TIPS from Tech Support

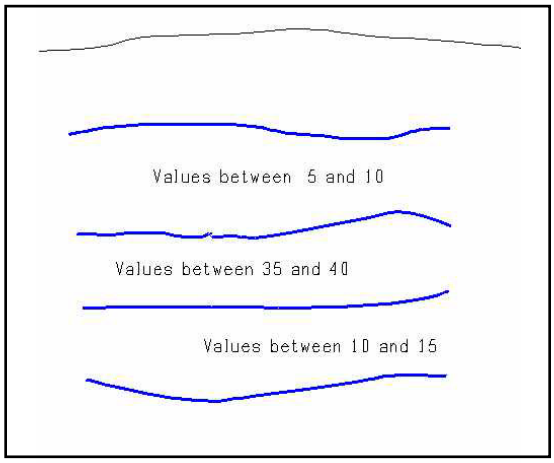
Modeling Zonal Anisotropy

What is zonal anisotropy?

Anisotropy exists if the structural character of a mineralization of an ore deposit differs for different directions. Studying the variography of such mineralization can help you detect anisotropy.

If the nugget and the sill values of variograms in different directions are the same but the ranges are different, then one is dealing with geometric anisotropy.

If the nugget and range of the variograms are generally the same, but their sills are different in various directions then one is dealing with zonal anisotropy. This situation is encountered in deposits in which the mineralization is layered or stratified (see Picture 1). In the example of picture 1, variation inside each layer (horizontal direction) is small (maximum difference is 5), but along the vertical direction the maximum difference is 35.



Picture 1. Vertical section.

Zonal anisotropy is much more difficult to handle during estimation than geometric anisotropy. Quite often, combinations of geometric and zonal anisotropy are encountered and can be very difficult to interpret. One way to deal with zonal anisotropy is to partition the data into zones, and analyze each zone separately.

Another way to handle zonal anisotropy is to use nested variogram structures which is discussed next.

Nested Structure in General

A variogram function can often be modeled by combining several variogram functions:

$$g(h) = g_1(h) + g_2(h) + \ldots + g_n(h)$$

For example, there might be two structures displayed by a variogram. The first structure may describe the correlation on a short scale. The second structure may describe the correlation on a much larger scale. These two structures can be defined by a nested variogram model. Nested variograms can also be used to solve the zonal anisotropy modeling problem of having to define the same sill values in all directions in M624V1 (kriging routine).

Example

Table 1 describes three variograms in 3 directions where zonal anisotropy is detected (assume same variography along minor and vertical axis for simplicity):

Axis	Nugget	Sill	Range	Model type
Major	0.1	0.6	350	Spherical
Minor	0.1	0.8	350	Spherical
Vertical	0.1	0.8	350	Spherical

Table 1 Initial (single) variography

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This information (Table 1) in order to be used in M624V1 needs to be modified to (Table 2):

Axis	Nugget	Sill1	Range1	Sill2	Range2	Model type
Major	0.1	0.6	350	0.8	Needs to be calculated (huge number)	Spherical
Minor	0.1	0.6	Needs to be calculated	0.8	350	Spherical
Vertical	0.1	0.6	Needs to be calculated	0.8	350	Spherical

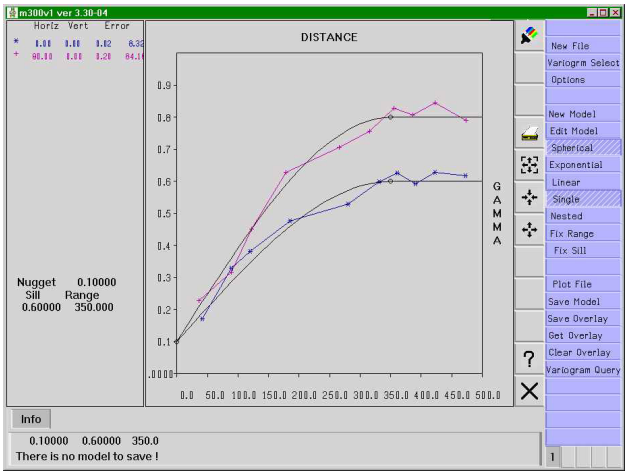
Table 2 Modified (nested) variography

One needs to calculate range1 for minor and vertical axis as well as range2 for major axis in a way that new variograms (Table 2) are as close as possible to the initial ones (Table 1).

In order to do so:

-Start M300V1 (variogram modeling).

