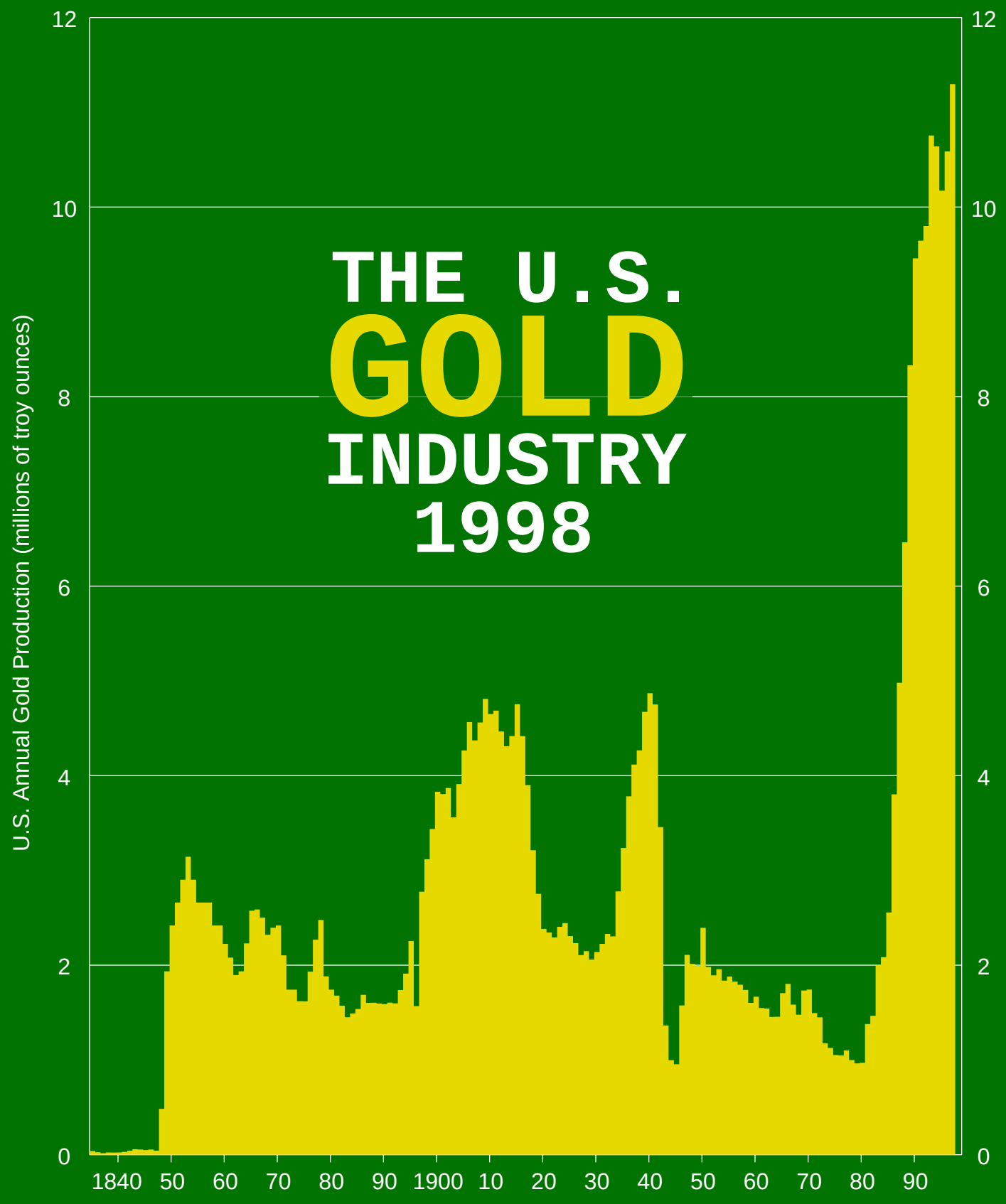
THE U.S. GOLD INDUSTRY 1998



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THE U.S. GOLD INDUSTRY 1998

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CONTENTS

Preface 3
Overview 4
Economic impacts 5
Trends in production costs 10
Total costs 15
Regulatory issues and mining law reform 20
Royalties 20
Economic rents 23
Mineral tax incidence: Who ultimately pays the tax? 24
Other policy issues 25
Industry outlook 25
Acknowledgments 32
References 32

PREFACE

This is the fifth edition of this monograph on the U.S. gold industry and as in the case of previous editions, its primary purpose is to provide an overview of economic impacts and general developments in the industry. Also as in previous editions the presentation follows the standard paradigm used in economic analyses of industries, focusing on industry structure, conduct, performance, and public policy affecting the industry. This is a somewhat different perspective than other studies of the gold industry in the U.S. or worldwide. This is not intended to be a detailed analysis of gold markets, for example. Gold Fields Mineral Services (GFMS) (Murray and others, 1998) and numerous other financial analysts track gold market developments, world mine supply, investment and fabrication demand, and worldwide movements of above-ground stocks in much more detail than is attempted here. These events are briefly commented on below but are not the primary focus. Similarly, this study does not examine geological issues associated with the industry except when these geological and technical issues have material implications for industry structure, conduct, and performance as it has at times in the past.

The industry structure, conduct, performance, and public policy paradigm focuses first on the sizes and numbers of firms in the industry and the concentration of production among these firms, i.e., industry structure. Second, the focus is on the conduct of firms in the industry or the nature of competition among firms. In this case conduct involves an examination of exploration activities since this is one way firms in the industry compete for raw materials or reserves. Conduct in the industry also involves merger and acquisition activity, which has been another very viable means of acquiring reserves in the industry over the past several years. In addition, as a result of the sharp decline in gold prices over the past two years, another important aspect of conduct in the current market has involved cutting production costs. All of these forms of competitive conduct are critical to the ability of firms to attract investment capital.

Third, the focus on performance is a focus on profitability. In the current low price environment, as discussed below, industry profitability has suffered although not as much as share prices and market capitalizations. Moreover, with the cost cutting seen in the industry over the past two years it is poised to achieve levels of profitability not seen in the U.S. industry since the 1930s if prices were to return to the levels of 1995 and early 1996. Whether this will happen is a matter of speculation, of course, and will depend on a wide variety of international events.

Finally, the focus on public policy issues, which has been a major topic in previous editions, once again examines the status of mining law reform in the U.S. Congress. As noted in the 1996 edition (Dobra, 1997), fundamental mining law reform issues are less critical to the industry's structure, conduct, and performance than in the early 1990s when fairly drastic changes were being considered in Congress. Nonetheless, these issues remain alive and efforts to enact regulatory changes to accomplish the goals of failed proposed statutory changes remain relevant.

Also as with previous editions of this monograph, the methodology relies on collecting data on the industry and compiling it to provide a view of overall industry structure, conduct, and performance. Most of the data used in this report are from publicly available sources such as Securities and Exchange Commission (SEC) filings, company annual reports, and some U.S. state and federal sources. A confidential survey of producers was conducted, however, primarily for the purposes of collecting standardized data on production costs. A total of 17 North American precious metals producers accounting for 95 percent of primary U.S. production, or 9.8 million ounces of gold, responded to the survey. Another key area of data collection in the survey concerned exploration, development, and capital expenditures. Since the data were collected with assurances of confidentiality and the purpose of this study is to overview the structure, conduct, and overall performance of the industry, these data are reported only in aggregate.

OVERVIEW

The years 1997 and 1998 were trying times for the world and U.S. gold industry. Falling gold prices are clearly the driving force behind changes in the industry. Prices have been shaken by events in Europe associated with the creation of the new European Central Bank and the float of its new currency, the Euro, as well as monetary disruptions in Asia. As a result of these events, gold prices have reached 20-year lows in nominal terms and the lowest price in inflation-adjusted terms since 1972. This price decline spurred expected results among North American producers with operations in the U.S.: a profit squeeze, cost cutting, corporate consolidation, and considerable concern in local economies supported by gold mining in the U.S. and in other major producing countries. In addition, falling prices appear to have fundamentally changed many producers' strategies, shifting their focus from the accumulation of new reserves to cost cutting and the acquisition of "quality" reserves, i.e., gold that can be produced at low cost.

With these developments hanging over the market, 1997 and 1998 were years of contrasts. Declining prices were contrasted by rising U.S. and world output as mine capacity grew with the completion of construction of new mines and expansions at existing mines begun before prices declined. Hence, output grew by virtue of momentum that cannot be sustained in the long run at current prices. Overall, world production in 1997 grew 4.6 percent while U.S. production grew 6.7 percent with increases in U.S. production accounting for over 20 percent of the increase in world output (Murray and others, 1998).

Another contrast can be seen in the way U.S. producers have reacted to the current low price environment in comparison to producers from other nations. In the U.S., producers have largely focused on cutting operating costs. Based on the survey conducted for this study, total cash operating costs (which includes taxes and royalties) for U.S. producers, as reported in further detail below, have declined from $256 per ounce in 1995, to $234 in 1996, $214 in 1997, are projected to be under $190 for 1998. Producers in other countries have focused on lowering operating costs as well, and achieved significant progress by various means. Producers in South Africa and Australia have benefited in this regard by declines in their respective currencies, lowering the South African rand and Australian dollar denominated costs relative to U.S. dollar denominated gold prices. U.S. producers have been victims, relative to producers in other countries, of both declining gold prices and a strong U.S. dollar.

Following the initial decline in gold prices in late 1996, there was relatively little corporate restructuring and merger and acquisition activity in the U.S. in comparison to South African producers. One significant exception was the merger of Newmont Mining and Santa Fe Pacific Gold to create North America's largest producer under the management of Newmont. However, as discussed below, this merger has created some significant cost-saving synergies useful in this period of low prices. In South Africa, in contrast, the industry has undergone a substantial corporate transition from their traditional mining finance-house model to a corporate model more similar to that found in North America.

As price declines reached more severe proportions and stretched out over time into 1998 and 1999, however, North American companies have become more active in restructuring and acquisitions. These activities have included mergers of medium sized companies such as Kinross and Amax Gold to create larger, million-ounce producers, as well as proposed mergers of juniors such as Rayrock and Glamis to create more viable corporate structures in the current environment. In addition, some of the stronger major North American producers such as Barrick, Placer Dome and Homestake have made some significant outright acquisitions of properties in the U.S. (e.g., Placer Dome's acquisition of Getchell Gold), in Canada (Homestake's acquisition of Prime Resources), Australia (Homestake's acquisition of Plutonic Resources) and South America (Barrick's acquisition of Arequipa and bid for Argentina Gold). Further, 1998 saw the first major initiative by a North American company in South Africa in recent times with Placer Dome's proposed joint venture partnership with Western Areas.

In addition, because of their higher costs, foreign exchange related advantages and different investor mindsets, Australian producers have generally increased their hedge positions as protection against further price erosion. With a weakening rand, South African producers have also become more active hedgers, but not to the degree of Australian producers. This is not to say that North American producers have not hedged their production since several producers, Barrick Gold, Placer Dome and Cambior, to name a few of the most active, have earned substantial premiums over spot prices through their hedge programs. These hedge positions, however, were established before prices eroded in 1996 and 1997 and reflected long-standing policies of these producers. As prices have declined, opportunities to earn these premiums have evaporated.

Other North American producers that have historically maintained no, or minimal, hedging programs are now seeking some degree of downside price protection through the purchase of put options contracts. However, the difference is a matter of degree. At year-end 1997 the output of the Australian industry as a whole for the next 34 months had been sold forward (Murray and others, 1998). In contrast, during late 1997 and early 1998 North American producers accounting for over a third of U.S. output unwound their forward sales suggesting an apparent belief that prices had reached their bottom. Part of this contrast can be explained by relative incentives created by currency movements with both the South African rand and the Australian dollar falling against the U.S. dollar. Nonetheless, while hedging future production at prices below $300 per ounce might have appeared unwise or "unnatural" to some industry analysts in 1997 and 1998, the longer the price remains below this level, the more likely other North American producers are to seek some down-side protection through hedging.

Still another contrast in the world industry has been the response to the profit squeeze resulting from falling prices. Low prices and the resulting profit squeeze has caused significant concern in local economies supported by gold mining in the U.S. However, these concerns have yet to materialize in the form of major layoffs or shutdowns. This is not to say that there have not been effects from falling prices. Direct industry employment in the U.S. precious metals mining industry has declined by over 2,000 jobs and direct plus indirect job losses are estimated to be on the order of ten times that figure primarily as a result of a decline in exploration and development activity. As of mid-1998, however, only three U.S. gold mines had announced plans to close immediately and these were associated with the bankruptcy reorganization of Pegasus Gold. Others, such as Vista Gold's Hycroft Mine, have announced imminent closures unless prices improve and still others, such as Homestake's Pinson Mine, have announced shutdowns of part of their facilities as cost cutting moves. More commonly, producers have announced postponements of exploration and development activities pending price increases. While these job losses and reductions in investment are clearly a matter of concern in local economies supported by gold mining, the damage has been relatively minor in the face of a 15 percent decline in year-over-year gold prices.

This observation on the effects of falling gold prices on regional economic trends in the U.S., however, depends entirely on where one looks. Montana's precious metals industry has clearly been hit hardest with the closure of two of Pegasus Gold's mines in that state. On the other hand, the opening of Amax Gold's (now part of Kinross) Fort Knox Mine north of Fairbanks, Alaska has provided significant stimulus to that local economy. Meanwhile, in Nevada, which accounts for approximately 70 percent of U.S. production, the major impacts have mostly been felt in exploration and development activity. There have been some layoffs of production workers at various mines, and these are likely to continue to mount as long as prices remain below $300 per ounce.

ECONOMIC IMPACTS

As noted, the decline in gold prices has yet to have a significant impact on overall industry output and employment. Layoffs at producing mines have been estimated to be in the range of 1,200 to 1,500 and, when combined with several closures of individual properties associated with the Pegasus bankruptcy reorganization, direct job losses are estimated to be around 2,000. While these losses are relatively small in proportion to total direct employment in the industry, because the losses have been localized geographically at mines closed in Montana and Idaho, local communities have clearly been impacted. In addition, because of the concentration of the industry in north central and eastern Nevada where there is relatively little other basic, or export oriented, economic activity, even these job losses have been the cause of serious concern in the local communities dependent upon the gold mining industry.

