

## Programs for Swath Plots

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*Swath plots are useful for identifying trends and understanding how the grade changes along a particular vector. Considering multiple swath plots along different vectors can indicate directions of continuity/variability. Three GSLIB-style programs are documented herein. The first, swathplt, is for calculating and plotting a swath plot along one vector. Any number of data sets/models can be included on the plot. The second, swathplt\_mult, is for calculating variability along many different vectors. This variability can be plotted on a stereonet-type plot using the third program, stereoplt, to indicate the directions with the most and least variability.*

### Introduction

Geological modeling requires prior understanding of any existent trends. The trend should have a physical or genetic explanation such as a fining-upwards trend of particle size distribution as larger particles settle prior to finer particles during deposition. The trend is often plotted against some coordinate of interest. For example, a vertical trend can be represented as a plot of elevation versus grade such as that shown in Figure 1. This plot is constructed by averaging all of the data that fall within regular elevation intervals. The trend represents the average within each interval. The grade can also be plotted against other coordinates such as the easting or northing. The plot is constructed in a similar manner where the average is calculated within regular intervals along the coordinate and the averages plotted against the coordinate value for that interval. The generic term applied to these plots of grade versus some coordinate is 'swath plot.' A swath plot has been defined as "a graphical representation of grade distribution derived from a series of sectional zones or bands (swaths), generated in two-dimensional sections which are propagated by a given step size along the vector normal to the sectional data" (Minesight, 2011). A swath plot can be constructed along any vector to allow the practitioner to observe how the grade changes along that vector.

In addition to observing how the grade changes along a vector, the variability in the grade along the vector can also be identified. The grade may change significantly along a given vector whereas the change along another vector may be less. Comparing the variability along multiple vectors allows the practitioner to understand better the trends and continuity present. The variability can be summarized for many vectors and then plotted on a stereonet-type plot to indicate those vectors with greatest and least variability.

This note documents three GSLIB-style (Deutsch & Journal, 1998) programs for working with swath plots. The first is called swathplt and calculates and plots a swath plot for any number of input data, regular or scattered. The second is called swathplt\_mult and calculates a swath plot for multiple vectors. The swath plots are summarized by their variance which is output for each vector. The third program is called stereoplt plots the results produced by swathplt\_mult as a stereonet-type plot.

### Swathplt

A swath plot can be calculated from either scattered data or gridded data. Therefore, a swath plot can be a useful tool for checking that a model reproduces the trend seen in the data along a given vector. It can also be a useful tool for comparing models built using different interpolation methods. As such, the swath plot program swathplt can generate swath plots for any number of input data sets. The number of data sets is the first parameter entered as seen on Line 5 of the parameter file shown in Figure 2. The name of the first data file is indicated next followed by a flag indicating whether the file contains scattered or gridded data. If the file contains scattered data, the next three lines correspond to this data set. If the file contains gridded data, the next six lines correspond to this data set. In the parameter file shown, the first data file is indicated to contain scattered data, so lines 8-10 indicate the columns for the coordinates and variable, the trimming limits, and the appearance of the swath plot for this data set. The dashing and

color codes are explained at the end of the parameter file. This parameter file directs the program to create a second swath plot from a gridded model specified on line 11 and 12. Line 13 specifies which column contains the variable of interest in the file specified on line 11. Lines 14-16 specify the grid. Line 17 specifies the trimming limits for this file while line 18 specifies the appearance of the swath plot for this data file. Line 19 specifies the output file. Line 20 specifies the vector for calculating the swath plot. The vector is defined by an azimuth and dip. Line 21 specifies how many bins. Too many bins leads to noisy results; too few bins leads to over smoothing. Lines 22 and 23 specify the axes extents for the plot. If the maximum is set less than the minimum, these will be determined automatically. The y-axis can be plotted with a logarithmic scale. Line 24 specifies whether to plot a histogram of the number of data falling in each bin. Lines 25-27 are where the title and axis labels are specified. Line 28 specifies whether to plot error bars. These bars provide additional summary of the conditional distribution. The percentiles represented by the error bars are controlled by specifying lower and upper percentiles. No additional lines are required for the program to run, however, it can be helpful to include a legend when multiple swath plots are plotted together. The first parameter on line 36 in the parameter file shown in Figure 2 indicates whether to plot a legend. The other parameters on this line specify the position of the legend. The following lines are for the user to indicate what each swath plot represents. A line must be included for each data set.

Figure 3 provides an example of the output produced by the swathplt program. The x-axis is distance while the y-axis is grade. Additional coordinates are shown on the x-axis when the vector specified is not perpendicular to that axis. For example, if the vector specified was perpendicular to the northing or Y-axis, the coordinate along this axis would be a constant value and would not be shown. The gray bars indicate the number of samples falling in each bin with the maximum number of samples indicated. The azimuth and dip of the vector are indicated on the plot.

