Target for ArcGIS Gridding and Contouring

Gridding refers to the process of interpolating data onto an equally spaced "grid" of values in a specified coordinate system, such as X-Y. In the Target for ArcGIS system the Minimum Curvature, Kriging and Inverse Distance Weighted gridding methods are available.

This How-to Guide will demonstrate opening a Geosoft database window, adding data and assigning a coordinate system to you data, gridding using two of the Target for ArcGIS gridding methods, Minimum Curvature and Kriging, and then plotting contours to your map.

See below for a short description of all the gridding methods available to Target for ArcGIS users.

Minimum Curvature Gridding

Minimum curvature gridding is a gridding method that fits a smoothest possible surface to the data points. It is best used when data is randomly distributed, sampled along arbitrary lines or if you want to include tie lines.

Kriging

Kriging is a geostatistical gridding technique for random data, non-parallel line data or orthogonal line data.Use the kriging method if the data is variable between sample locations, known to be statistical in nature, poorly sampled or clustered. Kriging is ideally suited to geochemical or other geological sample-based data; it is rarely used with geophysical data, which tends to follow a natural smooth surface.

Inverse Distance Weighting

This new method creates a grid from point data using an Inverse Distance Weighting algorithm, and is used primarily to interpolate geochemistry data.

Opening the Geosoft Database Window

The Geosoft Database Window is a special window within ArcMap that is used to create and view Geosoft's unique three-dimensional database structure. The Geosoft Database Window is specifically designed to enable users to access drillhole data using the organized and self-contained spreadsheet tab windows, as shown below.
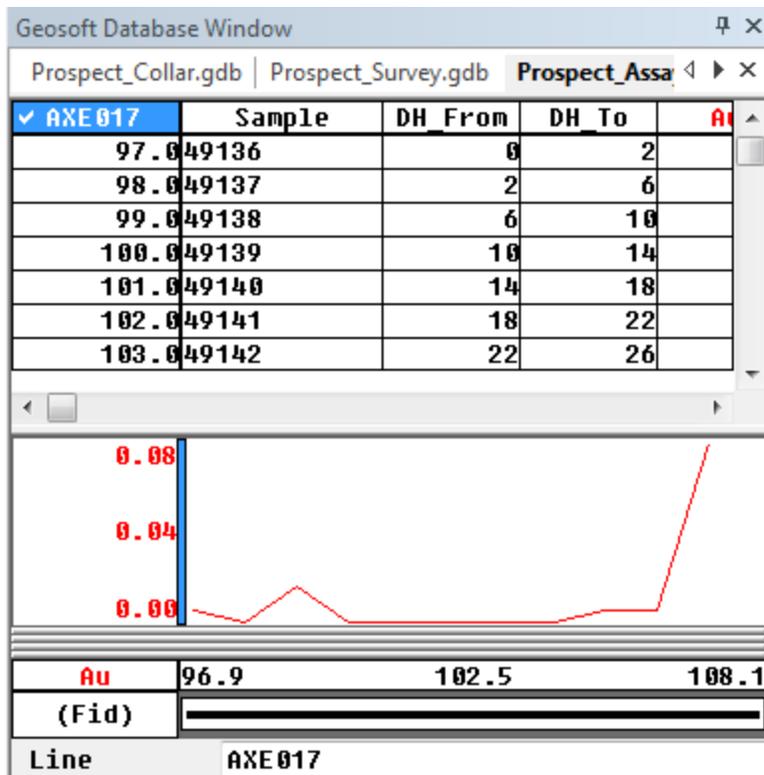
These windows offer a direct interface to your data and enable you to perform a variety of tasks, including:

> Display a view of the data in numerical or profile format
> Display database statistics
> Apply mathematical expressions to data
> Process and display resulting data
> Analyze data using built-in Geosoft eXecutable functionality

Spreadsheet Window

The data visible in the "Spreadsheet window" represents only some of the columns (channels). This differs from a conventional spreadsheet program, in that what you see on the screen is the data. The Spreadsheet window only displays those parts of the data that you choose to display.

In general, you may have as many lines and channel in your database as you require (i.e. there is no limit). You are also free to display the columns in any order or remove them from the window whenever you like.

Right-click inside the spreadsheet window to view the spreadsheet menus.

Profile Window

The data profile view is your "graphical window" to the Geosoft database. You can display profiles of one or more variables in your database simply by selecting the channel, right clicking and from the popup menu select Show Profile .

