



# **Market Failure in the Australian Mineral Exploration Industry: The Case for Fiscal Incentives**

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**with the support of the Australian Institute of Geoscientists**

## Introduction

This document is a response to the Henry Taxation review that has been compiled on behalf of the Australian Institute of Geoscientists by Chris Cairns (Integra Mining Limited), Jon Hronsky (Western Mining Services) and Richard Schodde (MinEx Consulting).

## The Proposition

The fundamental proposition put by this submission is:

- Australia's base and precious metal mining industries are not sustainable over the long term (ie several decades time frame) due to a decline in the rate of major new greenfields mineral discoveries. Current Australian base and precious metal production is strongly concentrated in a relatively small number of maturing mines, mostly discovered at least two decades ago.
- The information provided to Treasury (and the Henry Tax Review) on the national minerals endowment is reliant upon figures for Australia's Economic Demonstrated Resources (AEDRs). These figures are compiled by Geoscience Australia from listed companies' ASX announcements of Mineral Resources reported in compliance with the JORC Code. While these market announcements indeed reflect "demonstrated" Mineral Resources in the sense that they are likely to actually exist, they do not necessarily imply that these resources have been "demonstrated" to be economic under current or immediately foreseeable circumstances. The JORC Code does not require that economic studies be completed on Mineral Resources – in fact, those Mineral Resources found to be economic after appropriate studies have been completed are separately classified as Ore Reserves. Consequently, the AEDRs, as currently reported, provide a potentially misleading perspective on the future health of Australia's precious and base metals mining industry. To appropriately inform public policy, AEDRs must be interpreted in the context of market forces, the reality that Australia's precious and base metals production relies heavily on a handful of mature operations and that there is little in the way of major discoveries ready to replace declining production from current deposits.
- Exploration for precious and base metals deposits is fundamentally different to exploration for bulk commodities such as iron ore and coal. The former is a much more technically challenging and therefore uncertain process, with long lead times prior to discovery success. On the other hand, the discovery step is a much more critical part of the wealth creation process.

- A significant contributing factor to the decline in greenfields discovery rate over recent years is a “market failure” whereby the incentive structure currently in place for investment in the mining industry actively discourages investment in greenfields exploration. This largely relates to a disconnect between the very short term focus of the risk capital market compared to the longer-term gestation period required for well conceived greenfields exploration programs.
- The Australian government has the opportunity to mitigate this market failure through the introduction of appropriately structured fiscal incentives that provide more incentive for the risk capital market to support greenfields exploration. Such fiscal incentives specifically targeting greenfields exploration have already been introduced with great success in Canada, and Quebec in particular. These incentives should provide a tax concession to funding of greenfields exploration that is similar to the current scheme to support Research and Development investment.

## Macro-Economic Context

The global metal mining industry, in which Australia plays such an important role, is a critical component of the global economy although perhaps one somewhat neglected during the 1980s and 1990s. However the recent large growth in demand, in particular from China, has focused attention on the security of global mineral supply in a way we had not seen since the 1970s. The recent Global Financial Crisis and resultant economic slow-down is already appearing to be just a small perturbation in this trend.

The critical issue is not the **quantity** of the total identified amount of metal in the ground (which can be relatively easily measured) but rather the **quality** of these resources (which is somewhat more difficult to measure). Quality is essentially the economic viability (i.e. the profit margin, or revenues less costs) of mining a particular deposit. Although we measure costs in units of currency, this is only a proxy for all of the various inputs required to produce a unit of metal (labour, materials, energy and capital) and the externalities (“external costs”) associated with that production (primarily environmental and community impacts).

The most fundamental aspect of the macro-economic context for mineral exploration is that growth in human standards of living and economic well-being over the last 500 years has been primarily driven by the fact that we have been able to produce the material requirements of civilisation, including metals, at *ever decreasing real cost* (although critics would say that it is unfortunately often at the expense of increasing externalities). To sustain human development into the future, and in particular to raise the living standards of all people, we will need to continue to reduce the real cost of metal production, with an ever increasing emphasis on fully accounting for the externalities.

Although history has shown that the Club of Rome report in the 1970s was wrong in predicting that the world was about to run out of minerals by the turn of the century, this has not stopped a new generation of doomsayers prophesying similar events going into the next century – namely “peak-oil”, “peak-copper”, “peak-uranium” and even “peak-coal”!

We are very skeptical about these renewed warnings of resource scarcity. The economist’s response has been that market forces inevitably will come to the rescue. This is because scarcity increases prices which in turn provide the incentive for innovation, which in turn leads to the discovery of new sources of production and more efficient usage of materials which then lead to the end of scarcity. The validity of this model has been well demonstrated in economic history.

Even though the invisible hand of economics will resolve any potential mineral supply issues in the longer term, it should be emphasised that there may be short term disruptions. To ensure that Australia is not adversely affected by market turbulence, it is critical that industry have a long term vision and be innovative and act on new opportunities as they arise. Government has a key role to play in making sure that this happens.

In detail, it is important to emphasize that the critical link between the imperative of scarcity and higher prices on the one hand and the result of newer, lower-cost sources of mineral production is **innovation**. The most important engine of innovation in the mining industry is greenfields exploration – the discovery of new, large low cost sources of production.

The mining industry (both globally and in Australia) has established a large inventory of sub-economic mineralisation over recent decades. Because of this, there is a simplistic view that all that is required are scarcity-driven increases in metal prices to motivate the development of these poorer-quality deposits and that this will solve global supply problems. There are however two fundamental arguments against this:

- This strategy implies increasing real costs of metal production, not the decrease required to achieve global sustainability (see discussion above). If metals cannot be provided at constant or declining real costs, the ultimate result will be a stalling of global growth.
- In any environment of demand-driven increases in metal price, there will be inevitable attendant increase in the costs of metal production (labour, energy, materials) and therefore profit margins may not increase. Thus, deposits that were marginal prior to the period of price increase will tend to remain marginal during the price boom. This was the experience of many major mineral project developments during the most recent mining boom. In particular, a number of high-cost nickel mines were developed which were subsequently mothballed.

The above macro-economic issues are critical for Australia as the resource sector is the most important source of export income. Of Australia's top 10 exports by value (Figure 1), the top 7 are natural resources, with gold and base metals the third and fourth largest income earners respectively. In addition, the last decade or so has seen a very rapid increase in the relative importance of its resource sector, growing from around 4.5% of GDP in 1993-1994 to almost 8% in 2006-2007 (source: Wikipedia).

As has been well recognised by many commentators, Australia is well positioned to benefit from the emergence of developing economies such as China and India by providing them with the resources they need to grow. However, Australia will only be able to sustain its contribution

to the world's mineral supply over the long term (let alone grow it) if it continues to discover new high-quality greenfields mineral deposits.

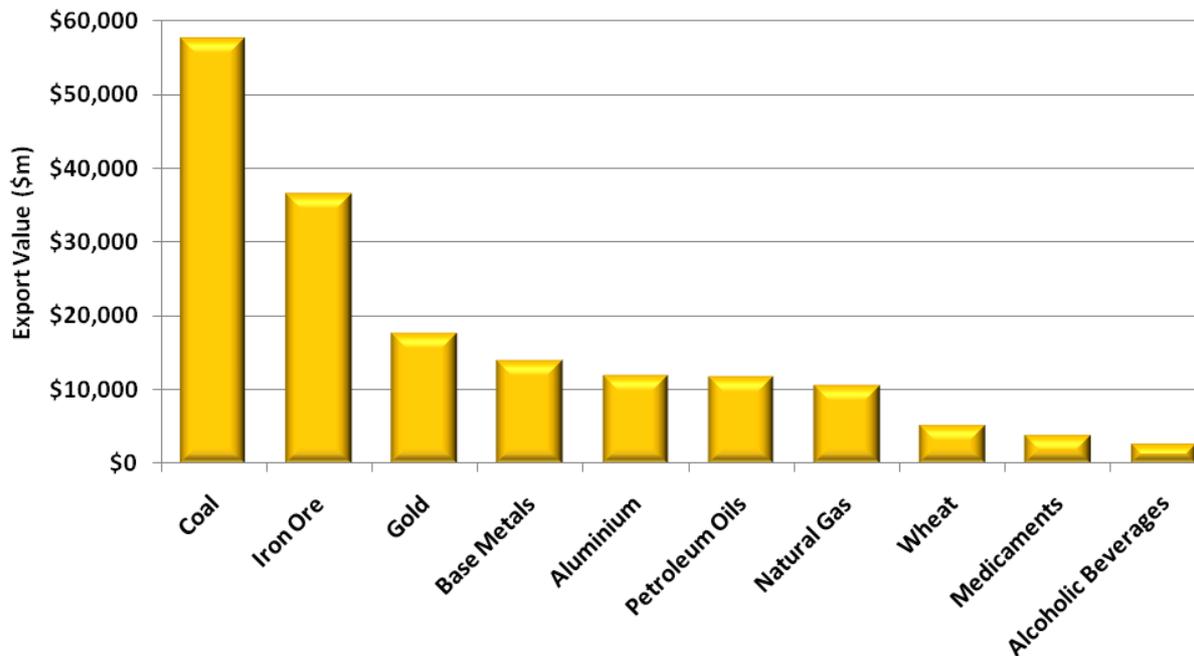


Figure 1: Australia's 10 Largest Exports by Value - 2008-09.

## What is Greenfields Exploration?

Greenfields exploration (sometimes referred to as “grass-roots” mineral exploration) is mineral exploration activity that seeks to discover major new mines away from areas of current mining activity. It is distinguished from exploration in close proximity to known mineral producing areas which is commonly referred to as “brownfields”.