### **Swathplt\_mult**

One item that can be deduced from a swath plot is the variability in the grade along that particular vector. The variability is vector-dependent; it will change depending on the vector being considered. Swathplt\_mult calculates the variability along a range of vectors spanning the user defined vector space.

The parameters for this program are shown in Figure 4. The first parameter (Line 5) specifies the data file. Line 6 specifies whether this file is scattered data or gridded. If the data is scattered, line 7 specifies the column numbers of the X,Y,Z coordinates and the variable. If the data is gridded, line 7 specifies the column number of the variable. Line 8 specifies the trimming limits; line 9 specifies the output file. Lines 10 and 11 specify the vector space. The vector space is specified similar to a 2D grid by the number of azimuths, starting azimuth, azimuth step, number of dips, starting dip, and dip step. Finally, the number of bins for the swath plots is specified on line 12. The swathplt\_mult program outputs a file with three columns: a column for azimuth, dip and variance. An output sample is shown in Figure 5.

### **Stereopt**

The program stereopt is for plotting the results produced by swathplt\_mult. A stereonet-type plot is produced, hence the name stereopt. Stereopt reads in the variability calculated at regularly spaced azimuths and dips.

The parameters for this program are shown in Figure 6. The file with the data to be plotted is indicated on line 5, the column number with the data on line 6. Trimming limits are indicated on line 7. The output postscript file is specified on line 8. The vector space is specified on lines 9 and 10. This should match the vector space specified in the swathplt\_mult parameter file. The title of the plot is specified on line 11. The color bar is controlled by the scale parameter on line 12, the color type parameter on line 13, and the color range on line 14. The color range can be determined automatically by setting the max value less than the min value.

An example of the output produced by this program is shown in Figure 7. The variance along each vector is represented by the colors. This particular deposit appears to have greatest variability along a vector with azimuth of 10° and a dip of 45°. The least variability is along a vector nearly perpendicular to this with an azimuth of 210° and a dip of 45°. On the stereoplot, more horizontal dips fall closer to the edge of the plot while more vertical dips fall closer to the center.

### **Conclusions**

Swath plots are useful for examining and understanding the behavior of the grade in a deposit. Swath plots are calculated along particular vectors to understand the grade behavior in different directions. Considering swath plots calculated in different directions can also indicate directions with more and less variability. The variability along many different vectors can be compared by plotting it on a stereonet-type plot. Three GSLIB-style programs have been documented for performing these various tasks. Each requires a parameter file and performs the task described.

### **References**

Deutsch, CV and Journel, AG, 1998. GSLIB: Geostatistical Software Library and User's Guide. Oxford University Press, New York.

Minesight, 2011. New insight for model and drillhole data. Accessed Apr 30, 2012 from [http://www.minesight.com/en/september\\_2011/september/swath-contact.pdf](http://www.minesight.com/en/september_2011/september/swath-contact.pdf)

