Discovery Performance of the Western World Gold Industry Over the Period 1985 - 2003

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ABSTRACT

This paper summarises the performance of the gold exploration industry in the Western World since 1970, with particular emphasis on the period 1985 - 2003. It identifies the number and size of major (ie >1 million ounce) primary gold discoveries made over this period by location and type of company. Estimation is also made of the likely contribution from smaller discoveries down to 0.1 million ounces.

It also assesses the overall trend in the percentage of grassroots discoveries that are converted into mines, and the time taken to get them into production.

By comparing the discovery data against total exploration expenditures it is possible to determine the average unit cost of finding a major gold deposit. It is significant to note that the average unit cost per discovery and per ounce of resource has tripled over the last 30 years.

An attempt is made to determine the overall economic value generated by the industry. This is based on a detailed analysis of the rates of return and the Net Present Values (NPVs) of 109 major gold projects. After including an adjustment for discoveries not modelled, the NPVs are compared against the total amount of money spent on exploration to determine the value-to-cost ratio for the industry.

Based on historical gold prices and tax rules, it is found that the return on investment for gold exploration in the Western World over the period 1985 - 2003 was around five per cent real after-tax. The returns achieved in the US and Australia were significantly higher than that for Canada. The returns also appear to have declined in recent years.

With regard to the relative performance of junior versus major companies, the paper estimates that the junior sector accounted for 30 - 40 per cent of the total exploration expenditure, and were associated with 34 per cent of the total number of major deposits, 27 per cent of the contained ounces and 25 per cent of the economic value found.

INTRODUCTION

In all business endeavours a fundamental question asked by management is ‘does this investment make money?’ In the case of mineral exploration this is a particularly challenging and vexed question because of the long lead times, the infrequency of discovery, and the uncertainty over the final size and likely value of the prize.

One way to overcome these difficulties is to look at the overall performance of the industry – with the view of using the data as a benchmark for setting targets for the company.


To this end, the following paper identifies how much money was spent on grassroots gold exploration in the Western World over the last three decades and how many major (defined as >11 million ounce) gold deposits were found. It also attempts to determine the value of these discoveries to arrive at an estimate for the overall return on money spent.

The current analysis excludes any additional gold found at existing mines, and ignores any byproduct gold credits associated with base metal discoveries.

TRENDS IN EXPLORATION EXPENDITURES

Industry level

Figure 1 shows the trends in exploration expenditures in the Western World between 1970 and 2003. The data is derived from the annual surveys compiled by the Metals Economics Group (1992 to 2003) and from work by Mackenzie and Doggett (1992 and 1995). The split between grassroots exploration, advanced exploration and feasibility studies, and mine site exploration for the years prior to 1992 are the author’s estimates.

All up, $37.8 billion was spent by private industry on gold exploration between 1985 and 2003. Approximately $28.6 billion of this was on grassroots and advanced exploration. The former refers to money spent on finding the deposit outside existing mining operations and the latter refers to amount spent on delineating an economic resource and carrying out feasibility studies up to the point where an investment decision can be made. Given that the two activities are associated with the same discovery, the author has combined the two costs together to arrive at the overall cost of making a grassroots discovery. Together, these two activities account for three-quarters of all the money spent on gold exploration.

In practice, the reported resource figure often continues to grow after the mine has started up. Consequently, some of the $7.8 billion spent on minesite exploration should also be assigned back to the original grassroots discovery cost. To keep the analysis simple, the author has excluded this cost.

Country level

Figure 2 shows where the exploration expenditures were incurred. Prior to the early 1980s, much of it went into just three countries – Australia, Canada and the United States – all of which have a long history of gold mining. In recent years, there has been a significant shift in efforts towards grassroots gold exploration in developing countries within Latin America and Africa.

Company sector level

Of interest is the split in exploration expenditures between major and junior companies. Unfortunately, only limited data is available.

An analysis of data from Bouchard (2003), over the period 1985 - 2002, indicated that 36.5 per cent of all exploration expenditures in Canada was associated with junior companies.