Greenfields exploration is naturally a higher risk activity than brownfields exploration because in the latter case the mineral endowment of the area has already been established. It is the essential first step in the mining process and all brownfields locations were at one time greenfields discoveries. Another important aspect of greenfields exploration from the perspective of the investor is that it is a long-term business with persistence over periods of 5-10 years usually being a pre-requisite for success. Although the time frames are longer and the risks are higher, the rewards (and the long term impact on Australia's economy) are potentially much higher.

## **The Nature of Precious and Base Metals Exploration**

Exploration for precious and base metals is fundamentally different to exploration for bulk commodities such as coal or iron ore. Coal and iron ore deposits typically are closely associated with the strata in which they occur. This mode of occurrence and the ability to interpolate the likely location of prospective stratigraphic horizons over many kilometres distance is unique to the bulk commodities. In addition, coal and, particularly iron ore deposits typically occur close to the surface. The large extent, high-continuity and near-surface occurrence of these bulk commodity deposits means that their locations globally are generally well known. Exploration for bulk commodities therefore is generally not about discovering major new resources but rather improving the knowledge of key parameters associated with known resources.

The important distinction for precious and base metals deposits is that these metals were deposited well after the formation of the host rock sequence. Metals are transported from depth by metal rich fluids until they reach a location where changes in physical and chemical parameters result in deposition of the metal. When this process is efficient, it may form an economic ore deposit. By their nature, the location of deposits of precious and base metals cannot be predicted by simple extrapolation of the stratigraphic sequence. Instead, they are typified by localised controls and a relatively small “footprint”. Therefore, exploration for precious and base metals is consequently higher-risk and the outcomes less predictable than exploration for the bulk commodities and this is clearly demonstrated by respective discovery success rates for these two groups of natural resources.

In precious and base metals, the initial resource discovery stage is a far more significant step towards a wealth-generating asset than it is for the case of bulk commodities where many other factors (eg infrastructure) are extremely important.

## **The Threat to Sustainability of the Australian Metal Mining Industry**

The core thesis of this submission is that, unless the Government takes action, Australia’s gold and base metals mining industries are not sustainable in the longer term. While the industry will continue to grow in the short-to-medium-term by increasing production from existing mines and exploiting currently known but undeveloped deposits, it is argued that neither route is sufficient to maintain our industry in the longer term. In particular, Australia’s known inventory of undeveloped deposits, while large, are of mediocre quality and that the current number of new high quality deposits being found through greenfields exploration is too low to sustain the gold and base metals industries into the future.

These issues are discussed in more detail below.

### **Australia's mining industry is living off past discoveries**

Current mine production is largely from maturing mines that have mostly been discovered more than 20 years ago. In general, these mines are becoming deeper and production rates are likely to fall over time (the one important exception to this is the Olympic Dam deposit, which although discovered in 1975 has not yet been developed to its full potential).

According to Surbiton Associates Australian Gold Quarterly Review for the December Quarter 2009, the top 6 gold producers for 2009 were:

<b>Operation</b>	<b>Ounces Produced</b>	<b>Discovered</b>	<b>Years Since Discovery</b>
Super Pit JV	688,000	1893	117
Telfer	674,445	1972	38
Cadia / Ridgeway	437,910	1992	18
St Ives	414,590	1980	30
Jundee	411,000	1992	18
Sunrise Dam	401,112	1993	17

Excluding the Super Pit (discovered 117 years ago), the average age of operations since discovery of the remaining top 5 producers is over 24 years. Notwithstanding the recent re-commissioning of the Boddington gold deposit (itself first discovered in 1979), expected to be Australia's largest single gold producer, the majority of Tier 1 Australian gold producing assets would be considered mature operations. The other major deposit in terms of gold resources (as a byproduct to copper and uranium production) is Olympic Dam, however the operation only produces some 100,000 ounces of gold per year and is not yet a meaningful gold producer.

The maturity issue is much more pronounced in the Tier 2 Australian Gold producers (from Surbiton Associates) including:

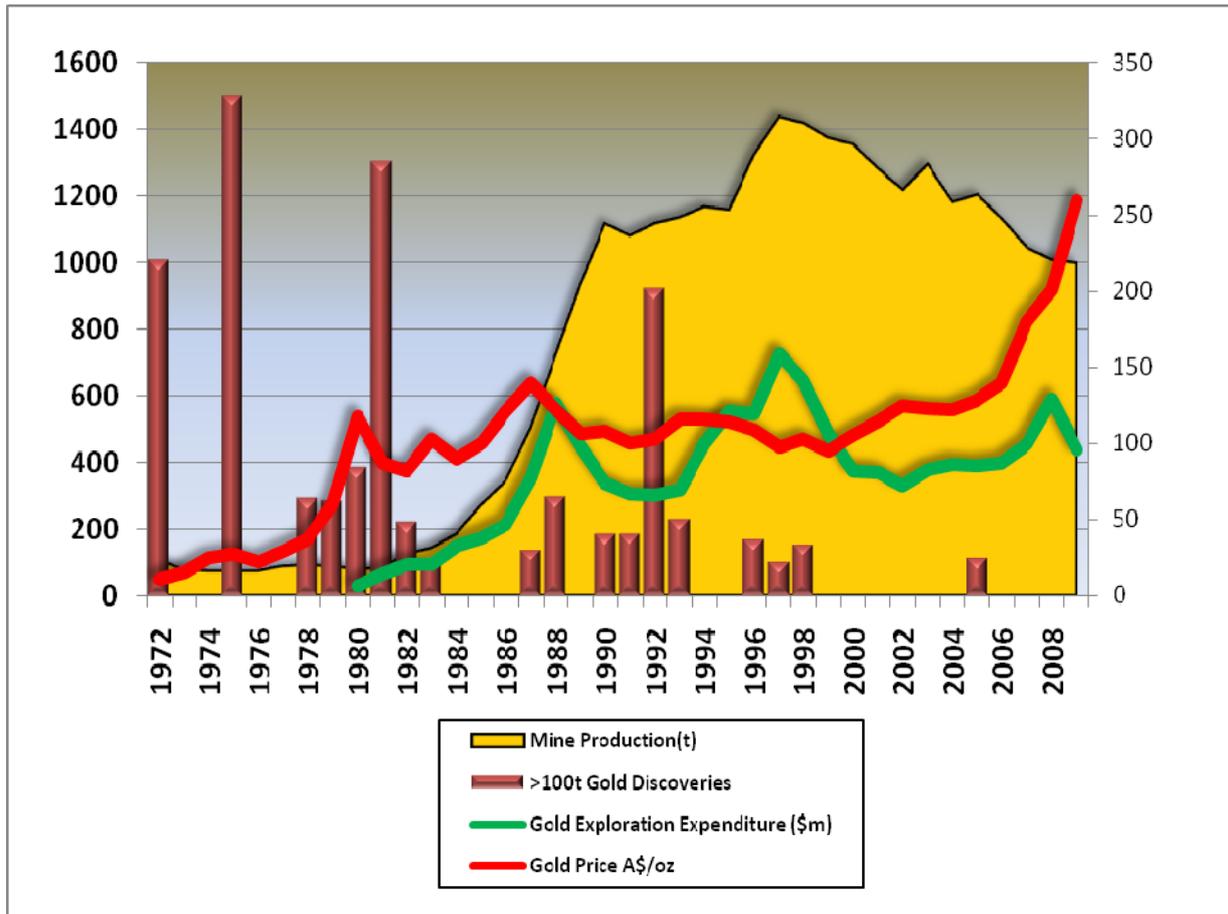
<b>Operation</b>	<b>Ounces Produced</b>	<b>Discovered</b>	<b>Years Since Discovery</b>
Yilgarn South Ops*	353,000	1979	31
Callie	298,000	1991	19
Kanowna Belle	284,000	1990	20
Cowal	232,000	1992	18
Agnew	187,486	1984	26
Higginsville	182,456	2004	6
Plutonic	143,000	1988	22
Marvel Loch	142,301	1906	104
Paddington	135,325	1982	28
Ravenswood	135,011	Early 1900's	~100

*\*Yilgarn South Ops includes the Granny Smith, Lawlers and Darlot gold mines – all mature.*

With the exception of Cowal and Higginsville operations, the other Tier 2 Australian gold operations must be considered in the latter stages of their mine lives and would be expected to mostly cease production within the next 5 years without significant near-mine exploration success or a sustained large real increase in gold price beyond current levels.

As can be seen in Figure 2, the frequency of major (+100t) gold discoveries over the past 40 years is heavily skewed to the period between 1978 and 1993. Although the gold price increased significantly at the beginning of this period, the primary reason of discovery success related to technological innovation. These innovations included the introduction of CIP processing technology, the introduction of cheaper drilling techniques, the introduction of low-level gold assay techniques and an improved understanding of weathering and regolith chemical processes. Collectively, these improvements produced a technology paradigm shift which resulted both in lower grade gold deposits becoming economic to mine and greatly improved exploration success rates. As a consequence, a ten-fold increase in Australian gold

production occurred, from 27 tonnes in 1982 to 314 tonnes in 1997. As previously stated, the discoveries made during these periods are now mature and the majority can be expected to close or materially reduce production in the next few years. Currently there is no apparent technology paradigm shift on the horizon that might halt the expected decay in Australia's gold production profile.



