Development and implementation of a PGE mineral asset valuation curve

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Mineral assets are valued for transactional, insurance or funding purposes during ‘boom’ or ‘bust’ transition periods. There are three broad categories of generally accepted approaches to mineral asset valuations (MAVs) namely: income, market and cost approaches.

In this paper, we focus on the market approach, in which the competent valuator (CV) estimates the value of a mineral asset by reference to market data on transactions involving similar or comparable mineral assets. In the platinum group elements (PGE) industry, Venmyn has over recent years developed a PGE mineral asset valuation curve (valuation curve) for use as a tool when conducting MAVs of PGE mineral assets, which takes into account the general individual characteristics of each mineral asset.

The PGE mineral asset valuation curve (PGE valuation curve) was developed based upon the comparative value per unit of attributable PGE ounces. It largely uses transaction-based monetary values and market capitalization per ounce established on the principle of ‘willing buyer, willing seller’ which requires that the amount obtainable from the sale of an asset should be determined as if the transaction was an arm’s length transaction. The curve is compiled and regularly updated from a comprehensive database of relatively recent transactions of PGE mineral assets and current market capitalization of PGE projects. The PGE mineral assets are valued in monetary value per unit of resource ounce (USD/oz) and sorted according to the development stage of the project, linked to the mineral resource and mineral reserve categories, as defined by the SAMREC Code.

This valuation curve has been successfully used over the past few years to value PGE mineral assets on a directly comparable basis. Importantly, the curve can be used to plot comparative results for the income and cost approaches to assess how those values relate to each other. This is particularly important as it can be used to void a method that appears to generate very low or high values that seem to be outliers.

Keywords: market approach; PGE mineral asset valuation curve; monetary value per unit of resource ounce; SAMREC Code; commodity price super cycle.

Introduction

Commodity prices are cyclical. When commodity prices, in real terms, follow a prolonged rising trend for close to a decade or more, that trend is called a commodity price super cycle. The trend is generally driven by the urbanization and industrialization of a major economy. Heap (2005) noted that there have been two commodity price super cycles in the last 150 years and a third has been underway post-2000. The first was in the late 1800s to early 1900s, driven by the economic growth in the USA; the second was in the period 1945 to 1975, prompted by post-war reconstruction in Europe and later by Japan’s massive economic renaissance; and the third is being driven by materials intensive economic growth in China. The global economic recession, however, that started in 2008 forced commodity prices to fall drastically, temporarily retarding the super cycle. Platinum, for example, as reported by Johnson and Matthey (2009), which had risen from a low of about USD$840/oz in 2005 to an all time high of USD$2276/oz in March 2008 (equivalent to USD$1987/oz in 2005 real terms) declined to below USD$800/oz in December 2008 (equivalent to USD$698/oz in 2005 real terms). It has been gradually picking up since then to the current levels of about USD$1 500/oz.

These changes indicate periods of ‘boom’ or ‘bust’ in the minerals industry. During boom periods many mineral projects are brought on stream and amalgamations are initiated because of the feeling that the boom will last. In ‘bust’ periods most companies will downsize to cut back on costs and those that fail to contain costs become possible targets of takeovers. In boom periods mineral assets are valued for board approval of funding or possible amalgamation; whereas in bust periods mineral assets are valued for possible takeovers. In both circumstances MAVs are required whether it is from the buying side or selling side and hence valuation tools, such as the PGE valuation curve, become vital for benchmarking and project value comparison.

There are three broad categories of generally accepted approaches to MAV namely, income, market and cost approaches. It is acknowledged that mineral assets incorporate more uniquely distinguishable factors such as...
location, geology, mineralization, reef type, stage of development, infrastructure already in place and exploration costs incurred. However, the global minerals industry has worked hard in the past 10 years to develop a common set of compliance and mineral asset reporting codes to ensure that all mineral assets are reported on a seemingly consistent basis. To this end, the Committee for Mineral Reserves and International Reporting Standards (CRIRSCO), as the global mining standards umbrella body has worked under the United Nations to align the reporting standards with the oil and gas industries, mainly represented by the Society for Petroleum Engineers (SPE). The International Accounting Standards Board (IASB) has initiated a project aimed at having a common and consistent mineral asset reporting process through an accounting standard for the extractive industries so that valuations can be used as a ‘reliable measure’ for accounting purposes. The CRIRSCO codes should facilitate the basis for this project. However, because of the idiosyncrasies of individual mineral assets, some levels of uncertainty will continue to exist in the value estimations of mineral assets.

