10IKC-30

EVALUATION AND VALUATION OF ALLUVIAL DIAMOND DEPOSITS

Tania R Marshall
Explorations Unlimited

Alluvial diamond deposits have, historically, been small artisanal operations that have had little or no geological control. As a result of multiple issues, including the real and perceived risks attached to alluvial diamond deposits, many analysts have been unwilling or unable to attribute significant value to such properties, often applying huge discount factors that instil fear in the hearts of potential investors. This is happening despite the fact that alluvial diamond mining has come of age with the appearance of a number of successful mines, owned and operated by listed, junior exploration and mining companies. The difficulties associated with evaluation and valuation of alluvial diamond deposits are widely known but, regrettably, often not widely understood – leading to several misconceptions over what can and can't be expected from such deposits. Fortunately, there is a reasonably well-established body of knowledge on alluvial diamonds that has resulted in accepted industry-standard practices of how to understand these deposits.

Similar to the steps taken in most other commodities, the evaluation of alluvial diamond deposits (Fig.1) begins with an initial programme.

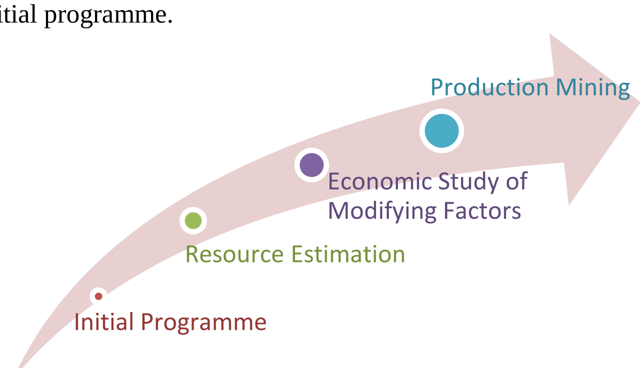

Figure 1: Stages of project evaluation

During a desktop study as much information as possible is collated from historical and anecdotal sources as possible. Satellite imagery and airborne geophysical surveys may also be used at this stage to generate broad target areas for further exploration. Due to the artisanal nature of many of these alluvial diamond projects, the background information available is, often, not as accurate or as reliable as one would wish, and caution must be employed if such information is used in compiling conceptual, preliminary business plans.

RESOURCE ESTIMATION

During the resource estimation phase of the project, combinations of ground geophysical surveys, drilling (including pitting, augering and trenching) and bulk-sampling are used to increase the geological knowledge and confidence required to estimate "resources" as defined in any of the international resource and/or reserve estimation codes. During this phase, the three main parameters to be determined are gravel volume, diamond grade and diamond value.

Since the geology can vary significantly from one alluvial diamond deposit to another, it is not possible to prescribe drill grid parameters or the number/size of samples. It is sufficient to note that drilling, sampling and sales of diamonds need to be adequate to satisfy the criteria of the resource classification to be used.

Probably, the most straightforward of the parameters to be determined on an alluvial diamond deposit is "diamond value". Canadian Institute of Mining (CIM) best practice guidelines (2008) indicates that parcels of at least 3,000-5,000cts are necessary to achieve reasonable valuation (i.e. for inclusion in Indicated Resource classification). Important in most alluvial diamond deposits is the caveat which notes that "caution should be expressed when an average diamond value is based on small parcels, since very large stones in the diamond size distribution may not be represented and insufficient stones may be present to adequately estimate the diamond value of medium and large stones which contribute most to the average diamond value". Since large stones of high value are often an integral part of alluvial diamond deposits, it is essential to investigate the effect that their recovery/loss will have on the potential profitability of the deposit. The use of "cumulative stone-size frequency" plots is especially useful in this regard.

Far more complex is the determination of gravel volume and average diamond grade. In contrast to many other commodities, alluvial diamonds cannot be assayed for in a laboratory setting. Alluvial diamond deposits are not characterised by any standard (or deposit-specific) satellite or indicator mineral assemblage that may occur in higher, more easily measureable concentrations than the diamonds. Neither do these deposits have any associated geochemical signatures that can vary according to diamond grade (or any other geological characteristic). The only reliable method of grade estimation is through bulk-sampling and the direct measurement of carats per volume processed. Some of the factors that impact upon the number of holes drilled and the number and size of samples taken are similar and include:

Depositional environments

Alluvial streams are highly transient environments. The braided channels are unstable through time and gravel bars are formed and destroyed continuously. Shifting bars and channels cause wide variations in local flow conditions resulting in varied depositional assemblages. Common features in braided stream deposits include irregular bed thicknesses, restricted lateral and vertical variations within the sediments, and abundant evidence of erosion and re-deposition. On a broad scale, most deposits are complex with units of no great lateral extent. Locally, bedrock features play an important role in diamond concentration of the alluvial deposits, with diamonds occurring preferentially in natural traps such as gullies, potholes and gravel bars (Fig. 2) and, typically, reworked through one or more post-depositional colluvial or eluvial processes.

