Published in *Newsletter*, American Institute of Minerals Appraisers, Vol. 1, No. 5, December 1995, pages 1-4.

VALUATION METHODOLOGIES FOR MINES AND MINERAL TENEMENTS

Trevor R. Ellis, CMA, CPG, M.AusIMM
Ellis International Services, Denver, CO

Introduction

A conference, *Mineral Valuation Methodologies 1994 (VALMIN'94),* was held in Sydney, Australia, on 27-28 October 1994. The conference was organized by The Australasian Institute of Mining and Metallurgy (The AusIMM) and its subsidiary organization, Mineral Industry Consultants Association (MICA). The AusIMM has published a proceedings volume of 24 papers, forming a comprehensive reference on methodologies for appraising mines and mineral holdings. This paper reviews important concepts and conclusions presented by the authors.

The conference was held as a lead up to the issuance in June 1995 of The AusIMM's *Code and Guidelines for Assessment and Valuation of Mineral Assets and Mineral Securities for Independent Expert Reports (the Valmin Code)*. Industry groups and securities industry regulatory bodies in Australia have endorsed this code. For a review of the Valmin Code, see *The Australian Valmin Code for Mineral Appraisals,* AIMA Newsletter, Vol. 1, No. 4, Oct. 95.

The Valmin Committee was formed in April 1991 to write the Valmin Code. The committee quickly recognized that there are widely divergent views on valuation methodologies. It removed the subject of valuation methodology from the Valmin Code.[1] As a result, The AusIMM and MICA decided it was important to hold a conference to review valuation methodologies.

Valuations of mines and mineral holdings are performed more commonly in Australia than in the USA. There are at least two reasons. Australia has a more dynamic mining industry than the USA. For example, it is estimated that Australia received 21% of the world's private sector mineral exploration funds in 1994, compared to 16% for the USA. The second reason is touched on in the paper by C.M. Jackson, a Chartered Accountant with KPMG Peat Marwick. He states that in Australia "accountants and auditors are required to consider each year the carrying value of interests in mining projects under the regulatory environment of Accounting Standards and the Corporations Law." Independent appraisals are often used to support the value of such interests in Australian statutory financial statements. There is no equivalent in the USA of this requirement for annual review. The values of mineral properties here are only reported in company accounts as capitalized costs based on the costs of acquisition and development. Because of this difference in the level of demand for appraisal services, Australian mineral appraisers have recently developed into a much more vibrant professional group.

It is apparent from the conference papers, that many companies use internal staff to develop valuations when regulations allow. Therefore, in some papers there is an area of greyness between valuations in the sense of market value appraisals as we in the USA know them, and

[1] The AIMA should keep this in mind if we decide to develop a code for mineral appraisals.

valuations for internal corporate planning and acquisition studies. Nonetheless, this grey area does not detract significantly from the usefulness of the literature.

Recent Practice

E.J. Malone, is a geologist with an MBA, who teaches mine and project evaluation at the University of New South Wales. His paper reviews the history of mineral valuation methodology. In the past, mineral valuations were based very largely on proved and probable reserves. Modern practice is to examine the potential for continued exploration to develop additional mineable reserves. A conservative proportion of that additional potential is then incorporated in the valuation model by extending the life of the operation. Malone observes that valuation of pure exploration holdings are the most difficult valuation exercises, particularly holdings without identified resources. In the past such valuations were generally not attempted. Now the demands of the Australian securities industry require valuers to attempt to value these assets.

NPV as a Basis for Valuation

Resource finance consultant, J. Ballard, and other authors discuss discounted cash flow (DCF) methodologies and net present value (NPV). They all recommend DCF as the primary method for valuing operating mines, or mineral assets with at least indicated resources and some form of feasibility study containing engineering, production and capital and operating cost data. However, R. Grant of Grant Samuel & Associates, emphasizes the need for a "sanity check" on the validity of DCF based valuations, by using the comparable sales method. This need is due to the highly subjective nature of the DCF methodology. Discussing exploration properties for which there are no technical studies, the authors agree that DCF methods should only be used as a secondary method of valuation. But, as Ballard said, NPV forms a very useful check.

There is varying theory and opinion presented on how to calculate an appropriate discount rate for use in NPV modeling. Some authors support the use of the Capital Asset Pricing Model (CAPM) to derive the discount rate from the stock market. These include C. O'Connor and D. McMahon, chartered accountants in the Corporate Develop Department of Normandy Mining (formerly Normandy Poseidon). However, they generally recognize CAPM's well publicized deficiencies discussed below. Other authors, such as Ballard and Jackson, support the use of the older, weighted average cost of capital (WACC) approach. This is especially for valuations using total cash flows calculated prior to any financing assumptions.