The profile appears directly below its corresponding database in a profile window. You can have up to five profile windows and you can plot each up to 32 variables (channels) in each window.

Profile windows are linked dynamically to their corresponding database. For example, when you select a value or range of values in the database , they are also highlighted in the profile window, and vice versa . Right click inside the profile window to view the Profile menu.

Database Tools

The following icons are available on the Geosoft Database toolbar in Target for ArcGIS to assist in navigating through any Geosoft database.

	Show/Hide Geosoft Database Window
	Use this button to Show/Hide the Geosoft Database Window.
	Open Geosoft database
	Use this button to open a previously defined Geosoft database.
	Commit Geosoft database changes
	Use this command to commit changes in the current Geosoft database.
	Discard Geosoft database changes
	Use this command to discard changes in the current Geosoft database.
	Go to First line/group in Geosoft database
	Use this command to show the data and profiles for the first (starting) line/group in your Geosoft database.
	Go to Last line/group in Geosoft database
	Use this command to show the data and profiles for the last (final) line/group in your Geosoft database.
	Go to Previous line/group in Geosoft database
	Use this command to show the data and profiles for the previous line/group in your database.
	Go to Next line/group in Geosoft database
	Use this command to show the data and profiles for the next (following) line/group in your database.
	Create new line/group in Geosoft database
	Use this command to create a new line/group in your Geosoft database. The Create Line dialog is displayed that enables you to specify the line/group parameters.
	Delete current line/group in Geosoft database
	Use this command to delete the current selected line/group in your Geosoft database.

As well as these icons, there are also a number of database tools available on the Geosoft Data menu.

For more information on these or any Target for ArcGIS options, click the **Help** button on the dialog of interest, or select *Help|Help Topics* from any of the Geosoft toolbars.

Minimum Curvature Gridding Overview

The random gridding method (RANGRID GX) fits a minimum curvature surface to the data points using a method similar to that described by Swain (1976) and Briggs (1974). A minimum curvature surface is the smoothest possible surface that will fit the given data values.

Minimum Curvature gridding first estimates grid values at the nodes of a coarse grid (usually 8 times the final grid cell size). This estimate is based upon the inverse distance average of the actual data within a specified search radius. If there is no data within that radius, the average of all data points in the grid is used. An iterative method is then employed to adjust the grid to fit the actual data points nearest the coarse grid nodes.

After an acceptable fit is achieved, the coarse cell size is divided by 2. The same process is then repeated using the coarse grid as the starting surface. This is iteratively repeated until the minimum curvature surface is fit at the final grid cell size.

A very important parameter in the Minimum Curvature gridding process is the number of iterations used to fit the surface at each step. The greater the number of iterations, the closer the final surface will be to a true minimum curvature surface. However, the processing time is proportional to the number of iterations.

Minimum Curvature stops iterating when:

> It reaches a specified maximum number of iterations, or

> A certain percentage of the observed points are within a limiting tolerance of the surface

By default these limits are 100 iterations and 99% of points within 1% of the data range.

Minimum Curvature gridding has the following capabilities:

> Specify data limits and clipping
> Grid the original data or log of the data (using cutoffs or a data range)
> Specify desampling values (for low-pass filtering) and blanking distance (for removing values bey.ond a certain distance)
> Specify the tolerance to which the minimum curvature surface must match the data points. The default is 0.1% of the Z range of the data. Also specify the percentage of points that must meet the tolerance for the iterations for the current processing step to stop
> Specify the maximum number of iterations to allow
> Adjust the tension to produce a true minimum curvature grid or to increase the tension to reduce overshooting problems in unconstrained, sparse areas

The Minimum curvature gridding algorithm generates a grid file (*.GRD) and grid report file (RANGRID.LOG).

⚠️ *The actual maximum size of the grid that you can use depends upon the available free disk space of your computer.*

Adding Data and Assigning a Projection

Target for ArcGIS enables you to grid shape files, event layers and table files. However, in order for the resulting grid to have a projection, you must grid either a shape file or an Event layer that already has a projection assigned to it. The grid will adopt the projection of the source data. ArcMap will not let you assign a projection to a table, so any grid created from an XY data table, i.e. not an Event theme or shape file, will not have a projection assigned to it.