**Figure 2: Major Australian Gold Discoveries over the past 40 years compared with mine production, exploration expenditure (in dollars of the day) and gold price.**

The status of base metals production in Australia is at even greater risk of decline with production from 6 major deposits responsible for 86% of copper production, 93% of lead production, 69% of zinc production and 77% of silver production (Table 1; Figure 3). With the exception of Olympic Dam, which contributed only 20% of Australia's 2009 copper production, the rest are mature mines. Broken Hill was discovered in 1885 and Mt Isa in 1924. The other 5

base metal (plus silver) mines are pivotal to Australia’s current production and export earnings, yet they are near the end of their productive lives. For example, the Century mine, the world’s largest zinc mine and producer of 35% of Australia’s zinc output, has only 5 years of Ore Reserves yet to be mined.

	Australia	Mt Isa	Broken Hill	Canning ton	Century	Ernest Henry	Olympic Dam	Other	Major Deposits Combined
Copper production (kt)	889	470	-	-	-	115	180	124	765
Percent		53%				13%	20%	14%	86%
Lead production (kt)	596	170	50	334	-	-	-	42	554
Percent		29%	8%	56%				7%	93%
Zinc production (kt)	1,411	300	55	122	500	-	-	434	977
Percent		21%	4%	9%	35%			31%	69%
Silver (t)	1,785	336	50	964	-	-	29	406	1,379
Percent		19%	3%	54%			2%	23%	77%

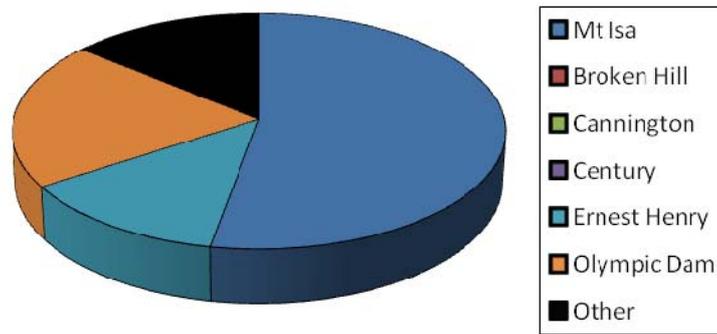
**Table 1: Australia’s major base metals mine production**

Although one would expect rising commodity prices to stimulate new capacity onto the market, this is not necessarily the case for the Australian mining industry. Instead, history shows that there is a poor correlation between prices and production for gold, copper or nickel in Australia (see Figures 5, 7 and 9). Clearly, other factors must be in-play.

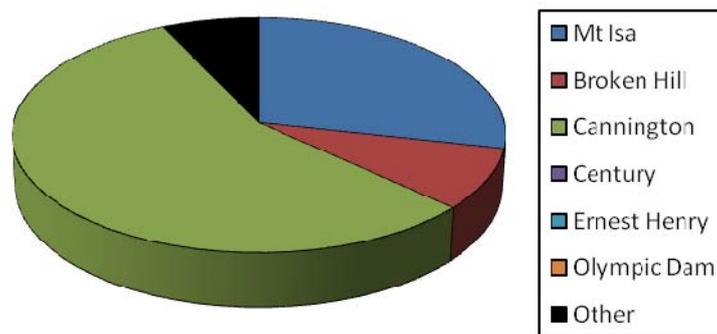
In the case of gold, Australia’s production peaked in 1997 and has been declining ever since – in spite of rising real prices (Figures 2, 4). In the case of copper, major price rises during the last decade were accompanied by only limited increases in physical production (Figure 7). In the case of nickel, the situation is much worse with very large price rises during the last few years being accompanied by stagnant and now declining production levels (Figure 9).

The fact that the Australian mining industry was unable to take full advantage of the recent spike in commodity prices (by producing more metal) clearly shows that the current mines were already operating at full capacity prior to this and more tellingly, there is not a ready inventory of quality new-term projects available for quick startup. As the existing mines mature, we can only expect Australia’s production to decline in the medium to longer term.

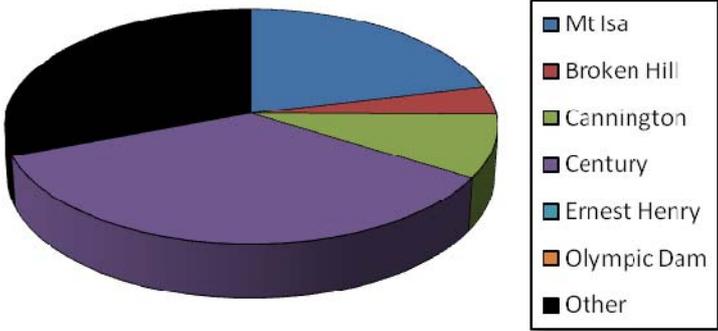
### Australia's 2009 Copper Production (889kt)



### Australia's 2009 Lead Production (596kt)



### Australia's 2009 Zinc Production (1,411kt)



### Australia's 2009 Silver Production (1,785t)

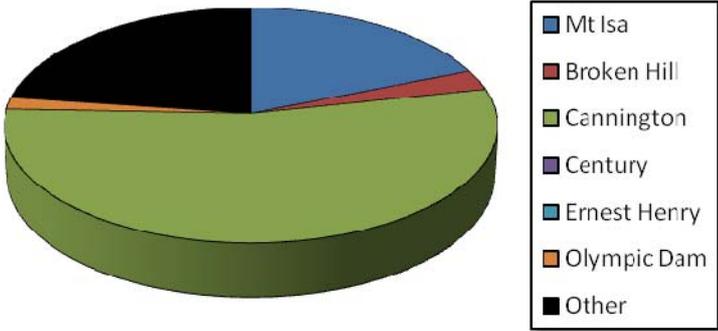


Figure 3: Summary of Australia's base metal and silver production in 2009 illustrating its concentration in a small number of major mines.

## **Australia's inventory of quality deposits isn't growing**

With regard to measuring the size of the resource inventory, Geoscience Australia (GA) has compiled several decades of statistics on Australia's Economic Demonstrated Resources (AEDRs) for all of the country's key commodities. These are defined in terms of known resources that are judged to be potentially economically viable to be extracted over the next 20 to 25 years. The data is sourced from company announcements to the ASX regarding new JORC-defined resources for their deposits. For deposits owned by private companies, GA contacted the companies directly for the resource data. For conservatism, the AEDRs exclude Inferred Resources, and (at GA's discretion) some of the Measured & Indicated Resources where it is perceived that the ore is sub-economic (source: Pers. Comm. with Mike Huleatt, November 2009).

Figures 4, 6 and 8 show the growth in Australia's Economic Demonstrated Resources for gold, copper and nickel over the last 30 years. In all cases the reported AEDRs have grown significantly. At face value this suggests that Australia's resource position is secure and that the industry is well-placed to grow over time. However, on closer analysis the real story for the general mining industry is different. In particular, much of the growth in AEDRs is associated with a just a handful of giant deposits. In the case of gold and copper (Figures 4 and 6) almost all of the recent growth<sup>1</sup> came from increased brownfield exploration proving up additional resources at Olympic Dam (first discovered in 1975). This means that the AEDR position for the rest of the industry has remained flat over the last decade. Consequently, while Olympic Dam has a long future, the same cannot be said for the rest of the companies operating in the gold and copper sectors. In addition, realising the full potential of this resource base is highly dependent on a decision for large-scale expansion at Olympic Dam. At the time of writing of this submission, the owners of BHP Billiton had not committed to that decision.

In the case of nickel (see Figure 8), much of the growth in the AEDR came from new nickel laterite deposits. While very large in size, recent history has shown that mining laterite deposits is at best a marginal proposition. Consequently, the viability of Australia's nickel industry lies with mining its sulphide deposits – of which the resource base has not materially grown in recent years.

On a more positive note, the huge impact of Olympic Dam on the overall AEDRs for copper and gold highlights the importance of grassroots exploration to Australia's national economy. It is only through such high risk / high reward exploration that the next generation of giant deposits will be found.

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<sup>1</sup> Caution: The reported MI&I resource and AEDR figures are not 100% comparable – as the latter excludes Inferred Resources. Even so, the general trends and conclusions still apply.

## The quality of Australia's inventory of undeveloped deposits is declining

The known undeveloped resource base, although large and growing, is mostly of poor (and progressively declining) quality. There are three main reasons for this:

- By definition, the undeveloped resource base reflects the progressive accumulation of all those resources ever defined but never deemed economic to mine. Therefore, because of this selective bias, as long as mineral exploration activity continues and there is some plausible possibility of eventual extraction, the defined resource base will tend to increase in size but decline in quality. To illustrate this point, when most mines close they usually still retain some resource inventory. Although such resources may be written off at that point in the current Geoscience Australia methodology for compiling the AEDRs, if a junior subsequently acquires the property they may be reported into the public domain again.
- An aspect of the compilation of AEDRs from ASX announcements by resources companies needs to be taken in context. In recent years the junior mining sector has become the dominant player in Australian mineral exploration. A decade ago there were some 200 resources companies listed on the ASX whereas there are now over 800. With the introduction of the JORC Code in 1989, each company has an incentive to report as much resources as possible, at the earliest opportunity they can be delineated, as market participants and analysts use these resources to calculate the underlying value of the company. This contrasts with the historical primary purpose of resource delineation (which still applies in major companies), which is to provide a timely framework for capital investment decisions and where there was little incentive to define resources beyond those requirements (as this would reduce project Net Present Value).
- The quality of new resources being discovered in both brownfields and greenfields is tending to decline as previously producing regions and exploration methodologies have become exhausted. This will be discussed in more detail below.