D.W. Barnett is a geologist and mineral economist with the economic consulting company, Minec Pty. Ltd. C. Sorentino, is a researcher in financial engineering, School of Earth Sciences, Macquarie University. They coauthored an in-depth review of DCF methods and CAPM. In their conclusions, Barnett expresses a frustrating opinion. After comparing CAPM with WACC, he is "not convinced that there is a known, impartial, scientific method in which to calculate the cost of capital to be used for mineral asset valuation." Many of us have probably come to this opinion independently through our professional experiences. But, we did not have the benefit

of the rigorous analysis presented by Barnett and Sorentino. Barnett proposes that the only impartial valuation is to present the profile of NPV's for all possible discount rates.

CAPM is a subset of modern portfolio theory. As explained by Jackson, CAPM theory holds that the cost of equity capital is equal to the risk-free rate of return plus the product of the stock's beta coefficient, multiplied by the risk premium of the market as a whole. The stock's beta coefficient is the index of its risk expressed as the volatility of its return in relation to that of a market portfolio.

Ballard provides the following CAPM formula for the cost of equity capital when valuing a mineral asset rather than a company:

$$R = R_f + \beta(R_m - R_f)$$

Where:

R = Cost of equity capital
R_f = Risk-free rate of return, such as long term government bonds
β = Beta of the asset being valued
R_m = Expected rate of return of the particular asset being valued

Ballard states, "In practice, R_m is the rate of return required for the particular asset being valued taking into account the risks associated with the project itself, the industry in which the project will operate as a going concern and the expected economic climate." Jackson suggests that the market risk premium (R_m - R_f) is 6% to 8% for Australian projects. This is similar to that estimated for the USA. O'Connor and McMahon said that recent research suggests that the market risk premium may be falling.

Beta (β) is a measure of systematic risk that investors cannot diversify away. It is the expected covariance of an equity return with that of a market index. An investment with a beta greater than 1.0 is expected to have a variance greater than the market. One with a beta less than 1.0 should have a variance less than the market. Determining an appropriate beta is often difficult when valuing mineral assets. Ballard recommends selecting a beta representative of the industry sector in which the project will operate.

Barnett and Sorentino show that the cost of capital for a listed company using the CAPM, can vary greatly based on the time chosen and the length of interval used. That is, the beta is not necessarily stable over time. The beta also varies depending on whether it is calculated using a daily, weekly, monthly or annual period. These authors show that in times of a sustained bull market, the cost of capital produced for a firm may be so high that valuers hesitate to use it. Using the interval February 1982 to March 1987, the CAPM produced a discount rate for the large Australian mining company, BHP, of 39.5%. Another dilemma Barnett and Sorentino present is the fact that the buyer of a mineral property can have a very different CAPM derived cost of capital to that of the seller.

O'Connor and McMahon believe that the high discount rates commonly applied to mining projects fail to take into account some fundamental issues. Mining companies are part of an international community and as such should devise their cost of capital accordingly. The beta for Australian stock calculated against an international index, such as the Morgan Stanley Capital Index, is reduced substantially below 1.0. They cite the work of some authors indicating that real rates of return after tax provided by listed Australian mining companies have been 5% or less over the long term. Using rates significantly above this level, they maintain, "is clearly not taking into account market expectations." In support of this contention, they use the fact that the market places a premium of 50% to 200% on gold stocks above their NPV basis.

Ballard and Jackson both support the use of the CAPM in deriving the cost of equity capital. If the NPV calculation includes financing assumptions in the calculation of cash flows, they agree that the CAPM derived rate is the appropriate discount rate. However, they believe that the WACC derived discount rate is applicable for valuations undertaken based on total cash flows (i.e., before any financing assumptions). WACC takes into account the costs of both project debt and equity. Jackson believes it is preferable to calculate cash flows on a pretax and preinterest basis, and to use a pretax WACC discount rate. This reduces the assumptions involved in the cash flow forecast.

Ballard recommends the total cash flow approach for projects that have indicated resources, but for which a prefeasibility study has not been completed. However, for projects that have progressed further, he says that it is not common practice for independent valuations to be undertaken entirely on a total cash flow basis. "Such valuations are normally based on the estimated value to equity holders."

Jackson provides the following formula for calculating the appropriate pretax WACC to apply to cash flows before interest, principal and tax:

$$WACC(pretax) = Kd * \frac{D}{D+E} + \frac{Ke}{1-t} * \frac{E}{D+E}$$

Where:

D	= market value of debt
E	= market value of equity
Kd	= cost of debt before tax
Ke	= cost of equity
t	= tax rate

The authors concur that an exact answer to the value of a mineral property is rarely determinable from the DCF method. A range of values must be presented to account for the uncertainties contained in the assumptions. This is a requirement under the Valmin Code.[2]

Expanding the development of ranges of values, some authors propose the use of simulations to account for project risk and uncertainty. These authors include Ballard, and Sorentino and Barnett in the second of their two papers. Recommendations include using Monte Carlo simulation, or its faster Latin Hypercube equivalent, and probability trees. These methods should be used instead of increasing the discount rate to account for project risk, a technically incorrect method. Sorentino and Barnett warn that it is often necessary to reduce the problem to a manageable size by ignoring the least important aspects. This is due to the complex arrangement of many dependent and interlocking events in the risk analysis of large mining projects.