Figures

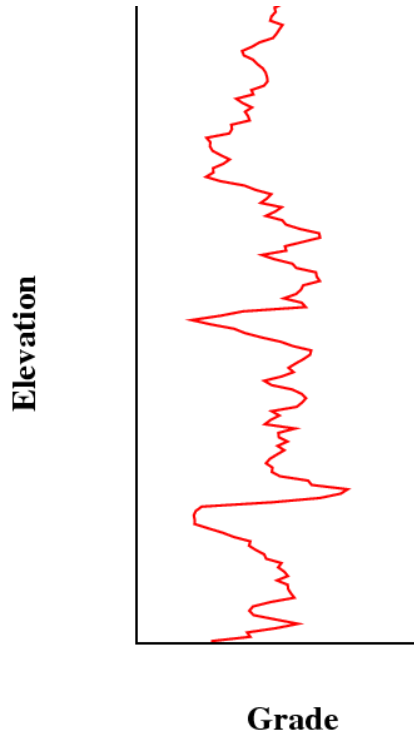


Figure 1: Plot of a vertical trend.

```

1          Parameters for SWATHPLT
2          *****
3
4  START OF PARAMETERS:
5  2          -number of data files to plot
6  data.dat      -data file 1
7  0          -scattered or gridded? (gridded = 1)
8  1 2 3 4      -columns for X,Y,Z,variable
9  -1.0e21 1.0e21 -trimming limits
10 2 0 5 1      -line width (0=none), dashing, bullet size (0=none), color
11 model.out    -data file 2
12 1          -scattered or gridded? (gridded = 1)
13 1          -column for variable
14 50 0.5 1.0  -nx,xmn,xsiz
15 50 0.5 1.0  -ny,ymn,ysiz
16 10 0.5 1.0  -nz,zmn,zsiz
17 -1.0e21 1.0e21 -trimming limits
18 2 0 5 10    -line width (0=none), dashing, bullet size (0=none), color
19 swathplt.ps -file for Postscript output
20 45 25      -azimuth, dip
21 10        -number of bins
22 0 -1      -X min and max
23 0 -1 0    -Y min and max, (0=arith, 1=log) (max<min for auto scaling based on data file #1)
24 1        -plot histogram of the bin count of the first data file (0=no, 1=yes)
25 Grade vs. Coordinate -title
26 Distance    -X axis label (default=get from data file #1)
27 default    -y axis label (default=get from data file #1)
28 1 25 75    -error bars?(1=yes), lower percentile, upper percentile
29
30
31 *****
32 Can remove lines below to shorten par file
33 *****
34
35 BLOCK FOR USER DEFINED LEGEND:
36 1 1 .7      -plot a legend for these shapes (1=yes).x.y between -1=left 1=right
37 Data set    -label for data set 1
38 Model      -label for data set 2
39
40
41 Color Codes for the curves:
42 1=red, 2=orange, 3=yellow, 4=light green, 5=green, 6=light blue,
43 7=dark blue, 8=violet, 9=white, 10=black, 11=purple, 12=brown,
44 13=pink, 14=intermediate green, 15=gray 16=gray10, 17=gray20, 18=gray30,
45 19=gray40, 20=gray50, 21=gray60 22=gray70, 23=gray80, 24=gray90
46
47
48 Dashing Codes for the curves:
49 1 = [40 20], 2 = [13 14 13 20], 3 = [12 21 4 21], 4 = [10 10],
50 5 = [20 20], 6 = [30 30], 7 = [40 40], 8 = [ 3 3],
51 9 = [ 5 5], 10 = [ 8 8]

```

Figure 2: Parameters for swathplt.

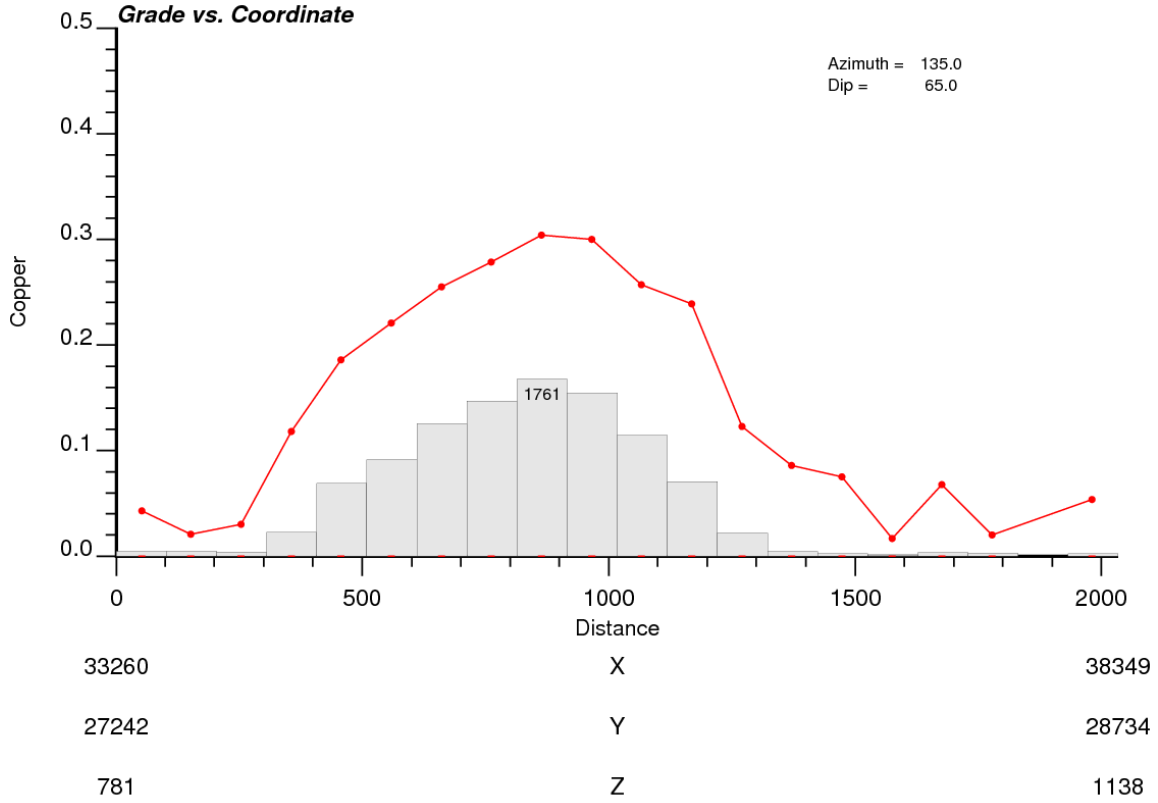


Figure 3: Sample swath plot produced by swathplt program.

```

1           Parameters for SWATHPLT_MULT
2           *****
3
4  START OF PARAMETERS:
5  mitch.dat      -data file
6  0              -scattered or gridded? (gridded = 1)
7  1 2 3 4       -columns for X,Y,Z,variable
8  -1.0e21  1.0e21 -trimming limits
9  swathplt.out  -file for output
10 36 0 10       -naz, azmn, azsiz
11 9 0 10       -ndip,dipmn,dipsiz
12 20           -number of bins
    
```