In addition to the localized impacts of production job losses another area of the industry that has sustained significant economic losses as a result of price declines is in the exploration sector. Exploration by the companies surveyed for this study excludes numerous junior producers and exploration companies. Worldwide exploration by the surveyed companies increased in 1997 to $500.6 million from $443.9 million in 1996. As with production increases in 1997, however, these increases reflect momentum of increases in previous years. These increases were followed by a 30.6 percent decrease in 1998 to $347.7 million and a projected further decrease in 1999 exploration budgets of 44.2 percent,

to $194.0 million. Hence, the momentum in exploration expenditures of the previous years has clearly reversed itself in this low price environment as would be expected. As discussed below, as a result of sharp declines in the market capitalizations of producers, the industry is approaching the point where it is cheaper to acquire reserves by corporate acquisitions than by exploration if, indeed, we have not reached that point already.

The overall trend of declining worldwide and U.S. exploration expenditures is supported by a survey of 51 companies conducted by the Nevada Division of Minerals (Driesner, 1998). These respondents, which included junior companies and pure exploration companies, reported a 32 percent decline in exploration expenditures in Nevada where the bulk of U.S. exploration is conducted. Budgeted expenditures in Nevada for 1998 were $94 million compared to $139 million in 1997. These same companies projected a similar decline in worldwide exploration expenditures for the same period, spending $767 million in 1998 versus $1,083 million in 1997.

Exploration in the U.S. by respondents to the survey of major North American producers conducted for this study accounted for approximately 25 percent of their worldwide exploration in 1996 at $113.3 million. The U.S. share of worldwide exploration increased slightly in 1997 but is projected to decline in 1998 and 1999 as shown on figure 1. Part of the projected decline in U.S. exploration is the result of the fact that three of the larger companies responding to the survey declined to offer a projection for 1999 based on the lack of internal budget projections. However, it should be noted that even interpolating the missing data does not reverse an unmistakable trend. Exploration spending in the U.S. is projected to fall at current price levels both in total and as a percentage of the total.

Based on these trends alone, it is not possible to conclude that the declining share of worldwide exploration expenditures projected for the U.S. is the result of a perceived increase in political risks in the U.S. There are those in the industry that have clearly raised this issue and, indeed, threats of royalties and increased regulatory burdens related to the acquisition of permits to conduct exploration on federally owned lands in the U.S. certainly play a role in companies' exploration investment decisions. Moreover, it should be noted that the decline in exploration activity and development in the U.S. relative to other parts of the world began before 1996 when prices began to decline. Political risk considerations simply exacerbate an already weak market and reduce economic stimulation of local economies from exploration activities.

What is clear, however, is that the decline in exploration activity has and will continue to have an economic toll in local economies. For example, the projected decline of $63.1 million in exploration expenditures by the major North American producers surveyed for this study from 1997 to 1998 will have both direct and indirect impacts in local economies. Based on the weighted average multipliers for precious metals mining derived from the RIMS II multiplier system (U.S. Bureau of Economic Analysis, 1992), this decrease in exploration will result in a loss of 1,275 total jobs, a reduction in total output of $118 million, and a loss of $35.7 million in household income in economies dependent upon precious metals mining. There will also be subsequent reductions in state, local and federal tax revenues from these developments as data from Nevada are already indicating.

Another economic impact of the current low price environment is the loss of construction jobs generated by the build-up in industry during 1995 and 1996. During this period

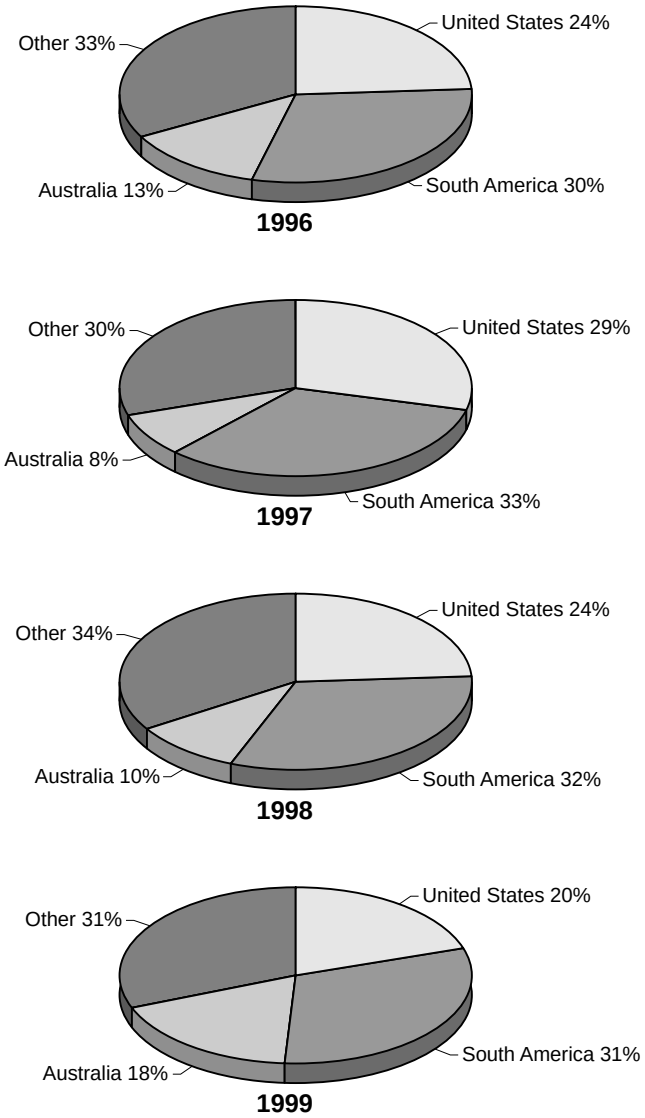

Figure 1. Allocation of gold producers' exploration expenditures, 1996–1999.

expenditures on capital development in the precious metals industry was in excess of $1 billion per year and, as reported in the previous edition of this study, generated an additional 21,600 direct plus indirect jobs in the affected local economies (Dobra, 1997, page 10). Hence, the loss of these jobs is an additional impact of the low price of gold in the affected states.

Tables 1 and 2 provide a breakdown of U.S. gold and silver production by state and the estimated economic impacts based on the RIMS II multiplier system. Estimates of gold and silver production are derived from numerous sources including company reports of production at various mines, reports of state agencies, and the U.S. Geological Survey (USGS). Because gold and silver are produced at hundreds of locations ranging from small placers operated for recreation to large scale commercial operations producing in excess of one million ounces, production is difficult to estimate precisely. Consequently, for total gold production reported on table 1, we have relied on the estimates of GFMS (Murray and others, 1998). In the case of silver production, GFMS's estimate is the same as USGS (U.S. Geological Survey, 1998) at 53.3 million ounces; however, company and state agency reports used to compile table 1 indicate several million more ounces of primary and by-product silver production. The most significant increase in silver production has come from the Greens Creek polymetallic mine in Alaska reaching full production (Alaska Department of Natural Resources, 1998).

U.S. gold and silver production in 1997 (table 1) was up by 11.1 and 12.6 percent, respectively, over levels reported for 1995 in the previous study, and the total value of production down marginally, 3.6 percent. Gold production, as indicated at the outset, largely increased on the momentum of investments in capacity expansions started before prices began decreasing in late 1996. Silver production increases, on the other hand, resulted from a combination of reopening some closed mines in the Silver Valley around Coeur d'Alene, Idaho associated with strengthening of silver prices in the latter part of 1997 and mid-1998, and the reopening of the Greens Creek Mine in Alaska noted above.

In the case of changes in the value of gold and silver output, declines in both gold and silver prices were partially offset by higher production levels of both metals. Overall, the value of precious metals output declined 3.6 percent. However, the marginal decline in value nationwide reported above glosses over some significant differences between different states. Alaskan production, for example, benefited from both the reopening of Greens Creek and the opening of the Fort Knox Mine just north of Fairbanks. As a consequence of these developments, the Alaskan economy has seen an almost five-fold increase in the value of output. Since economic impact multipliers are driven by the value of production in the local economy, the impacts of precious metals mining on employment, local output, and household incomes in Alaska have increased by the same order of magnitude. Hence, in spite of lower metal prices, areas of Alaska's economy dependent upon mining are doing well compared to 1995 and 1996 levels. Whether this state of affairs will continue, of course, depends upon future metals prices.

At the other extreme are states that have suffered because of the decline in metals prices and subsequent effects on local mining. Three such examples of economic

Table 1. U.S. gold and silver production and value, 1997

	Gold Production		Silver Production		Total
State	**(oz)**	**($1,000)**	**(oz)**	**($1,000)**	**($1,000)**
Alaska	590,516	195,632	14,401,160	70,566	266,198
Arizona	8,681	2,876	0	0	2,876
California	776,420	257,220	377,400	1,849	259,069
Colorado	230,000	76,197	0	0	76,197
Idaho	231,580	76,720	12,898,230	63,201	139,921
Montana	321,060	106,364	820,400	4,020	110,384
Nevada	7,853,000	2,601,620	24,700,000	121,030	2,722,650
South Carolina	120,890	40,050	0	0	40,050
South Dakota	500,200	165,711	161,398	791	166,502
Utah	779,770	258,330	4,200,000	20,580	278,910
Other	94,174	31,199	0	0	31,199
Totals	11,506,291	3,811,919	57,558,588	282,037	4,093,956

decline in mining based local economies are Arizona, Montana, and South Dakota. Arizona experienced a sharp decline in revenue from precious metals production between 1995 and 1997 and currently has no primary gold or silver production of any significant commercial size. Almost all Arizona precious metals production is a by-product of copper production, and precious metals have traditionally been a very small proportion of the value of that production. Hence, the decline in precious metals prices has not been responsible for a serious economic slowdown in that state. However, low precious metals prices have combined with copper prices that are also at the lowest levels experienced since the mid-1980s to add to concerns about the viability of mining-based rural economies in Arizona. These concerns have been heightened by the write-down of the bulk of the assets acquired from Magma Copper by BHP in rural southeastern portions of the State. However, Arizona has a much larger and more diversified economy than the other states under discussion other than California, so the overall economic damage done to Arizona by recent metals prices is relatively minimal.

The situation in South Dakota is similar to Arizona in that the impacts of slowdowns in the mining based economy are regional. Precious metals production in South Dakota is confined to the Lead area in the Black Hills region in the extreme western part of the State, where Homestake Mining's Homestake Mine is the primary producer. The Homestake Mine had produced continuously from 1876 (except during World War II) until recently, when low gold prices forced its operator to cease underground mining. The operator still produces from a near-by "open-cut" (open-pit) mine and continues to process stockpiled ore, but placed underground mining operations on hold until gold prices improve and/or a new mining plan can be implemented. Clearly, however, unless prices improve, the mining-based economy of Lead will suffer a significant blow.

The situation in South Dakota and, to a greater extent, Montana, is more serious than Arizona where the numbers of displaced miners are fairly small in comparison to the State's more diversified urban economy. In contrast, in 1997 Montana ranked forty-sixth in the nation in terms of income per capita at 78 percent of the national average, and ahead of only Arkansas, New Mexico, West Virginia, and Mississippi (U.S. Bureau of Economic Analysis, 1998b). Hence, replacing relatively high paying lost jobs in mining may prove to be a problem. The problem is compounded by the fact that rates of population growth in both South Dakota and Montana are below the national average, which tends to indicate a weak construction industry and fewer employment opportunities for workers exiting the mining industry.

These economic impacts can be seen more clearly on table 2, which shows overall U.S. impacts and impacts by state based on the U.S. Department of Commerce's regional impact modeling system (RIMS). Overall total employment derived from the sector declined to 82,435 in 1997 compared to 90,270 in 1995, a decline of approximately 7,800 jobs, or 8.7 percent. Similarly, economic impacts measured in terms of increased overall economic output and contributions to household earnings in the respective states declined relative

Table 2. Economic impacts of U.S. gold and silver production, 1997

State	Jobs Multiplier	Jobs	Output Multiplier	Output ($1,000)	Earnings Multiplier	Earnings ($1,000)
Alaska	13.9	3,700	1.7724	471,809	0.5103	135,841
Arizona	31.8	91	2.4518	7,051	0.8130	2,338
California	18.5	4,793	2.0508	531,300	0.5646	146,271
Colorado	36.2	2,758	2.6351	200,786	0.6961	53,041
Idaho	22.1	3,092	1.8165	254,167	0.5305	74,228
Montana	25.2	2,782	2.0217	223,163	0.5844	64,508
Nevada	19.0	51,730	1.7843	4,858,025	0.5484	1,493,101
South Carolina	24.5	981	1.8595	74,472	0.5301	21,230
South Dakota	25.5	4,246	1.8352	305,565	0.5768	96,038
Utah	32.8	9,148	2.6325	734,231	0.7782	217,048
Other	20.5	639	1.8868	58,865	0.5632	17,573
Total		83,962		7,719,396		2,321,335
Weighted Average	20.5		1.8868		0.5632	

to 1995 estimates. Economic output from the precious metals industry and induced by the industry declined 2.6 percent from 1995 levels, and household incomes derived from precious metals production declined by 5.7 percent. These differing percentage declines in employment, output, and household income reflect differential multipliers in the respective states. Hence, reductions in the value of output in states like Montana with relatively well developed mining industry related infrastructures and relatively high multipliers are not made up for by increases in the value of output in states with less well developed infrastructures and lower multipliers like Alaska and Nevada.

Nevada remains the main producing state and, consequently, the place where the major economic impacts of the industry are felt. Nevada production increased by approximately 800,000 ounces in 1997 over 1996 to 7.9 million ounces (Price, 1998) and is expected to increase again in 1998. However, because of lower prices, reduced exploration and other cost cutting measures adopted by precious metals producers in Nevada, the overall measures of economic impacts stayed about even with 1995 estimates. Estimated direct plus indirect employment in Nevada derived from precious metals production in 1997 was 51,730 jobs, as shown on table 2, versus 51,460 in 1995. Similarly, the impact of precious metals mining on Nevada overall economic output and household earnings also shows slight increases for 1997 over 1995. Economic output and household income derived from precious metals mining in Nevada increased by slightly more than 0.5 percent between 1995 and 1997.