J.K. Winsen is an accountant who is Professor of Commerce at the University of Newcastle. He recommends the use of option theory to overcome the tendency of NPV analysis to undervalue projects. Option theory is now academically popular. Winsen proposes that through its use, mining valuations should incorporate an analysis of optimal future decisions involved in managing the project. Dependent on the prevailing market for product, management decisions can include changing the time for opening the mine, adjustments to production, and expansion or idling of operations.

In contrast, undervaluation through using NPV is of no concern to P. Butler. He is an engineer and economist who is a senior manager with the bank, Republic Mase Australia. He says that more projects fail because reserves do not measure up to prediction than for any other reason. In Australia, 35 gold mines came into production in the period 1983 to 1987. Of these, 66% failed to meet their first year gold production targets. For 68% of the mines, recovered grades were below feasibility study estimates. If the project defaults, Mr. Butler says, "it is likely to be in a situation where the original NPV estimates are seriously astray."

Butler's statistics are in line with a more comprehensive and disastrous set of international statistics presented by G.R. Castle of Chemical Bank in 1985.[3] There may be a relationship here with the problem of NPV undervaluation as presented by Winsen, and O'Connor and McMahon. The high potential for mining projects to fail to meet objectives is often overlooked. Miners have long known that mining the market can be more lucrative than mining the ground. Maybe the market is currently overvaluing mineral projects and will eventually fall back in line. However, as appraisers, the end result of our work must be an estimate of the market value of the mineral property, not what we think the project is worth as an investment. Other valuation methods can help us meet this objective.

---

[2] It would be useful to determine if value ranges can be presented in the USA without going against the dictates of the Uniform Standards of Professional Appraisal Practice.

[3] Castle, Grover R., 1985, Feasibility Studies and Other Pre-Project Estimates. How Reliable are They?, *in* Finance for the Minerals Industry, SME, pp. 461-465.

Other Valuation Methods

Some of the authors discuss other methods of valuation. Due to lack of space, not all methods can be reviewed below.

R. Grant is Director of Grant Samuel & Associates, a firm of corporate advisors. He observes that the comparable sales method of valuation rarely finds favor as a methodology for valuing mining and exploration properties. For mineral properties the limitations are obvious. These include: limited number of sales; limitations on comparability; transaction data loses relevancy with time; and, adequate data on many transactions are not made public. Grant notes that comparable sales data are much more difficult to come by for the mining industry than for the petroleum business. However, he proposes that the real benefit of the comparable sales method for valuing mineral assets is in its use as a validity or "sanity" check. Cash flows from mining operations are influenced by a wide range of variables. The DCF valuation methodology involves a great deal of subjectivity, which makes it fragile. Grant Samuel endeavors to establish benchmarks from comparable sales, or stockmarket values, to test the validity of valuations produced by DCF models. An example involves comparing sales of coal mines by the calculation of cost per annual unit of production. For other minerals, it can involve a complex set of adjustments to get the "comparable" data onto a similar basis. He provides an example involving comparison of two properties on alternate sides of the world. Grant concludes that valuation is an art, not a science.

G.R. Appleyard, Principal, Australian Mining Consultants, presents the Joint Venture Method as a procedure for estimating the value of exploration properties. He says it has most relevance to properties where the resources have yet to be delineated. The method assumes that in incurring expenditure on a farm-in property, the farm-inor or "buyer" is placing a monetary value on the farm-inee's or "seller's" interest in that property at the time the deal is closed. Unless there are two or more existing owners and not all are farming out, the value of the seller's interest is the full value of the property at the time.

J. Goulevitch and G.S. Eupene are geologists with the consulting firm Eupene Exploration Enterprises. They recommend using a geoscience rating system for valuation of exploration properties containing no identified resources or reserves. The method was originally developed by a Canadian geologist, Lionel Kilburn. Kilburn recognized that the value of a mineral property changes with time due to external economic factors. However, the Kilburn method only attempts to quantify the geotechnical prospectivity of a property. It looks at four main characteristics in the appraisal. These are: location with respect to off-property mineralization; the grade and amount of mineralization known on the property; geophysical and/or geochemical targets present; and geological patterns present. He identifies a total of 19 categories within these four groups, which have varying weightings relative to each other. The area being valued is divided into units of 40 hectares or less. The weighting process is repeated for each unit. Kilburn then takes the results for each of the four groups and multiplies these by the base acquisition cost of a standard sized exploration area (16 hectares). Adding the values for all of the areas gives the geotechnical

value of the property. The two authors have modified the Kilburn method to comply with the tenure situation in their region of Australia.

Conclusion

The proceedings volume is an important reference for the minerals appraisal practitioner. Of course, as with almost any technical volume, the mathematics and other in-depth examination gets heavy at times. Those not interested in the detailed theory can skip over it and still find much valuable reading.

For ordering information, write to: The AusIMM, PO Box 660 Carlton South, Victoria 3053, Australia; or fax: 011-61-3-9662-3662.