distinguish the fertility of mineral systems (is there metal there?)*
- *Push on with research into Cooperative / Joint inversions*
- *Collect and consume far more petrophysical data (to constrain the above)*
- *Continue to develop our key **geophysical** systems focussing on ability to map **geology***

Bring this all together to yield:

- Best view of discovery potential within each mineral terrane (3D GIS)
- Effective and targeted processing of all available data (Big Data meets the Cloud)
- Deliver those critical insights that ultimately drive discovery success
- But do not forget that everything is underpinned by **geology** and everything we are looking for are **geochemical** anomalies