These estimates, however, are somewhat misleading since direct employment in Nevada is down slightly from 1995 levels and most available casual economic indicators for primary gold producing areas of the State are negative. The RIMS methodology merely reflects the fact that percentage growth in Nevada output has slightly more than off set decreases in metals prices. This ignores substantial decreases in exploration and development expenditures discussed below.

As noted above, Alaska benefited from a substantial increase in output of both gold and silver. With these production increases, the value of Alaskan output rose from $54.5 million in 1995 to $266.6 million in 1997 and generated proportional increases in economic impacts. The 3,700 jobs, the contribution to State output of $471.8 million and $135.8 million the contribution to household earnings in Alaska represents almost a five-fold increase over 1995 levels.

For both Alaska and especially Nevada, precious metals mining makes a significant contribution to their overall economic health. In Nevada, the $4.9 billion in precious metals mining and mining induced output represents approximately 9 percent of total 1996 Gross State Product (U.S. Bureau of Economic Analysis, 1998a). In addition, in all likelihood, although sub-state data are not available, precious metals mining accounts for the majority of economic activity in the north central and north eastern parts of the State. In Alaska, the relative impact of precious metal mining is smaller, but still significantly greater than other states, with the $471.8 million in output accounting for almost 2 percent of Alaska Gross State Product.

At the other end of the spectrum are the three states noted above where production has declined sharply, Montana, Arizona, and South Dakota. The value of precious metals production in Montana dropped from $180.7 million in 1995 to $110.4 million in 1997, or 38.9 percent, and is expected to show further decreases for 1998 and for the foreseeable future at current prices. This downward trend in Montana is likely to be accelerated by the passage of a November 3, 1998 ballot initiative banning the use of cyanide in metals extraction at new mines. If this initiative withstands legal challenges, it will make it very unlikely that new mines will be opened in the state. However, if a sufficiently high grade deposit were found, it would still presumably be possible to mine the ore, concentrate it, and ship it out of state for processing. This, however, would minimize the economic benefits of precious metals mining to Montanans.

Similarly, since 1995 Arizona's only primary gold producer of any size has closed and the production indicated on table 1 is a by-product of copper production. Like Montana, there is little indication that this trend in Arizona will be reversed. Finally, in the case of South Dakota, the value of precious metals output fell 22.8 percent between 1995 and 1997 but, in this case, the outlook is less certain. The Homestake Mine contains a significant gold resource of over 2.5 million ounces at $350 per ounce, and the company is examining new mining plans that would allow the mine to restart operations.

As indicated by tables 1 and 2, Colorado is not a significant precious metals producer. However, Colorado deserves some comment because numerous precious metals mining, exploration, and consulting firms are located in the Denver metropolitan area, and precious metals mining clearly has a much greater impact on the Colorado economy and the Denver metropolitan area economy than indicated by the tables. Further, since firms of all types tend to look for cuts in non-production personnel first, precious metals mining executive and support jobs in the Denver area are clearly vulnerable. Recent corporate downsizings and restructurings at firms located in Denver and other regional mining centers such as Reno, Salt Lake City, and Spokane have resulted in two-thirds or more of their corporate staffs cut in some cases.

TRENDS IN PRODUCTION COSTS

As noted at the outset, much of the attention of industry executives during 1997 and 1998 has been directed toward cutting production costs and, almost across the board, they have been quite successful. The discussion below focuses on both the magnitude of these cuts and their implications for the future, in particular, their implications for the industry's reserves.

Figure 2 shows trends in "total cash" production costs in the U.S. gold industry from 1989 to 1998 based on previous studies and survey data collected for this edition. Following the accounting convention established for the industry, "total cash" production costs include both direct production related costs such as extraction, processing, and on-site administration costs and nonproduction-related obligations such as state and local government production taxes when they are imposed and royalties. Following this accounting convention, "cash costs" excludes the latter two obligations since these can vary substantially between properties and are not production costs.

Excluded from both "total cash" and "cash" costs are off-site costs such as depreciation and depletion, corporate overhead expenses, exploration and development expenditures, and federal income taxes. The accounting convention adopted in the industry for defining "total production costs," or "total costs," also excludes all of the above except mine specific depreciation. Consequently, reported "total costs" only includes costs associated with production at a particular site and excludes costs incurred by other general corporate activities including off-site exploration. Even though these other "non-cash" costs must ultimately be covered by revenues generated by production, they are excluded from the definition of total costs because they are the result of a wide variety of corporate level activities.

All but one major North American producer reports cash and total costs, i.e., "total cash" plus non-cash costs and these are shown below on figures 3, 4 and 5. Reporting of these costs is a form of competition among firms that is relatively unique to the minerals industry and, as such, is a

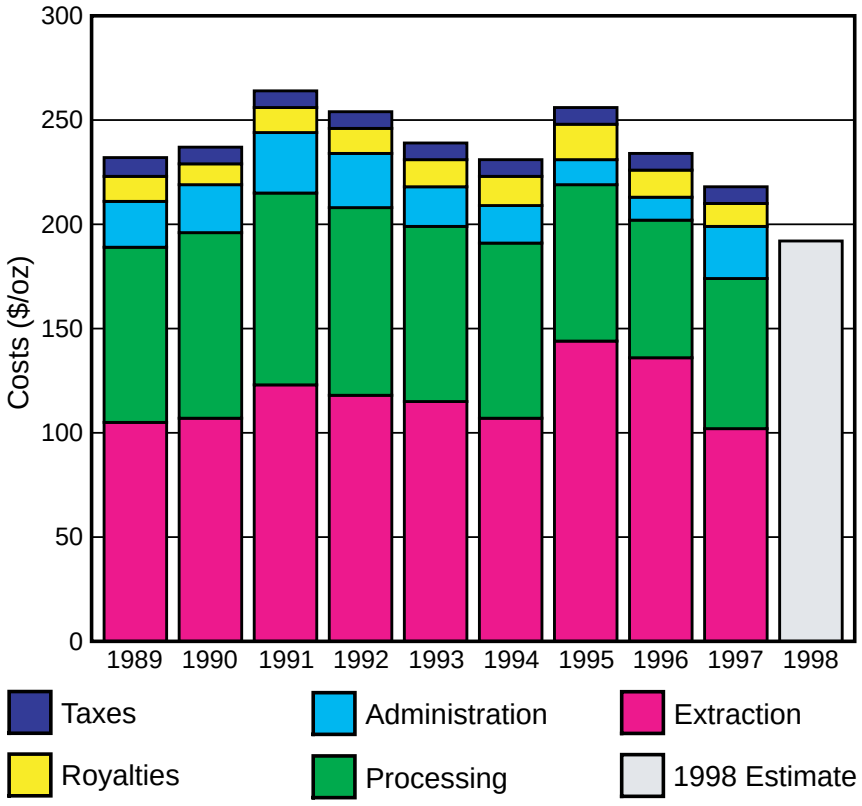

Figure 2. Average total cash costs, 1989–1998.

relatively unique aspect of industry conduct. Firms routinely report costs and especially if they are a low cost producer as an inducement to investors, particularly in periods of low prices. In periods of higher prices in the recent past, firms have tended to put more emphasis on their reserves and reserve growth. This emphasis on production costs and reserves is a response to analysts' focus on financial indicators such as cash flow per ounce of production, i.e., sales price less total cash costs, and ounces of reserves per share of stock. These indicators are interpreted as representing the relative financial strength of producers, their potential short and long term profitability, and, hence, their attractiveness as an investment.

The openness of virtually all North American producers with the investment community contrasts somewhat with practices in the world industry prior to the 1980s. The older, more conventional approach in the industry to attracting capital was based on the belief that "gold sells itself" and, by extension, shares of stock in gold mining companies. Information on production costs and financial results has been available from sources such as the London-based *Mining Journal* and other sources since the 1930s. However, the industry's need to attract substantial sums of capital in the 1980s to finance its expansion and the decline in prices from their heights in the early 1980s brought the issue of production costs to the forefront as an indicator of competitiveness. Interestingly, in the current survey, companies refusing to disclose costs were companies with backgrounds in the copper industry where openness is more the exception than the rule.

The most obvious feature of figure 2 is the downward trend in cash production costs over the past three years including estimated costs for 1998 following an 11.2 percent increase in costs in 1995. Table 3 provides the accompanying numerical data for the figure through 1997. For 1996 the decline in costs largely reflects the effects of properties under development in the previous year reaching capacity and achieving planned cost levels. The decreases in 1997 and 1998, on the other hand, reflect aggressive cost cutting efforts noted at the outset that were put into effect after prices started to decline in late 1996. As prices continued to fall and failed to recover through the third quarter of 1998, cost cutting pressures have intensified throughout the industry worldwide.

Table 3. Cash and long-run average total costs in dollars per ounce at U.S. gold mines, 1989–1997

	1989	1990	1991	1992	1993	1994	1995	1996	1997
Extraction	105	107	123	118	115	107	144	136	102
Processing	84	89	92	90	84	84	75	66	72
Administration	22	23	29	26	19	18	12	11	25
Cash Costs	211	219	244	234	218	209	231	213	200
% Change		3.8	11.4	-4.1	-6.8	-4.1	10.5	-7.8	-6.1
Taxes									
Property	2	2	3	3	3	3	3	3	5
Mining	7	6	5	5	5	5	5	5	3
Total Taxes	9	8	8	8	8	8	8	8	8
Royalties	12	10	12	12	13	14	17	13	11
Total Cash Costs	232	237	264	254	239	231	256	234	219
Non-Cash Costs	na	101	na	77	na	86	51	47	75
Total Costs		338		331		317	307	281	294
Ave. Price	381	384	362	342	360	382	384	384	331
% Change		0.8	-5.7	-5.5	5.3	6.1	0.0	0.0	-13.8

na - not available

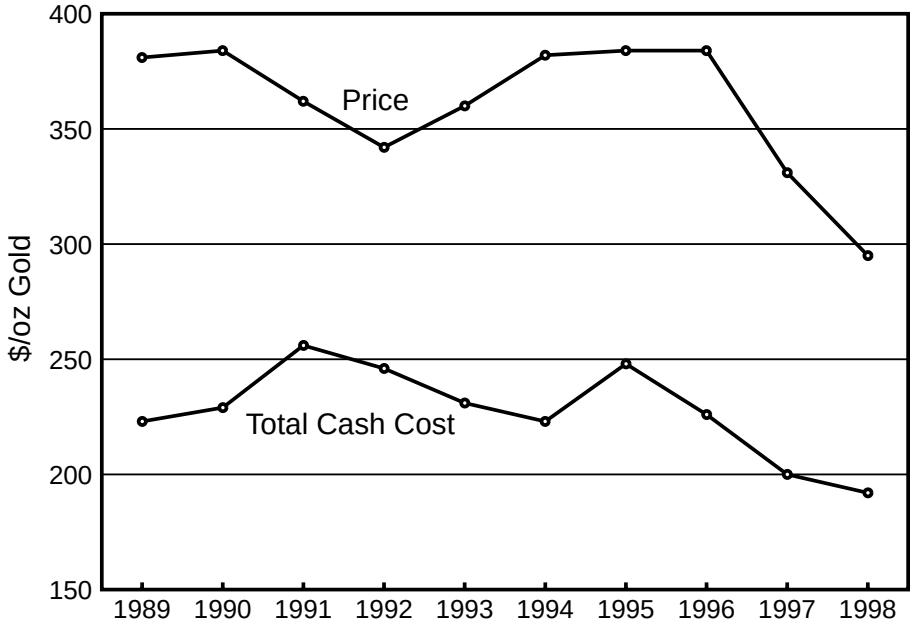

Figure 3. Average total cash production costs and average annual prices, 1989–1998.

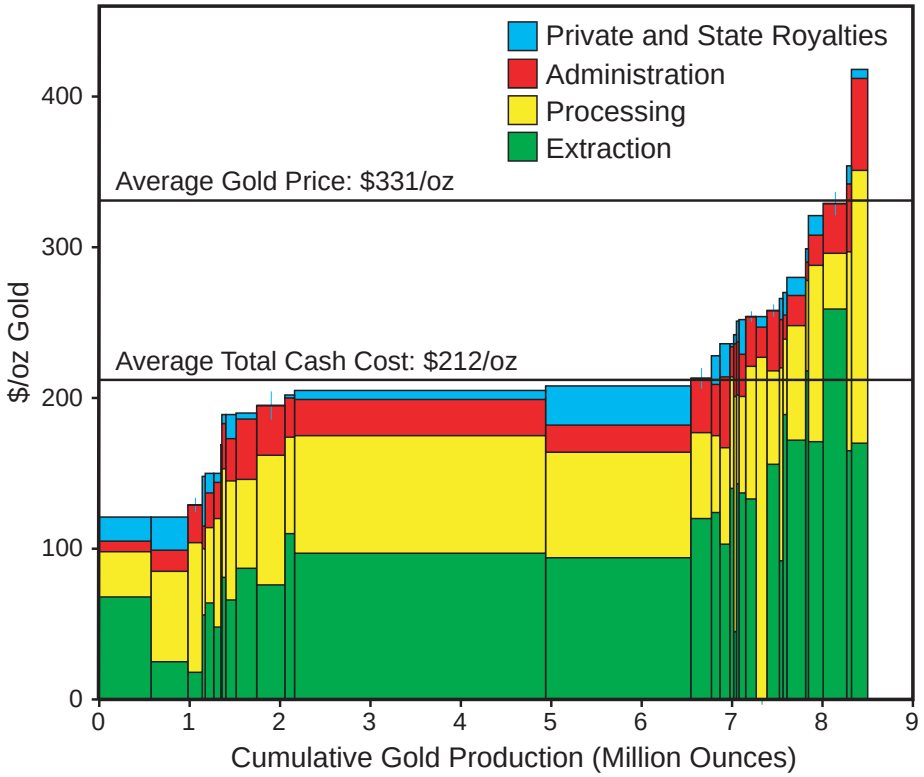

Figure 4. Total cash cost of production at U.S. gold mines in 1998.