-Save initial variograms as overlays (see Picture 2)

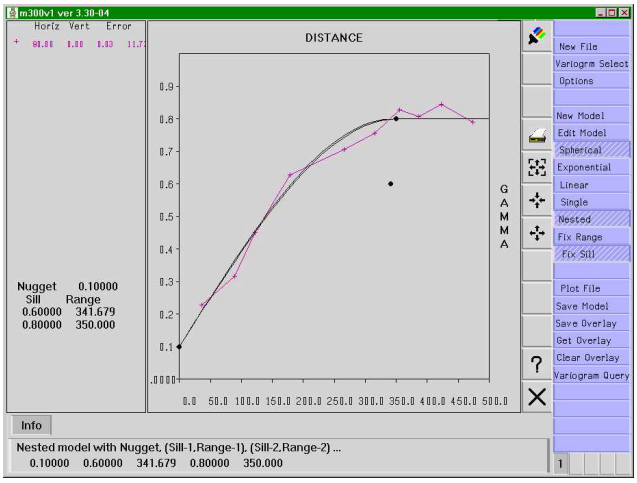


Picture 2 Overlays of single variograms

-Create new nested models trying to match visually the initial variograms (overlays). Make sure you click on the nested option from the menu.

For the minor/vertical axis:

Enter nugget (type in 0.1)
Enter a second point (digitize)
Type in a thrid point (0.8 350)
Fix sill to 0.6 and edit model. Adjust range1 so it fits overlay (see Picture 3).



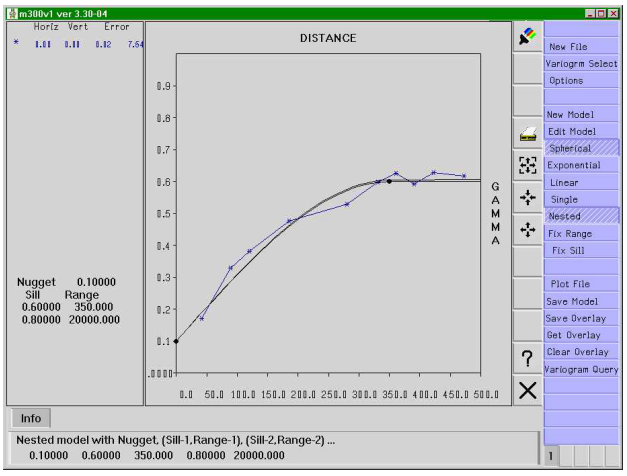
Picture 3 Nested minor axis on top of overlay of single minor axis.

For the major axis:

Enter nugget (type in 0.1)
Type in the second point (0.6 350)
Type in the third point (08.20000)

See Picture 4.

The huge range 20000 is only used so we can form a nested variogram that matches (mathematically) the single model. If you want to use the variogram ranges as an indication for the search distances, you should still use search distances around the 350 range.



Picture 4 Nested major axis on top of overlay of single major axis.

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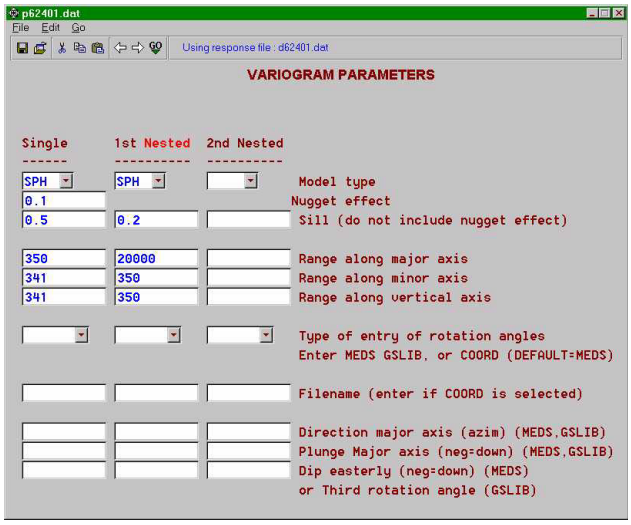
The final variogram should now be:

Axis	Nugget	Sill1	Range1	Sill2	Range2	Model type
Major	0.1	0.6	350	0.8	20000	Spherical
Minor	0.1	0.6	341	0.8	350	Spherical
Vertical	0.1	0.6	341	0.8	350	Spherical

Table 3 Final (nested) variography

The information from Table 3 can now be entered in the Krigin procedure (p62401.dat) as in the panel shown to the right.

Notice that the sill needs to be entered in increments. The direction of the major axis is assumed to be at) degrees (no dip or plunge).



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