With regard to Australia, a recent study by Maritz (2003) estimated that between 1994/1995 and 2001/2002, junior companies spent a total of $A 2125 million on mineral exploration for all commodities, compared with a total of $A 6907 million spent by the entire industry. This suggests that...
the juniors accounted for 31 per cent of total expenditures in Australia. However, it should be noted that Maritz’s definition of a junior is broader than the author’s. In detail, Maritz defined a junior as any mining company with a market capitalisation of less than $A 200 million. On the other hand, Maritz’s data includes minesite exploration – which, if excluded, would boost the share assigned to the junior sector for grassroots exploration.

Finally, a study of the exploration performance of the international mining industry by the Metals Economics Group (2000) estimated that, between 1989 - 1998, junior and intermediate companies accounted for 37 per cent of the total exploration expenditures in the Western World. These numbers included minesite exploration. In a more recent study by the Metals Economics Group (2004), they estimated that, between 1997 and 2003, junior companies spent a total of $3948 million (in dollars of the day) on all forms of gold exploration. Given that, over the same period, the entire industry spent $8942 million on gold exploration, implies that the junior companies accounted for 44 per cent of total expenditures.

Unfortunately, none of the data sources provide a breakdown of grassroots gold exploration by industry sector over the study period.

Given the above, it is estimated that the junior sector accounted for approximately 30 to 40 per cent of the total industry expenditures on grassroots gold exploration over the period 1985 - 2003.

**NUMBER OF GOLD DEPOSITS DISCOVERED BETWEEN 1985 - 2003**

Over the last decade, WMC has built up a comprehensive database on geological information on nearly 112,000 mineral occurrences around the world. This includes discovery data on over 2500 primary gold deposits. This includes 354 grassroots deposits with a pre-mined resource greater than 100 koz and were found in the Western World between 1985 and 2003. The cumulative size-frequency curve for these deposits is plotted in Figure 3.

It should be acknowledged that no geological database is 100 per cent complete. Notwithstanding this, every effort has been made to capture as many as possible of the large economic deposits. Figure 3 shows that the shape of cumulative-frequency curve rolls-over below 1 Moz. Industry experience is that the size distribution of mineral deposits follows a lognormal distribution. Consequently, the overall number of small-sized discoveries was
estimated by extrapolating the curve below the 1 Moz threshold. On this basis, it is estimated that approximately 1000 primary gold deposits (greater than 100 koz) were found in the Western World over the study period. These contain 1127 Moz of gold. Approximately 190 of these deposits were larger than 1 Moz.

Figure 3 also includes data on the number of deposits found in Australia, the United States and Canada. It is estimated that 200, 150 and 100 gold deposits (>100 koz) were respectively found in these three countries. They respectively contain 179, 206 and 61 Moz of gold.

The above numbers are consistent with studies done by other workers. In detail, Geoscience Australia (2002) identified 147 gold discoveries, rediscoveries and renewals in Australia since the 1960s. Hogan et al (2002) estimated that around 172 Moz of gold was found in Australia between 1984/1985 and 2001/2002. Cranstone (2002) identified that 103 Moz of gold was found in Canada between 1985 and 1990 – though 60 Moz of this was associated with porphyry and VMS base metal deposits.

The frequency of major gold discoveries per year is shown in Figure 4. On average, between 1985 and 2003, around ten deposits containing more than 1 Moz were found each year. Half of these deposits contained more than 3 Moz of gold.

**COST PER DISCOVERY**

All up, between 1985 and 2003 approximately 190 gold discoveries larger than 1 Moz were found in the Western World – this includes 172 identified deposits (see Figure 4) and 18 unknown deposits (as extrapolated from the cumulative frequency curve). Dividing this by the $28.6 billion spent on exploration implies an average finding cost of around $150 million per major discovery.

Figure 5 shows that the average cost per discovery has increased significantly over time – especially in the last five years. The latter may due to the time delay in reporting and delineating a major discovery, resulting in under-estimation in the true number of discoveries. For this reason, the results for the most recent years of the survey period should be treated with caution.

