Abstract

The author has appraised an interest in a group of mining claims at a major Nevada gold mine five times in four years. The claims are leased to the mining company, which pays the owners a royalty of 5 percent of sales of minerals mined from the claims. The gold reserves defined at the time of the first appraisal, were mined out by the time of the last appraisal. During this period, the price of gold also fell from $380 per ounce to $285. However, those reserves were more than replaced by reserves newly defined through continuing exploration of the deposit. The value of the mining claims was maintained even though much of the gold deposit was removed and the price of gold fell substantially. This value maintenance flies in the face of conventional understanding of a mineral deposit as an asset which is depleted as it is mined. This paper addresses the concepts of value of exploration potential and mineral reserve replacement, and their application in the appraisal of mineral properties.

Appraisals of a Gold Property: A Case Study of Reserve Additions

By Trevor R. Ellis

Introduction

Mining properties tend to fall into two categories. The first category fits the conventional perception of a mineral deposit. It has a fairly well defined quantity of reserves at the beginning of mining, which is then extracted over the life of the mine until fully depleted. A coal mining property and a river gravel quarry property are typically good examples of this *static reserve category*[1].

The second category of mineral properties shows a propensity for the mine operator to keep finding and developing more reserves as needed to replace reserves extracted. This circumstance occurs most commonly with metallic mineral deposits, where the mineralization is widely disseminated through the host rock in three dimensions in fine to microscopic veinlets. Copper and gold deposits frequently fit this *dynamic reserve category*[2]. Exploration of such deposits through drilling and other methods is typically very expensive, ranging from many hundreds of thousands to many millions of dollars per year. This discourages mining companies from doing more exploration than necessary to meet near-term needs. The operator typically schedules exploration only to define the existence of sufficient reserves to replace reserves as they are consumed. This provides the necessary few years of reserves to support planning and capital budgeting.

For some mining properties in this dynamic reserve category, there has been a dance going on for as long as decades between the apparent pending exhaustion of reserves, and the "discovery" of additional reserves. The historically rich Homestake Gold Mine in western South Dakota provides an excellent introductory example of a mineral property which has undergone dynamic reserve growth for more than a century. It illustrates nicely the dance between apparent pending exhaustion and the discovery of additional reserves.

The original Homestake claim was staked in 1876, and the first gold production is reported as beginning that year. The next year, George Hearst purchased the claim for $70,000 and also acquired a fractional interest in the adjacent Gold Star claim (Slaughter). Since then, the Homestake Mine has sold approximately 39 million Troy ounces of gold production, which would have a value today of about $10 billion. When George Hearst purchased the claim, only a tiny fraction of the gold deposit was known. Gold production to date is several orders of magnitude greater than any reserve defined at the time.

In recent years, Homestake Mining Company has been maintaining a reserve base at the mine of less than 10 years of production. If we did not have the benefit of knowledge of the geology and history of the property, we would likely expect the Homestake Mine to be closed down in less than 10 years due to exhaustion of reserves. However, history, geology, and continued exploration success suggest that the mine may operate for some decades to come. The history of other mines shows that eventually the ability to find additional reserves will end, in this case probably due to the high cost of deep mining.

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The Marigold Mine, the subject of this case study, has exhibited similar dynamic reserve maintenance to the Homestake Mine example. This has been exhibited over a much shorter period, with mining starting only in 1989, and involves a smaller scale of operation.

Mining companies typically pay a significant premium over the reserve base value at mines and undeveloped mineral properties for geologically demonstrated potential that additional reserves may be found. The purpose of this paper is to show that minerals appraisers need to understand whether they are appraising a deposit with a static or a dynamic reserve. An appraisal that ignores the potential to find additional reserves could miss a substantial portion of the value of the property.

The Marigold Mine is a major Nevada gold mine. The following describes the history of maintenance of its dynamic reserve. It then shows the impact of this phenomenon in maintaining the value of a royalty interest in the mine during five appraisals I conducted over a four year period. It also demonstrates how I incorporate my understanding of this phenomenon into my analyses.

Reserves, Resources, and Exploration Information

First, a technical explanation of a few terms is necessary to understand the principals involved in reserve development through exploration. The following three terms have been defined by the mining industry in international standards – reserves, resources, and exploration information.