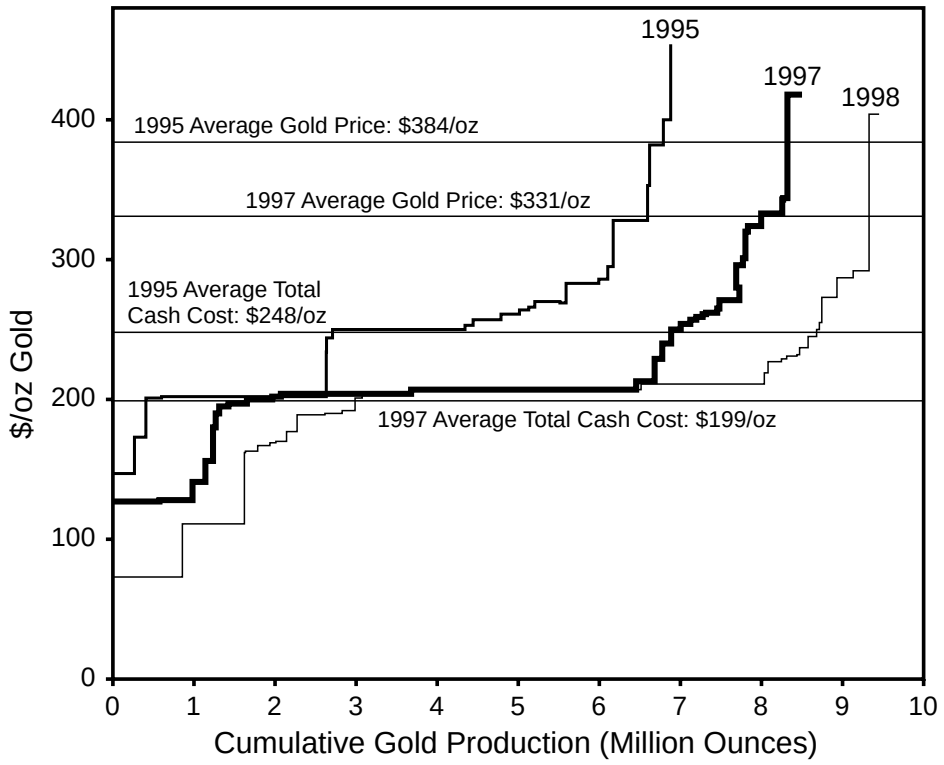

Figure 5. Average total cash production costs in 1995, 1997, and 1998.

Cost cutting in the U.S. has been matched by producers in other major producing countries. One of the most clear indications of this and the way it is being accomplished can be seen in a review of the World Gold Analyst (Burton, 1998) which provides operating data for 70 percent of the world's gold production. Overall, 46.8 percent, or nearly half of the mines reporting sufficient information (59 out of 126) showed an increase in head grade in the most recent periods (the second and/or third quarters of 1998) over 1997. Although this source does not provide sufficient detail to verify the presumption, it is very likely that this increase in grade of material processed is the result of either stockpiling lower grade ores and/or directing mining activities to known higher grade areas. This "high grading" will lower production costs but it does so at the expense of a shortened mine life unless prices rise substantially.

A second fairly obvious trend illustrated by figure 2 and the accompanying table is the correlation between production costs and prices. Over the period covered there have been two major cycles in the price of gold. The first of these bottomed out in the fall of 1992 in the mid-$320 range, and the second is the most recent cycle which has seen gold prices begin falling in late 1996 to the $270 range in 1998. In each case, industry's lagged response has been to cut costs accordingly to maintain the margin between price and costs. As indicated by table 3 and figure 3, following the price declines in 1992, cash costs fell 3.9, 6.1, and 3.5 percent in 1992, 1993 and 1994, respectively. Similarly, while the reduction in cash costs in 1996 were more a reflection of increased utilization of increased capacity, cash costs have fallen again in the most recent price down turn by 11.5 percent in 1997 and by a projected 14.5 percent in 1998. Figure 3 clearly illustrates the margin between prices and cash costs and the lagged relationship.

This latter relationship between gold prices and production costs carries several interesting implications for the overall market, both the gold and gold equities markets and the outlook for U.S. producers more generally. Numerous times over the past couple of years the decline in gold prices has been described or forecasted in the business press as falling toward its production costs with the implication that prices should be in the low $300 range. While this explanation or forecast has some fundamental reasonableness and probably works for almost any other good, it does not really fit the facts of the gold industry and ignores the fundamental dynamic between prices and costs. As prices have fallen in each cycle, costs have fallen by more, if not immediately, then cumulatively in the following years

of the cycles. Hence, while prices may fall toward production costs in the short run, the implication that prices can stabilize based on their relationship to production costs is incomplete. Many other factors are involved, particularly since annual mine supply only accounted for about 58 percent of 1997 supply or sales, and is less than 2 percent of total potential supply including identifiable above ground stocks. This "potential supply" includes 4.3 billion ounces of gold held in identifiable above ground stocks, over one billion ounces, or 23.7 percent, of which is held by governments and central banks (Murray and others, 1998, p. 30).

There is a clear causal relationship between prices and costs and production but the logic that mine production costs drive prices is backwards since over 50 times annual world mine production could be supplied to the market at no mining cost. Hence, gold production "would appear to have" very little impact on prices. Rather, prices reflect the willingness of private investors and central banks to hold the metal as an asset.

The relationship between prices and costs derives from several factors but primarily from producers' ability to select higher grade materials to process. If producers do not have higher grade materials as is the case some low grade operations, they stop mining but continue processing stockpiled materials if available. Either course of action reduces cash costs and increases cash flow. In the latter case, production will generally begin to decline and, of course, the longer the period of time mining is stopped the more certain and the larger the decline will be. In the case of processing higher grade materials, however, the opposite may occur. Processing the same quantity of higher grade material will likely increase production while decreasing costs.

This gain in lower costs and higher output, however, comes at the cost of lost future production or, to put it differently, a shorter mine life from existing ores at current prices. In selecting this course of survival in a low price environment producers are raising their current cut-off grade, i.e., the lowest grade of ore they will process, and reclassifying lower grade "ores" or "reserves" as "waste." For these lower grade materials to be reclassified back to reserves, future prices will have to be not only higher than their current low level, but frequently prices will have to higher than they were when the materials were originally classified as ore. For many U.S. mines this will require prices over $400 per ounce. This situation results from the fact that producers are mining the higher grade material during the current period of low prices that they were counting on mining in the future along with lower grade materials and that made the lower grade materials worth mining and processing. Hence, without a significant price increase or technological breakthroughs, these lower grade materials may be permanently lost, or wasted.

It is frequently pointed out that an orebody is a "wasting asset" because the asset is depleted by the act of mining it. The act of mining the resource, however, provides scarce resources to society and represents a social gain. The permanent reclassification of ore to waste, on the other hand, represents a social loss since these scarce resources will not be available for the foreseeable future.

Figures 4 and 5 provide another perspective on cash costs in the industry and changes in cash costs over the past several years. Figure 4 shows total cash production costs broken down by type of cost, e.g., extraction, processing, administration and private and state royalties, for 31 producing mines. Each vertical bar on figure 4 represents an individual mine with the exception of the widest bar on the figure that represents the complex of Nevada mines operated by Newmont. This bar actually represents 10 separate open-pit and underground mines operated as a unit. That is, the ore from these mines are processed at common facilities making it difficult, if not meaningless, to assign anything other than extraction costs to an individual mine because of the synergies generated by the process.

With this exception, the width of each vertical bar on figure 4 reflects the output of a mine and the height represents costs broken down by the components shown. The cumulative output of the mines represented is shown on the horizontal axis and is approximately 8.5 million ounces or approximately 80 percent of primary U.S. production. Missing from this group are several medium sized mines from companies that refused to disclose operating costs broken down as shown on the figure and smaller placer operators primarily in Alaska and California. Figure 4 represents all but approximately one-half million ounces of U.S. gold produced from lode mining operations or about 94 percent of total lode or "hard rock mine" supply.

One thing figure 4 illustrates quite well is the degree to which output in the U.S. gold industry is concentrated in a few mines and producers. The widest bar on figure 4, as indicated above, represents Newmont Mining's Nevada complex. The second and third widest bars on the figure represent two adjacent mines operated by Barrick Gold, Goldstrike and Meikle, which are also adjacent to the bulk of Newmont's Nevada operations. These two Barrick mines and Newmont's Nevada complex account for almost 5 million ounces, or 43.9 percent, of U.S. production. The next largest producing mines, Echo Bay and Homestake's Round Mountain Mine in central Nevada and Placer Dome and

Kennecott's Cortez Mine combine for another 856,000 ounces of production. Hence, the production of the top five mines (and complex of mines) is approximately 5.8 million ounces, or 51 percent of U.S. production.

On a corporate basis, U.S. production is similarly concentrated. The largest U.S. producer, Newmont, produced just over 3 million ounces in 1997, or 26.6 percent of total U.S. production. The second largest producer, Barrick Gold, produced 2.48 million ounces in 1997, or 22 percent of U.S. production. Hence, the top two producers accounted for approximately 5.5 million ounces, or 48.5 percent of U.S. production. The top five producers, which would add a distant third largest Placer Dome (680,300 ounces), Homestake (532,400 ounces) and Echo Bay (518,500 ounces) account for 7.2 million ounces, or 63.9 percent of U.S. production. In addition, 6.36 million ounces of the production of these five companies, and 56.3 percent of U.S. production, comes from Nevada and most of this from a 150-mile-square area in the north central part of the state.

Figure 5 shows total cash costs from U.S. mines without the breakout of cost components for mines for which data is available for 1995, 1997, and 1998. Each of the irregular stair-step "curves" represents the top of its corresponding bar chart like figure 4. Two fairly obvious features illustrated by figure 5 are the shift in the curves to the right, reflecting increased production, and the downward shift reflecting lower costs. In the case of increases in production which result in a longer curve, a fraction of the rightward shift between 1995 and 1997 came from better participation rates in the survey of producers. However, the majority of the shift is due to increases in production associated with new mines coming into production. Since data for both 1997 and 1998 come from the same survey, all the shift reflected between these years came from new mines coming on line and reaching full capacity in 1998.

The downward shift of the curves shown on figure 5 reflects the cost cutting discussed above. As long as prices remain below $300 we can expect these curves to continue to shift downward and, as marginal production is shut down, to shorten to reflect decreased production.

Total Costs

A related implication of the upward trend in ore grades concerns the estimation of long-run total production costs. In previous studies, and in accordance with accepted conventions in mineral economics, long-run average total costs have been calculated on a life of mine, present value of discounted cash-flow basis. In this calculation both cash costs, discussed above, and non-cash costs were included. The latter primarily includes depreciation of capital investments in plant, equipment and mine development. Using this conventional cost modeling approach, the calculated long-run average total cost represents the break-even price for a mine, i.e., the minimum price it must receive over its life to recover all costs and earn a modest rate of return on investment. In previous studies the modest rate of return on investment used to discount future cash flows was 9 percent. This rate is low for an industry that faces as much risk as gold mining as recent experience illustrates. Indeed, most producers would use discount rates several times higher than 9 percent in a feasibility study on a mining project. However, the choice of a discount to calculate an internal rate of return in investment depends on a variety of factors.

Among the more important factors in the choice of a discount rate are investors' price expectations and risks. Because investors seeking exposure to gold price risks have historically held expectations that prices would rise, they have tended to accept lower rates of return calculated with current prices. This bias in the expectations of investors has resulted in low levels of profitability in the industry even during periods, such as 1995 and 1996, of higher prices.

On the other hand, required rates of return are also affected by geological, political and other risks. Investors in projects with relatively little political and geologic risks such as in Nevada, with a relatively friendly government and proven mineral potential are generally willing to accept lower risks. Investors in projects in Russia, Africa, Asia, Indonesia and, perhaps, Montana, would require substantially higher rates of return.

The current situation presents a significant problem for the application of this methodology because of the nature of available data on ore reserves that would be mined over the life of currently producing properties. Data on ore reserves used in this analysis are from company Security and Exchange Commission (SEC) filings as of year-end 1997. Under SEC reporting rules, producers can only report that they have "proven" reserves that have a 90 percent probabilility of being mined and processed on at least a break-even basis. "Probable" reserves, on the other hand, are defined as materials that have a 75 percent probability of being mined and processed on at least a break-even basis. In both cases, reserves are estimated at a specified price that the producer may reasonably expect to receive for output based on either current market prices or expected future production that has been sold forward at a fixed price.

The current low price environment brings reported proven and probable reserves into question. Table 4 shows

Table 4. Reported U.S. gold and silver proven and probable reserves, year-end 1997

State	tons of ore (1,000)	Gold grade (oz/ton)	Gold oz (1,000)	Silver oz (1,000)
Alaska	192,564	0.038	7,236	156,195
California	81,761	0.034	2,768	0
Idaho	27,031	0.031	850	63,943
Montana	38,315	0.044	1,701	0
Nevada	1,402,397	0.068	94,980	111,235
South Carolina	W			
South Dakota	13,574	0.205	2,784	0
Utah	W			
Washington	10,039	0.187	1,876	0
Other	226,000	0.024	5,429	na
Totals/Aves.	2,000,417	0.059	118,399	331,373

na - not applicable
W - withheld

Table 5. Prices used for estimating year-end 1997 reserves.

Price (US$/oz)	Percent
400+	1.6
375+	13.0
350+	72.6
335+	3.6
325+	2.5
300+	2.7
Not available	3.4

proven and probable reserves reported by 22 North American companies with U.S. operations broken down by state. These data are for primary gold and silver producers only; they do not include by-product production from copper mines. As indicated, the vast majority of gold reserves are located in Nevada with 94.98 million ounces of reserves, or 80 percent of total reported reserves. Alaska is a distant second with 7.24 million ounces.