**Mineral asset valuation (MAV)**

The word ‘valuation’ in a mining project context has the rather narrow meaning of ‘placing a monetary value on the worth of the mineral asset as a whole’. The value can be determined in the market at any specific point in time, or may be estimated by one of the several methods that are in use, depending on the stage of development of the mining project. The word ‘valuation’ in a mining project context denotes the broader meaning of ‘determining the numerical values of all possible factors or variables that are important in establishing the worth of a mining project’. In other words, mine evaluation denotes the assessment of such factors as the relative economic viability of the mining project’s ore reserves, mining rates, revenue, costs, expected returns and associated risks, as well as the monetary worth of the project or investment opportunity.

**Valuation**

Valuation, in its simplest form, is the determination of the amount for which the property will transact on a particular date (Pagourtzi et al., 2003). However, there is a wide range of purposes for which MAVs are required. This ranges from valuations for purchase and sale, transfer, insurance, tax assessment, expropriation, inheritance or estate settlement, investment and financing.

The income approach is regarded as the most reliable method of estimating value for a mineral asset and primarily uses discounted cash flow (DCF) analysis. In our opinion, this methodology yields the most accurate, fair and reasonable results by capturing the pertinent aspects of the business’ investment case. The cost approach relies primarily on audited or auditable historical expenditures on exploration and acquisitions, to which can be applied prospectivity enhancement multipliers (PEMs) to arrive at a mineral asset value.

This method essentially incorporates the principle of ‘successful efforts’ and endeavours to capture the change in mineral asset value, mainly for exploration assets, based upon a qualitative assessment of improved or reduced prospectivity. The market approach bases the value of an asset on prices and other relevant information on transactions involving similar or comparable mineral assets that have occurred in the market. The market approach may be considered to be problematic in the minerals industry since it is difficult to ensure complete comparison of different mineral assets because of technical idiosyncrasies that apply to almost every mineral property. To a certain extent this is similar to the real estate sector but the volume of transactions helps to provide broadly comparable transactions.

Individual PGE mineral assets are at different stages of production and development, hence different valuation approaches will be adopted in accordance to the international mineral asset valuation guidelines, such as the South African Code for the Reporting of Mineral Asset Valuation (the SAMVAL Code) and the Institute of Mining, Metallurgy and Petroleum on Valuation of Mineral Properties (CIMVAL Code). Each valuation approach then has a number of methodologies that can be used in the valuation profile.

Certain valuation methods are more widely used and may be more generally acceptable as industry practice than others, although this could change over time. Some methods can be considered to be primary methods for MAVs, while others are secondary methods or rules of thumb, considered suitable only to check MAVs by primary methods, but it is imperative to use at least two methods as required by the valuation codes. Table I summarizes the valuation approaches and the underlying methodologies as stipulated in the SAMVAL Code.

The quality and quantity of the ultimately recoverable mineral reserves is known only on permanent abandonment of the mineral asset and, at any other date of valuation, the quantity of mineral reserves is always uncertain. This provides a challenge for valuation, as not knowing the

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**KEY**

- Most acceptable method and widely used
- Acceptable method and quite widely used
- Less acceptable method, less widely used and poorly understood
- Not acceptable

(Source: SAMVAL Code, 2009)
Overview of the market approach in mineral asset valuation

Market value is defined by the International Valuation Standards Committee (IVSC) (2005) as ‘the estimated amount for which a property should exchange on the date of valuation between a willing buyer and willing seller in an arm’s length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently, and without compulsion’. The market approach was defined by IVSC (2003 p 420) as, ‘any approach to value based upon the use of data that reflect market transactions and reasoning that corresponds to the thinking of market participants. A general way of estimating a value indication for an asset using one or more methods that compare the subject to similar assets that have been sold.’