With regard to the period 1985 - 2000, the average cost per known major discovery was three-times higher than that for 1970 - 1984 ($160 million versus $61 million). Not only did the average cost per discovery go up, but the weighted average size of each discovery made shrank from 7.2 to 5.0 Moz.
Cost per Major Discovery (US$\text{m in 2002}$)

![Diagram showing cost per major discovery over years]

**Fig 5 - Average cost per major discovery.**

Gold Discovered (moz pa)

![Diagram showing gold discovered over years]

**Fig 6 - Estimated amount of gold discovered.**

Cost (US$/\text{oz in 2002}$)

![Diagram showing cost per ounce of gold discovered over years]

**Fig 7 - Average cost per ounce of gold discovered.**
These results are consistent with studies by other workers. For example, Mackenzie and Doggett (1992) determined that the average historic cost of discovery of a gold deposit in Australia in 1969 - 1986 was $15 million in constant 1990 dollars, compared with average 1969 - 1988 costs of $24 million in Brazil and $96 million in Canada. After adjusting for inflation, these figures equate to around $21, $34 and $135 million in constant 2002 dollars for Australia, Brazil and Canada respectively. It should be noted that the Mackenzie and Doggett data included several deposits smaller than 1 Moz in size.

Figure 6 highlights the trend in the amount of gold discovered per year. All up, between 1985 and 2003 a total of 1127 Moz of gold is estimated to have been found in the Western World. Around 895 Moz of this is contained in deposits larger than 1 Moz. The average unit discovery cost for the period 1985 - 2000 is estimated to be around $25 per ounce (Figure 7). This is nearly four times the $7 per ounce cost calculated for the period 1970 - 1984.

CONVERSION RATES

From a business perspective, identifying the cost of discovery is only part of the story. To gain a complete picture of the industry’s overall performance one also needs to identify their value. A useful metric for this is the percentage of these discoveries that were ultimately converted into mines.

Figures 8 and 9 detail the status of 276 major gold discoveries made since 1970. It shows that most of the recent discoveries are still at the exploration or feasibility stage. This is not surprising given the long lead times involved in delineating the resource, evaluating the economics of the project and securing the necessary permits and finance to build the mine.

Figure 9 indicates that around 70 per cent of all major discoveries are eventually converted into mines. A further five to ten per cent of projects were stalled at the decision-to-build stage. This was due to a wide variety of reasons including environmental and social (Crown Jewel in USA), legal (Las Cristinas in Venezuela), political (Gold Ridge in the Solomon Islands) and economic issues (Metates in Mexico).
There is a general perception that it now takes longer to start up a mine than in the past, especially in developed countries. Analysis indicates that this is not the case. Figure 10 plots the discovery and mine start-up dates for 214 known grassroots deposits found in the period 1970 - 2003. It shows no change in the length of the delay over the last 30 years. Over this period it took 6.3 years for half of the mines to start production. Surprisingly, the delay was shorter in Australia, Canada and the United States than in other countries (5.4 versus 8.3 years). Notwithstanding this, some mines took more than 20 years to develop.

The two main variables considered were gold prices and tax rules.

Over the study period, the price of gold has fluctuated from a high (in real terms) of $765/oz in December 1987 to a low of $271/oz in February 2001. Consequently, the timing on when a project was developed has a huge impact on the value created.

Tax is also an important variable. As an example, in Australia, prior to 1990, gold producers did not pay corporate income tax. Between 1991 and 1999 the tax rate was 36 per cent, and is now currently set at 30 per cent. Furthermore, in 2001 the State Government of Western Australia introduced a 2.5 per cent royalty.

Three general cases were modelled. The first (called the Spot Price Case) involved using the actual historical gold price and tax rules prevailing at the time the mine operated. For any sales post-2004, it is assumed the future price remains fixed at $US 400/oz in real terms. This case sets a lower bound on the project’s value.

In practice, many producers took advantage of financial instruments to sell forward production. This often resulted in a higher effective price for the gold produced. Unfortunately, it is very difficult to identify the actual price achieved for all the projects modelled. As a proxy for hedging, a second case (Forward Price Case) was constructed which involved selling-forward all of the gold at the price (in constant real terms) at the time the decision was made to build the mine. The case also assumed no future changes in tax rules. This case effectively sets an upper bound on the likely value of the project – as most producers didn’t hedge 100 per cent of production.