These reserves are estimated by producers using standard geological modeling techniques in which geological information obtained by drilling are combined with a mine plan to estimate how much material can be processed and how much metal can be recovered. Mine plans and reserve estimates are dependent upon an assumed cut-off grade, which, as noted above, is dependent upon the price. Aggregating the data on the prices used in the industry for estimating reserves (see table 5) indicates that 73 percent of the reserves were estimated using a price of $350 per ounce, over 20 percent above the actual price for most of 1998. Almost 15 percent of reserves were estimated using a price above $350, most generally, $375 per ounce, almost 30 percent higher than the actual price. About 9 percent of reserves were estimated using prices below $350.

The data on prices used for estimating reserves are not, in and of themselves, cause for general concern since using estimates over the current price could be justified by a hedging policy that guarantees higher prices for future production. Indeed, at the time these reserve estimates were being prepared, $350 and even $375 were reasonable estimates. Hence, to see if these prices result in an overstatement of reserves, one would first have to match prices used to estimate reserves against producers' hedge positions.

In addition, even if a producer were not hedged, one would have to look at the sensitivity of reserves to prices and cut-off grades. This sensitivity is likely to vary significantly between mines and producers are not required by the SEC to provide information on the sensitivity of reserve estimates to prices. In the dozens of filings examined to compile the above, only two producers mentioned the issue and, in one of these cases, the producer simply stated that a $350 price was used but that reserves were not reduced significantly at $325. The other producer indicated that its reserves would be reduced by 32 percent if calculated at a price of $300.

While we lack the detailed geological information on every mine to determine reserve sensitivity, an indirect means of estimating sensitivity is available. The reserves reported on table 4 can be contrasted with an estimate of approximately 170 million ounces of reserves reported as of year-end 1995 and in the previous edition of this study. Like current reserves, 1995 reserves were estimated at a range of prices by producers, but it is believed that most used prices in the $400 per ounce range. This also does not suggest a problem or misrepresentation since, throughout 1995 and much of 1996, gold was generally in the $380 to $390 range and producers could, and many did, hedge future production from stated reserves at prices well over $400.

Between year-end 1995 and 1997 approximately 22 million ounces of gold were mined in the U.S. leaving approximately 148 million ounces of the 170 estimated at year-end 1995 in the ground. Consequently, the shift from a $400 estimated price to a $350 price reduced reserves 30 million ounces to the 118 million ounces shown on table 4. This reflects a 20 percent reduction in reserves without netting out new reserves discovered during the period that would cause the percentage reduction in reserves to be even greater if they were included. This oversight of newly discovered reserves, however, is not likely to be significant since the pace of discovery of new reserves has slowed sharply during this period because of the factors discussed above. This oversight also yields a more conservative estimate of reserve/price sensitivity. Indeed, analysis of capital development expenditures below indicates that only 3.2 million ounces of new reserves associated with new projects are currently under development compared with 42.3 million ounces put into capacity in the previous two-year period.

The data on prices used for estimating reserves and the interaction between prices and reserve estimates do, however, raise concerns about the estimates of long-run average total costs based on these reported reserves. If we examine the percentage change in reserves divided by the percentage change in price, we can estimate the sensitivity of reserves to price changes in the range of $400 to $350 used for reserve estimates in 1995 and 1997, respectively. This measure is similar in its interpretation to the price elasticity of demand in that it shows the percentage decrease (increase) in reserves with respect to percentage change in price. Over this period gold prices used to estimate reserves decreased 6.7 percent while reserves, net of production, decreased 11.3 percent for a ratio of 1.69. In other words, a one percent decrease in price resulted, on average over this period and price range, in a 1.69 percent decrease in reserves.

Extension of these results to the use of even lower prices to estimate reserves is complicated by the lack of detailed geologic and mining engineering data on individual orebodies. The estimate above simply reflects reserve sensitivity in the $400 to $350 per ounce price range. Reserve elasticity outside of that price range may well be greater.

Table 6. Trends in heap-leach and mill production, 1996-1999				
	1996	**1997**	**1998**	**1999**
Heap-Leach Processing				
Tons processed (1,000)	269,597	265,012	197,537	167,186
Percent of total	74.7	73.5	68.6	53.9
Gold production (1,000)	3,263	3,665	3,221	3,257
Percent of total	27.0	26.7	24.1	28.7
Mill Production				
Tons processed (1,000)	91,184	95,601	90,365	143,269
Percent of total	25.3	26.5	31.4	46.1
Gold production (1,000)	8,821	10,081	10,143	8,074
Percent of total	73.0	73.3	75.9	71.3

Further, orebodies with equal estimates of contained ounces but with higher proportions of higher grade ore will exhibit lower degrees of reserve sensitivity to price changes than orebodies with larger quantities of lower grade materials. The analysis is also complicated by the validity of our estimate of year-end 1995 reserves. With the caveat that the implied sensitivity of reserves to prices estimated above only applies in aggregate and may not apply to even lower prices, the implied impact on reserves of using $300 to estimate reserves reduce estimates by an additional 30 million ounces. Netting out an additional 10 million ounces produced in 1998 from these reserves, would result in a year-end 1998 reserve estimate of approximately 80 million ounces compared to the 118 million indicated by table 4 and 170 million at the end of 1995.

An analysis of the sensitivity of this estimate to the estimate of 1995 reserves and newly discovered reserves was conducted to ascertain the reasonableness of the estimate. This sensitivity analysis indicates that 80 million ounces at year-end 1998 is at the lower end of estimates and that an estimate in the 85 to 95 million-ounce range is most probable. Nonetheless, this still constitutes a substantial loss of reserves due to lower prices.

Further insight into the sensitivity of reserves to prices can be gained from an examination of table 6, which shows a breakdown of heap-leach and mill production based on the survey of U.S. producers. As the table indicates, the vast majority of ore processed is heap-leached while the vast majority of gold produced is from mill production. Since these leach-grade ores are generally more vulnerable to reclassification to waste or to being stockpiled in hopes of future price increases because of their lower grades, production from leach grade ores is the primary object of concern in the discussion above.

It should be noted that total production reported on table 6 exceeds U.S. production because a small proportion reported is from non-U.S. mines as a result of misunderstanding by some respondents. It should also be noted that since completing the questionnaire, some of the respondents have publicly announced reductions in planned heap-leach production. Hence, data for 1999 probably understate mill production as a percentage of the total and, consequently, overstate heap-leach production for that year. Nonetheless, the data shed light on the situation in the short run and indicate that the estimate above of 85 to 95 million ounces appears reasonable since close to three-quarters of production is coming from ore that is less likely to be affected in the current low price environment.

Based on these considerations, however, there are serious questions about the meaningfulness of a life of mine discounted cash-flow analysis to determine long-run average total costs. Under the circumstances, this type of analysis would yield misleading results. Even though it is the correct methodology, because it would have to be applied to incorrect data, it would tend to overstate both cumulative production and costs. As a consequence, in the discussion of total costs below, the focus is on short-run costs that conform more closely to accepted accounting definitions.

As a result of these considerations, total cost estimates shown on table 3 for 1996 and 1997 reflect short-run average

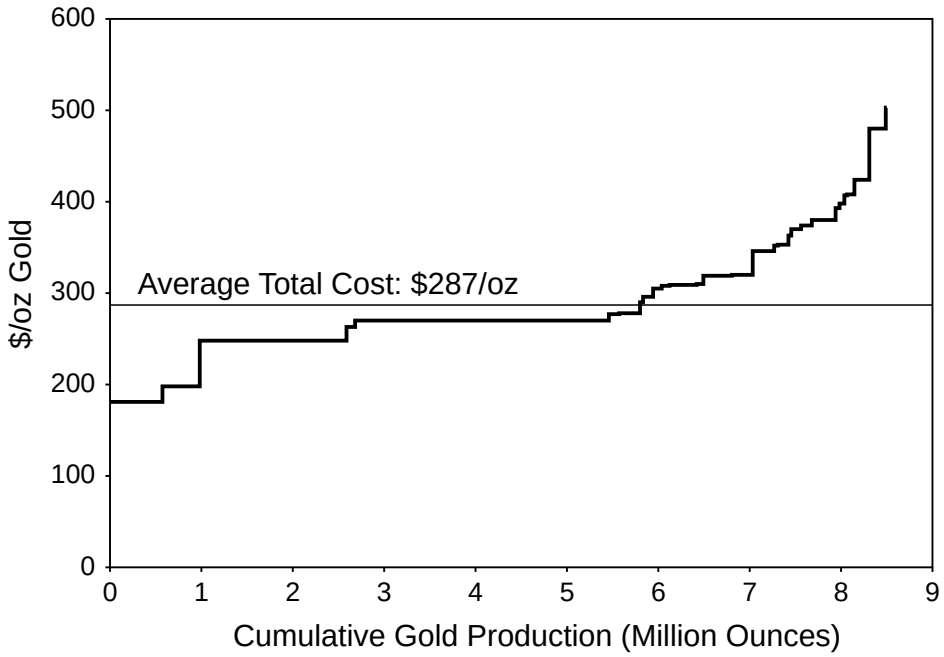

Figure 6. Average total production costs, 1997.

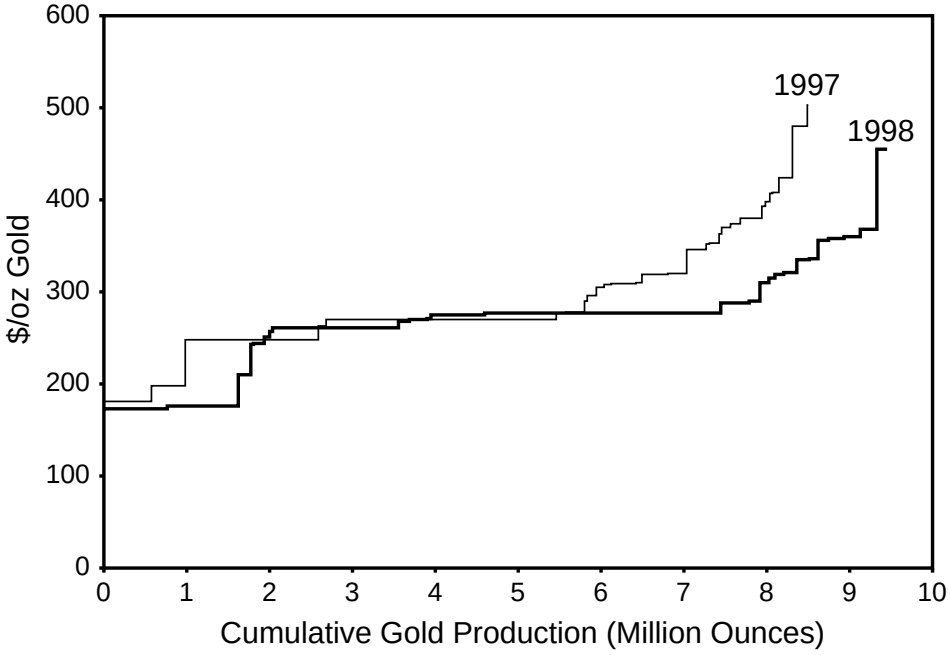

Figure 7. Average total production costs, 1997 and 1998.

total costs. This definition is also followed for individual mine total cost calculations reflected in figures 6 and 7. Short-run average total costs, unlike long-run average costs are not discounted and simply reflect current total cash costs defined above plus current depreciation and amortization. Figure 6 shows short-run average total costs for 1997, and figure 7 shows short-run average total costs for 1997 and estimated costs for 1998. Like figure 5, which showed reductions in total cash costs and increases in output in recent years, figure 7 also illustrates both of these trends in relation to average total production costs. As indicated above, as long as prices stay below $300 and even in the low $300 range, costs can be expected to continue to trend downward as producers adopt new mine plans, delay development of new ore zones for future production, and achieve greater efficiency through other means.

In some cases, industry consolidation may play a role in achieving cost reductions. Aside from the fairly obvious effect of consolidation in reducing administrative overhead expenses per ounce of production, other synergies can result. For example, one consequence of Newmont's acquisition of Santa Fe Pacific Gold has been to allow ten separate mines with processing facilities for oxide, sulfide, and carbonaceous ores, to be operated as a unit. In practical terms, this has allowed Newmont to allocate ores of various types from these mines to the most efficient existing processing facilities in the area and maximize recovery. This combination has allowed Newmont to close redundant processing facilities, which lowers costs while increasing output. In the future, it will also allow Newmont to develop new orebodies in the area without incurring additional capital costs for processing facilities, thereby lowering future non-cash costs.

REGULATORY ISSUES AND MINING LAW REFORM

Discussions of policies toward and regulation of U.S. mineral producers has been the subject of debate for much of the past decade. These discussions generally relate to one of two issues: environmental regulations and revenue generation. Both of these issues have surfaced again in recent congressional deliberations and have raised concern in both corporate boardrooms and in local economies supported by mining.

Since Congress and federal regulatory agencies have the most power to affect exploration and mining activities on unpatented lands, various segments of the mining industry are affected differently by federal actions. The copper and base metals industry tend to operate older mines that have been granted patents, i.e., ownership of surface rights, and stand to be less affected by federal actions. Similarly, older gold and silver mines also tend to operate on patented lands and are also somewhat insulated from federal actions. Newer mines and expansions at older mines, however, which sought operating permits after the imposition of a patent moratorium in early 1990s, are much more exposed to political risks. In addition, exploration activity for all hard-rock minerals is exposed to a greater degree of political risk, because most future mineral development will occur on unpatented lands unless the current moratorium is lifted.

The following discusses the major issues that are currently being deliberated in Congress: efforts to enact production royalties and generate revenues for the federal government and efforts to change regulations that affect access to federally owned lands for exploration purposes.

