SIZE AND VALUE DISTRIBUTIONS OF DIAMONDS.

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Diamond sizes in a kimberlite can range from molecule-sized crystals to stones of several hundred carats. Only the tail of the size distribution, say stones larger than 0.02 carats, are of economic interest. Microdiamond studies can extend the range of the observed size distribution down to the order of 0.00001 carats. The complete size distribution remains however unknown.

In kimberlites and lamproites, diamonds tend to increase exponentially with diminishing size. A decrease in number frequency at the smallest recoverable diamond sizes may occur, but is artificial and due to a gradual loss in recovery efficiency. The exponential decrease of number frequency with increasing size is not necessarily uniform. The corresponding weight frequency distribution often displays a clear mode. A statistical model explaining both the exponential increase of the number frequency with diminishing size and a weight frequency distribution with a mode is the log-hyperbolic distribution. If the weight frequency is plotted versus size on a log-log scale, a hyperbola is obtained. The corresponding number frequency distribution versus size on a log-log scale keeps on increasing with diminishing size and has no mode.

The log-hyperbolic model does not imply that the diamond size distribution is genetically homogeneous. In fact, the log-hyperbolic distribution can be obtained as a mixture of lognormal distributions, showing a linear relation between logarithmic mean and logarithmic variance.

A gradual decrease in recovery efficiencies at both the lower and upper sizes during sampling or on an industrial scale in the plant, results in the bending down of the extremities of the log-hyperbolic distribution. The hyperbola of the log-log plot of weight frequency versus size turns into a parabola. As a consequence, 3- or even 2-parameter lognormal distributions can be fitted to the recovered stone size distributions. The lognormal size distribution is therefore an artefact of recovery efficiency.

The observation that the combined microdiamond to commercial-sized distribution fits reasonably well the lognormal model is of much practical use during the initial drilling stage when the first samples are submitted for microdiamond analysis. When the microdiamond sizes are plotted on a lognormal cumulative probability graph, part of this plot, especially in the middle, will tend to lie along a straight line, with strong deviations possible at one or both extremities. A strong deviation toward the larger sizes is due to the chance effect of having a large diamond in the small sample. A lognormal line can be traced through the linear portion. The corresponding logarithmic mean and variance of the graphic lognormal fit can be used to solve the integral of the lognormal size distribution between the range 0.01 or 0.1 to 100 carats.

The distribution of stones within a homogeneous kimberlite facies is much more uniform than in alluvial deposits. The number of stones per unit weight follows a Normal or Poisson distribution. The total weight of microdiamonds recovered from a sample can be multiplied with the fraction of commercial-sized diamonds, derived from the extrapolation of the lognormal frequency distribution, to obtain an approximate grade.

Sorting in an alluvial environment results in a gradual truncation of the log-hyperbolic size distribution from the primary source. Finer diamonds tend to concentrate in the sand fraction, while larger diamonds tend to be enriched in the bottom gravels of an alluvial sequence. The resulting distribution is lognormal.

Two types of value distribution can be considered: the value per stone distribution and the value per carat distribution.

The value per stone distribution is usually well-fitted to a 2-parameter lognormal distribution. However, the logarithmic variance can be very high. While in alluvial deposits the logarithmic variance of the value of the individual stones is often three or less, on many kimberlites the logarithmic variance can be 5 or more.

The value per carat distribution is the quotient between the value per stone distribution and the stone size distribution. The latter two are often lognormal, but their quotient not necessarily so, as they are not independent. The value per carat distribution is useful in determining the optimal bottom screen size and top crushing size.

At the evaluation stage, the average carat price is traditionally obtained by dividing the total value of the diamonds recovered during a sample programme by their total weight. This is equivalent to dividing the arithmetic mean of the value per stone distribution by the arithmetic mean of the stone size distribution. Considering the high logarithmic variances of the value per stone distribution, this is not a very efficient procedure. In case of lognormality, the average carat price is better estimated by dividing the t-estimator of the value per stone distribution by the t-estimator of the stone size distribution.