A third case (Real Price Case) was constructed which involved using a constant real price over the life of the mine. In this case, the current (2004) tax rules were used. The intent of this case is to determine the value of finding and developing a given deposit today using today’s gold prices and investment rules. The price was notionally set at $US 400/oz in constant 2002 dollars to reflect the price of gold prevailing at the time this paper was written.

It should be cautioned that the Real Price Case ignores the issue of changes in costs over time. For example, if the mine was found and developed today, it would benefit from using the latest systems and equipment. Another key issue is that many of the mines operated during times of high gold prices. If the same mine was developed today it might use a different cut-off grade and hence may have a completely different production schedule and cost structure.

All up, 109 gold projects were modelled. This represented 57 per cent of the estimated total 190 major discoveries made during this period. They also contained 74 per cent of the estimated ounces found. On this basis, the modelled results should give a fair representation of the true performance of the overall industry.

The modelled results for the Spot Gold Case are given in Figures 11 and 12.

As can be seen in Figure 11, many of the projects had Internal Rates of Return (IRR’s) well in excess of 20 per cent real after-tax. Consequently, it is not surprising that most of them were developed into mines.

The estimated Net Present Values (NPV’s) for the various projects are given in Figure 12. As a generalisation, the larger-sized deposits were more valuable – though there are obvious exceptions to this rule. Over the study period, the most valuable discovery was Yanacocha in Peru – which contains more than 50 Moz of gold and has an estimated NPV @ seven per cent discount rate of $1881 million. The least valuable project was Mt Todd in Australia, which had major technical problems with treating hard low-grade ore. This project cost $290 M to build but only produced 336 koz of gold before closing down in 2000.
DISCOVERY PERFORMANCE OF THE WESTERN WORLD GOLD INDUSTRY OVER THE PERIOD 1985 - 2003

Fig 11 - Internal Rate of Return for major gold deposits found between 1985 - 2003.

Fig 12 - Net Present Value for major gold deposits found between 1975 - 2003.

Fig 13 - NPV per ounce of resource for major gold deposits found between 1985 - 2003.
In the Spot Price Case, the combined value of the 109 deposits modelled was $12.35 billion. It should be noted that this figure excludes the value of the 26 projects with negative NPVs. This was done on the basis that with better knowledge these projects should not have been developed – and hence the loss of value is due to management and operational issues rather than the fault of exploration.

The reported NPVs are sensitive to the price case used. As a generalisation, the Forward Price Case generally gave the highest values. The only exception is for projects developed in the late 1990s – when gold prices were low.

A good crosscheck on the reasonableness of the valuations can be found by comparing the calculated NPV per ounce of gold against the sales price of known gold projects. Figure 13 shows that there is a wide range of NPV values, with the highest being the high-grade Pajingo deposit in Australia (at $177/oz), which started production in the late 1980s during a period of gold prices and zero corporate tax. Under the Spot Price Case, the weighted average value of all the economic projects modelled was $19 per ounce. The equivalent values under the Forward Price and Constant Price cases were $25 and $21 per ounce respectively.

For comparison, data from Schodde (2003) identified that the weighted average sales price for undeveloped gold deposits sold in North America and Australia over the period 1993 - 2003 was $21 per ounce in nominal dollars.

WHO FOUND THE DEPOSITS?

Within the industry there is vigorous debate about what type of companies are better at exploration – principally junior versus major companies. Based on the current study, the answer depends on which metric is used to measure success – namely the number of deposits discovered, the total ounces found or the discovery rates over time.

For purposes of this study, the author has separated the major companies into two groups – Major Producers (defined as companies producing >300 koz of gold per annum plus Diversified Companies with >$500 M pa in other sales revenues) and Moderate Producers (100 to 300 koz pa of gold). The Junior Companies were defined as the sum of small producers (<100 koz pa), junior explorers (which have no production) and individual prospectors. This approach differs from other workers, such as Maritz (2003), with use market capitalisation as means for defining the various groups.

