THE PROSPECTING AND EVALUATION OF ALLUVIAL DIAMOND DEPOSITS

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EXPLORATIONS UNLIMITED
Once an alluvial diamond project has been selected, the mineral resource/reserve present on the property has to be determined before it’s economic potential can be estimated. Prospecting does not convert a small, low grade deposit into a commercial mine, it simply determines what the resource is and where it lies on the property. Feasibility (and pre-feasibility) studies will then determine the commercial aspects of the operation and convert the economic portion of the resource into a mineable reserve.

Not all deposits are similar in bedrock geology or even in alluvial fill. Varying climatic, tectonic and geomorphic history will result in vastly different deposits. Prospecting and evaluation techniques that are appropriate in one instance may be entirely inapplicable elsewhere. However, in most cases an exploration programme will comprise:

1. Geological understanding of the deposit;
2. Remotely sensed data in the form of satellite images and/or aerial photographs;
3. Collection and interpretation of historical data;
4. Geophysical surveys;
5. Drilling / pitting / trenching on reconnaissance and more detailed scales; and
6. Bulk-sampling to determine the grade of the deposit, the value of the diamonds, as well as the various mining and engineering properties that will be needed to determine the economic feasibility of the deposit.

Each of these steps involves an increase in expenditure of time and money, moving on to the next stage when positive results are obtained. At each stage a decision must be made whether to walk away from the deposit or to continue. Not every deposit will be an economic success, but with a sensible approach to the exploration programme, costs and mistakes can be minimised and the possibility of success enhanced.

1 Geological understanding of the deposit

Before embarking on a physical exploration programme it is fundamentally important to have as complete an understanding of the geology of the expected deposit as possible. Without understanding what kind of deposit one is looking for, it is very easy to either use the wrong prospecting techniques to try and locate it, or even to use the right technique and still miss the deposit. Factors to be considered are:

The depositional environment
1. Is it marine, beach, glacial, karst, fluvial and if it is fluvial, what is it’s nature;
2. What are the stratigraphic relationships, the sedimentology, of the entire sequence and of the ore horizon, in particular;
3. What is the nature of the palaeodrainage and how was it affected by successive climatic and tectonic events;
4. Are the deposits structurally controlled.

Post depositional modifications
1. Have the deposits been modified by calcretisation or laterisation and how does this impact on the prospecting of the deposits;
2. How much of the deposit is likely to have been eroded since deposition.
2 Remotely sensed data

In the use of satellite images, as with any other tool, it must be remembered that they are tools in the exploration programme, and not an end in itself. Satellite, aerial photo, radar and laser data can be combined with geophysical or geological data in one or other of the commercially available exploration/mining software programmes.

Landsat TM

Landsat TM, especially, is extremely useful for regional interpretation and target generation, but may have limited use in detailed farm scale applications, mostly due to large pixel sizes. Spot Images have better resolution, but can be costly for the smaller operator.

Aerial Photographs

Aerial photographs are indispensable for any size operation and can be used in exploration as well as mine planning. Both black & white, and colour, photographs can be considered for different applications. In dolomitic terranes, Colour Infra-Red photographs have proved very useful. However, since these surveys have to be specially commissioned, cost is often a major consideration for smaller projects.

Side-Looking Airborne Radar

Side-Looking Airborne Radar (SLAR) imagery can be used to good effect in tropical or equatorial regions where microwaves are capable of penetrating cloud and, to a degree, rain and vegetation. In addition, radar is an active sensor and can operate during both day and night. This is especially beneficial in areas where daylight hours are limited.

Ground Penetrating Radar

Ground Penetrating Radar (GPR) is a geological mapping method useful for a wide variety of mining and geological applications and has been used with varying success to detect channels buried beneath deep sand cover in desert and semi-desert environments. GPR assists with geological mapping, water content/chemistry evaluation and buried structure location for exploration, mining, engineering projects and environmental site assessment.

Imaging Laser Altimetry

Imaging Laser Altimetry is a useful tool to obtain the third dimension for topographic mapping purposes (digital terrain modelling). Its ability to 'see through trees' allows the accurate determination of ground elevation even in vegetated areas. As a direct 3D mapping technique, Imaging Laser Altimetry is useful in providing a high degree of vertical accuracy and can be used very effectively for exploration in many environments, as well as for modeling drainage systems that rely on digital elevation data.

3 Historical data

Generally, an alluvial diamond project does not come with an overabundance of reliable geological information or diamond production data. In many cases the deposit has been mined by artisanal or professional "diggers". Such operators seldom keep reconcilable tonnage and production records and independent verification of this data is, typically, not possible. In other cases, the deposit may have been mined by a professional mining company in the past but the geological/production data may have been misplaced in the archives of companies which no longer exist, or have been irretrievably lost in the course of civil uprisings. And, in a small number of cases, false or misleading information is purposely supplied to prospective buyers by the mineral rights holders or operators in order to facilitate a "quick deal".
As a result, although it is necessary to acquire and interpret all available historical information, it is also important to be circumspect regarding reliance on this data.