Royalties

In the U.S., royalties have traditionally been paid to landowners for the right to extract minerals from their lands. This followed the practices in Europe where royalties were paid to the crown or national government as owner of subsurface rights. The difference on this side of the Atlantic, however, was that in many cases land grants and sales provided individual land owners "fee simple title" to their lands, meaning that they owned both surface and subsurface rights. This policy was generally followed in the U.S. until just after the turn of the twentieth century when federal land disposal acts began to reserve title to subsurface rights for the federal government (Coggins and Wilkinson, 1981). In addition, of course, the federal government retains title to all federal lands administered by the U.S. Department of the Interior and the U.S. Forest Service.

The issue of land ownership is crucial to understanding the gold industry since 87 percent of Nevada, the largest producing state and main target of exploration, is owned by the federal government. Under U.S. mining laws, an individual may acquire title to hard rock mineral rights by exploring federal lands open to mineral entry, staking and

recording claims, developing the resource into an economically viable mine, and, of course, applying for and receiving the appropriate permits from federal, state, and (in some cases) local regulatory agencies at each step along the way. Prior to the above mentioned patent moratorium, the mine operator would apply for "patent," i.e., ownership of surface rights after demonstrating diligent development of an economically viable, i.e., profitable, mine.

The granting of patents has been a source of controversy because under U.S. mining laws the price of these surface rights was set at $2.50 per acre in 1872 and has remained at that level. This has evoked accusations of "corporate welfare" and prompted some to call for reform of the 1872 Mining Law. During Congressional debates on mining law reform, however, mining industry representatives have a longstanding offer on the table to pay fair market value for surface rights. This offer, along with other reforms, such as a royalty on mineral production, have been repeatedly rejected. Proponents of reform seek more far-reaching modifications to the mining laws, and the apparent giveaway involved in paying $2.50 for land that may be worth hundreds per acre helps draw attention to the issue. The revenue generation potential of sales at the time of patenting at fair market value is minimal, however. Much of the land in question is in remote areas with little agricultural or other value and would be worth very little on an open market. Consequently, the controversy over $2.50 per acre land sales is largely symbolic.

A potentially more significant revenue generation issue, however, is the payment of federal royalties on mineral production. As noted above, current mining laws allow an individual to stake a claim and acquire subsurface mineral rights on federally owned lands. At this point, as noted in a previous edition of this report, potentially valuable property is transferred from the federal government to an individual or corporation free of charge. Defenders of the status quo argue that, first, locating minerals can be very expensive and the transfer of the mineral right is a reward for an investment that may ultimately benefit the public. While true, this line of argument does not explain why the federal government as a landowner should not receive a royalty when a private mineral right owner on a possibly adjacent piece of land generally would receive a royalty.

Second, and partially in response to the above, defenders of the status quo argue that governments benefit from the wealth created by mining in ways not available to private royalty recipients. Most notably, the government may tax the corporate profits derived from mining as well as the incomes that individuals derive directly and indirectly from mining. This second line of argument usually leads into discussions of the tax treatment of natural resource extraction industries and, in particular, the depletion allowance, but more generally from the perspective of reformers, the failure of these industries to compensate the federal government as a landowner for the minerals transferred.

As a consequence of the lack of a clear and logical argument against a federal royalty, the issue has repeatedly surfaced. One attempt to impose a federal royalty was incorporated into the federal budget that was vetoed and caused the federal government shutdown in 1995. Although there were other issues at stake to prompt the veto, these issues were mentioned as a cause in the press. Another attempt came in the last days of 105th Congress (September 1998) to impose a 3 percent net smelter return (NSR) royalty on gold and a 2 percent NSR royalty on other hardrock minerals. The deal, reportedly, and not surprisingly, was being brokered by non-gold producers who largely produce from patented claims (which would be exempt from royalties) and Senator Dale Bumpers, who retired at the end of the session and who had sought a royalty for years. No doubt, the issue will be alive in future sessions so a brief review of royalties in the U.S. and around the world is warranted.

Historically, landowners were generally granted NSR royalties in the range of one to five percent. The magnitude of the royalty generally depended upon the quantity and quality of the information on the potential orebody in question. The greater the potential for an orebody that could be mined relatively cheaply would command a royalty at the higher end of the range and perhaps higher than 5 percent in unusual circumstances.

A NSR royalty is a somewhat dated industry term that is paid on the final sales price of the mineral less, in the gold industry, refining fees, which are generally less than $1 per ounce. Hence, in the modern context, an NSR royalty is essentially a gross royalty because the royalty is equal to the royalty rate times the price of gold less one dollar (or less).

The term is further outdated with respect to gold and silver since they are not smelted like copper (except when produced as copper by-product). Gold is processed at mine sites down to metal (doré) bars or buttons which are shipped to a refinery, where the various constituent metals in the doré bars are separated to produce 99.99 percent pure gold and silver. In contrast, at the time NSR royalties became common in the industry, high-grade gold ore was frequently shipped directly from the mine to a smelter with no, or minimal, processing. The smelter then deducted all processing fees from the value of the contained metal and

paid the mine owner an amount reflecting what represented the "net proceeds" of the mine. The NSR royalty holder then received an agreed upon percentage of this payment. Hence, the NSR royalty truly was a "net" royalty before mining and processing were vertically integrated into modern mining companies.

Based on this practice, in the 1860s the Nevada Constitution established a tax on "net proceeds" defined as the value of the metal recovered minus all production costs, which was similar to the base for calculating an NSR royalty. Nevada law, however, allowed the deduction of mining costs. This method of taxation has remained in place and is generally defended on the basis that it approximates a tax on "economic rents." That is, it does not distort the economic incentives of producers and lead to the wasting of economic resources as a tax on gross proceeds would do.

While there are still many NSR royalties in existence as a consequence of past practices, the practice of negotiating royalties in the U.S. precious metals industry is shifting away from "net smelter" royalties to royalties based on some measure of profitability. In some cases basing royalties on profitability is as simple as establishing a sliding scale. For example, a rate of 5 percent can be paid if sales prices are over $400, a rate of 3 percent on prices between $350 and $400, and a rate of 2 percent below $350. In other cases, mineral leases may specify a flat percentage of the sales price less certain costs making the royalty similar to the Nevada Net Proceeds of Mines Tax.

Average royalties paid in the gold industry in 1997 were approximately $10.80 per ounce of production, or 4.2 percent of the 1997 average price of $331. This figure represents the average royalty paid by all producers whether or not they that actually paid royalties. Average royalties paid by producers that actually paid royalties were $13.76 per ounce or 4.16 percent of the average 1997 price of $331 per ounce. The overall royalty bill for the industry was above 3.3 percent of the value of all production because over 20 percent of 1997 production was royalty free. The fact that a royalty is currently paid on some 80 percent of production is another source of opposition to a federal royalty in the industry since many will then pay double royalties.

Data collected for the 1996 edition of this study showed that almost 90 percent of U.S. production came from patented claims. These data were not collected in the survey for this edition but based on other information, approximately one million ounces of annual capacity brought into production since 1996 comes from unpatented claims. Hence the percentage of U.S. production coming from unpatented claims has increased slightly, but very likely remains less than 20 percent. Assuming 20 percent of production would be subject to royalties, this would amount to approximately 2.25 million ounces valued (at $300 per ounce) at $675 million. It should be further noted that, at $300 per ounce gold, this sum is not likely to increase in the future and is expected to diminish over time.

Based on these assumptions, a one percent NSR royalty on this sum would, consequently, generate $6.75 million and a 3 percent NSR approximately $20.25 million. The revenue generation potential of a royalty is further diminished by the fact that the royalty will likely be deductible for purposes of calculating state, local and federal taxes. Hence, the actual net revenue realized by the federal government will be even less than estimated above and some of that revenue will reflect transfers of revenues from state and local governments that are already being adversely impacted by current low prices. In either event, the revenue generation potential of the imposition of a federal royalty is very limited and can hardly justify the lobbying expenses of a royalty's proponents or, for that matter, devoting congressional resources to the issue.

With such limited revenue generation potential, proponents can make a similar argument that the industry should simply agree to pay the royalty and, to some extent, this has happened. The major producers have agreed to pay a royalty but the issue has changed from whether to pay a royalty to what kind of royalty. This issue is economically significant because the future impact of a royalty in the form of further erosion of reserves, diminished exploration activity in the U.S. relative to other countries, and losses in economic output, jobs and household incomes could equal the actual net revenues transferred to the federal government.

Examining the prospect of a potential federal royalty raises the issues of the form and level of the royalty. In this context, a royalty is analytically indistinguishable from a tax except that it would only be levied on minerals produced from claims that are currently unpatented and mines that may be developed in the future on federally owned lands or privately owned lands where subsurface rights have been reserved by the federal government.

Mineral production has long been an inviting target for taxation by U.S. states and by national governments around the world. Part of the attraction of mineral taxation is that many view minerals as national patrimony or the property of the sovereign and, hence, the tax is payment to the sovereign government and people for their property.

In most places in the world except the U.S., governments own mineral rights so this rationale has merit. In the U.S., as noted, ownership of mineral rights is mixed with private

landowners holding mineral rights in most of the eastern U.S. and the federal government retaining mineral rights in much of the western U.S. In addition, many places in the developing world either do not have general business taxes or these taxes are minimal, so direct taxation of minerals is the only means of generating revenues from mining operations for the host nation. This rationale for mineral taxation has less credence in the U.S., however, since well developed codes for business and personal income taxation exist.

Another attraction of mineral taxation is the commonly heard observation that mines are immobile sources of wealth. While it may be true that the mineral deposit is immobile, there is ample evidence and numerous examples of the fact that mining capital, including both technical expertise and investment funds, is highly mobile. Hence, this rationale for mineral taxation appears short-sighted by threatening future economic activity.

Academic treatments of mineral taxation vary somewhat on their view of optimal tax systems for mineral resources, however, as a practical matter, these differences are minor. In developing nations, authors (Garnaut and Ross Clunies, 1983) have suggested that since minerals are part of the national patrimony, mineral taxes should maximize revenues to the government. Another characterization of optimal mineral tax policy is that the tax regime should maximize the actual net value of the mineral to society (Mackenzie and Bilodeau, 1979). Note that this formulation of optimal mineral tax policy makes no distinction between government and private recipients of the proceeds of mineral resource development by including consideration of private incomes earned in the industry as well as taxes.

Another formulation of optimal mineral tax policy holds that pragmatic tax policy goals should be 1) maximization of resource based revenues, and 2) maximization of the total wage bill generated from extraction and processing industries. In the short term, these objectives would appear to be in conflict. However, in the long run, these goals are highly consistent. A pragmatic tax or royalty policy that will maximize both tax revenues and the wage bill generated by the extraction and processing of nonrenewable resources is a policy that will encourage efficient extraction of the resource, wasting as little as possible. This same policy will also maximize long-run employment in the industry (Church, 1981).

Consistent across all of these treatments of nonrenewable resource taxation policy is the conclusion that optimal tax policy should have a neutral effect on resource development decisions. That is, taxes should have no impact on decisions to open or close mines or other extractive operations. This has led virtually all analysts to focus on ways that taxes can extract the economic rents generated in the resource development and extraction process.

Economic Rents

In economic theory, economic rent is a payment above the minimum amount required to bring the resource into production. The rent is a return for simply owning the resource without any contribution to bringing the resource into production. Hence, rent is net of discovery costs, production (or cash) costs and net of a rate of return on investment sufficient to attract resources into the industry. While the concept of economic rent is intuitively straightforward, in practice it is extremely difficult to quantify. However, from the standpoint of optimal tax policy, a tax on pure economic rents will not distort producers' and investors' decisions and will lead to efficient extraction of resources.

Industry performance, or profitability, is discussed in greater detail below. However, suffice it to say that in the current low price environment very little, if any, rent is being earned in the precious metals industry. At higher prices, of course, rents would exist and their taxation would have little impact on the efficient extraction of resources.

It should also be noted that using standard financial reports to estimate rents can be misleading because some rents are paid in royalties to landowners (more commonly in the gold industry than any other) and then reported as costs to the producer which, in fact, they are. However, royalties are generally not pure economic rents either since, in most cases, royalty recipients incurred some discovery or acquisition costs and costs associated with auditing their royalties. Because of these difficulties in quantifying rents, as a practical matter, developing a royalty on pure economic rent is technically very difficult if, indeed, possible.

The upshot of these difficulties in defining rents is that mineral tax analysts have sought various means of approximating rents without reaching consensus on an optimal policy mechanism (Church, 1981, p. 294, for example). All agree, however, that in a competitive market, taxes should extract pure economic rents so that the tax system does not induce changes in the behavior of producers and investors.

An exception to this conclusion occurs when there are significant non-compensated resources affected by mining activity. That is, if mining has serious dilatory affects on environmental or other resources that are "external costs," i.e., costs not borne by producers. In debates over mining law reform in Congress this argument has been advanced by some in various forms. The general form of this argument

is the assertion that there is "too much mining" based on aesthetic or environmental grounds. Proponents of this perspective advocate a high royalty or tax on mining to improve the allocation of resources by closing marginal mines. This assertion, of course, is a purely normative assertion not subject to objective assessment, i.e., an opinion. Recent proposals to liquidate U.S. gold holdings at Fort Knox to drive down gold prices are based on similar motivations and logic.

This type of argument clearly had some merit in the era prior to the adoption of environmental protection and mining reclamation laws. If the actions of mining companies in the past are judged by today's laws and regulations, many might agree that some of the rents earned in that era should have been used to protect the environment and reclaim abandoned mines either through taxation or by requiring producers to meet standards. Yet, this argument also applies equally to many industries of that era and is not, therefore, a persuasive argument for a tax or royalty unique to mining. Further, in the context of judging today's mining companies, this argument is much weaker because, by law, mining is not permitted if it has a significant long-term impact on generally accepted environmental values.

Other areas of general consensus in the literature on mining taxes and royalties is the conclusion that taxes on output, which include all forms of severance taxes and NSR royalties, discourage conservation of resources (or encourage the wasting of resources). This occurs because these taxes generally induce producers to "high-grade" deposits and shorten their effective operating lives. Once a mine closes leaving low-grade material in the ground, it may never be economically feasible to retrieve the minerals and, therefore, they are wasted.