Table 1 and Figure 14 show which types of organisations that discovered the 190 major gold deposits found between 1985 and 2003. The general trends in discovery rates over time can be found in Figure 15.

It should be noted that there was incomplete information on 23 of these deposits. They were assigned to the known categories on a pro-rata basis. Using this approach, it was estimated at 44 per cent of the major discoveries were made by Major Producers, with an additional 11 per cent found by Moderate Producers. By comparison, the Junior Companies accounted for 34 per cent of the discoveries. A further five per cent were found by joint ventures between the two main groups.

At face value, the relative performance of the junior sector is at odds with previous studies by other workers. These include a study by CRU International, as reported by Maponga and Maxwell (2000), where it was estimated that between 1970 and 1997, junior exploration companies made 51 per cent of significant gold and copper discoveries in Australia. A more recent study by Geoscience Australia, as reported by Hogan et al (2002), identified that junior companies accounted for 66 per cent of all gold discoveries, rediscoveries and renewals in Australia since the 1960s.

It is argued that the difference is due to the assessed date of discovery, location and size of discovery.

Figure 15 shows the percentage breakdown of discoveries by date. As can be seen, in the 1970s and 1980s Junior Companies made a significant proportion of the major discoveries – but this has diminished in more recent years.

With regard to size, Table 1 indicates that Junior Companies found more of the 1 - 3 Moz orebodies than the Major Producers. A recent study by Schodde (2003) of the exploration performance of the Australian Gold Industry identified that junior companies found half of the identified discoveries in the 0.1 to 1 Moz size range. A breakdown of the 190 major discoveries indicates that 36 of these were in Australia. Of these, 13 were found by Junior Companies plus a further three as joint ventures between major and junior companies. This equates to 36 to 44 per cent of all the major discoveries in Australia. The implication is that Junior Companies are very active in Australia.

Table 1

Major gold deposits (>1 Moz) found in the Western World between 1985 - 2003, by company.

<table>
<thead>
<tr>
<th>Discovery Sector</th>
<th>Major producers</th>
<th>Moderate producers</th>
<th>Junior companies</th>
<th>Shared (major + juniors)</th>
<th>Other (oil cos and industri)</th>
<th>Government</th>
<th>Not specified</th>
<th>Unknown and not in database</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Number of major (&gt;1 Moz) gold deposits found</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>&gt;5 Moz</td>
<td>25</td>
<td>6</td>
<td>13</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>46</td>
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<tr>
<td>3 - 5 Moz</td>
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<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>41</td>
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<tr>
<td>1 - 3 Moz</td>
<td>30</td>
<td>7</td>
<td>34</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>18</td>
<td>103</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>18</td>
<td>56</td>
<td>7</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>18</td>
<td>190</td>
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<td>Pro-rated total</td>
<td>84</td>
<td>20</td>
<td>65</td>
<td>9</td>
<td>4</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>190</td>
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<tr>
<td>(%)</td>
<td>(44%)</td>
<td>(11%)</td>
<td>(34%)</td>
<td>(5%)</td>
<td>(2%)</td>
<td>(4%)</td>
<td>-</td>
<td>-</td>
<td>(100%)</td>
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<tr>
<td>Amount of gold found in major gold deposits (Moz)</td>
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<td></td>
<td></td>
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<tr>
<td>&gt;5 Moz</td>
<td>389</td>
<td>47</td>
<td>122</td>
<td>-</td>
<td>6</td>
<td>7</td>
<td>-</td>
<td>-</td>
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<td>19</td>
<td>39</td>
<td>4</td>
<td>3</td>
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<td>2</td>
<td>6</td>
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<td>Total</td>
<td>503</td>
<td>79</td>
<td>219</td>
<td>16</td>
<td>11</td>
<td>20</td>
<td>12</td>
<td>34</td>
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<td>Pro-rated total</td>
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<td>84</td>
<td>237</td>
<td>19</td>
<td>12</td>
<td>23</td>
<td>-</td>
<td>-</td>
<td>895</td>
</tr>
<tr>
<td>(%)</td>
<td>(58%)</td>
<td>(9%)</td>
<td>(27%)</td>
<td>(2%)</td>
<td>(1%)</td>
<td>(3%)</td>
<td>-</td>
<td>-</td>
<td>(100%)</td>
</tr>
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</table>
With regard to the amount of gold found, Table 1 indicates that Major Producers found 58 per cent of the ounces discovered in major deposits between 1985 and 2003. The Junior Companies accounted for 27 per cent, with a further two per cent associated with joint ventures between junior and major companies. This is consistent with the observation that Major Producers tend to focus on exploring for giant gold deposits, while the junior sector is more active at developing smaller projects.