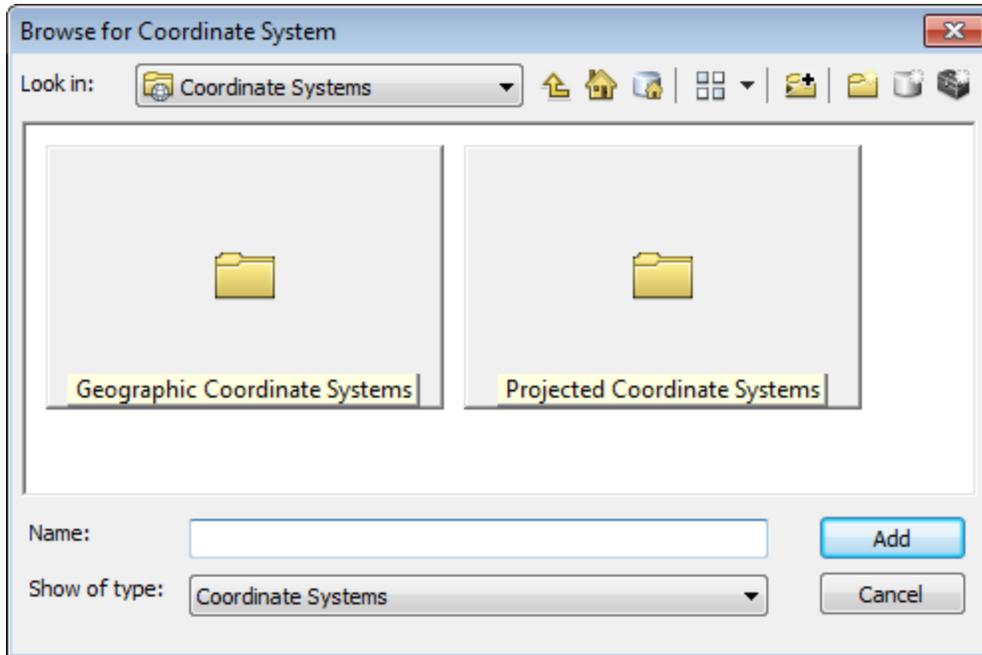**To Add XY Data and Assign a Projection**

1. Open ArcMap. On the *File* menu, select **Add Data**.
2. Select **Add XY Data**. The *Add XY Data* dialog appears.
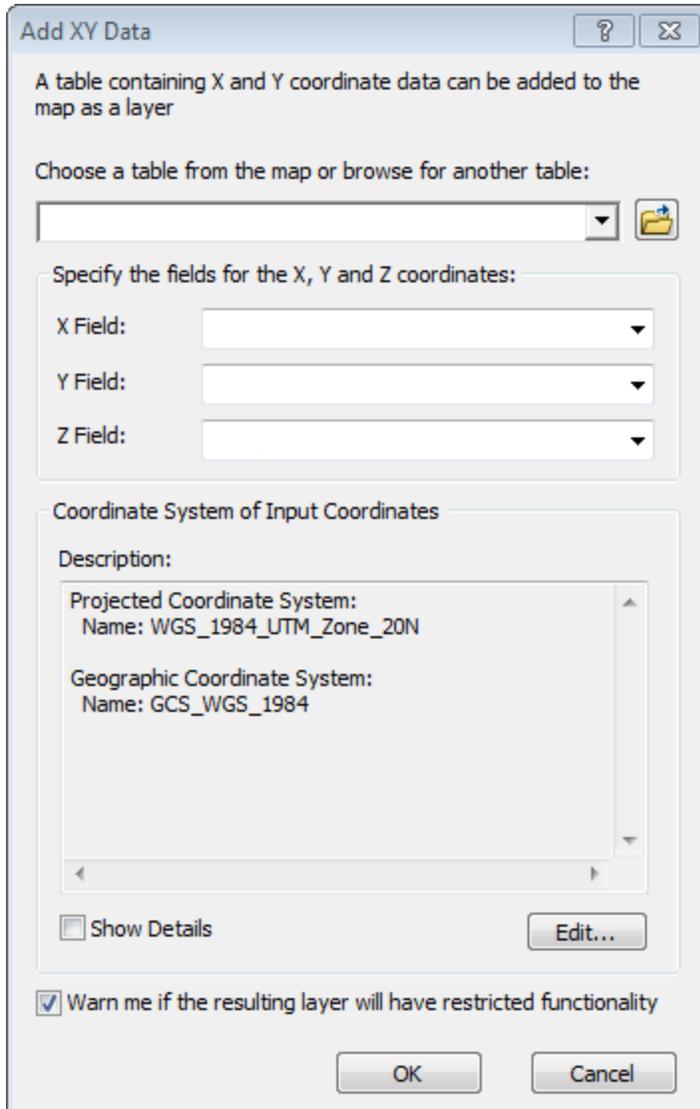
3. Use the *Browse* button to choose the table to add.