Figure 4: Parameters for swathplt\_mult.

```

1 Variances
2 3
3 Azimuth
4 Dip
5 Variance
6 0.0000000E+00 0.0000000E+00 0.1903072
7 10.00000 0.0000000E+00 0.2193839
    
```

Figure 5: Sample output from swathplt\_mult.

```
1 Parameters for STEREOPLT
2 *****
3
4 START OF PARAMETERS:
5 swathplt.out -file with gridded data
6 3 - column number for variable
7 -1.0e21 1.0e21 - data trimming limits
8 stereoptt.ps -file with PostScript output
9 36 0 10.0 -naz,azmn,azsiz
10 9 0 10.0 -ndip,dipmn,dipsiz
11 StereoPlot -Title
12 0 -0=arithmetic, 1=log scaling
13 1 -0=gray scale, 1=color scale
14 0.0 -.25 5 -continuous: min, max, ninc.
```

Figure 6: Parameters for stereoptt.

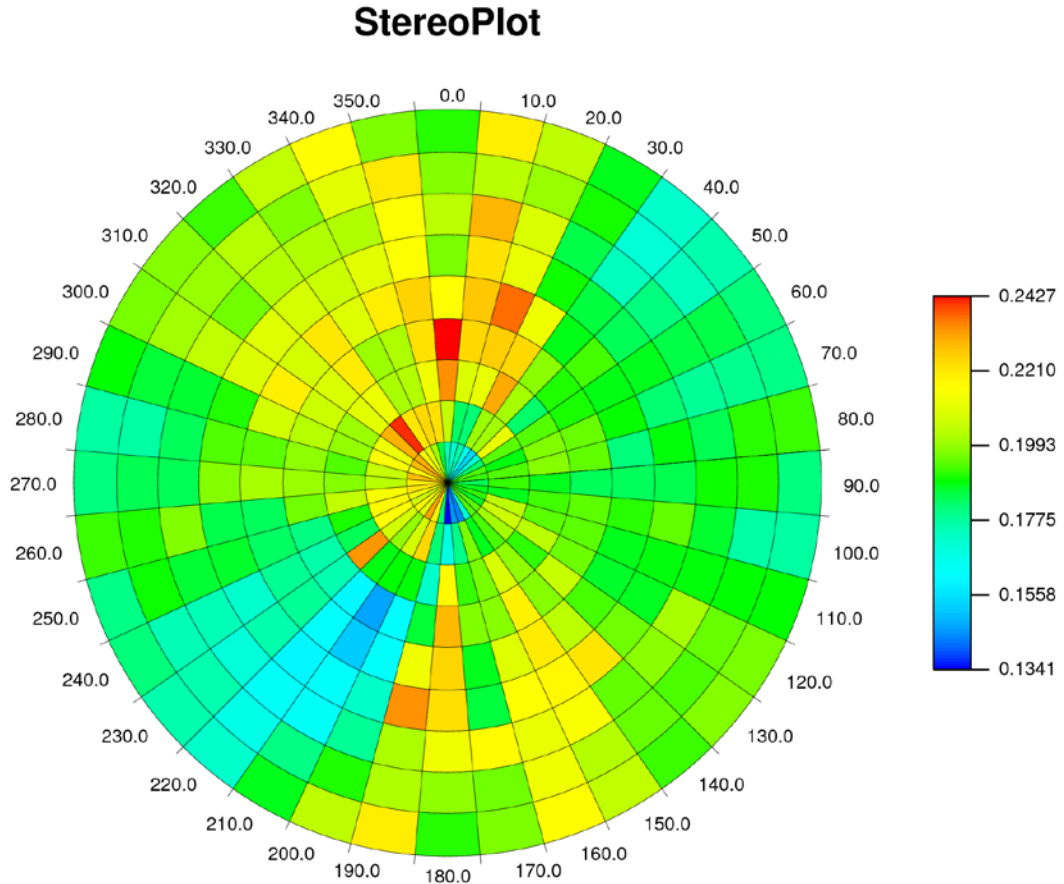


Figure 7: Sample stereo plot produced by stereoptt.