Only the portions of a mineral deposit that can be mined for sale of their mineral content at a profit can be called *reserves* (SME; AusIMM, 1999; US SEC). This generally requires that extensive geological studies, based on a considerable amount of drilling, have been conducted to thoroughly understand the deposit in three dimensions with reasonable confidence. Preliminary engineering studies and mine design will have, at least, been conducted to determine the feasibility and cost of mining the reserves. Similarly, the ability to process the mined mineralization into a marketable product will have been demonstrated, with the cost of doing so known with reasonable confidence. In the case of gold, this requires determining the percentage of the gold contained in the mined rock that can be economically extracted and refined into high purity gold bars, and determining the cost of doing so. Comprehensive economic analysis must also have been conducted to demonstrate the overall economic viability of mining, processing, and marketing the mineral.

The portions of the mineral deposit which do not meet this high level of knowledge and confidence, but have been investigated in three dimensions, can often be termed *resources* (SME, AusIMM). To be called a resource, the mineralization must have the potential of being upgraded in classification to reserve by additional investigations and/or improvements in market conditions, within prudent possibility. Resources and reserves are typically reported as tons and grade of mineralized rock. Strictly, a reserve is a subset of a resource, being the portion that has been demonstrated to be economically mineable. At large mines, annual exploration budgets of many hundreds of thousands to millions of dollars may be spent on drilling the known resources to develop three dimensional knowledge with adequate confidence to classify portions of the resources as reserves.

At the same time, from lower levels of the mine, and on other portions of the land holdings at the mining property, the operating company may have a geological exploration crew seeking and following mineralized trends and drilling areas of mineralization. The company's hope is that through the geological exploration work, the crew can find and define additional pods or bodies of concentrated mineralization. These will then be delineated by more drilling to define additional resources.

This exploration stage reveals data on mineralization termed *exploration information* (SME) or *exploration results* (AusIMM). Any reporting of this data is in terms of average grade of drill intersections. The international standards do not allow reporting of a quantitative estimate for non-resource mineralization, such as an estimate of the tonnage and grade of mineralized rock discovered.

Such ongoing exploration for additional bodies of concentrated mineralization is often needed for minerals with variable distribution and concentration across the property. It is frequently required for the metallic minerals, such as gold, copper, and zinc. It can also be applicable to some of the industrial minerals such as talc, garnet, manganese, and kaolin, where tight market specifications for purity and mineral characteristics require careful selection before mining. It is generally not needed for seam deposits such as coal and limestone.

Despite the fact that resources and exploration information do not have proven economic viability for mine production, their existence is necessary for the long term planning and survival of most gold mines and other mines with dynamic reserve bases. To date there are no published works studying the market allocation of value between reserves, resources, and exploration potential at operating mines. However, indications from my experience and discussions, suggest that around 25 percent of the price paid for many gold and copper mines is for the resources and the potential to find additional resources shown by the exploration information (exploration potential). A higher percentage may be typical during a strongly bullish market for the relevant commodity, like the 1980-1996 period for gold.

For undeveloped copper and gold properties where reserves have been defined, the percentage of the purchase price for resources and exploration potential can run quite high. For example, in June, 1994, Colorado based Cyprus Amax Minerals Company paid $330 million for a 51 percent inter-

est in the El Abra mining concessions in Chile, covering 33,000 acres. Two analysts for competing bidders discussed the sale with me, one having interviewed those involved in the winning bid. The purchase price was twice to three times the net present value of the income producing capabilities of the interest in the property's reserves. One-half to two-thirds of the purchase price was for exploration potential and poorly defined resources. Similar examples are provided in a paper by Ross Lawrence.

Bias to Valuation of Reserves Only

The issue of whether an appraiser should allocate value only to reserves, or also to resources, exploration information, and exploration potential, is critical to the discussion in this paper. It is presently a hotly debated topic among minerals industry practitioners involved in the valuation of mineral properties. Domestic and international regulations and standards strongly influence this issue. The impression I've gained from discussions and literature, is that a higher percentage of U.S. minerals appraisers are for valuing reserves only, than of their counterparts in the major mining countries of Australia and Canada. This is particularly true for valuations employing the income approach as the primary or only approach (ASFMRA; AusIMM, 1998; Ballard; Lawrence, M; Lawrence, R.; Roscoe).

Decades-old public reporting regulations of the U.S. Securities and Exchange Commission (SEC) generally restrict information disclosure by mining companies listed on the U.S. stock markets to estimates of tonnage and grade of reserves only. The same SEC regulations generally restrict value to reserves only in SEC filings (US SEC). In contrast, the 1983 reporting regulations in Canada have provided for much more open disclosure (CPSA, 1983). New Canadian regulations are being designed to follow international standards (CPSA, 1998; TSE-OSC). Australia also requires complete disclosure (AusIMM, 1999).