Low grades

The grade of a diamond deposit is the estimated number of carats contained in one hundred tonnes (cpht) or hundred cubic metres (ct/100m^3) of gravel. Typical alluvial diamond deposits have grades that vary from 1-20ppb (two orders of magnitude less than a low grade gold deposit). Consequently, single positive or negative samples may be meaningless.

Large individual diamond size

Diamonds constitute discrete units of varying size (weight). Consequently, they form discrete particle deposits as opposed to disseminated particle deposits. Often the size and value distribution from stone to stone is erratic and it is possible that the majority of the value of a parcel is attributed to a single stone. Therefore, single small samples will often results in spurious results.

Low homogeneity of diamond distribution

Individual diamonds are not evenly or uniformly distributed throughout an alluvial deposit; neither are they randomly distributed. Rather, their distribution has been described as a random distribution of clusters of points, where the clusters are both randomly distributed in space, and the point density of each cluster is also random (Rombouts, 1987).

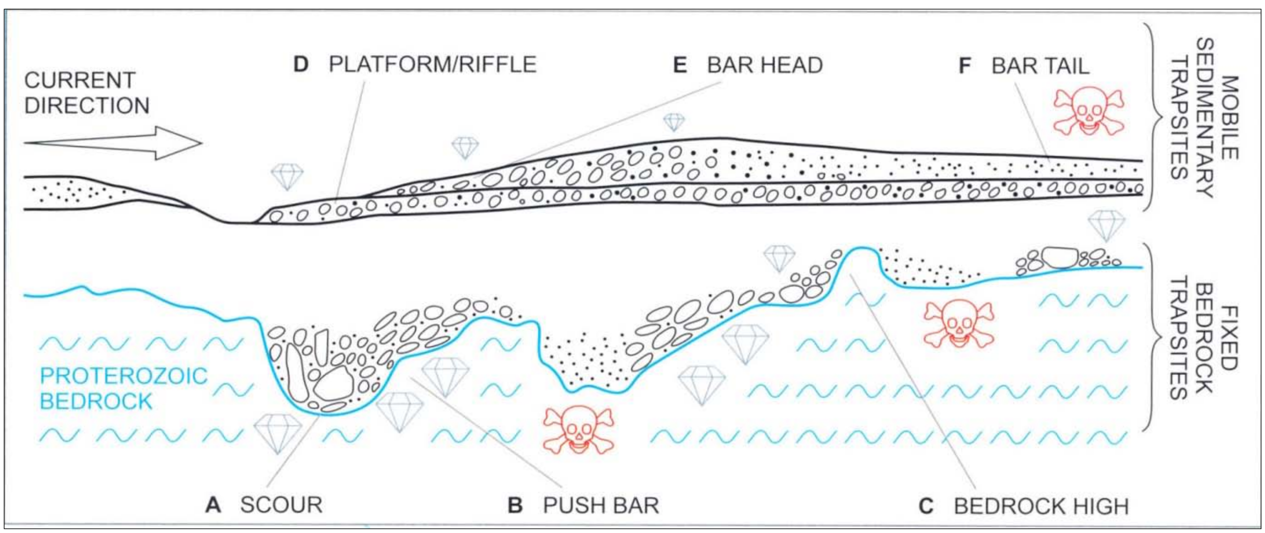

Figure 2: Variability of diamond trap-site locations, both in sedimentary and in bedrock deposits (Jacob, 2005)

In a single gravel unit (or even within a few metres), diamond grades may vary from barren to over 100cpht, due to the development of localized trap-sites under favourable bedrock conditions, or hydraulic fractionation within a channel or bar. Consequently, the diamond distribution pattern (grade) of alluvial deposits is such that there is no repeatability of small sample results, even from adjacent samples.