The market approach in MAV encompasses all of the methodologies that rely on databases of historical mineral assets transactions (Lilford and Minnitt, 2005). These databases tabulate the prices at which all previous mineral asset transactions occurred. Such data provide a benchmark against which current mineral asset information and prices can be compared in order to estimate the value of the mineral asset under question. The transactions include acquisitions, disposals and mergers, in addition to the market capitalization per ounce. This analysis has been adjusted for cash and debt in the calculation of market capitalization per ounce in the form of enterprise value (EV). These transactions are assumed to have been ideally completed at arm’s length with the transacting parties being under no compulsion to transact.

The market approach may be considered to be fairly subjective due to professional judgement that has to applied when comparing the mineral asset to be valued and the pool of mineral assets that have implied value from previous transactions. In applying the market approach, CVs develop an indication of value for the mineral asset that is being valued by comparing similar mineral assets and making adjustments for the differences in the characteristics of mineral assets that have been sold. It is difficult to ensure direct comparisons of different mineral assets because of technical idiosyncrasies that apply to almost every mineral asset. The most appropriate approach to a valuation problem would be the income approach. However, if there are sufficient mineral asset transactions, these should be analysed and included in the MAV report to establish a reasonable range within which the value of the mineral asset should fall. However, some sales should not be considered because the transaction price may not be indicative of market value (MacCrate, 2010).

Comparative valuation of mineral projects

The market approach is indispensable in valuing exploration projects, where there is limited information to perform a DCF analysis. Accordingly, Lilford and Minnitt (2005) argued that in the event that insufficient geological and techno-economic information is available on a mineral asset to perform a DCF analysis, the USD/ha or USD/oz method of valuation or equivalent can be considered. For development and producing mineral assets, this method can provide a benchmark when calculating the fundamental value of the asset. Therefore, while comparable valuation need not necessarily reveal an asset’s fundamental value, it introduces discipline into the valuation process. Whereas these values are indicative, they do provide a guideline as to the magnitude of comparable values that have been paid, or are likely to be paid, for the exchange of in situ mineral resources and mineral reserves for PGE projects.

The PGE mineral asset valuation curve development process

In the PGE industry, Vennyn has over the years developed a PGE valuation curve for use when valuing PGE mineral assets, which takes into account the individual characteristics of each mineral asset. The valuation curve is used to determine the USD/oz value for mineral resource and mineral reserve taking into account the PGE grade, depth of mining, infrastructure, other technical parameters and mineral resource classification confidence.

The valuation curve for PGE projects at different phases of development in South Africa, in the early days of development was as illustrated in Figure 2. This was extended to PGE projects in relevant surrounding African countries as well as the rest of the world. The projects were separated on the basis of the stage of development as well as the style of mineralization.

On ordinary graph paper, no meaningful relationship could be established between the USD/oz and stage of development. However, on assessing the data and plotting the project value (in USD/oz) versus the stage of development on log paper, it was noted that projects in the mineral resource category tended to plot towards the base of the curve and most advanced projects in the mineral reserve category tended to plot at the top of the curve with the rest filling the space in between by order of development. It was, therefore concluded that PGE projects in a similar development stage tend to have similar USD/oz values. Another observation was that significant change in value tends to occur in the transition from inferred, to
indicated and measured resources, whereas the transition from measured resources to reserves tended to be just slight. This observation can be explained using the principle that the higher the risk the higher the reward is likely to be, since there is more uncertainty at the resource stage than at the reserves stage of a project. On plotting these transaction values onto a valuation curve, based on the weighted average mineral resource and mineral reserve category, the category of the asset determines where it falls on the valuation curve.