Due to the SEC regulations, minerals appraisers have considerable difficulty obtaining data on anything more than reserves for deposits controlled by U.S. listed companies. In contrast, for mineral properties controlled by companies listed on the Australian stock markets, comprehensive estimates are publicly reported annually for the tonnage and grade of resources and reserves (Resource Information Unit). Australia's VALMIN Code for valuation of mineral properties is founded on its regulatroy standards for reporting reserve and resource estimates and exploration results. This inherently implies that estimates of Market Value should include the value of the non-reserve portions of mineral deposits. Some Canadian regulators prohibit use of discounted cash flow analysis and other economic analysis on non-reserve mineralization (VSE). These prohibitions were designed to control feasibility studies and fund raising. It does not appear that they were designed with the valuation process in mind (Lawrence, R.). Trends in new Canadian regulations are allowing a broader allocation for valuation (CPSA, 1998; TSE-OSC).

The appraisal assignment is of course greatly simplified for those appraisers who believe in only attributing value to reserves. However, the mining industry literature of the 1990s shows that there is a significant problem in the industry with undervaluing mineral properties by those who develop bids and analyze sales (Bhappu and Guzman, Davis, and Adamson). In a recent comprehensive study of the dynamic reserve phenomenon at U.S. gold mines, David Hammond, geologist and mineral economist, writes:

> "Anecdotal evidence suggests that many industry participants believe inadequate assessment of the uncertainty surrounding potential reserve growth may be one of the key factors leading to the significant undervaluation of the mineral assets, particularly when conventional financial techniques are employed. They feel this is demonstrated by the wide variation often noted between the estimated and actually observed property transaction prices."

In other words, Hammond proposes that minerals appraisers and mining industry analysts are generally undervaluing resources and mineral exploration potential. He believes that because of this, the value of mineral properties often is substantially underestimated relative to what companies are paying for those properties.

An example of the value mineral resources can attain is the 1987, arms length purchase of an undeveloped tract of oil shale property in northwest Colorado, for $37 million by Shell Oil Corporation. The prevailing crude oil price was no more than half of that necessary to define a reserve at the property. In contrast, at the Marigold Mine the prevailing price of gold has been adequate to allow continual conversion of resources to reserves since mining began in 1989.

U.S. regulations generally require companies to withhold value estimates and quantitative estimates for the resources of mineral properties (US SEC). Shell has not released a quantitative resource estimate for the oil shale tract it acquired. This lack of disclosure can cause the minerals appraiser extensive problems while appraising a property with a significant resource base. It can result in a lack of released exploration and resource information for the subject property and sold properties for the sales analysis (Ellis). This problem was present during this appraisal case study.

Dynamic Reserve Maintenance at the Marigold Mine, Nevada

The history of reserve maintenance at the Marigold Mine is used here to illustrate the concept and mechanics of dynamic reserve maintenance. These are applicable to small and large mines with

dynamic reserve bases. The importance for the appraiser to develop a comprehensive geological understanding of the subject mineral property and its economic potential is demonstrated.

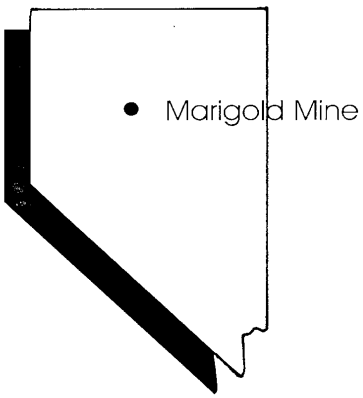
The Marigold Mine is situated in north-central Nevada, approximately 12 miles northwest of the large town, Battle Mountain (Figure 1). Glamis Gold Ltd., based in Reno, Nevada, holds the majority ownership of the mine operating company, Glamis Marigold Mining Company. Glamis Gold Ltd. is listed on the New York and Toronto, Canada, stock exchanges. The previously referenced Homestake Mining Company, listed on the same and other exchanges, holds a one-third interest. In 1999, Glamis Gold merged with Rayrock Resources of Canada, which held the controlling interest. Glamis now owns mines and exploration properties in the western U.S. and Central America. Humboldt County, in which the Marigold Mine is located, has historically been one of Nevada's important mineral producing counties. Silver was discovered in 1849, and gold and silver mining began in 1860.

The Marigold Mine is in a major northwest-southeast oriented trend zone of gold mineralization called the Battle Mountain Trend. This trend zone, which is around 100 miles long and 20 miles wide, contains numerous operating and depleted gold mines.