With regard to the value created, the Major Producers dominated the scene. Figure 16 ranks the top 30 gold discoveries by value (as per the historical Spot Price Case). Major Producers made 15 of these discoveries versus eight by Junior Companies. More significantly, in the top ten discoveries by value, the Majors made seven.

As stated before, in the Spot Price Case, the combined value of the 109 deposits modelled was $12.35 billion – with an average unit value of around $19 per ounce. With regard to discoveries made by the Major Producers, 46 deposits were modelled containing 393 Moz of gold. This group also found a further 38 deposits containing 127 Moz that were not modelled. Assuming that the notional value of the additional discoveries is the same as the average modelled value of $19/oz, it is possible to estimate the total value found by the various sectors. On this basis, the total value of all 190 major deposits found between 1985 and 2003 is estimated to be around $16.61 billion. The Major Producers accounted for $9.81 billion or 59 per cent of the overall value. The Junior Companies accounted for 25 per cent with an additional two per cent associated with joint ventures between junior and major companies. A further ten per cent is associated with Moderate Producers.

A similar percentage breakdown in value between the various sectors is achieved under the other two price scenarios (see Table 2). It should be cautioned that the above analysis might underestimate the importance of Junior Companies in creating wealth – as it excluded discoveries smaller than 1 Moz, which is the size range than many juniors are actively working on.

WHERE WAS THE GOLD FOUND?

Referring back to Figure 3, it is estimated that, between 1985 and 2003, approximately 1127 Moz of gold was found through grassroots exploration the Western World on deposits greater than 100 koz. This was made up of 179 Moz found in Australia, 206 Moz in the United States, 61 Moz in Canada and 681 Moz in other countries.
Details of the estimated value of these discoveries for the various locations under the three different price cases can be found in Table 3. These figures are based on the 109 modelled projects (which contain 665 Moz) plus estimated values for the other 462 Moz of discoveries not modelled. The value of these other deposits was notionally calculated using the average modelled discovery value for the world. This approach ignores the issue of possible variations in value between countries associated with differences in local costs, tax rules and country risk issues. Furthermore, the value may also be overly optimistic, as the non-modelled deposits tend to be less economic (which is often the reason why there is no cost data available for them).

Notwithstanding the above qualifications, as shown in Table 3, it is estimated that, based on the Spot Price Case, the total value created by the Western World exploration industry over the period 1985 - 2003 was around $20.92 billion. This is based on a seven per cent real after-tax discount rate. Approximately $3.40 billion of this was found in Australia, $3.48 billion in the United States, $1.26 billion in Canada and $12.79 billion in other countries. On a percentage basis, 61 per cent of the total value was found outside the traditional gold producing countries of Australia, Canada and the United States.
HOW MUCH VALUE WAS CREATED?

The ultimate objective of exploration is to create value. One measure of wealth creation is to look at the ratio between the value of what was discovered and the cost of finding it. However, while simple to measure, this approach ignores the issues of timing (ie when the money was spent versus when the value was created), option-value (principally the opportunity to make additional money if the gold price goes up) and taxation (companies can get tax credits for money spent on exploration). Even so, it gives an approximate measure of the industry’s ability to generate wealth.

Industry level

Based on the historical Spot Price Case, Table 4 shows that over the period 1985 to 2003 the Western World Industry created an estimated $20.92 billion of value from gold exploration at a seven per cent discount rate. Over the same period it spent $28.63 billion on grassroots and advanced exploration. This implies a value-to-cost ratio of 0.73. In other words, the industry generated 73 cents of after-tax value per (pre-tax) dollar spent – with a net loss of 27 cents. Alternatively, if the discount rate was lowered to 4.8 per cent the industry would have broken-even.

