predictive mineral discovery
COOPERATIVE RESEARCH CENTRE

The Fractal Distributions of Base and Precious Metal Systems, Mt Isa Inlier, Australia

Arianne Ford
James Cook University, Townsville Qld 4811, Australia. Arianne.Ford@jcu.edu.au

1. Introduction

Mandelbrot (1983) suggested that mineral deposits in the earth's crust have a fractal distribution. This hypothesis has been tested in several studies of precious metal distributions. The Mt Isa Inlier, NW Queensland, Australia is an ideal place to test Mandelbrot's hypothesis for base and precious metal deposits. The world famous Proterozoic province contains a wide variety of base and precious metal deposit types including Cu, Au, CuAu, Iron oxide-CuAu and U-REE. The similar geology of the Georgetown Inlier, NE Queensland, Australia makes an ideal location for comparison of results.

Provided that each of the deposit types in each location has a fractal distribution, the corresponding fractal dimensions can be compared. The fractal dimension measures the degree of clustering of deposits: smaller fractal dimensions mean greater clustering.

2.

Figure 1: Study Areas
Mt Isa Inlier and Georgetown Inlier
Image adapted from: Queensland Department of Natural Resources and Mines, 2002

3. Method

By adapting the box counting method described by Carlson (1991) a view of how the fractal dimension varies across a study area can be generated (Figure 2). The study areas (the Mt Isa Inlier and Georgetown Inlier) are initially split up into boxes of a specified length and a grid of square cells (length r) is placed over the top of each of these boxes. The number of deposits (N(r)) in each grid cell is counted. The size of the grid cells is then reduced and the process repeated for a range of grid cell sizes. The box is then shifted in 50km increments along the study area and the cell counting repeated so that the regional variation of fractal dimensions can be analysed.

The regression limits of the resultant log-log graphs were determined by viewing a range of graphs which showed that the line-of-best-fit was over the points with cell sizes greater than 10km and smaller than the largest cell size examined. The largest cell size was ignored due to the fact that it is fixed with respect to the size of the study area.

Regions showing comparatively small fractal dimensions may warrant further exploration for undiscovered mineral occurrences in areas with fewer deposits.

4. How does the fractal dimension for Cu deposits vary in the Mt Isa Inlier?

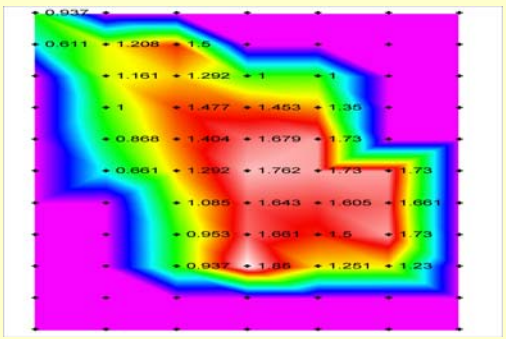

Figure 2: Variation of Fractal Dimension for Cu Deposits in the Mt Isa Inlier

5. Table 1: Results of Fractal Dimension Calculations for Mt Isa Inlier with correlation coefficient R and standard error E

Deposit Type	No. of Deposits	Fractal Dimension	R	E
Cu	1869	1.4	0.988	0.032
Au	136	0.7	0.981	0.022
CuAu	416	1.4	0.980	0.063
IoCG	198	1.3	0.989	0.038
U-REE	144	0.9	0.993	0.016

6. Table 2: Results of Fractal Dimension Calculations for Georgetown with correlation coefficient R and standard error E

Deposit Type	No. of Deposits	Fractal Dimension	R	E
Cu	90	0.9	0.974	0.028
Au	1014	1.2	0.989	0.024
CuAu	34	0.7	0.942	0.033
U-REE	51	0.8	0.936	0.037

7.

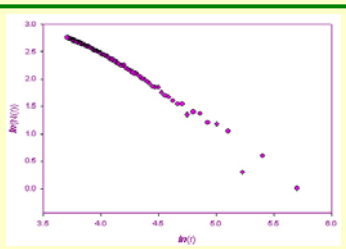

Figure 3: Plot of ln(r) vs ln(N(r))
for Cu Deposits in the Mt Isa Inlier

8.

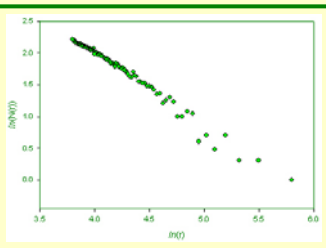

Figure 4: Plot of ln(r) vs ln(N(r)) for
Au Deposits in the Georgetown Inlier

9. Conclusions

The box counting method used shows significant differences between the fractal dimensions of mineral deposits of the same type. There are also noticeable differences between the fractal dimensions of similar deposit types in the two study areas. This indicates that the mineralizing systems may have had different properties and the geological controls on the systems may be different. Figure 2 shows that the Western Succession of the Mt Isa Inlier has comparatively smaller fractal dimensions (deposits are more clustered) than the Eastern Succession. This may be attributed to the different mineralization systems in the two areas.

The fractal dimensions for Au deposits in the Mt Isa Inlier and Georgetown Inlier are respectively less and greater than the fractal dimensions of Archaean lode Au deposits in the Zimbabwe craton (Blenkinsop, 1994). When compared to the results obtained by Carlson (1991) in the Basin and Range the fractal dimensions of Au deposits in this study fall below Carlson's for large box sizes and are higher for small box sizes.

The shifting box counting for Copper deposits in the Mt Isa Inlier shows that there are regions with low fractal dimensions (more clustered), possibly indicating that further exploration may be warranted in the areas with few deposits after geological variations are accounted for.