The gold mineralization is of the type typical to the Carlin region of Nevada, the major gold mining region of the U.S. where the Marigold Mine is situated. The gold is dispersed through coarse to fine-grained sedimentary rocks. It was emplaced in the rock by hot water solutions related to regional volcanic activity millions of years ago. Gold is rarely visible to the naked eye in the reserve rock, even in high grade ore[3] samples, because the grains of gold are of microscopic size.

Several thousand tons of ore averaging 0.20 Troy ounces[4] of gold per ton (opt Au) were shipped from underground workings at the Old Marigold Mine in the late 1930s. Discovery of the high grade mineralization and geological interpretation leading to the current workings took place in 1985 and 1986.

Figure 1. Location of Mine In Nevada



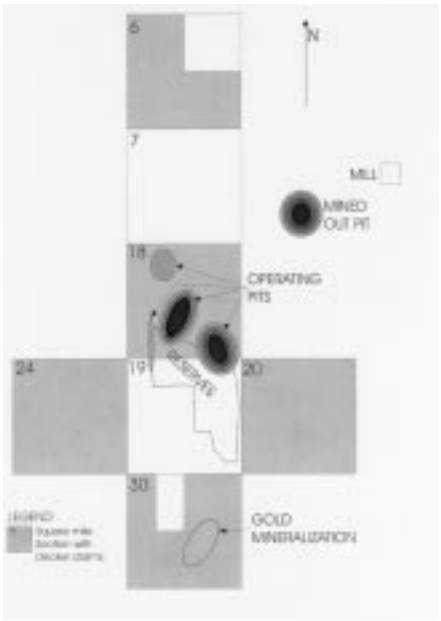
Glamis Marigold Mining controls 30 square miles of contiguous mineral rights surrounding and encompassing the Marigold Mine. Of those mineral rights, the Decker Group of unpatented mining claims, the subject of the appraisals, comprises approximately 4.6 square miles. The Decker Group encompass the bulk of the area of five government survey sections, each of one square mile. Two of those sections, although non-contiguous, lie on the main southerly trend of mineralization. One of the two, Section 18, contains the majority of the current mining operations and reserve base (Figure 2).

By the end of 1998, Marigold had sold 703,021 Troy ounces of gold (oz Au). Of this, 312,913 oz (44%) had been produced from the Decker Group.

The Decker Group was primarily staked by Donald J. Decker in the period 1974-1983, who also acquired some claims during that period from third parties. The lease agreement providing for the present mining operations was executed in October 1986. The lease provides for the value of five percent of gross gold production from the Decker Group to be paid to Mr. and Mrs. Decker. The Deckers have since assigned some undivided interests in the Decker Group of claims to trusts. The primary subject of the appraisals has been a 12.5 percent (an eighth) interest assigned to one of the trusts.

The Marigold mining operations to date have been mainly from three major pits and two smaller pits (Figure 2). The pits are up to hundreds of feet deep and more than a thousand feet across. They are scattered over three square miles with a southerly trend. Initial mining, which began in 1989, was mainly from a rich pit off the Decker Group, immediately to the northeast of the Decker Section 18 primary claim block. Since then, the focus of mining operations has moved south onto

Figure 2. Location of Decker Mining Clains



Section 18, following the southerly trend of discoveries.

Initial royalty payments to the Deckers did not begin until October 1990. Production from Section 18 in 1991 through 1993 averaged 15,000 oz Au per year. In the most recent four years, 1995-1998, it has averaged approximately 60,000 oz Au per year, comprising 80 percent of total mine production. This is due to Section 18 being the focus of the current mining and discoveries.

Reserve and mine development through exploration drilling shows a southerly trend onto the non-Decker Group Section 19 immediately to the south, where mining has begun (Figure 3). Current exploration plans include intensification of exploration drilling on the next section to the south, Section 30, the large majority of which is part of the Decker Group (Figure 2). The mineralized trend continues south across this claim block. Promising intersections of gold mineralization have been encountered in the few exploration holes drilled in Section 30.

The main pit being developed on the Decker Group Section 18 is designed to reach a depth of 800 feet. Mining is done by blasting the rock and shoveling it into 85 ton capacity ore trucks by front-end loaders (Figures 4). The trucks take the ore to a crusher. Ore grading at least 0.080 opt Au is then milled in on-site ball and rod mills, which grind the ore to expose the gold particles (Figure 5). The gold is then dissolved by a sodium cyanide solution and recovered in "columns" (tanks) onto activated carbon. Average recovery of gold from ore processed through the mill is 94 percent.