4 Geophysics

Geophysics can be used successfully to cut down the amount of area that has to be physically opened up for visual inspection. Geophysical surveys are used, not to identify diamond-bearing gravel lenses, but to outline a relatively small area of interest that can then be prospected further. Although a great many of the geophysical techniques can be used in specific examples, two methods that have been shown to be successful are some of the electromagnetic methods (in particular, EM31, EM34, Max-Min and Electro-resistivity Tomography (ERT)) as well as gravity/microgravity surveys which are especially useful in dolomitic terranes.

With geophysics, as any other exploration tool, it is important to be aware of the limitations, as well as the potential, of the methods used as well as the data reduction and processing techniques. Also important is selecting the technique that is most appropriate to the deposit and the geological setting.

5 Drilling/Pitting/Trenching

The ultimate goal of this phase is to determine the resource/reserve of diamondiferous gravels present on the property. Depending on individual circumstances, auger, percussion and RC drilling can all be used. In all cases, it is important to follow up drilling with pitting/trenching to avoid over-estimation of gravel thicknesses.

There is no universally applicable rule for drill-spacing within the various resource/reserve categories. It is important here to look at the required level of confidence and then plan the drilling, pitting and trenching accordingly. Drill line and hole spacing is entirely dependant on the deposit, i.e. the grid should allow for inhomogeneity within the deposit and should be close enough to pick up palaeochannels, gravel bars and other areas where diamonds may be concentrated.

Delineating a “Measured Resource” or a “Proven Reserve” can be both time consuming and costly. For smaller projects it is important not to spend more on this exercise than will actually be realised from the mining of the property.

6 Bulk-sampling

This is the stage where the all important details that determine the economic viability of the project are obtained; such as diamond grade and value, the mining and processing methods as well as costs. Accuracy of results are vital in this phase and so good record-keeping along with effective security is vital - a single stone removed from, or added to, a sample renders that sample unuseable and the resources spent to obtain it will have been wasted.

In selecting both sample location and sample size it is important to recognise that alluvial diamonds represent the ultimate “nugget effect”. Grade distributions in alluvial deposits are very skew, often with a large proportion of barren samples, which do not necessarily reflect barren ground, but simply the chance effect of not recovering a stone in too small a sample. Diamonds constitute discrete units of varying size (weight) and, therefore, the usual parameters of grade measurements are not entirely applicable. Further complications are introduced due to the fact that diamonds do not have a unit value, rather, individual stone values depend on size and quality.
Individual diamonds are not evenly or uniformly distributed throughout an alluvial deposit; neither are they randomly distributed. Diamonds occur in clusters formed by natural traps such as gullies, potholes and gravel bars, and are not evenly spaced throughout those traps either. Due to this non-uniform distribution pattern, the grade estimated from any individual sample can vary widely. A single sample provides only a limited amount of information and the conclusions drawn are, correspondingly, uncertain. As a result, the most representative samples are those that have been composited from a number of different locations within the same gravel type. Consequently, it is necessary to process sufficient material to obtain a statistically meaningful sample grade based on diamond size distribution, USD/ct and USD/tonne values. Such samples many, necessarily, be quite large and, in areas of extreme variability, may be as much as 10% of the defined resource.

Resource blocks should not be based purely on sample results, but on more fundamental geological features such as bedrock contours or facies boundaries. Alluvial deposits generally show a decrease in diamond size and grade upward from the base of the ore horizon. In deposits containing thin ore horizons grade can often be optimised by restricting the ore thickness to the basal unit. In these instances, resource/reserve statements are best expressed as planar grades.

A bulk-sampling programme is, typically, planned to recover commercial-size diamonds. The average stone size recorded is dependent on the screen sizes selected, and especially on the lower screen size, since, if diamonds are recovered to a smaller lower screen size then the average stone size will, obviously, decrease. Typical lower screen sizes for alluvial deposits usually range between 1-2mm, while those for beach deposits may be as small as 0.5mm.

Summary

For the most part, prospecting for alluvial diamonds is relatively routine and can be summarised as:

1. Understand the geology (including, but not limited to, where and why the required deposit occurs and how it may be modified by post-depositional processes or erosion).
2. Know the potential and limitations of the available tools (remote sensing techniques, geophysical surveys) and use them wisely
3. Determine Mineral Resource/Reserve which comprises both physical factors (Tonnage, diamond grade and quality) and economic factors (mining costs, markets, environmental considerations, capital costs, operating costs, socio-economic-political factors, taxes & royalty payments).

Palaeo-alluvial diamond deposits can, generally, be brought into production within a relatively short time and with a reasonably small capital investment. Although these properties may have comparatively restricted gravel resources, alluvial diamond deposits have been known to yield remarkably high profit margins and, as such, should be prospect and evaluated with care.