As a result of these (and other) issues, limited drilling can result in the overestimation or underestimation of available gravel volume. In addition, inadequate sampling (both numbers of samples and volume of individual samples) can result in spurious grade results. Although attempts have been made to apply geostatistical tests to estimate average grades on alluvial diamond projects, few reliable, repeatable studies have been documented.

It is usual for an alluvial diamond project to progress from “Exploration Targets”, through “Inferred Resource” to “Indicated Resource” classification. “Measured Resources are seldom determined, however. Measured Resources, by definition, cover the situation where all of the geological characteristics of the deposit can be estimated with a high level of confidence – sufficient to *confirm* geological and grade continuity. Alluvial diamond deposits are well known for their extreme low grades and inhomogeneity, as a result of the characteristics described above (Fig. 3).

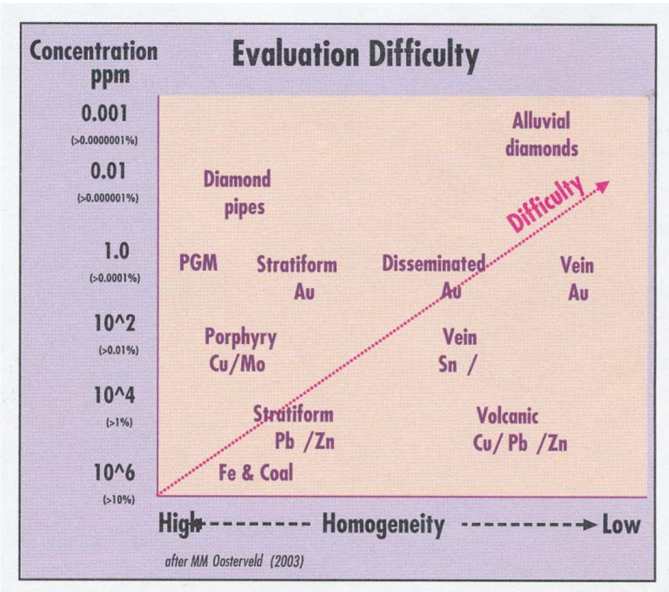

Figure 3: The extremely low concentrations of diamonds, combined with low homogeneity results insignificant difficulties in the evaluation of alluvial diamond deposits (after Lock, 2003)

The resulting scenario makes it extremely difficult to estimate the required parameters to a “high level of confidence” (with the exception of diamond value) without over-capitalising the project. The industry standard for reserve estimation on alluvial diamond mines is to estimate some two/three years of Indicated Resources and multiple years of Inferred Resources. As these are consumed, there is a continuous cycle of resource rollover.

Typical parameters for “Indicated Resources” include:

- Sufficient drilling to generate a 3-D model based on well- constrained geology;
- Extrapolation of drilling results only within similar geological environments to distances determined by the geology of the deposit;
- Sufficient bulk-sampling to take account of all the geological variables expected from the deposit in question.
- The recovery of 3,000-5,000cts of diamonds for valuation or sale to estimate diamond value. This pre-condition will also influence the amount of gravel processed during bulk-sampling.

RESERVE ESTIMATION

Reserves are determined through the application of “modifying factors” to appropriate resource categories. Pre-Feasibility (PFS) and Feasibility (FS) studies are applied to indicated and measured resources respectively to convert them to probable and proven reserves. Since measured resources are seldom estimated on alluvial deposits, probable reserves can be determined through the application of PFS.

As with any other commodity, a PFS is a comprehensive study of the “modifying factors” in sufficient detail so as to demonstrate that extraction is economically possible. Since most, if not all, of these factors are determined during bulk-sampling and trial-mining, indicated resources can be routinely converted into probable reserves.

VALUATION

In much the same manner as for any other commodity, one of the best measures of value is Fair Value, the highest price obtainable in an open and unrestricted market, between informed and prudent parties, with no obligation to buy or sell. Three dominant themes are evident (Spence, 2002):

1. The valuator must follow good valuation practices in the process of valuation (this is even more essential in the valuation of alluvial diamond projects).
2. Different methods of valuation may be more applicable depending on the stage of development of the mineral

property (Table 1). It is, however, important to note that mineral properties represent a continuum from early stage to late stage and, therefore, the transition from one method to another will demand some level of judgement.
3. A range or cluster of values derived from more than one method is highly recommended.