Of course, some types of taxes on output are less wasteful. More efficient forms of output taxes are those which 1) impose the tax as early as possible in the production process, at mine-mouth if possible; 2) are levied on the net value of the material extracted; and 3) provide a uniform rate of taxation for all minerals (Conrad and Hool, 1980, p. 72–73). Imposition of the tax at the earliest point in the process comes closer to taxing pure rents because it avoids taxing value added by later stages of the production process, i.e., processing and fabrication. However, a mine-mouth tax still taxes value generated prior to extraction by discovery and investment in development. Consequently, even a mine-mouth severance tax or royalty can lead to some distortion of producers' and investors' decisions and to some degree of high-grading and waste unless applied with some deductions for expenses.

Similarly, a tax levied on net value comes closer to taxing pure rent than a tax on tonnage (or other measure of output) because it will impose higher taxes on higher grade ores which generate more rent. Finally, providing a uniform rate of tax for all minerals avoids distorting investment decisions between different minerals and encourages efficient utilization of capital.

Mineral Tax Incidence: Who Ultimately Pays the Tax?

Ownership of the underlying mineral rights is an important issue in any discussion of the incidence of taxation of minerals because efficient severance taxes or royalties on minerals are taxes on pure economic rents and, as such, are borne by the landowner. Hence, the first point to be made with respect to the potential imposition of a severance tax or royalty on metals mined in the U.S. is that the burden will be borne by the landowner, i.e., the federal government. This burden will primarily be in the form of lost future tax revenues on corporate and individual incomes when the existence of a tax or royalty has an impact on cut-off grades, which is probably the general case.

This conclusion, however, hinges critically on the assumption that the tax is, in fact, a tax on pure economic rents. To the extent that the incidence of a tax falls on factors of production other than ownership, the tax is shifted to other resource owners, i.e., workers and owners of capital. The most obvious example of the shifting of tax incidence is the most extreme case. If a severance tax or royalty is onerous enough to close mines or shorten their lives, the burden is borne by the workers who lose their jobs and the owners of mining-specific capital. This would include the stockholders of the mining companies and those who benefit from the taxes paid by the mine and its workers when it operated. As a general rule, however, stockholders and upper management of mining companies will suffer the least of these groups if they are able to shift their capital to developing mines in other jurisdictions that do not have onerous taxes. But, by extension of these conclusions, the federal and other levels of government will experience reductions in tax revenues.

Similarly, if the tax precludes the development of new mines on federal lands, the burden of the tax is on all U.S. taxpayers, who own the land. They will suffer economically because their resources will not be developed and no taxes will be paid on the income generated. Offsetting this loss of economic value, it can be argued, are environmental values retained by the public by discouraging mining. This argument, however, begs several issues of fact discussed above.

Other Policy Issues

Perhaps the most significant other policy issue affecting the gold industry in the past two years concerns attempts by the U.S. Department of the Interior (USDI) to restrict exploration access to federal lands by promulgating new regulations. The controversy over so-called "3809" (43 CFR § 3809) regulations, which contain administrative rules for obtaining permits to enter and disturb federal lands, has once again raised the issue of delays in project development resulting from federal and state government permitting processes. Such delays have been the source of increasing complaints as the periods of time required to get necessary permits has increased over the past decade.

In this particular case, changes in regulations proposed by USDI would have changed the process involved in getting permits necessary to conduct exploration. Prior practice has required exploration companies to file a notice of intent to enter federal land for exploration purposes. If the intended area of disturbance was less than five acres, USDI had 30 days in which to evaluate the notice of intent and, if USDI had concerns, it could delay entry and require further filings. In either event, the exploration company was required to revegetate and recontour disturbed lands following standard reclamation practices. If, on the other hand, USDI did not respond within the 30-day limit, the company was free to conduct exploration.

The proposed regulatory changes would have required exploration companies to file a more detailed "plan of operation," which was currently required for larger than 5-acre disturbances. Eliminating the distinction between large and small scale disturbances did result in some controversy, but stronger objections arose from the fact that there was no time limit imposed on the Department's review of the plan of operation. This, in the view of opponents, raised the possibility of even greater delays in project development. On the other hand, the Department was concerned that many "small" disturbances could have the same aggregate impacts of a "large" disturbance and wanted more time to consider these cumulative impacts.

It should be recalled, however, that only less than one third of federal lands remain open to mineral entry as a result of numerous withdrawals for parks, recreational areas, wilderness, defense and various other purposes. Consequently, exploration activity of the type revision of the 3809 regulations targets is occurring on land that, after almost a century of land withdrawals, has been deemed as having no unique values or alternative uses that would preclude mineral development as one of multiple acceptable uses.

As with many policy debates involving the mining industry, the ultimate resolution has not been based on the merits of the matter. In this case, the Department adopted the regulations but they were later rescinded by the courts based on the process used to adopt them. Congress later referred the matter for further study so that the issue, like many facing the industry, remains an open issue.

INDUSTRY OUTLOOK

As noted at the outset, the U.S. gold industry's outlook is currently overshadowed by the outlook for gold prices. Much of the discussion above, for example, has focused on the ways in which the industry has reacted to low gold prices by cutting costs, and the effects of low gold prices on reserves and the outlook for future production. The future direction of gold prices, however, holds the key for answering questions about the industry's future. These questions include whether costs can and will continue to be cut, ultimately shrinking the industry's economic impact, costing communities jobs and governments tax revenues, shrinking the industry's reserve base, and, ultimately, shrinking the number of producers as a result of corporate consolidation and, in some cases, bankruptcies. These are fairly daunting prospects but, while they cannot be ignored, their discussion is premature.

Since gold prices are of such critical importance to a discussion of the outlook for the industry, a closer look at where prices have been over the past several years is worthwhile. Figure 8 shows average monthly gold prices from 1995 through 1998. After recovering from lows in the $320 per ounce range in late 1992, gold prices rose throughout 1993 to the $375 to $395 range where it remained until late 1996. Figure 8 shows the end of this three-year stay in the $375 to $395 trading range, and then the precipitous decline in prices that occurred in three distinct moves. The first of these moves occurred in late 1996, as prices fell from the $375 to $395 range to below $350. The second downward move occurred in the summer of 1997 to below

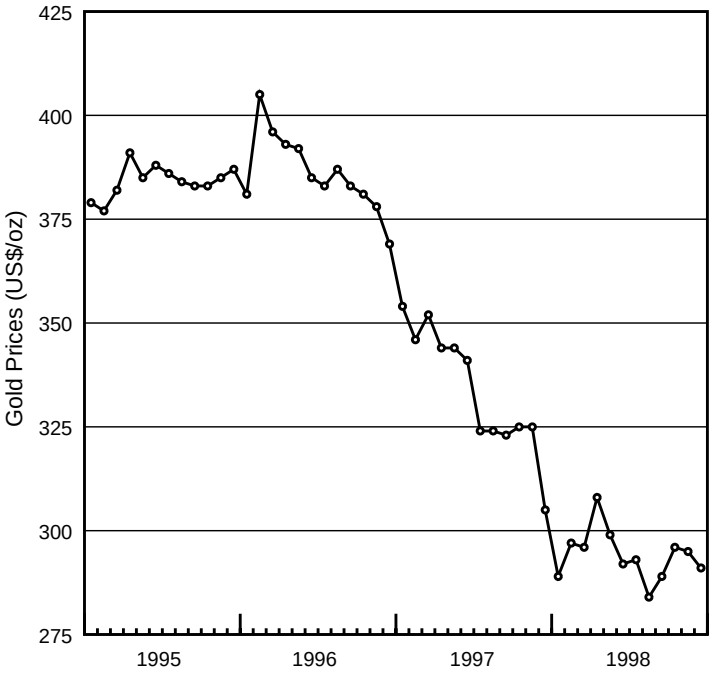

Figure 8. Monthly average London PM gold fix, 1995–1998.

$325, and the final plunge occurred in late 1997 to a monthly average low of $289 per ounce in January 1998. During 1998, prices appear to have established a new trading range of $280 to $300 per ounce.

At current price levels U.S. production is expected to beginning falling slightly from approximately 11.3 million ounces in 1997 to 10.4 million in 2001 (The Gold Institute, 1998). It is further expected, based on the survey conducted for this study, that Nevada's production and its share of U.S. production will initially rise to over 8 million ounces and then production will decline slightly thereafter if prices do not recover. These initial increases in Nevada production will be offset by closures and reductions in output at mines in other states.

These projected increases in Nevada production will be the result of higher grade mill throughput that will also result in lower costs. This adaptation to low prices, as noted above, is limited by the availability of higher grade ore and can only be sustained at a limited number of operations. Among the latter operations would be some of those on the Carlin Trend and the Getchell Trend in Nevada.

In the current low price environment these considerations remain relevant, but a factor of increasing importance will be cash flows, earnings and debt. Table 7 presents some key financial indicators for the North American gold industry based on corporate disclosures of 22 companies. Companies represented in the totals produce the vast majority of U.S. gold and silver but also have operations in other countries, hence total production in table 7 of 16.9 million ounces of gold exceeds U.S. production. All but one of the 22 North American companies represented in the total are public.

As indicated, both production and sales have increased for the industry over the three-year period shown, although 1997 increases in production, 18.5 percent, have not been matched by increases in sales revenues, 12.8 percent, because of price declines.

This difference would be substantially greater if about one-third of 1997 production had not been sold forward, or hedged, some at substantially above market prices. Looking forward, the contributions of hedging programs to producers' revenues will diminish over time as existing contracts to sell in the high $300 and low $400 range are delivered against and closed out. Hence, even if prices do not fall below their current levels, revenues per ounce will continue to decline for the foreseeable future or until prices increase.

Perhaps the three financial indicators shown on table 7 that reflect the industry's current depressed conditions are related to earnings and market capitalization. As would be expected given the price decreases in 1997, earnings are not good, and return on equity for the industry is well below comparable industries in the currently booming U.S. economy. However, as a result of two factors, hedging gains and cost cutting, earnings before taxes and asset write-downs actually increased between 1996 and 1997. Based on publicly available financial data, 13 of the 22 companies

Table 7. North American gold industry financial indicators, 1995–1997

	1995	1996	1997
Average gold price	$384	$388	$331
Worldwide gold production (1,000 oz)*	12,997	14,261	16,897
Sales ($millions)	$6,117.8	$6,498.0	$7,327.5
Assets ($millions)	$15,438.8	$18,352.9	$17,626.7
Equity ($millions)	$9,532.6	$10,870.5	$10,046.2
Net income before federal taxes ($millions)	$351.9	($125.4)	($1,710.7)
Return on equity (%)	3.69%	(1.15%)	(17.03%)
Net income before federal taxes and write-downs ($millions)	$478.4	$282.8	$326.5
Return on equity (%)	5.02%	2.60%	3.25%
Market capitalization ($millions)	$28,854.5	$30,659.2	$20,251.5

in the group showed a loss before taxes and asset write-downs and the remaining nine showed combined incomes $326.5 million more than the combined losses of the other 13 companies. This improved on their aggregate 1996 earnings by approximately $43.6 million but, from the perspective of the industry's return on investment, a 3.25 percent return on owner's equity is quite anemic.

At this point, however, it is worth reiterating a comment above on returns in the gold mining industry and investor bias. Barring a sharp and sudden increase in the price of gold which would cause traditional measures of profitability such as return on equity to increase dramatically earnings in the industry, will always tend to lag behind market averages. Investor bias, resulting from the fact that those willing to invest in gold mining tend to believe that the price of gold will rise leads to financing of marginal projects that lower returns. If prices do rise, financial performance will initially be outstanding but financing of new marginal projects will ultimately bring these returns down. What drives investors under these circumstances, is not traditional measures like return on equity, but a market capitalization that is highly leveraged to gold prices.

Other financial indicators on table 7, however, reveal a situation that is much more serious. Net income before federal taxes (NIBT), which includes the effects of asset write-downs, is more indicative of the effects of the current low price environment. In 1997 the industry wrote down $2.04 billion of its assets, or 11 percent of its assets at year-end 1996. With these asset write-downs, the 22 companies represented had a combined loss before federal income taxes of $1.7 billion for a return on owners' equity of -17 percent.

These asset write-downs reflect a variety of actions taken by producers in the face of the current low price environment. These actions ranged from write-downs and closure of entire operating properties, to write-downs of investments in exploration targets and assets such as investments in development work at existing properties that remain in operation and other investments in plant and equipment. In most of these cases, these write-downs are associated with a loss of proven and probable reserves or loss of resources at exploration sites that could possibly have been brought into the reserve category in the future.

On one hand it can be argued that these write-downs are a one-time event and perhaps should not reflect on the outlook for the industry. More positively, these write-downs will allow the industry to show higher rates of return in the future, whatever gold prices do, write-downs of exploration targets and related investments can be reversed, and these resources could ultimately be brought into the reserve category at higher prices. With the exception of the latter point, however, most of these arguments relate to accounting conventions, not real economic phenomena and industry prospects. Low prices over the past two years have clearly had significant impact on the industry's reserve base as suggested above, and these write-downs simply reflect this fact. The extent of the damage, however, will not be known

until reserves are re-evaluated at prices closer to those that the industry is likely to realize in the future.

The financial indicator on table 7 that reflects the investing public's assessment of the damage done to the industry by current low prices is the industry's market capitalization, which fell approximately 34 percent during 1997. Share prices have remained depressed versus 1996 levels through most of 1998. It should be emphasized that this is a reflection of the investing public's perceptions and, as such, is affected by many factors other than the economic fundamentals of North American gold mining companies.

Two factors suggest that the public has, perhaps, overreacted to the industry's current situation. The first and most significant of these is that the public evaluates gold mining as a sector in relation to its other investment opportunities which, during most of 1997 and 1998, when major U.S. stock indices have experienced unusually high rates of capital appreciation, have been, by some measures, unprecedented. Indeed, the performance of stocks as a whole probably should bear a major share of the burden for the performance of gold, and the performance of gold equities is simply a derivative of the former relationship.