The JORC Code for reporting of Mineral Resources defines them as follows:

**“A ‘Mineral Resource’ is a concentration or occurrence of material of intrinsic economic interest in or on the Earth’s crust in such form, quality and quantity that there are *reasonable prospects for eventual economic extraction.*” *Emphasis added.***

It is important to note that the reporting of a resource as JORC compliant relates primarily to the confidence with that resource is known to exist rather than any statement of its true economic viability (ie quality). The JORC Code only states that to report a mineral resource there must be *reasonable prospects for eventual economic extraction\**. The definition of

reasonable and eventual are left to the discretion of the reporter. Another factor to note is that in recent years, higher commodity prices have encouraged companies to restate their reported resources using a lower cut-off grade. This has the effect of increasing the size of the apparent resource base with no additional drilling or discovery.

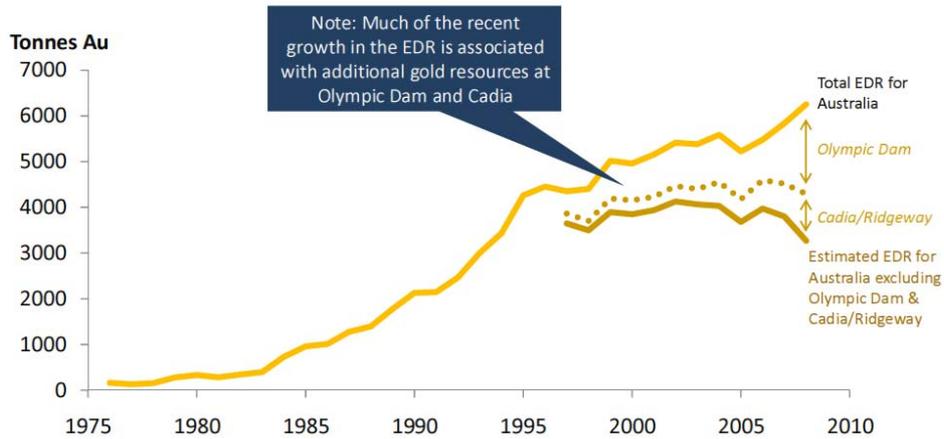
*\* (Note to ASIC: The authors do not imply any criticism of the JORC Code and consider the Code the premier reporting standard for Exploration Results, Mineral Resources and Ore Reserves. While not as prescriptive as the Canadian NI 43-101, the JORC Code is competency based and has served Australian investors well – the highly prescriptive NI 43-101 has not prevented outright fraud as was recently the case for TSX-listed Southwest Resources.)*

Significantly, the JORC Code does not specify that the Mineral Resource being reported needs to, in its own right, justify the capital investment required for development. In practice, a professional judgment is made by the Competent Person, based on grade and mineralisation continuity, that it could be economically mined at some time in the future. Often Mineral Resources are 'stranded' in that they cannot alone justify the capital cost of infrastructure for exploitation without additional discovery in the area creating "critical mass". The irony is that in order to realise the potential value of much of the AEDRs, additional discovery is a prerequisite.

One high-level method of testing the above assertion that the known resource base is poor quality is to compare the growth in AEDRs with production data for each commodity.

As illustrated by Figures 5, 7 and 9 below, it is clear that sustained large rises in the AEDR inventory for gold, copper and nickel have *not* translated into significant rises in production levels. For example in the case of nickel, the AEDR inventory increased by more than a factor of 4 during the period 1995-2000 but nickel production in the subsequent period (2000-2008) remained essentially flat. As stated before, over 60% of the nickel AEDR is now associated with nickel laterite deposits – but production from such deposits has flat-lined at 35,000 tonnes per annum, which is less than 25% of total nickel production.

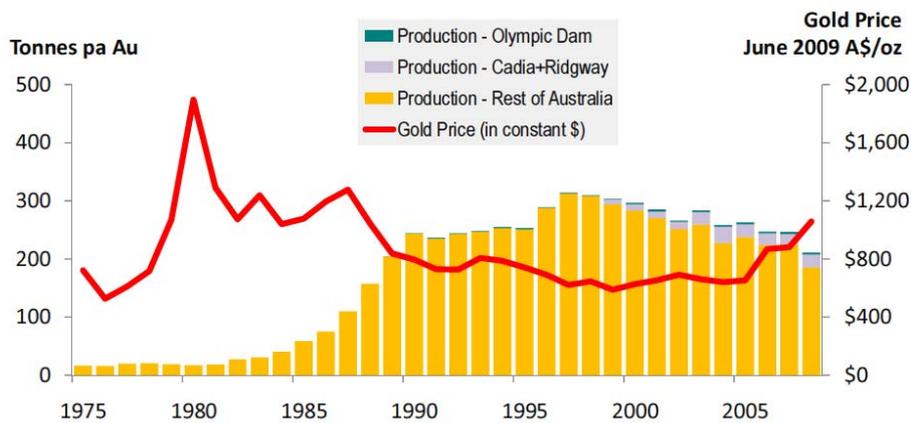
Given the strong economic imperative of increasing metal prices over the last decade, the only logical conclusion from this data is that the majority of AEDRs are in fact uneconomic, and probably by a considerable margin!



Note: The EDRs for Olympic Dam and Cadia/Ridgeway are based on reported P&P Reserves + Measured & Indicated Resources

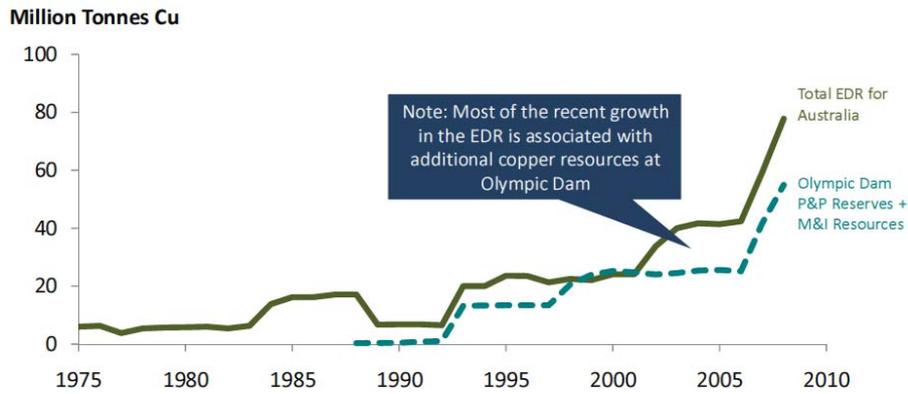
Sources: Geoscience Australia  
BHP Billiton, WMC and  
Newcrest Annual Reports

Figure 4: Australia's Economic Demonstrated Resources for Gold over the period 1975-2008.



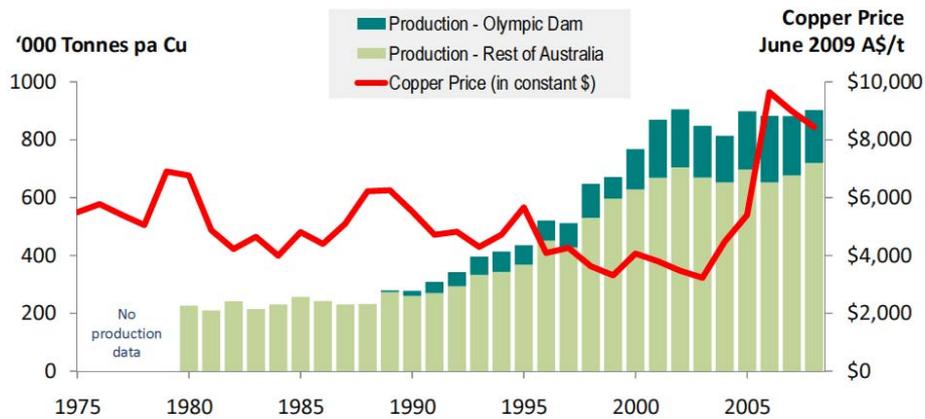
Sources: Geoscience Australia, Macquarie  
BHP Billiton, WMC and  
Newcrest Annual Reports

Figure 5: Australia's gold price and annual production over the period 1988-2008.



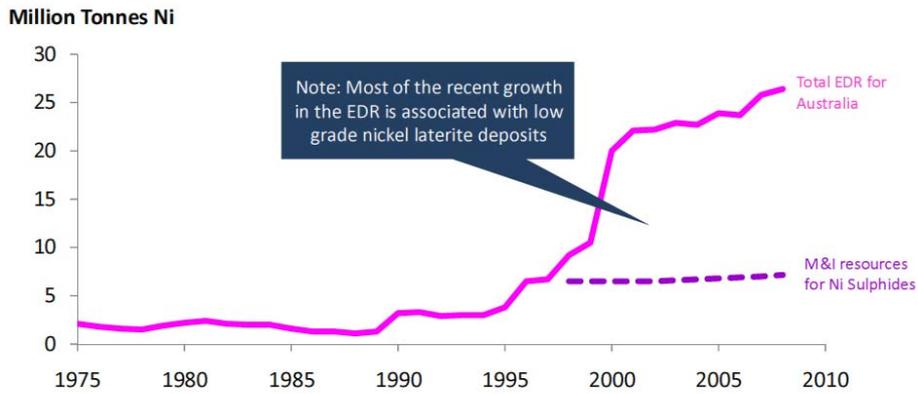
Sources: Geoscience Australia  
BHP Billiton and WMC Annual Reports

**Figure 6: Australia's Economic Demonstrated Resources for Copper over the period 1975-2008.**



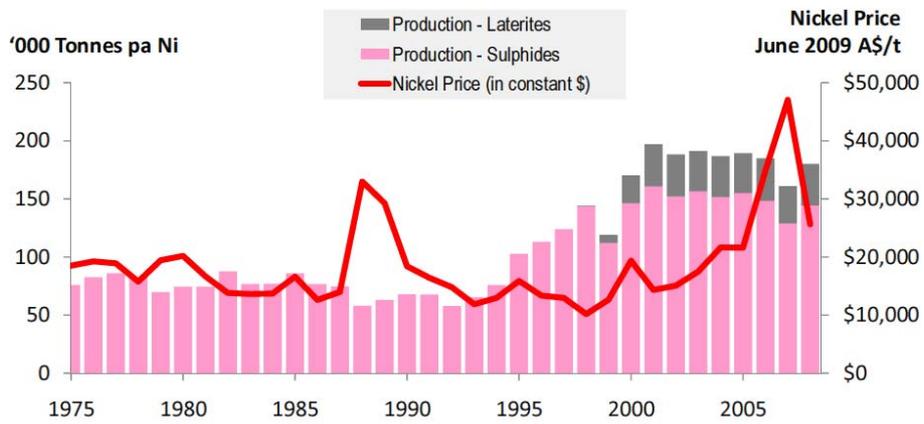
Sources: Geoscience Australia , USGS  
BHP Billiton and WMC Annual Reports

**Figure 7: Australia's Copper price and annual production over the period 1975-2008.**



Sources: Geoscience Australia, MinEx Consulting

Figure 8: Australia’s Economic Demonstrated Resources for Nickel over the period 1975-2008.