The Cost Approach is based on the principle of contribution to value. The appraised value method is one commonly used method where exploration expenditures are analyzed for their contribution to the exploration potential of the Mineral Property. Relevant exploration expenditure may be subject to premiums or discounts (typically 0-3) based on previous results. This method is extensively used in early stage valuation of alluvial diamond properties without identified resources.

The Market Approach is based primarily on the principle of substitution. The Mineral Property being valued is compared with the transaction value of similar Mineral Properties, transacted in an open market. Methods include comparable transactions and option or farm-in agreement terms analysis. Realistic results rely upon the presence of public valuations of similar deposits. Such documentation on alluvial diamond deposits are limited (since relatively few public companies explore/mine alluvial diamond deposits) and, consequently, market valuation approaches are often difficult to apply.

The Income Approach is based on the principle of anticipation of benefits and includes all methods that are based on the income or cash flow generation potential of the Mineral Property. These methods are the most accurate measures of value, but they also require the most input data.

Table 1: Valuation approaches appropriate for different stages of a project (Roscoe, 2002)

Valuation Approach	Exploration Property	Mineral Resource Property	Development/ Production Property
Income	No	In some cases	Yes
Market	Yes	Yes	Yes
Cost	Yes	In some cases	No

Discounted Cash Flows (DCF's), typically, require that a minimum of a PFS has been completed on the project and that reserves have been estimated. Preliminary economic assessments (admissible in public reporting only under very specific circumstances) that consider the potential viability of mineral resources are extremely useful for in-house planning purposes, but are dangerous in the public domain as they can build unrealistic expectations.

In constructing a DCF, one of the most sensitive issues is the rate at which the anticipated total returns are discounted to bring them back to their present value (i.e. the NPV discount rate). A simple discount rate for a mineral project, typically, comprises three principal components (Smith, 2002; Baurens, 2010): Risk-Free Interest Rate, Country Risk and Mineral Project Risk

Risk Free Interest Rate

Typically, the risk free rate used to come up with expected returns should be measured consistently with the currency in which the cash flows are measured (Damodaran, 2008; Baurens, 2010). The rate used would not be any different for alluvial diamond deposits than it would be for any other commodity.

Country Risk

The geo-political location of a mineral project can have a significant effect on the final discount rate used in the valuation. The level of risk varies from country to country and from year to year. It is essential to have both a current assessment and an historical record of a country's risk level when considering mineral investment.

The application of country risk discounts are especially applicable to alluvial diamond projects, given that such projects are, often, located in areas where sovereign risk, political risk, risk of resource nationalism, uncertain tax, royalty and licence regimes, as well as fraud and corruption are widespread and where quality of geological database and infrastructure access is, generally, poor (PWC, 2011; McMahon & Cervantes, 2011).

Mining Project Risk Components

Mineral project risks include risks associated with reserves/resources (tonnage, mine life, grade), mining (mining method, mining recovery, dilution, mine layout), process (labour factors, plant availability, metallurgy, recoveries, material balances), construction (costs, schedules, delays), environmental compliance, new technology, cost estimation (capital and operating), and sales values and market factors.

The discount rate applied to the constant-dollar valuation of mineral properties will, most commonly, be within the range of 8% to 20% per year (Lattanzi, 2002). Discount rates at the lower end of this range are applicable to the valuation of well-established, operating mines, while cash-flow evaluations deposits at feasibility study levels typically use discount rates in the region of 10% (Smith, 2002) or even 12-15% (Lattanzi, 2002). At earlier stage assessments, discounts rates increase to between 15-20%.

The complexity of the geology also influences the discount rate, with base-metal deposits at feasibility level averaging 11.3% and gold deposits typically at 8.8% (Smith, 2002). Although no similar, formal studies on diamond operations have been completed, the variability of sedimentological features in alluvial diamond deposits might be expected to result in somewhat higher discount factors, (Fig. 4)

