

Structurally informed resource estimation

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Metalliferous deposits are almost invariably either structurally emplaced or modified, rendering the underlying statistics of the deposit non-stationary. One approach to this problem is to subdivide the deposit into a number of domains in which the statistics can be assumed locally stationary. In mineral deposits having a high level of curvilinear geometrical variation this leads to a conflict between the need to adequately model the geometrical variation and the need to ensure an adequate number of points for the construction of reliable experimental variograms. In cases where the domains dictated by geometry do not contain enough data for experimental variograms to be constructed reliably several domains must be combined for variography. This practice may compromise the carefully constructed geometrical models.

Since mineralisation continuities are not in general rectilinear, but curvilinear in space, the range anisotropies interpreted from experimental variograms calculated from combined domains are an average of the true grade anisotropy that varies through space. Combining domains thus results in a spatial averaging of the mineralisation continuities and could potentially be a major source of error in the resource estimation process. Furthermore it is difficult to accurately describe spatial grade variations using variogram models because geometries of mineralisation cannot uniquely be forced into rectilinear geometries.

A novel solution to the problem of curvilinearity of mineral deposits is the multiple-point statistical approach (Strebelle 2002, Krishnan & Journel 2003). Here the geologist provides a training image for conditional simulation. This technique is effective if the spatial pattern is repeated in the volume (eg. stockwork deposits), but when modelling the unrepeated first-order continuities of mineralised zones (eg. single mineralised fold, shear zone), a direct interpretation by the geologist would appear to be a more straightforward alternative.

We propose a technique that allows geologists to generate the most realistic continuous geometric models directly in 3D and interpolate the grade continuously through space. Analogous to foliation and lineation trajectory maps created by structural geologists, the models required for resource estimation are effectively tensor fields defined in 3D space. Rapid volumetric spline interpolation can be used to first define local continuities of mineralisation. The orientation of the local mineralisation continuity ellipsoid is anchored to the 3D tensor field. The local mineralisation can thus be modelled from a geometrical interpretation provided by the structural geologist. This procedure of allowing a continuous variation of the interpolation basis is a radical departure from the traditional method of constructing resource domains in which the mineralisation continuities are assumed to be discrete and rectilinear and the statistics stationary.

References

- Strebelle S., 2002, Conditional Simulation of Complex Geological Structures Using Multiple-Point Statistics. *Mathematical Geology*, 34, 1-21.
- Krishnan, S. & Journel A.G., 2003, Spatial Connectivity: From Variograms to Multiple-Point Measures. *Mathematical Geology*, 35, 915-925.