Sources: Geoscience Australia , ABARE Company Annual Reports

Figure 9: Australia’s Nickel price and annual production over the period 1992-2008.

## Declining Greenfields Investment and Success Rates

There have been two important trends in Australian greenfields exploration, that left unchecked, will have major negative consequences for the sustainability of the Australian metal mining industry:

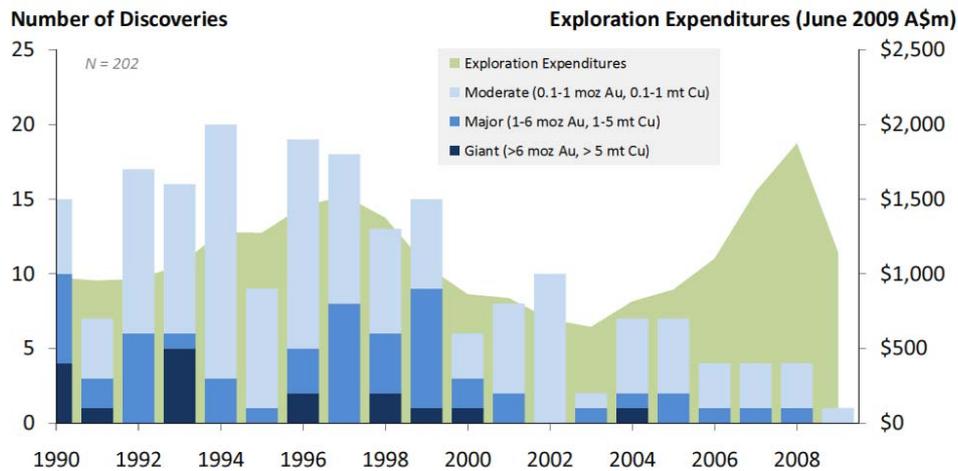
- A general decline in the success rates of greenfields exploration as measured by the amount of in-situ metal resources discovered per dollar invested and the quality of these resources.
- A general decline in the relative and absolute amounts of investment in Australian greenfields exploration.

A number of previous studies have concluded that greenfields success rates (both Australian and worldwide) have declined significantly over the last few decades. Data compiled as part of this submission has confirmed this trend (see Figures 10 and 11 below).

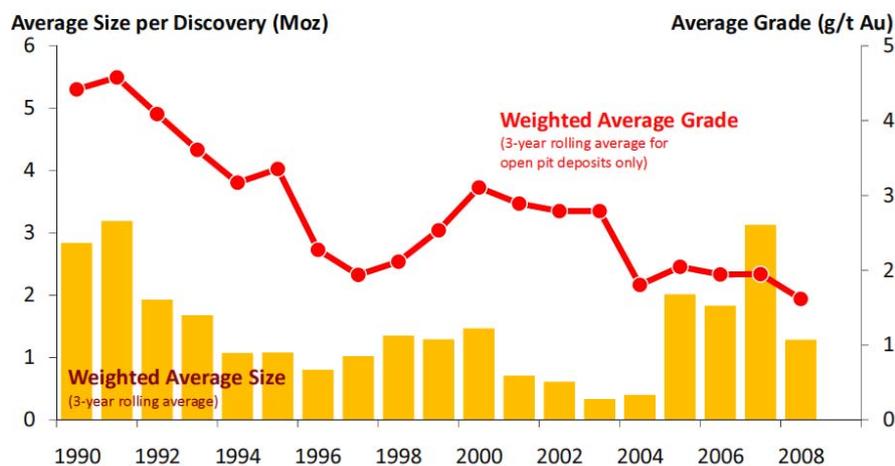
Since 1990 over 202 significant gold and base metal deposits have been found in Australia. However, as can be seen in Figure 10, most of these were found in the early part of this period. In spite of higher exploration expenditures in recent years the rate of discovery has dropped precipitously.

Not only are fewer deposits being found, but the average size and quality (as measured in terms of head grade for gold deposits) has declined over this period (see Figure 11).

The general reason postulated to explain the global-scale decline in discovery performance is that very few major near-surface mineral deposits remain to be found (at least in low-risk jurisdictions) and that the exploration currently lacks the technology and/or skills to cost-effectively explore for buried deposits that are “blind” to surface expression. In this context, Australia is perceived to be a “mature” country for exploration and many companies (particularly the majors which are more internationally focused) have redirected their exploration efforts to “easier” locations offshore.



**Figure 10: Exploration expenditures versus the number of significant gold and base metal deposits found in Australia (for period 1990-2009).**



**Figure 11: Declining average grade of Australian greenfields gold exploration discoveries.**

Figure 12 shows that much of our past exploration successes in Australia have occurred in areas of outcrop or shallow cover. Notwithstanding this, in short-to-medium-term there still remain large tracts of Australia (in the remote areas of Western Australia, Northern Territory and South

Australia) which are still ripe for grassroots exploration. In the longer term, as new tools are developed to effectively explore under deep cover, additional large areas of Australia will become prospective for grassroots exploration. On this basis, the authors view that Australia clearly has the potential to regain its pre-eminent position as country to find major new deposits. The Government can play a key role in making this happen more quickly.

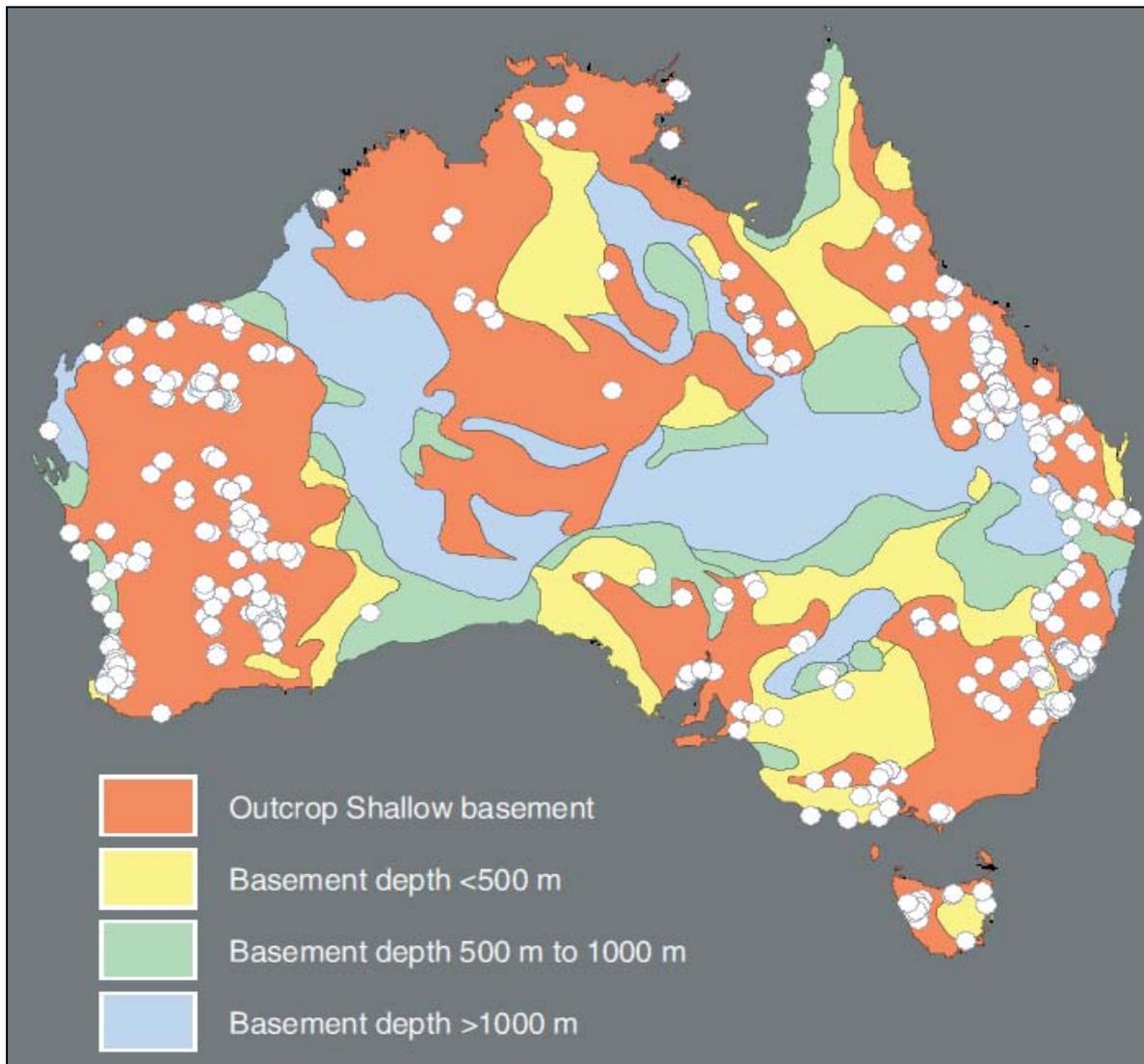


Figure 12: Depth to basement for known deposits and current operating mines in Australia (source: Geoscience Australia 2009).