The valuation curve was developed based upon the comparative value per unit of attributable PGE ounces. It largely uses transaction-based monetary values established on the principle of ‘willing buyer, willing seller’ which requires that the amount obtainable from the sale of an asset should be determined as if the transaction was an arm’s length transaction. The curve is compiled and regularly updated from a comprehensive database of relatively recent transactions of PGE mineral assets and current market capitalization of PGE projects. The PGE mineral assets are valued in monetary value per unit of resource ounce (USD/oz) and sorted according to the development stage of the project which can be linked to the mineral resources and mineral reserves categories as defined by the SAMREC Code. The transactions used to construct the valuation curve occurred at specific points in time and therefore at specific PGE basket prices and USD/ZAR exchange rates, which are then adjusted to current PGE prices and exchange rates.

**Current PGE mineral asset valuation curve**

Venmyn’s proprietary valuation curve demonstrates the range of indicative market-related values of in situ USD/oz attributed to the different categories of mineral resources and mineral reserves. It has been developed from the initial conceptual valuation curve as detailed above. Since then, the valuation has been continually updated and refined to its current state as illustrated in Figure 3. Whereas these values are indicative, they do provide a guideline and a ‘valuation playing field’ as to the magnitude of comparable values that have been paid, or are likely to be paid, between a willing buyer and a willing seller for the exchange of in situ mineral resources and mineral reserves PGE projects.

The other reason that necessitated the development of the valuation curve was the fact that the transactions that occur in the industry are not always simple and straightforward to unscramble, thus making it imperative to construct a graph in a simplified manner that consolidates all the transactions that occur, and to create a pattern from the information. Moreover, the graph is also necessary as it shows the difference between the transactions that occurred in different time frames, in this case, years.

This information is also overlaid against the market capitalization per unit of the resource and, if a multi-commodity company is in question, all the other products are converted into the equivalents of the commodity in question. The graph is presented as a simplified two-dimensional picture and even though the other dimensions are not represented on the valuation curve, they should be considered and enshrined in the valuation results. In this way, the information presented graphically and visually is

![Figure 2. Initial PGE valuation curve based on a few projects in 1999](image1)

![Figure 3. PGE valuation curve 2010 (courtesy Venmyn)](image2)
easy to compare. On average, mineral projects tend to be valued in a specific pattern with a nearly constant range between low and high. By considering the transactions that have occurred in recent years, one may unscramble these to estimate the USD/oz values.

The concept of comparative valuation as one of the market approach methodologies has been extended to establish a PGE valuation curve for use in valuing PGE projects. Since it is also time based, the curve is a reflection of sentiments on the value of PGE mineral assets with market conditions at the time as illustrated by the different trend lines. For example, the general sentiment in June 2009 was significantly lower than the sentiment in June 2008. As a generalization, investors were willing to pay more per unit of PGE ounce in June 2008 compared to June 2009, mainly driven by the buoyant platinum prices.

The transactions that are cash based tend to fall towards the bottom of the curve as these are significantly discounted as illustrated by the trend line in Figure 3. The share-based transactions, however, tend to lie towards the top of the curve, and any other combination lies in the middle.

The transactions used to construct the valuation curve occurred at specific points in time and, therefore, at specific PGE basket prices and USD/ZAR exchange rates, which are then adjusted to current PGE prices and exchange rates. The curve is compiled and regularly updated from a comprehensive database of relatively recent transactions of PGE mineral assets and current market capitalization of PGE projects. The PGE mineral assets are valued in monetary value per unit of resource ounce and sorted according to the development stage of the project, which can be linked to the mineral resource and mineral reserve categories.

This valuation curve has been successfully used over the past few years to value PGE mineral assets on a directly comparable basis. Importantly, the curves can be used to plot comparative results for the income approach, cost approach and the market approach and assess how those values relate to one other. This is particularly important as it can be used to void a method that appears to generate very low or high values that seem to be outliers.