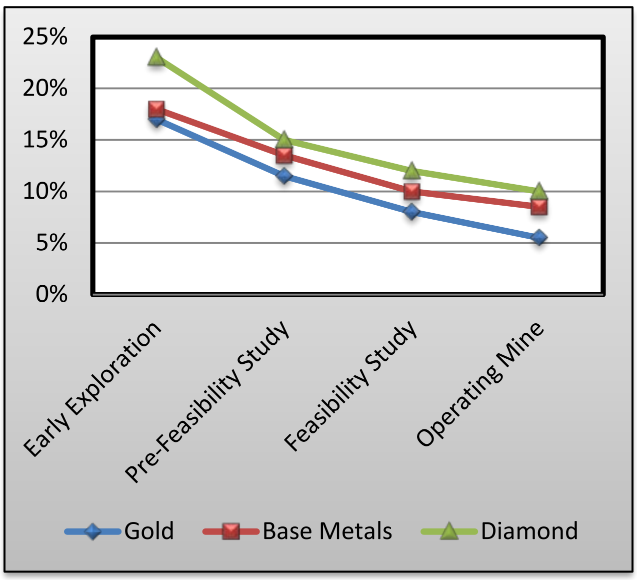

Figure 4: Discount Rate vs. Project Stage (modified after Smith, 2002)

CONCLUSIONS

Alluvial diamond deposits can, and should be, evaluated according to internationally accepted resource and reserve estimation criteria. There is nothing explicit about these deposits that preclude the application of requirements applicable to most other commodities. However, there are a number of issues that need to be addressed by the Competent (Qualified) Person evaluating the deposit:

- Alluvial diamond deposits are affected by specific conditions relating to low diamond grades and high levels of heterogeneity within the deposit. These issues need to be acknowledged and addressed by a well-designed evaluation programme.
- When converting resources to reserves, a comprehensive bulk-sampling and/or trial-mining programme must have been completed in order to *demonstrate* that extraction is economically feasible.

Valuation of deposits with defined resources/reserves is very similar to the valuation of any other commodities, through the construction of Discounted Cash Flows (and/or Preliminary Economic Assessments). Specific attention needs to be given to the applicable discount rates appropriate for the location and level of resource/reserve data available to the project.

However, since most alluvial diamond projects do not have defined resources, the greatest challenge is in evaluating very early stage deposits. In these situations, carious "Cost" and "Market" approaches can be used, although the results are, often, far from satisfactory.

REFERENCES

Lock, 2003: Comparing carats to kilograms. Mining Mirror, October 2003, p36-38.

Baurens, S. (2010): Valuation of Metals and Mining Companies. A document produced in collaboration with the University of Zurich, Swiss Banking Institute and Prof T Hens, 81pp

CIM (December 2005): Canadian Institute of Mining Guidelines for the Reporting of Diamond Exploration Results and the Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines.

CIM (May, 2008): Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines, Canadian Institute of Mining and Metallurgy, May 4, 2008

Damodaran, A (2008): What is the risk-free rate? A Search for the Basic Building Block. Stern School of Business, New York University, December 2008

Jacob, R. J. (2005): The erosional and Cainozoic depositional history of the lower Orange River, south-western Africa. PhD thesis, University of Glasgow, 167pp.

Lattanzi, C. R. Discounted Cash Flow Analysis Input Parameters and Sensitivity, 13pp Mining Millennium Valuation 2000, Special Session on Valuation of Mineral Properties, March 8, 2000, Toronto, Canada

McMahon, F. and Cervantes, M. (2011): Survey of Mining Companies 2010/2011. Fraser Institute Annual, 100pp. www.fraserinstitute.org

PWC (2011): Mine 2011. The game has changed. Review of global trends in the mining industry, 52pp. www.pwc.com/mining

Rombouts, L (1987): Evaluation of Low Grade/High Value Diamond Deposits. Mining Magazine (September, 1987), 217-220.

Roscoe, W. E. (2002): Valuation of Mineral Exploration Properties using the Cost Approach, 11pp. Mining Millennium Valuation 2000, Special Session on Valuation of Mineral Properties, March 8, 2000, Toronto, Canada

SAMREC (2007): South African Code for Reporting of Mineral Resources and Mineral Reserves. Prepared by the South African Mineral Resources Committee (SAMREC), under the auspices of the South African Institute of Mining and Metallurgy (SAIMM). Exposure Draft June 2006.

Smith, L. D (2002): Discounted Cash Flow Analysis Methodology and Discount Rates, 15pp. Mining Millennium Valuation 2000, Special Session on Valuation of Mineral Properties, March 8, 2000, Toronto, Canada

Spence, K. (2002): An Overview of Valuation Practice and the development of a Canadian Code for the Valuation of Mineral Properties, 9pp. Mining Millennium Valuation 2000, Special Session on Valuation of Mineral Properties, March 8, 2000, Toronto, Canada.