Crushed ore grading 0.008 opt Au and above is stacked about 50 feet high on heap leach pads, and may reach 180 feet height per the operating permit. Sodium Cyanide solution is leached through these ore heaps over many years to dissolve the gold. Most of the gold is dissolved in a few months. The dissolved gold is then recovered in columns onto activated carbon. The average recovery by heap leaching is about 70 percent of the gold contained in the rock. The heap leach facility can handle 2.5 million tons of ore per year.

Figure 3. Drilling to Define Reserves of Gold Ore

The operation typically produces 70,000 to 80,000 oz Au per year, exceeding its early design capacity of 64,000 oz Au per year.

Development of the Marigold Mine, which began in August 1988, was based on the reserves in the now exhausted pit in Section 8, to the northeast of the Decker Group Section 18 (Figure 2). The initial reserves were estimated to be 5.028 million tons @ 0.073 opt Au average grade. Of the contained 367,000 oz Au, indications are that nearly 90 percent was expected to be recovered (approx. 330,000 oz). The initial reserve base provided five years of reserve life. Production began on September 28, 1989. During that year, the price of gold averaged $381.44 per oz. The capital cost for the mine development totaled $37 million.

By early 1990, reserves were reported to be 12.285 million tons @ 0.054 opt Au. This contained 667,000 oz Au, for the potential production of 562,000 oz Au (Table 2). The initial reserve base on which the mine was built was exhausted before the first appraisal was conducted early in of 1995. Reserve additions caused the remaining reserves to exceed the initial reserves. By the end of 1995, Marigold had sold 483,440 oz of gold, while reserves remaining had increased to 14.586 million tons @ 0.036 opt Au. This contained 528,000 oz Au, for the potential production of 405,000 oz Au.

Figure 4. Mining Reserves of Gold Ore. The truck is 85-ton capacity.

Figure 5. Extracting Gold From the Ore in the Mill Building. Ball and rod mills in background for grinding ore. Columns for recovering gold onto activated carbon are in foreground.

The annual exploration budget was averaging a little over one million dollars. The average gold price in 1996 was $387.87 per oz, and remaining reserves at the end of 1996 were adequate for seven years of full production.

The gold price underwent a substantial fall during 1997 to $287.05 per oz at year end. This required redesigning the mining operations to remain economic at the lower price, resulting in a contraction of the end-of-year reserve base to five years. Despite the weak gold price, the operator increased its 1998 exploration expenditure to $1.54 million, resulting in a number of years of additional reserves being proven. The average gold price for 1998 was $294.16 per oz. Substantial employment cuts were made and more efficient mining equipment is gradually being introduced.

By the end of 1998, Marigold had sold 703,021 oz of gold, approximately 225 percent of the recoverable reserves the mine was originally built on. Despite the fall in gold price, reserves remaining stood at 19.976 million tons @ 0.032 opt Au, containing 637,000 oz Au, for potential production of 510,000 oz Au. These reserves provide nine years of mine life, and are equivalent to more than 160 percent of those on which the mine was built. A little more than 50 percent of the reserves are on the Decker Group. The exploration budget for 1999 was pushed up to $1.95 million. Despite continued weakness in the price of gold during 1999, continued cost reductions and an increase in the average ore grade through mine design have maintained the profitability of the mine.

The above description illustrates the process of reserve maintenance at the Marigold property, despite the falling gold price and mining out the defined reserve base a number of times. The interaction between geological and economic principals in reserve maintenance and additions for a dynamic reserve base is poorly understood. Hammond recently completed his doctoral thesis on this topic at the Colorado School of Mines (Hammond). I provided extensive research assistance to Dr. Hammond. Results suggest that for open pit mining of gold properties with similar geology to Marigold, the total amount of gold mined before a mine closes will typically be in the order of ten times the reserves the mine was built on, but could vary widely from that. The Marigold Mine is following this pattern of continued reserve development very well. This attribute is important to the market for the royalty and the mine.

Income Approach to the Value of the Resource and Exploration Potential

U.S. based mining companies do not typically publish any information of significance regarding their resource development, exploration findings, and exploration potential at their mines. The senior exploration geologist for the Marigold Mine was generally only willing to speak with me in broad brush, conceptual terms. Detailed geological information from work on the Decker Group could have been petitioned under the terms of the lease. However, it may not have transferred to legal access terms, given the purpose and potential use of the appraisals. The benefit of such data analysis for the Decker Group would be severely degraded without the results of similar analysis for the rest of the Marigold property, in order to place the results in a relative context.