A second factor weighing on the market capitalization is the Bre-X salting scandal perpetrated by personnel of a junior Canadian exploration company at its property in Indonesia. The fact that this company is not even remotely comparable to the companies included in this analysis is immaterial to the investing public since it was advertised as a gold company, and some major companies that are examined in this report were involved in the story as it played out. It is equally immaterial that none of the North American producers examined here were involved in the scandal, and it was a North American mining company, although not a North American producer that would be included in this analysis, that was responsible for revealing the scandal. What clearly caught the public's attention was that Bre-X's stock was listed on major stock exchanges alongside the major North American producers, and its stock had a meteoric rise and a widely publicized crash when the scandal broke. Another factor weighing on the industry's market capitalization is that analysts from respected U.S. and European investment banks were also involved and recommended buying Bre-X stock.

There is no way of measuring the impact of the Bre-X scandal on the market capitalization of the North American gold industry but, combined with the effect of the bull market in other sectors' equities, it could clearly have had no beneficial impact on share prices. Perhaps the only benefit to be derived is the creation of new safeguards for investors, which is occurring, because these will also benefit other companies by restoring public confidence.

Gold equity valuations, however, are only a derivative of the value of underlying commodity. However, here too, North American producers' market capitalization has been undercut. In this case, the Asian currency crises have been responsible for undercutting physical demand. At the same time, European central bank sales and producer hedging, primarily by Australian and South Africa producers, have been responsible for increasing physical supply. This combination of events has clearly pushed prices down and a rebound of physical demand appears to rest on the rebound of Asian economies.

The situation has been made worse by the threats of further, and possibly much more substantial sales by European central banks related to the formation of the European Monetary Union. And, as if the above were not enough bad news for gold producers' market capitalizations, the Swiss, holders of substantial central bank gold reserves, have held numerous public discussions and plan a public vote on an initiative that would result in substantial gold sales.

With all of these events in gold markets in the past two years it is difficult to imagine what else can happen. Surely, European central banks could sell. But liquidating assets at their lowest price (in real terms) in three decades does not appear likely and would be contrary to public pronouncements. In short, it would appear that North American gold companies' market capitalizations have suffered from almost every conceivable unfavorable turn of events.

The net result, however, is that the entire sector has been spurned by investors, and has resulted in the reduced market capitalizations reported above. At the same time, cost cutting efforts and, to a lesser extent, hedging programs described above have reduced the impacts of price decreases on cash flows per ounce of production. In 1997, for example, cash flow per ounce in the industry decreased 8.6 percent compared to 1996 as a result of declining prices and compared to a 14 percent decline in prices. 1998 results are not available but all indications are that because of production cost decreases achieved in 1998, cash flows per ounce of gold produced may actually increase in the face of declining average prices.

Hence, not only are there reasons to believe that changes in the market capitalization of the sector have been excessive compared to changes in gold prices, but even more so in relation to the fundamentals of the business. With slimmed down production costs and hedge positions, the industry is in a position where its earnings will be highly

Table 8. Capital costs for selected new mines and development projects, 1989–1998

Development cost category	Number	Total cost ($millions)	Initial reserves (1,000 oz)	Cost of new reserves ($/oz)
New producing mines (1989–90)				
Surface	8	$369.7	7,465	$49.50
Underground	2	87.4	1,136	76.90
Totals/Weighted average	10	457.1	8,601	53.10
New producing mines (1991–92)	5	262.0	5,594	46.80
Development projects (1992–93)	8	741.0	13,891	53.30
Development projects (1994–96)	11	2,151.2	42,811	50.25
Development projects (1997–98)	2	145.4	3,238	44.90

leveraged to any increases in gold prices. These prospects are clearly dependent upon increases in gold prices, which in turn are dependent upon changes in worldwide market fundamentals. In particular, prospects of a rebound in Asian economies, a slowdown in the world's equity markets, and a reversal of worldwide deflation of commodity prices in general may well lead to a reversal of fortunes for the sector.

These prospects aside, the outlook for the sector remains poor, but is not without bright spots. There is perhaps no better illustration of the industry outlook than table 8, which shows capital costs and reserves brought into production through the development of U.S. gold mines from 1989 through 1998. This table has been added to in each of the previous editions of this series of studies to illustrate the growth of the industry production capacity and the magnitude of capital investment in the industry.

Like other aspects of industry conduct addressed above, such as cost cutting, table 8 illustrates the cyclical nature of investment activity and its sensitivity to gold prices. As would be expected, the pace of investment activity has accelerated in periods of higher prices and decelerated in periods of low prices. Illustrating the down side of the cycle are levels of investment in the 1991–1992 period and the most recent period. Illustrating the up side of the cycle are the initial period and the periods on the table corresponding to 1993–1996 when gold prices rebounded from lows in the $320 range in late 1992. The effects of the price cycles on industry investment activity is reflected by fluctuations in all of the indicators on the table. Perhaps most telling, however, is the measure of the cost per ounce of new reserves which indicates both the size and grade of orebodies being developed. Development projects during periods of higher gold prices show higher costs per ounce indicating a combination of investment in marginal projects that would be avoided or postponed in periods of low prices, and lower cut-off grades applied to mining plans in periods of higher prices. This sensitivity of investment and development should also be recognized as applicable to changes in policy discussed above. Policies that affect costs, such as production royalties, and delay development will also affect investment in marginal projects and cut-off grades.

Not surprisingly given gold price levels, the most recent period shows the lowest cost per ounce of new reserves and the lowest total ounces under development in the decade. The two mines under development in this period are the Ken Snyder Mine in north central Nevada through a joint venture of Franco-Nevada and Euro-Nevada, which have until this venture been royalty companies and not involved in mining. High grades of both gold and silver allow this underground project to be developed. The only other mine brought into production in this period is Alta Gold's Olinghouse deposit in northwestern Nevada. This project is a lower grade, more typical Nevada-type deposit, which can be operated at relatively low cost.

The most recent period stands in sharp contrast to the 1994-1996 period when an unprecedented number of new mines with large orebodies were brought into production. These included a number of very good deposits that have since been brought into production, such as Barrick Gold's Meikle Mine, Placer Dome and Kennecott's Pipeline joint venture in Nevada, and Kinross' Fort Knox Mine in Alaska. In each of these cases, several millions of ounces of reserves were brought into production, accounting for an unprecedented increase in U.S. reserves during the period.

The sharp contrast between the 1994-96 and the most recent periods also illustrates the source of the slowdown in economic activity in local economies affected by mining discussed above. As noted, investments in new production capacity during 1994-96 generated $118 million per year in economic output and almost 1,300 jobs that have been lost in the current downturn.

A discussion of the outlook for the U.S. gold industry cannot be complete without consideration of merger and acquisition activity. As noted at the outset, this activity by U.S. producers was fairly minimal following the initial decline in prices from the $375 to $395 per ounce trading range that the industry had seen since 1994. During this initial period the only major activity was the Newmont merger with Santa Fe Pacific Gold, which gave Newmont an additional 18 million ounces of reserves in Nevada where, as discussed above, it has been able to achieve some significant synergies which became increasingly useful as prices continued to decline. This merger, however, was under consideration by the two companies well before prices started their initial decline, so price changes could hardly be considered a factor.

Following this merger and as prices fell in 1997, no major combinations or acquisitions occurred until year-end when the first of two distinct types of merger and acquisition activities emerged. In late 1997, Homestake acquired Plutonic Resources, an Australian producer, which added approximately 2.2 million ounces to Homestake's reserves and, by virtue of the proximity to existing Homestake operations in that country, offered some prospects of synergies from the acquisition. Since this acquisition, several other examples of large North American companies purchasing outright or buying into smaller producers both in the U.S. and around the world established a trend.

The trend continued with Homestake's subsequent acquisition of the portion of Prime Resources' Eskay Creek operation in Canada that it did not already own, and two acquisitions by Placer Dome. The first of these acquisitions was a 50 percent interest Western Areas' South Deep orebody in South Africa, which Placer acquired for a very low price of approximately $16 per ounce. The second was a bid for Getchell Gold's Nevada property at a considerably higher price of $171 per ounce. All totaled, these four transactions involved control of approximately 40 million ounces of reserves, with three quarters of that total in Placer Dome's South African offer.

The price differentials between acquisitions will, in general, reflect a wide variety of factors. A major factor involved is the quality of reserves, which includes the grade, since higher grade reserves will remain mineable at lower prices. Another factor is the extent of development at the time of the acquisition. In the case of the Getchell property, current ownership was close to completing development of the mine and was scheduled to begin production in 1999. This property also has significant exploration potential on 50 square miles of privately owned land in the middle of one of Nevada's most productive regions. The South African property, on the other hand, is large but will require substantial development expenditures on Placer's part, will involve higher cost mining at extreme depths, and will require considerably more time to reach full scale production.

The second type of merger and acquisition activity that has emerged since prices began their decline has involved wholesale mergers of North American companies with multiple properties. In one case, the merger between Kinross and Amax Gold was announced in February 1997 and resulted in a merged company with over a million ounces of annual production, which is considered as a threshold to be considered a "major" producer. By virtue of its timing, however, this merger also had to be well underway at the time prices began their decline. Yet, the merger went ahead in spite of lower prices and, perhaps, because of them.

In a more recent case, two relatively small producers, Glamis Gold and Rayrock appear to be merging with Glamis as the surviving entity. As this report goes to press, however, the details and prospects of this merger are uncertain. Glamis' initial offer for Rayrock came on the heels of other bids for the relatively cash rich company in a relatively cash starved industry. Interestingly, Glamis' offer included disbursement of some of the cash to Rayrock shareholders. While the disbursement of cash to shareholders is not likely to continue, this disbursement reflects capital leaving the industry, which is a trend that is likely to continue as long as prices remain depressed.

In the case of the initial Glamis-Rayrock merger, the implied price per ounce was just under $50 per ounce of reserves. This price compares quite favorably to acquisitions of other U.S. properties with production facilities in place, but Rayrock's relatively small reserves are not likely to attract the interest of, and bids from, larger producers. This, of course, could change in a dynamic market. Other acquisitions of U.S. properties and companies cited above averaged approximately $159 per ounce of reserves. In comparison, acquisitions discussed above of non-U.S. properties averaged $46 per ounce of reserves.

The combination of medium sized and smaller producers and/or the absorption of smaller producers is a trend that becomes increasingly likely over time as long as prices remain at current levels. In addition, the longer prices remain at current levels, even combinations of larger producers becomes more likely. In an industry where there are

substantial differentials between producers costs as indicated by the cash and total cost curves shown above, and where there are significant differentials in the realized price per ounce because of hedging programs, significant differentials in profitability will result. This clearly creates the opportunity for takeover activity. The only question is whether those making money in this environment will choose to increase their exposure to gold prices or take their capital elsewhere.

To date, the acquisitions described above indicate that the answer to this question has largely been affirmative, indicating a fundamental optimism about gold prices. However, the sentiment that with real, inflation-adjusted, gold prices at twenty year lows, prices are more likely to rise than fall further is pure speculation. Consequently, the worst case scenario is worth considering.

Further declines in gold prices associated with, for example, potential European central bank sales or worsening Asian economic conditions or other unforeseen circumstances would bring on even more intense cost cutting by producers. This would be achieved by further corporate restructuring and streamlining and by modifying mining plans and focusing on higher grade ores. There are limits, however, as to what this can achieve that has not been achieved already in two years of adjusting to lower prices. Consequently, it is worth looking at the competitiveness of the U.S. industry relative to its competitors around the world because, as prices fall or simply fail to recover, higher cost producers will begin to fall out of the market.

Table 9 presents GFMS's (Murray and others, 1998) estimates of gold production costs for 1996 and 1997 for major gold producing countries. As indicated, the 1997 worldwide weighted average cash cost is $250 and the weighted average total cost is $315 indicating that over half of world-wide production is incurring losses on a total cost basis. Additional analysis by GFMS indicates that just under 30 percent of 1997 world production had cash costs above $300 per ounce. Hence, this production is in a negative cash-flow situation and will ultimately have to be curtailed unless costs can be cut substantially or prices rise.

Also indicated is the fact that the world's largest producers other than the U.S., namely, South Africa and Australia, have the highest costs. U.S. producers, on the other hand, are the second lowest cost producers next to Brazilian producers, whose costs are very similar.

As a result of cost cutting, 1998 cash cost estimates for U.S. producers included in this study are less than $200 per ounce and total costs are below $290 per ounce. It is expected that other producers around the world will probably be able to cut their costs by similar amounts. However, even if other countries' producers can cut their costs proportionate to U.S. producers, they will remain in a negative cash flow situation that cannot be sustained and will eventually lead to mine closures.

In a worst-case scenario of, for comparative purposes, $250 per ounce gold, a significant portion of world output is in a negative cash flow position and perhaps one-third of world mine supply would close based on GFMS's 1997 world cash cost curve (Murray and others, 1998). At $200 per ounce gold, perhaps 80 percent of world mine supply is in a negative cash flow position based on 1997 costs, but, with the changes in mining plans that would ensue if these prices were reached, losses would be less although still substantial. Because of its low costs, at least two thirds of U.S. production could survive this worst case scenario at least in the short term. Nonetheless, there are numerous smaller producers on the right-hand side of the total cash cost curve (fig. 4) that would more than likely be forced to close.

In many industries this worst-case scenario would result in a leftward shift in the industry supply curve and result in an increase in price. And, indeed, there would be a leftward shift in the world gold mine supply curve in these scenarios as well. However, because world mine supply is less than two percent of potential gold supply when above ground stocks are considered, price increases are not guaranteed for gold mining.

In sum, the outlook for the industry clearly rests on gold prices. But, even with current low prices, the outlook also hinges on producers' ability to find technical means of lowering costs and managing their resources to improve their performance. Since there is much evidence to suggest that producers are being successful in the latter, there is at least some prospect for improved financial performance even at current price levels.

Table 9. Weighted average gold production costs ($US per ounce)

	Cash Costs		Total Costs	
	1996	1997	1996	1997
Australia	$292	$261	$363	$338
Brazil	235	215	327	282
Canada	227	221	289	288
Papua	237	240	302	351
South Africa	304	301	344	340
United States	239	216	305	289
Other	228	217	305	293
Total	268	250	327	315

Source: Murray and others (1998)

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