Figure 17 shows the trend in value creation versus exploration expenditure over time. It is surprising to note that the two periods of greatest value creation (1986 - 1987 and 1993 - 1997) actually preceded the peaks in exploration expenditure (1988 and 1997). This goes against the conventional wisdom that there is a lag of several years between expenditure and discovery.

Notwithstanding the proviso that the recent discovery record is incomplete, Figure 17 clearly shows that there has been a marked decline in industry performance from 1998 onwards. In addition to the reduced amount of ounces found in recent years, the industry also suffered from lower spot gold prices which affected the unit NPV value of a given project.

If the company sold-forward all of the project’s production at the time the decision was made to build the mine (Forward Price Case), the value created would have been $27.99 billion – resulting in a value to cost ratio of 0.98 and a breakeven discount rate of 6.8 per cent.

In practice, the value created by the industry lies somewhere between these two cases.

An interesting scenario to consider is the likely value of finding and developing the same portfolio of projects today, at today’s gold price of $US 400/oz. This is captured in the Real Price Case, which shows the industry would have created $23.28 billion of value – resulting in a value-to-cost ratio of 0.81 and a breakeven discount rate of 5.5 per cent.
Country level

Under the Spot Price Case, on a country-by-country basis, United States generated a value-to-cost ratio of 1.02, versus 0.78 for Australia and only 0.25 for Canada. The corresponding breakeven discount rates were 7.2 per cent, 5.2 per cent and 5.5 per cent for USA, Australia and other countries respectively, and a negative return for Canada. The surprisingly poor performance for Canada is a combination of a relatively low discovery rate coupled with a very high level of expenditure on exploration. During the period 1985 - 1990, tax incentives associated with flow-through financing, stimulated $3.5 billion of spending on gold exploration in Canada. This was equal to 30 per cent of all the western world’s expenditures at the time. However, over this period only seven deposits larger than 1 Moz were found in Canada.

Under the Forward Price Case, the value-to-cost ratio for Australia rose to 1.51, which is higher than the 1.42 for USA, and 0.98 for the Western World. This variance is due to differences in timing of projects between the various countries.

Some of Australia’s most profitable mines were found in the early part of the study period when gold prices (and hence forward prices) were very high and when no corporate taxes were charged.

Company sector level

With regard to relative performance of different sectors of the industry, Tables 1 and 2 indicate that Major Producers and Moderate Producers collectively accounted for around 55 - 65 per cent of total expenditures, 55 per cent of the major deposits found by number, 67 per cent of the total ounces found and 68 - 70 per cent of the value created. In comparison, Junior Companies (optimistically including all of the value of the joint ventures with major companies) accounted for 30 - 40 per cent of expenditures, 39 per cent of the total number found, 29 per cent of the ounces and around 27 - 29 per cent of the value.

In terms of value created per dollar spent, it appears that the Junior Companies did not perform as well as the Major Producers.
This observation matches the results of a similar study by Metals Economics Group (2000), which concluded that the ‘majors have been more effective at discovering significant new orebodies than the juniors and intermediates’. This study was based on an analysis of gold and base metal discoveries made between 1989 and 1998 with an in situ metal value greater than $US 1 billion. In detail they found that the majors were associated with 80 per cent of the discoveries by in situ value and 73 per cent of the discoveries by number – yet only accounted for 63 per cent of the total exploration expenditures.

It should be noted that the above data was based on discoveries larger than 1 Moz. As mentioned before, the junior sector is quite active in finding and developing deposits in the smaller size range. Notwithstanding this, factoring in smaller deposits is unlikely to affect the general observations of the present analysis. This is because deposits less than 1 Moz in size made up less than one-quarter of the ounces discovered and associated value created (see Table 3).

DISCUSSION

The paper estimates that over the period 1985 - 2003 the Western World gold exploration industry generated an average rate of return of around five to seven per cent. This is of the same order as the average cost of capital for the mining industry. This implies that investing in exploration is, on average, a break-even proposition.