Through discussions with the senior exploration geologist, examination of the geology, mine plans, and drill locations for each appraisal, a quantifiable indication of exploration and reserve development potential was developed. The quantity of reserves expected to be developed from the defined resources and exploration discoveries was estimated. To these estimates, a probability of success to account for geological and engineering uncertainty was applied. The probability factor ranged from 50 to 75 percent for exploration discoveries. A probability factor of 85 to 95 percent was applied to resources at an advanced stage of engineering.

Estimates of potential reserves were then added to the mining time-line for the reported reserves. For the 1995 appraisals, an additional six years of production beyond the reported reserve base was estimated. For the end of 1998 appraisal, an additional nine years of production beyond the reported reserve base of nine years was estimated. From these, the portion of the potential reserves which will be produced from the Decker Group of claims was estimated. From those reserve quantities, the gold recovery, sales, and resultant royalty payment for use in the net present value calculation was estimated. Attributing value to exploration potential beyond discoveries was not attempted, due to lack of data, and the long time horizon for discounting.

Table 1 shows the value conclusions for the one-eighth undivided interest in the Decker Group. It also shows the portion of the value that was derived from the resources and exploration potential. In the two 1995 appraisals, these contributed approximately a third of the value. In the end of 1996 appraisal, this reduced to 15 percent due to conversion of resources to reserves, and the addition of only poorly outlined potential. In the most recent two appraisals at the end of 1997 and end of 1998, that portion increased to approximately one-quarter, due to conspicuous exploration success. The attributed value is heavily dependent on the discount rate used in the analysis, which in turn is dependent on how bullish or pessimistic potential investors are about the particular commodity being produced.

Sales Analysis

Useful sales of precious metals royalty interests in operating North American mines were

found to be extremely scarce. Interests in mineral holdings are very thinly traded; only three companies with an active interest in purchasing Nevada mineral holdings for their royalty interests in gold mining operations were found. Two of those three were sister companies with the same upper management. Any attempt to sell the interest to other parties would likely require intense marketing and education of the potential buyer if the interest is not to be sold at a substantial discount. Therefore, the market exhibits characteristics of severe imperfection.

Quantitative data on resources and exploration potential were not available for properties selected for the sales analysis. This is largely due to the US regulatory restrictions discussed above (US SEC). When no direct information is available on the earnings potential after existing reserves are exhausted, this sales analysis process is handicapped.

For the end of 1998 appraisal, sales were selected which reflected the impact of the fall in gold price and loss of investor confidence in the gold mining industry. Five sales were analyzed.

Among the valuation methods employed, was a sales comparison approach based on dollars paid per ounce of reserves only. However, the purpose of this paper is to illustrate the importance of accounting for the value of the potential for continual reserve replacement and development, and ways in which I dealt with this complexity. Therefore, the two methods relied upon in developing a conclusion of value are discussed. Due to the aforementioned shortage of information about the sales, and their lack of direct comparability to the subject, the methods of analysis employed are far from precise.

The first method is based on the ratio of price paid to the undiscounted total revenues to be derived from the interest in the precious metal contained in the reserve at the time of the sale. This ratio is sometimes called Percent of Retail. This is designed to show the overall discount that was allowed for time value of money in the revenue stream, the risks involved in mining the rock and extracting the precious metal, and the cost of the five percent Nevada minerals extraction tax.

For example, assume a royalty interest is expected to yield $100,000 of gross revenue annually over a ten year reserve life. If the buyer paid $400,000, the price paid is 40 percent of the total revenue forecast of $1,000,000, providing a Percent of Retail factor of 40 percent. The discount from total revenues is 60 percent. John Widdoss, ARA, who teaches the minerals sections of ASFMRA's A-34 course, Advanced Resource Appraisal, calls this discount factor the Bulk Discount (ASFMRA).

For the second method, the sales were analyzed to abstract market internal rates of return (IRRs) to guide the net present value generation of the capitalized income approach. IRRs were derived based on both net income before income taxes and after tax cash flows. Use of after tax cash flows is common practice in the minerals industry by buyers and appraisers. Most mining projects have special income tax benefits and often require cash flow analysis for twenty to fifty years. Many theoreticians of the minerals industry believe that the higher discount rates inherent in before income tax analysis unfairly penalize the value of long term mining projects.

