STATISTICAL DISTRIBUTIONS FOR DIAMONDS.

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Models for the sizes and spatial distribution of diamonds are necessary to sample and evaluate diamond deposits in a rational and economic way. The distribution models can be interpreted as the result of physical processes acting on discrete particles. For instance, size distributions could be diagnostic for constraints during crystallisation of the diamonds.

If the growth of diamonds in the mantle was subject to the proportional effect, diamond sizes will be well approximated by two-parameter lognormal distributions. If we assume, on the other hand, a size-invariant growth, fractal models will be applicable, with the size distribution obeying a power law. Lognormal distributions fit very well the size distributions of macrodiamonds in kimberlites, lamproites and sediments. The size distributions of microdiamonds (e.g. in the Argyle lamproite), however, seem to follow a power law. The difference between the lognormal and fractal distribution can be illustrated with the theory of fragmentation. If fragmentation is explosive - or sudden and pervasive -, the resulting fragments will follow a fractal size distribution. This has for instance been studied in coal mines, where the sizes of coal fragments from the broken mine face follow a power law. On the other hand, if breakage is slow, say in a mill, at every stage in the process the fragments created are a random fraction of a previous larger fragment. This proportional effect will result in a lognormal size distribution for the fragments. The model of stable growth proportional to size seems plausible for macrodiamonds in the mantle. Kimberlites tap these macrodiamonds as xenocrysts. The power law of the microdiamonds seem to point to a sudden random growth, possibly at the time of kimberlite explosion.

Deviations or variants on these ideal cases will often create distributions intermediate between Pearson III and Pearson V type curves. Within this family are gamma distributions, inverse gaussian distributions, three- and four-parameter lognormal distributions and log-hyperbolic distributions. The latter two are especially useful in an alluvial environment, where due to alluvial sorting a linear relationship could exist between the average stone size and the standard deviation.

During diamond crystallisation in the mantle, carbon molecules will diffuse by random walk to the nearest nucleation seed. If the nucleation seeds appear at random but at a constant rate in time and per unit volume, the distribution of the volumes of influence of each seed will have a coefficient of variation of 1.066. The latter is very similar to the coefficient of variation of diamond sizes in the Banankoro kimberlite pipes in Guinea, where diamonds are large, clear and well-crystallised.

Diamonds are brought to the earth's surface during kimberlite volcanism and are spread in secondary deposits by rivers, wind and sea. Sichel's compound Poisson distribution is a very useful model to describe the distribution of diamonds as particles in space. The compound Poisson distribution is obtained by mixing a simple Poisson distribution with a distribution intermediate between the Pearson III and V curve. The model can be visualized as a random distribution of clusters. The compound Poisson distribution is flexible with parameter theta (between 0 and 1) indicating the degree of clustering. If theta is zero, the distribution becomes a simple Poisson distribution, with particles distributed at random without clustering. If theta approaches one, the clustering effect becomes stronger. This allows the clustering of diamonds in favourable trapsites to be modelled.

If samples of diamond deposits are large enough to contain several tens of stones, the resulting grade distribution will loose its discrete character and tends to be lognormal. In kimberlites or lamproites, the grade contains a spatial structure, wich can be modelled in a spherical variogram. A random distribution of points will create a spherical variogram if the number of points are counted in successively overlapping spheres. The range of the variogram is then equal to the degree of overlapping of two successive spheres.

The value distribution of diamonds is well approximated by lognormal distributions. The value distribution will show a high logarithmic variance in deposits with a high gem content. The t-estimator is in such a case more efficient than the arithmetic mean for estimating the average carat price of the diamonds.