It should be emphasised that the above returns are industry averages only. Individual companies and projects performed better. Also, these returns don’t fully capture the option-value associated with investing in gold. In particular, some people view gold as a defensive ‘play’ in their overall investment portfolio.

On a more general note, it is interesting to compare the returns generated from gold exploration with other high-risk investments – such as the biotech industry.

A detailed study by Grabowski, Vernon and DiMasi (2002) for the Pharmaceutical Research and Manufacturers of America looked at the performance of the US biotech industry between 1990 - 1994. They found that only one out of 5000 to 10 000 compounds screened is ultimately approved as a new medicine; that it takes an average ten to 15 years to bring a new drug to market; and that seven out of ten drugs brought to market never earn enough revenue to cover the average out-of-pocket cost of drug development. They also determined that the average cost of developing a new drug was $US 802 million pre-tax or around $500 million after-tax. In comparison, the average NPV generated was only $US 520 million – resulting in a value-to-cost ratio of 0.65. This suggests that, on average, investing in the biotech industry is also a break-even proposition.

In their paper, Grabowski et al concluded that, the task is getting harder – as R&D costs are rising, success rates falling and the time-to-market lengthening.

From the above it appears that, in spite of its glamour, biotech companies face challenges equal to if not harder than that faced by the minerals exploration industry.

CONCLUSIONS

Over the study period 1985 - 2003, the Western World gold industry found an estimated 1127 Moz of gold in grassroots discoveries. Over this period a total of $28.63 billion was spent on grassroots and advanced exploration – resulting in an average finding cost of $25 per ounce of resource.

This gold was contained in 1000 deposits greater than 100 koz, 190 of which were in major deposits larger than 1 Moz. This equates to an average cost of $150 million per major discovery (containing, on average, 5.0 Moz).

CONCLUSIONS

Compared to the period 1970 - 1984, the average unit discovery cost per ounce and per major discovery rose by a factor of four and three respectively.

Over time, it appears that around 70 per cent of all major discoveries were eventually developed as mines. For those projects that became mines, half of them were developed within 6.3 years. Contrary to popular perception, the time taken to put the project into production has remained unchanged over the last three decades. Also, on average it took less time to develop a grassroots project in Australia, USA and Canada than other countries (5.4 versus 8.3 years).

Detailed financial modelling of 109 of the major deposits found that many of these discoveries were very profitable, with IRRs well in excess of 20 per cent. In general, the larger deposits were more valuable – with the most significant discovery made being Yanacocha in Peru.

After including an adjustment for discoveries not modelled, it was found that using historical spot gold prices, the industry generated on average 73 cents worth of after-tax value for every pre-tax dollar spent on exploration. This is a lower-bound estimate as many producers hedged their production at higher prices. As an upper bound, assuming that all gold production was sold-forward at the decision-to-build stage, the average return rose to 98 cents per dollar spent. These equate to a rate of return of 4.8 to 6.8 per cent for the industry.

If the same deposits were found today, but developed using the same production profile and costs as before, with all output sold at a constant $US 400/oz, the average return would be 81 cents per dollar spent.

Based on historical spot gold prices, companies exploring in the United States and Australia performed significantly than those in Canada – generating 102, 78 and 25 cents of value respectively per dollar spent.

With respect to major versus junior companies, it was found that the latter performed better in terms of the number of deposits found, but the former found more ounces and created more value. It is estimated that, over the study period, Major Producers and Moderate Producers collectively accounted for around 55 per cent of the major deposits found by number, 67 per cent of the total ounces found and 68 - 70 per cent of the value created. In comparison, Junior Companies (including joint ventures with major companies) only accounted for 39 per cent of the total number found, 29 per cent of the ounces and around 27 - 29 per cent of the value. However the junior companies are estimated to have incurred 30 - 40 per cent of the total exploration expenditures.

Notwithstanding the fact that investing in gold exploration on average appears to be a break-even proposition, the industry provides a similar return as other high-risk investments such as biotech.

Finally, it should be recognised that the current paper only looked at average returns for the industry. Individual companies do much better or worse than this. The challenge is to find ways to be in the former category. The hope of this paper is that it provides some useful yardsticks for measuring a company’s performance along its path to success.

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