For the five sales, Table 2 provides the Percent of Retail and the Bulk Discount. These are based on allocation of all of the purchase price to the defined reserves only. It also provides the derived IRRs based on net income before income taxes.

Sales A and B are two related royalty sales at different mines. The purchase prices show negative discounts for gold in the reserve rock at the

Table 1. History of Reserve Development, Production and Valuation

Date	Gold Price	Marigold Mine		Decker Claim Group			
	$ per oz	Recoverable Reserves oz Au[a]	Cumulative Production oz Au	Recoverable Reserves oz Au	Expected Additions oz Au[b]	Value of Eighth Interest $	Value from Expected Additions %
Aug 88[c]	437	330,000	0				
Early 90	410	562,000					
7/31/94	385	360,000	384,000				
2/01/95	378	349,000		141,300	134,000	400,000	34
5/25/95	385			132,700	134,000	395,000	36
12/31/95	387	405,000	483,440				
12/18/96	355			219,600	227,500	504,000	15
12/31/97	287	306,000	631,085	163,800	137,100	376,000	27
12/31/98	287	510,000	703,021	263,300	291,600	410,000	26

[a] After accounting for losses during extraction.

[b] After reduction by risk factors and losses during extraction.

[c] Development of the mine and plant began August 1988. Mine production began September 1989.

mines compared to the prevailing price of purified gold bars. The negative discounts are even greater if the direct expense of the five percent minerals extraction tax is included. A prudent person will not pay more than the prevailing retail price of purified gold for gold in rock that will not be mined for several years. This shows that substantial premiums were paid in both cases for an interest in resources and exploration potential. These premiums support the approach taken to valuation of the interest in resources and exploration potential at the Marigold Mine.

Insufficient mining schedule information was available to derive IRRs from Sales A and B. Information derived from interviewing the parties involved indicated that the IRRs would be very low, even with inclusion of unreported data. However, these two sales occurred slightly before the full implications of loss of investor confidence in the gold industry had been digested.

Sale C is closely comparable to the subject. In developing its implied IRR, a probability estimate of foreseeable reserve additions is developed, to put this analysis on a similar basis to that applied in the Decker Group analysis at the Marigold Mine.

Sale D involves an interest at a mine which may be closed before mining of the defined reserve of the subject mining claims. This is due to the high operating cost of the mine relative to the weak gold price. In the available information, no conspicuous potential for reserve additions was apparent.

Sale E involves mining claims containing defined reserves adequate for 40 years of production. Any potential for reserve additions is irrelevant to its analysis. The reserve falls into what is termed the static reserve category. An interview and other research indicated that seller motivation and lack of detailed industry knowledge resulted in a low selling price. Despite this, comparison of the results for Sale E in Table 2 to the results for Sales A, B and C, suggest that the premium paid for the potential for reserve additions may be greater than my allocations in Table 1 show.

I based conclusions of appraised value primarily on factors derived from Sale C. In developing the net present value for the subject, the 13 percent IRR from Sale C was reduced to a discount rate of 12 percent, due to a higher confidence in the long term viability of the Marigold mining operation. For the same reason, in applying the Percent of Retail method, Sale C was adjusted upward to the subject. Other data sources were also considered in making the discount rate selection.

In developing conclusions of value, I gave the greatest weight to the net present value results, as that method is designed to model the time value of money. It also allowed the inclusion of the potential for reserve additions for the subject and sales. My experience and understanding indicates that ratio methods of analysis, such as Percent of Retail, tend to undervalue the subject if it has a reserve base that is to be mined over a short time frame relative to those of the sales. Conversely, ratio methods tend to overvalue the subject if it has a reserve base that is to be mined over a long time frame relative to those of the sales. Many geological and geographic parameters can also enter into the analysis. In appraising minerals properties, we rarely have sales data that adequately surround the subject's parameters, and therefore we often make subjective adjustments for such factors.

Conclusions

Conventional analysis has its place in the appraisal of mineral deposits, particularly the net present value method, provided such methods are applied with care and understanding. The appraiser needs to understand the deposit and mining operations for the subject, and for the sales being analyzed, in order to derive the correct value as a mining industry buyer would see it. If the potential for reserve additions through exploration is present, this can add significantly to the value of the deposit, and should be taken into account.