With regard to the depth of cover issue, the authors view is that mineral exploration industry is currently going through a transition similar to that which the international petroleum industry successfully went through about a century ago. Based on the petroleum industry analogue, it seems reasonable to forecast that, given the appropriate level of investment in innovation, the minerals industry will in the future develop cost-effective undercover exploration capabilities that reverse this declining performance trend.

The recent action by the Government and industry to set up a new Cooperative Research Centre focused on Deep Exploration Technologies (CRC-DET) should be commended. The CRC has attracted \$28M in funding from the Federal Government plus \$70M from industry partners, and is sure to lead to a suite of effective search tools and techniques.

However, by itself the technologies developed by the CRC-DET will not be a magic bullet that will solve Australia's resource issues. For the industry to be sustainable in the longer term, companies have to *actively use* these and other tools to explore in new greenfield terrains. Clearly, the Government has a key role to play in encouraging companies to take longer term higher risk (but higher reward) exploration outside established areas. The potential magnitude of the prize (of finding say another Olympic Dam, Golden Mile or Mt Isa) is of great national importance.

The impact of technology is not limited to developing new exploration search tools. New low cost mining and processing methods are equally important in opening up new areas for exploration success.

In recent decades, a driver for all major commodities has been the increasing economies of scale for bulk open pit mining. This has allowed the discovery and exploitation of large low-grade resources that would previously have been considered uneconomic. However, this trend appears to have now largely run its course and it seems unlikely that any imminent technological developments will result in a step change in economically minable grade for any of the major metallic commodities.

Another very important technological development specific to the Australian gold industry was the application of Carbon-in-Pulp (CIP) gold processing, which allowed previously untreatable oxide gold resources to be mined profitably. The advent of such technological discontinuities typically results in a rapid wave of exploration success as those deposits amenable to the new technology are quickly found. However, after this first phase the discovery rate inevitably declines because there are fewer deposits remaining to be found. In the case of Australian gold exploration, it is clear that there was a major wave of new discoveries in the 1980s and early 1990s relating to the advent of CIP technology (together with advances in understanding gold dispersion in the regolith) but that this period is now over.

## Factors behind the general decline in greenfields exploration

Over the last decade there has been a significant shift in exploration activities from grassroots to mine site exploration (as evidenced in Figure 13 by the reduction in off-production lease expenditures<sup>2</sup>).

As shown in Figures 14 and 15, a similar shift is evidenced in the annual survey data collected by the Metals Economics Group (a leading consulting firm based out of Halifax, Canada). When interpreting this data, it should be noted that a large proportion of the exploration reported by MEG as “grassroots” carried out by the junior companies is actually directed to incremental targets in known mineralised areas, so in practice is essentially brownfields (ie this work has little chance of leading to a major new world class discovery such as Olympic Dam). Consequently, the level of effort focused on greenfields exploration to find large new deposits in Australia has significantly declined.

A number of reasons are postulated for this trend:

- An increasing perception, driven by the declining success rates discussed above, that Australia is a relatively mature environment for mineral exploration and that there is a better chance of success elsewhere in the world (particularly in higher political risk jurisdictions) where it may still be possible to find near-surface deposits.
- A perception (particularly amongst the majors) that globally a large inventory of known deposits existed available for development, particularly in an environment of higher metal prices. This perception has been driven by the global rise of liberal capitalism that followed the end of the Cold War in the early 1990s. This resulted in the opening up to mining development of many countries that were previously off limits to foreign-owned mining. As discussed above however, it now appears that both globally and in Australia the remaining inventory of available deposits is relatively poor quality (and expensive for a third party to acquire).
- An increasingly short term focus in the major mining companies, incompatible with the long lead times of greenfields exploration. This focus has been largely driven by increasing market expectations of short-term high returns. In this environment it will always be tempting to make short-term acquisitions of available resources of questionable quality rather than commit to a highly uncertain long-term program to discover new deposits. Additionally, for major companies, the likelihood of a greenfields discovery of a major deposit (say in the top 10% of deposits globally) which will satisfy

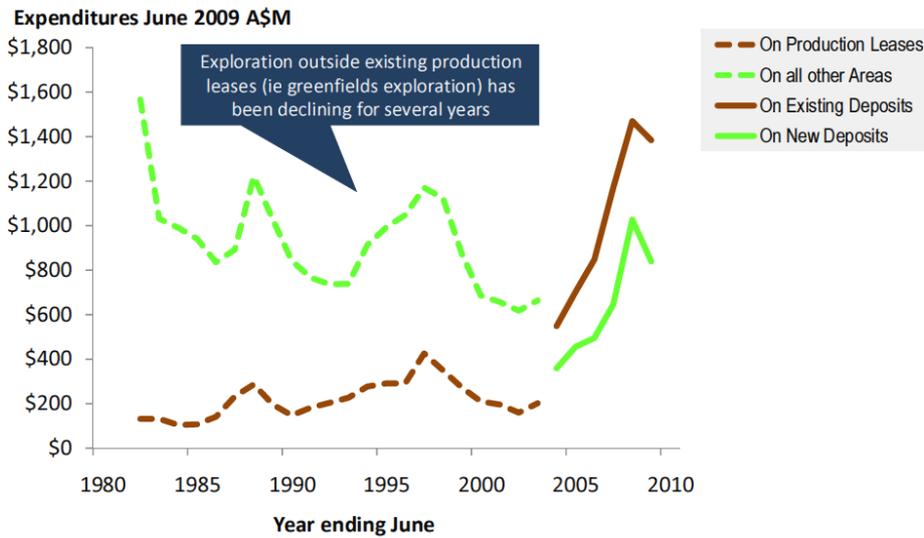
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<sup>2</sup> Although the ABS changed its survey methodology in 2004 from “on/off” production lease to “existing/new” deposits, the general trend away from greenfields exploration is evident in the data.

corporate hurdles for scale, minelife and production cost is remote. Figure 16 illustrates how the relative proportion of exploration expenditure committed to greenfields by major companies exploring in Australia has halved since 2003.

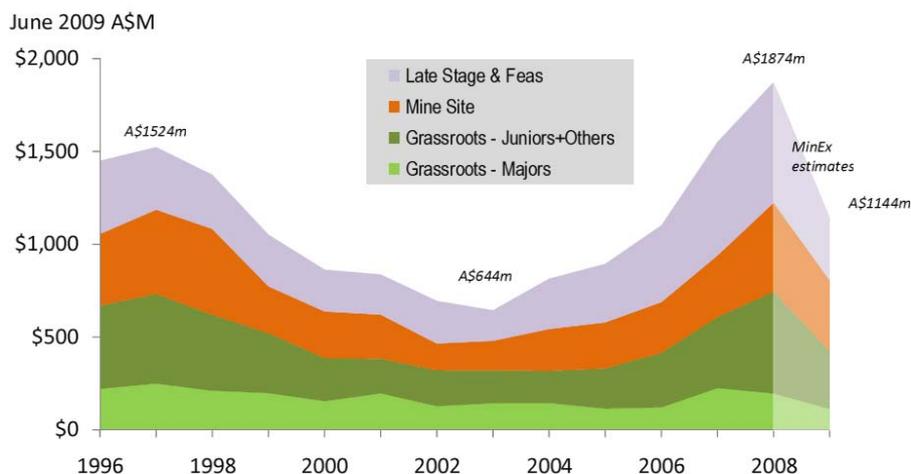
- Interestingly, there has also been a perception amongst the senior management of major mining companies that the increasing participation of the junior sector in exploration (see Figure 17) would relieve them of the need to fund greenfields exploration themselves, as the juniors would find the new deposits and they (the majors) would then acquire them. Evidence of this can be seen in the type of exploration projects held by major companies. As shown in Figure 18, over half of all exploration projects involve the major joint venturing into a discovery or project held by a junior company. However, as discussed below, an increase in participation of the junior sector has in fact correlated with a reduction in the relative level of greenfields expenditure.
- An increasing consolidation of the mining industry to form fewer, much larger companies. Consolidation impacts on the quanta of greenfields investment in two ways. Firstly, the inevitable consequence of almost all major corporate mergers has been the disappearance of the exploration budget of the company that was taken over. Exploration expenditure is usually considered a corporate overhead in this context and the reduction in spending relative to the premerger situation an example of the merger “synergies” which in part are generally used to justify the consolidation. The other impact of mining industry consolidation is that as companies become larger the immediate impact of even a major mineral discovery on the valuation of the enterprise is relatively quite small. For example, if a major mining company with a market capitalisation of about \$100 billion discovers a world class deposit, which may have a Net Present Value of about \$1 billion, it has added less to the total enterprise value than the value impacted by the fluctuation of the share price on many trading days. As a result, mineral exploration, particularly greenfields, becomes significantly less strategically important to senior management in these large organisations. This contrasts with medium-sized mining companies, for whom a major greenfields mineral discovery can have a very significant impact on corporate valuation.
- An increasing proportion of exploration expenditure is now carried out by the junior sector and therefore funded by the risk capital market (Figure 17). Companies in the junior sector, because of an absence of cash flow, are extremely sensitive to market perception which tends to be very short-term in nature. A recent survey of Australian junior exploration companies by one of the authors (Schodde) found that the median company currently only had 1.1 years of cash reserves (see Figure 19). The need to constantly raise fresh capital to survive forces these companies to deliver a constant

stream of “good news”. This often involves reporting “concrete” evidence of exploration success such as drill intersections or resource statements. The inevitable consequence of this tends to be a necessary focus on relatively well known, mature areas without the high-risk (but also high-reward) characteristics of greenfields exploration.