Research and development has continued to add more data to the initial set of data and currently maintains a comprehensive database of recent transactions involving PGE mineral assets in the world as a means of establishing the valuation playing field. An updated PGE valuation curve is illustrated in Figure 3. The graph also shows that, for values within any category of mineral resource or mineral reserve classification, there is a band of values a mineral asset is expected to assume. The curve also exhibits the logarithmic relationship that was observed earlier. If, during a valuation process, a PGE project plots outside of this generalized curve, the project valuation process renders further investigations to justify the abnormality.

**Market proxy and commodity price adjustments**

Further to the development of the valuation curve, it became apparent that some clients and investors wanted to understand the relationship between the project value and the changes in the PGE prices. This was especially evident during the peak of the economic crisis as commodity prices were volatile. In response to this, a platinum market analysis was conducted on the different players in the platinum mining sector, and their contribution to the J153 index (the index that represents the platinum sector on the JSE Limited) as illustrated in Figure 4. The J153 can be taken to be the market proxy for the platinum mining sector.

It was found that Anglo Platinum (AMS) was by far the biggest driver of the J153 index. Figure 5 shows that the AMS share is in sync with the J153; hence, there is a close correlation between the AMS share and the J153.

This was further verified by comparing the changes in the share prices relative to the market (J153). In calculating the betas of the different PGE producing companies listed on the JSE, it was found that the beta for AMS relative to the J153 was close to one, indicating that AMS is a good proxy for the PGE stock market.

An analysis was conducted on the effect of the change in the platinum price (ZAR/oz) against the change of the platinum index (J153). The resulting logarithmic relationship (Figure 6) had a regression coefficient of between 85% and 90%, indicating a high degree of confidence in the relationship. An equation of the relationship is given as:

\[
y = 96.765 \ln(x) - 802.61
\]

where:

\[
y = \text{J153 index on a particular date}
\]
\[
x = \text{the effective platinum price (ZAR/oz)}
\]
The resulting relationship was tested on historical data to predict the share price for AMS relative to the market (J153), and it was found to be a fairly reliable estimate for valuation purposes. This relationship is then used to adjust valuation results to any changes in the PGE commodity prices. The PGE valuation curve, since it represents this very platinum market, can be adjusted accordingly to the changes in the commodity prices at any given time.

**Conclusions**

The concept of comparative valuation as one of the market approach methodologies has been extended to establish a PGE valuation curve for use in valuing PGE projects. Since it is also time based, the curve is a reflection of sentiments on the value of PGE mineral assets with market conditions at given times. This methodology, when applied to PGE transactions, provides general guidance in terms of a range of transaction values for the PGE mineral assets.

Venmyn’s PGE mineral asset valuation curve provides a graphic illustration of the historical PGE transactions that have taken place. The graph also plots the estimated unit values per mineral resource or mineral reserve of all the major mining companies listed on the various securities exchanges. This commodity valuation curve clearly shows, in a graphic form, the range of values for mineral assets, depending on the mineral resource classification, access, geology, and commodity price, just to mention a few factors. Value ranges are applicable whether buying or selling a mineral asset. The commodity valuation curves also serve as a good tool for cross-checking valuation results, using either the cost approach or the cash flow approach.

Venmyn records similar information and valuation profiles for a number of the mineral commodities and, the fact that many transaction values have been reported in a similar quantitative and qualitative manner, provides assurance that this is a reasonable and reliable method of estimating value for PGE mineral assets.

**References**


SPECIAL COMMITTEE ON VALUATION OF MINERAL PROPERTIES (CIMVal), Standards and Guidelines for Valuation of Mineral Properties, February 2003.

Godknows Njowa
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Godknows has eight years experience in the minerals industry gained in mine production and consulting. His mining career started in 2000, at Rio Tinto Zimbabwe’s gold mines and has been working as a Mineral Industry Advisor for Venmyn since 2006. Godknows currently serves on SAMREC/SAMVAL sub-committees. His key areas of expertise lie in technical and financial analysis, management accounting, and corporate governance. Mineral asset valuation, compliance and public reporting of mineral assets for the various stock exchange jurisdictions are his core focus areas. Godknows is currently studying for a PhD in mineral asset valuation at the University of Witwatersrand.