Table 2. Sales Analysis

Sale	Price $	Percent of Retail[a]	Bulk Discount[b]	IRR[c] %	Comment
A	34,950,000	104	-4	<10	Reserve additions potential
B	21,300,000	115	-15	<10	Reserve additions potential
C	2,468,000	79	21	13	Reserve additions potential
D	175,000	51	49	30	Mine closure risk
E	36,000,000	13	87	21-26	40 year static reserve

[a] Selling price as a percentage of undiscounted total gross revenues to be generated from the royalty interest in the defined reserves at the commodity prices prevailing at the time the interest was sold.

[b] Discount that the selling price represents to the total gross revenues to be generated from the royalty interest in the defined reserves.

[c] Internal Rate of Return based on expectations of additional reserve development.

Epilogue

Since writing this paper, I have updated the last appraisal from December 31, 1998 to December 31, 1999. The price of gold closed the year at approximately $287 per oz, essentially unchanged from the preceding two years. End of year recoverable reserves at the Marigold Mine were approximately 460,000 oz Au, a drop of 50,000 oz from end of 1998. During 1999 the mine sold production of 74,237 ounces. Exploration drilling was broadened across more of the Marigold property than in previous years. Continuation of this exploration strategy is planned for 2000. The milling of ore has ceased at the least temporarily, due to a current lack of high grade ore. The heap leach facilities are being expanded to maintain production of at least 75,000 oz Au per year. The focus of production for the next few years will be the Decker Group. End of year recoverable reserves for the Decker Group were approximately 255,800 oz Au, a reduction of 7,500 ounces. Final 1999 gold sales figures from the Decker Group are not yet available, but are known to be two to four times the reduction in reserves. The updated appraised value for the eighth interests is $450,000, an increase of $40,000.

These results show that replacement of mined reserves is still continuing at the Marigold property, and in particular in the Decker Group of mining claims. They again support the thesis of this paper, that the exploration potential of the subject mineral property and the ability to replace reserves must be taken into account in the appraisal process.

Endnotes

1 The term *static reserve category* is my own descriptive term. I am not aware of a mining industry term for this situation.

2 The term *dynamic reserve category* is my own descriptive term. I am not aware of a mining industry term for this situation, although it has been described mathematically (Hammond).

3 Ore is mineralized rock that can be mined at a profit. It is the mineralized rock which composes a reserve. Usage of this term is generally restricted to rock containing minerals.

4 Much of the world's precious metals trade is conducted in Troy ounces. A Troy ounce is 1.097 regular (Avoirdupois) ounces.

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Glossary of Minerals Industry and Related Terms Used

Au: The chemical symbol for gold, as defined in the periodic table.

AusIMM: The Australasian Institute of Mining and Metallurgy, which is headquartered in Carlton, Victoria, Australia.

Mineral Assets: Mineral reserves, mineral resources, and exploration potential.

Mineral Reserve: "A Mineral Reserve is the economically mineable part of a Measured or Indicated Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments, which may include feasibility studies, have been carried out and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction is reasonably justified. Mineral Reserves are subdivided in order of increasing confidence into Probable Mineral Reserves and Proved Mineral Reserves." (SME).

Mineral Resource: "A Mineral Resource is a concentration or occurrence of material of intrinsic economic interest in or on the Earth's crust (a deposit) in such form and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge. Mineral Resources are sub-divided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories. Portions of a deposit that do not have reasonable prospects for eventual economic extraction must not be included in a Mineral Resource." (SME).

Mining claim: A portion of public mineral lands which a person or company holds for mining purposes in accordance with mining laws. Claims are defined on the ground at corners and other required points by mounds of rock and/or stakes made of wood or metal. Hence, the act of taking up a mining claim is commonly termed staking a claim. Claims of the type discussed in this paper may be up to 1,500 ft long and 600 ft wide. Patented mining claims are claims for which ownership of the minerals, and possibly the surface, has been transferred from the public to the claim owner. For unpatented mining claims, which are the subject of this paper, ownership of the minerals has not been transferred from the public to the claim holder.

Mining concession: A term used in the minerals statutes of many countries for a tract of land defined for mining.

opt: Ounce(s) per ton. The abbreviation 'opt Au' means the gold content of the rock, estimated in Troy ounces per ton (see Endnotes).

oz: Ounce(s). The abbreviation 'oz Au' means Troy ounces of gold (see Endnotes).

Royalty: A portion of the production or proceeds from a mineral property paid to an owner or interest holder of the property.

Section: A 1 square mile (640 acres) area of land within the U.S. public land Rectangular Survey System. Sections are numbered from 1 to 36, with 36 Sections forming a Township.

SME: Society of Mining, Metallurgy, and Exploration, Inc., which is headquartered in Littleton, Colorado.