Source: ABS 8412.0

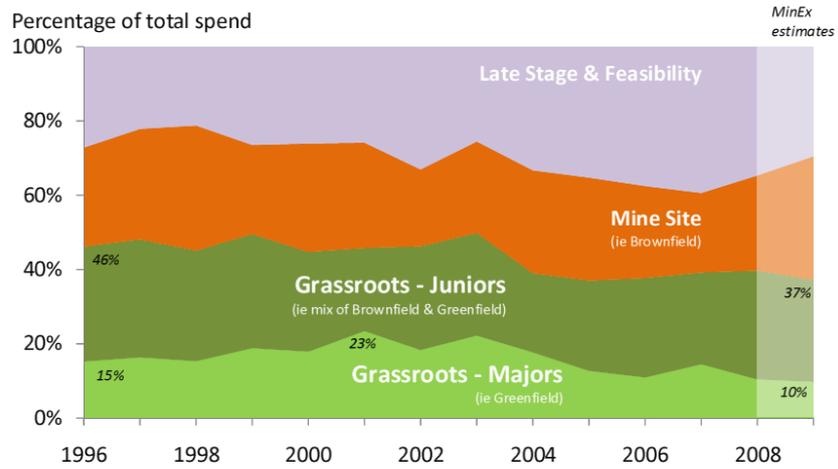
**Figure 13: Exploration expenditures by type of lease in Australia from 1982 to 2009.** *Caution: The Australian Bureau of Statistics changed its survey definitions in 2004 – so the trends between the two sets of data may not be fully comparable.*



Note: Excludes exploration on Bulk Minerals, Coal & Uranium

Source: Derived from MEG

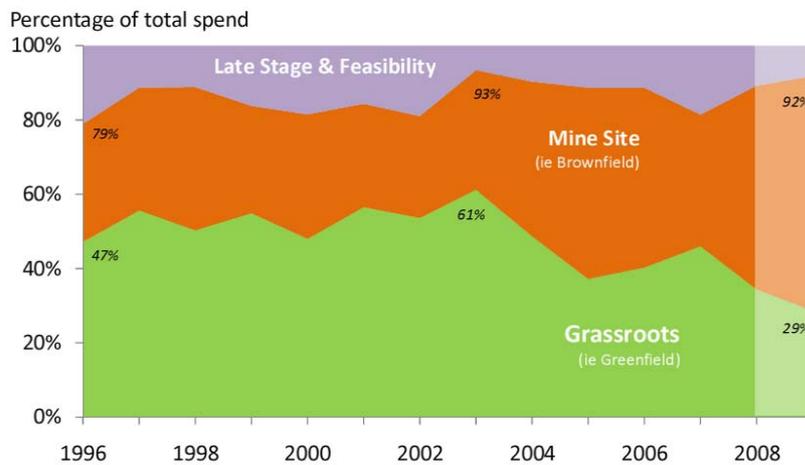
**Figure 14: Exploration expenditures by stage in Australia from 1996 to 2009.**



Note: Excludes exploration on Bulk Minerals, Coal & Uranium

Source: Derived from MEG

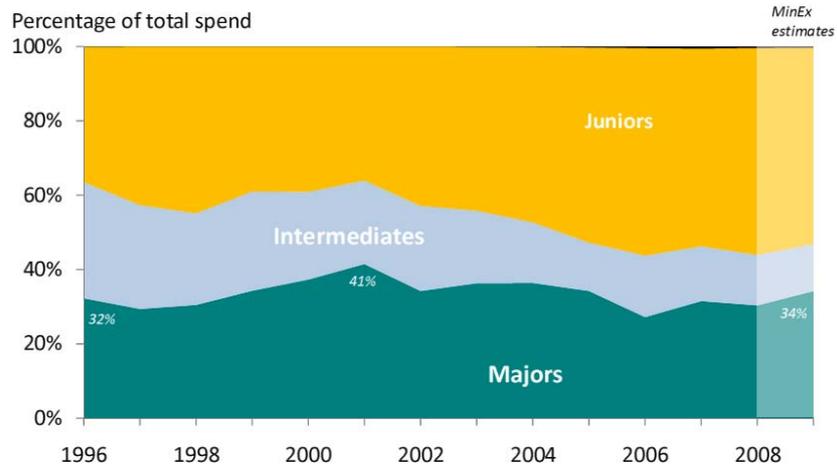
Figure 15: Percentage breakdown of exploration expenditures by stage in Australia from 1996 to 2009.



Note: Excludes exploration on Bulk Minerals & Uranium

Source: Derived from MEG

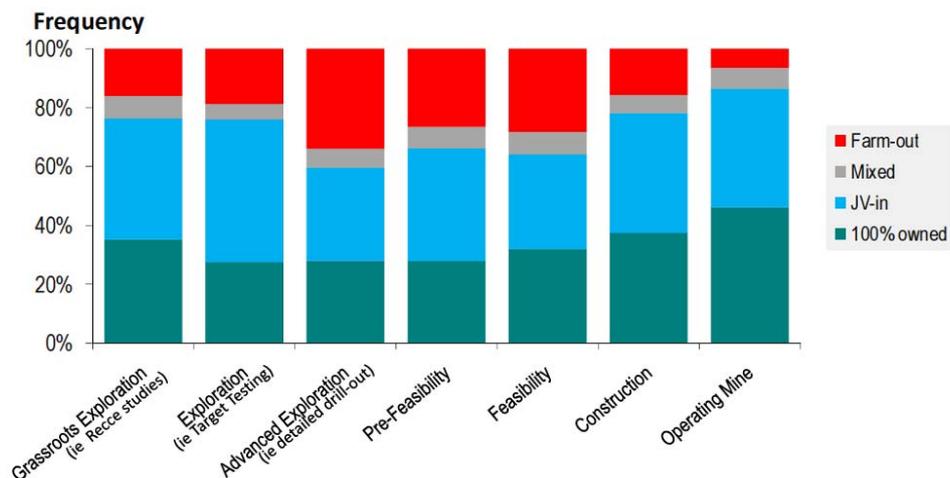
Figure 16: Trends in allocation of exploration expenditure for Major companies exploring in Australia.



Note: Excludes exploration on Bulk Minerals, Coal & Uranium

Source: Derived from MEG

**Figure 17: The junior sector comprises an increasing proportion of the total Australian exploration spend (now more than 50%).**



Note: Survey based on the projects held by 11 Major Companies

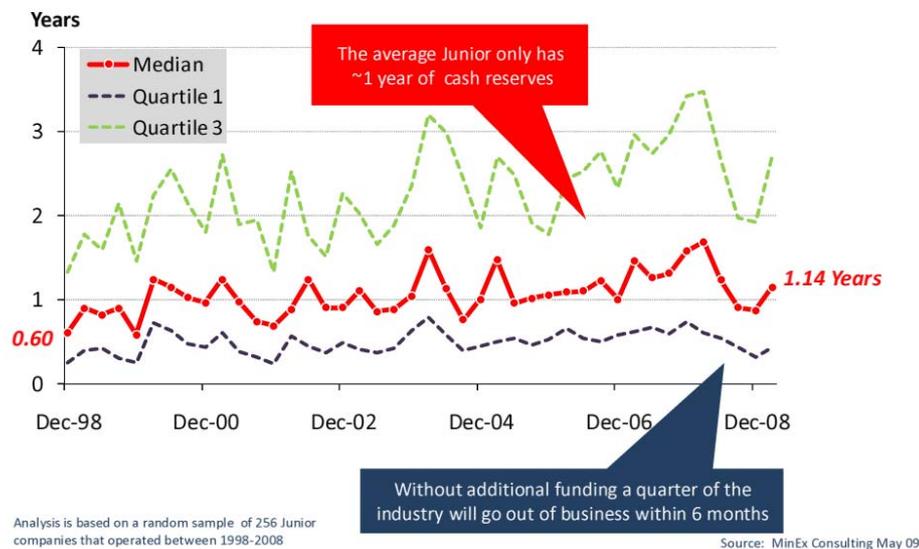
Includes projects outside Australia

"Mixed" refers to projects where company has 10-49% equity and has option to increase/sell down

"Farm-out" refers to projects where the company only retains a passive interest in the project

Source: MinEx Consulting Dec 08

**Figure 18: Percentage breakdown of the ownership terms for the portfolio of exploration and mining projects owned by a sample of 11 major mining companies in 2007. Caution: Includes overseas projects**



**Figure 19: The cash burn rate (in years) for Australian Junior mineral exploration companies.**

*Note: The cash burn rate was calculated by dividing the cash reserves by the current expenditure rate for each company.*

## The Case for Market Failure

The root cause of many of the trends that are contributing to insufficient investment in Australian greenfields exploration is the short-term focus of the capital markets. This short-term capital market focus impacts on both major and junior companies.

In the case of the majors, it is through pressure for them to deliver short-term growth options through acquisition of existing resources at the expense of a long-term investment in greenfields (which in a short-term perspective is seen as just a cost item affecting the bottom line). In many cases the existing resources acquired are of poor quality and therefore relatively high-risk investment options.

In the case of the juniors, the impact is felt though very strong pressure to deliver short-term “news-flow” with “concrete” results such as drill hole intersections and/or resource statements. Given the limited funding resources of most junior companies, this can usually only be achieved in mature areas with known mineralisation. In most cases, such areas of known mineralisation are only likely to be available to the junior company if they are also considered by the industry to be relatively poor quality and/or already largely depleted. Therefore, the ultimate net result in terms of mineral discovery tends to be relatively small, incremental new deposits at best and sub-economic resources at worst.

Realistically, a well considered and executed precious or base metals exploration program would have a gestation period of several years. This function was previously performed by a vibrant mid-tier of domestic producers. Typically, the mid-tier domestic producers would have had one or two operations providing strong cash flow which funded exploration programs both in regional proximity to the operations plus one or more substantial pure exploration projects. The stability of cash-flow provided the ability to invest in substantial exploration programs over the sustained periods required to make meaningful new discovery. With the elimination of the Australian mid-tier producers in the 1990's by a series of takeovers by North American and South African majors, this function within the precious metal and base metals sectors has disappeared. In its place, as discussed previously, the focus of the new owners was on brownfields exploration which results in incremental increases to local, operation scale Mineral Resources and Ore Reserves but is unlikely to result in significant new discovery.

The mantle of much of the grassroots exploration has fallen upon the junior exploration sector. However, the market dynamic for juniors is driven by the fact that there are large amounts of companies competing for the limited attention of those technical analysts that advise those making investment decisions. For these analysts, "concrete" results of the type discussed above provide a useful, readily-accessible "short-hand" for junior company valuations, despite the severe limitations of this approach discussed above. In contrast, greenfields exploration does not deliver a significant "news-flow", particularly in its earlier stages which can be years. Instead the greenfields exploration value proposition for an investor is a relatively complex narrative, the validity of which depends on a large number of contextual factors. It is also very difficult to quantify exploration potential (ie compared with metrics such as market capitalisation per unit of in-situ metal resource). Unless a junior company has a particularly strong profile and/or track record, it is unlikely to attract the attention of investors and their analysts to this complex grassroots exploration narrative.

In summary, a consequence of the short-term focus of the capital markets, and the increasingly large role that they are playing in funding Australian mineral exploration, is that mineral exploration investment is being allocated into less productive opportunities than might otherwise be the case. New greenfields discoveries are in the best long-term interests of all stakeholder groups; shareholders in junior companies, shareholders in major companies, the Australian nation and the global customers for Australia's mineral products. However the current incentive structure for mineral exploration discourages investment in the type of opportunities most important for long-term, sustainable wealth creation: greenfields exploration. This is a classic case of "market failure" where market forces result in an inefficient allocation of resources.

## Recommendations

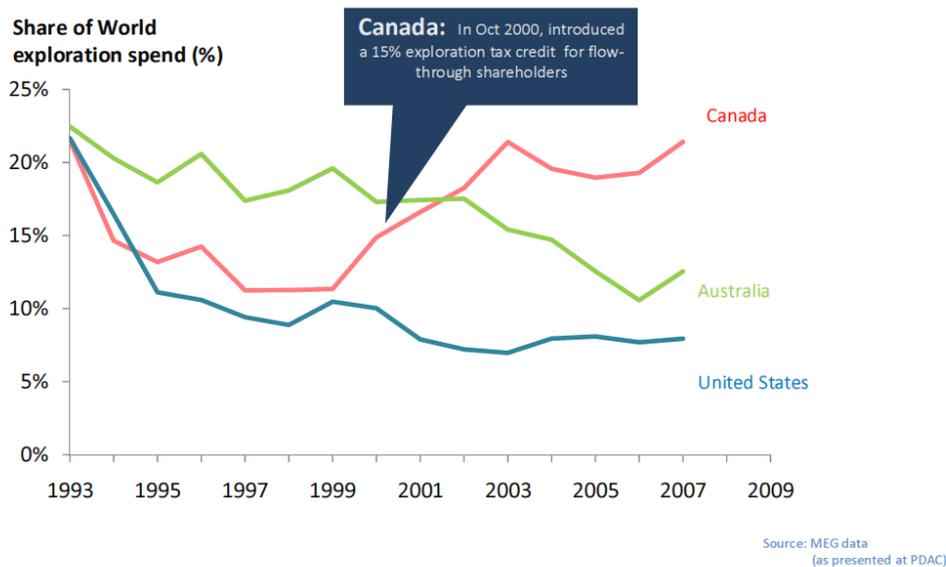
One of the critical roles of government policy is to mitigate the effect of market failures, particularly when they impact on areas of key strategic national interest. The current market failure relating to investment in Australian greenfields mineral exploration is a very clear example of such a situation. The Australian government now has the opportunity to change the incentive structure for investment in mineral exploration through fiscal reform.

The current fiscal structure actually discriminates against investment in exploration by companies that do not have producing mines. As demonstrated above, these now comprise about 50% of the total exploration expenditure in Australia. No tax concession is available to the investors in those companies for the investment they make in exploration unless the company eventually develops a producing mine, providing a cashflow against which accrued exploration investment can be amortised. However, mineral exploration, and in particular greenfields mineral exploration, is a high risk business with less than one in a hundred projects going on to become a significant mine. Therefore, the overwhelming majority of exploration expenditure by the junior sector does not attract any tax concession. In contrast, exploration expenditure by producing miners attracts a full tax concession. Given the dynamics in the mining industry discussed above, it is clear that the current fiscal structure is contributing to the inefficient allocation of resources in the Australian economy.

There is a major opportunity to encourage investment in greenfields exploration by junior companies by providing fiscal incentives. These fiscal benefits need to be structured in such a way that they “flow through” to the investors that put up the capital for these junior companies. Such tax concessions would be earned when the junior company carries out exploration expenditure and need to be passed to the investor on an annual basis. The model for such a scheme would be the concessions the Australian Government provides to support and foster the local film industry. Under Division 10BA of Part III of the Tax Act investors receive a 100% deduction for capital expenditure used to produce a ‘qualifying Australian film’.

If such incentives are introduced, it is very important that they effectively target investment in genuine greenfields exploration only. For example, in the case of the province of Quebec in Canada, which has such fiscal incentives, they are only available if the exploration activities are carried out north of the 59<sup>th</sup> parallel. These incentives are considered to have been highly successful in encouraging greenfields exploration in the remote parts of northern Quebec with several significant recent discoveries, including the 6 Million ounce Eleanor gold deposit. A more complex formulation would be required in an Australian context but this would still be readily achievable. As shown in Figure 20, the introduction of these incentive schemes has radically increased Canada’s market share of global exploration expenditures – relative to other perceived “mature” countries such as the United States and Australia.

It is also recommended that a working group comprising representatives from Geoscience Australia, the mining and exploration industry and other stakeholders be set up to assess ways that reporting of the national mineral resource endowment can be improved in order to provide a more meaningful input into public policy development.



**Figure 20: Government fiscal policy does have a material impact on exploration investment – the introduction of tax credits for exploration in Canada has been the primary driver for that country dramatically increasing its share of global exploration expenditure this decade.**

## Conclusion

The long term sustainability of the Australian base and precious metal mining industry (a critical sector in the Australian economy) is under threat because of a lack of significant new greenfields discoveries in the last two decades. This lack of greenfields success relates to a decline in levels of investment in greenfields exploration in Australia.

In turn, this decline in investment relates to the short-term imperatives of the capital market which has become a much more important factor in Australian exploration funding during the last decade. It is argued that this short-term focus of the capital markets and the behaviour it drives in both major and junior mining companies constitutes an example of market failure, where market forces are resulting in an allocation of resources that is not consistent with long-term wealth creation, both for shareholders and the nation.

It is one of the important roles of government to mitigate the effect of market failure when this impacts on areas of critical national significance (such as the Australian mining industry). An opportunity exists for the government to encourage investment in greenfields exploration through the introduction of appropriate targeted fiscal incentives.

## **About the Authors**

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Chris Cairns is a geologist with over 20 years experience in mining and mineral exploration working for large and small companies including BHP Billiton, Aurora Gold, LionOre, Sino Gold and is currently the Managing Director of Integra Mining. He has extensive mineral exploration, project feasibility and project development experience in Australia and South-East Asia. He is a Committee Member of the WA branch of the Australian Institute of Geoscientists and is a member of the JORC Committee.

### **Jon Hronsky**

Jon Hronsky is a geologist with over 26 years experience in the mineral exploration industry who has worked across both major and junior sectors and a wide range of mineral commodities. He is currently a Director of consulting group Western Mining Services and was previously Manager of Strategy and Project Generation for BHP Billiton's global mineral exploration group and prior to that, Chief Geoscientist for WMC Resources. He is also currently Chairman of the Board of the Centre for Exploration Targeting at the University of Western Australia and Curtin University of Technology, and a member of the National Executive of the Geological Society of Australia. He is an Adjunct Professor at the University of Western Australia and Macquarie University.

### **Richard Schodde**

Richard Schodde holds a Degree in Materials Engineering and an MBA. He has over 30 years experience in a wide variety of project analysis and strategic planning roles within the international resources industry – including 15 years at WMC (in their Business Development Group and as Strategic Planning Manager for the Exploration Division) and more recently, 4 years at BHP Billiton (as Minerals Economist in their Global Exploration Team). In 2008 Richard founded MinEx Consulting to provide strategic and economic advice to mining and exploration companies. In 2009 he was appointed an Adjunct Professor at the School of Earth Sciences at UWA and currently serves on the AusIMM and Melbourne Mining Club committees.