4. Using the dropdown lists, specify the fields for the *X* and *Y* coordinates (the *Z* field is optional).

5. Select the **Edit** button, lower right of the dialog box, and the *Spatial Reference Properties* dialog appears.
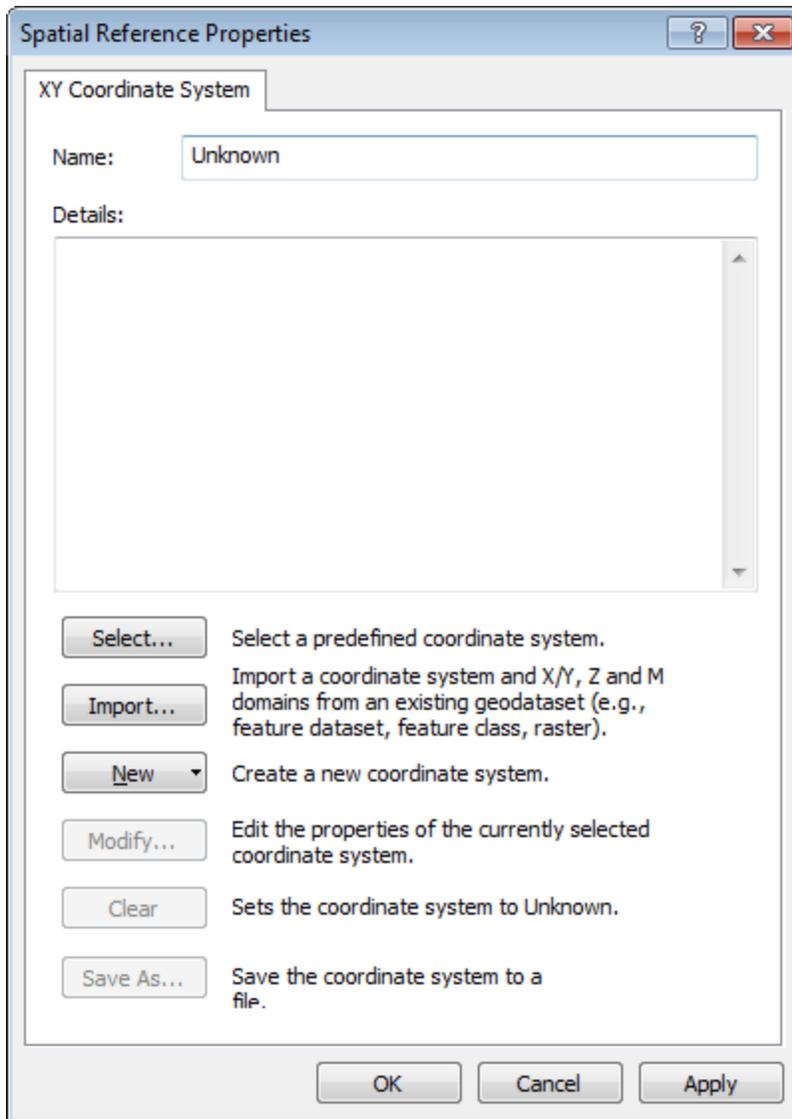
6. Select **Select**. The *Browse for Coordinate System* dialog appears.

7. Select a coordinate system.

8. Select the **Add** button to return to the *Spatial Reference Properties* dialog.

9. Select **OK** to apply the projection to the XY data and return to the *Add XY Data* dialog.

10. Select **OK** to add the XY Event data to the layer.

> ⚠ *The added XY Event data only exists in the current map document. To save the layer as a separate file, you must export it as a shape file.*

11. In the Table of Contents (TOC) window, select (highlight) the layer, **Right-click** and from the pop-up menu, select **Data**.

12. Select **Export Data**. The *Export Data* dialog appears.
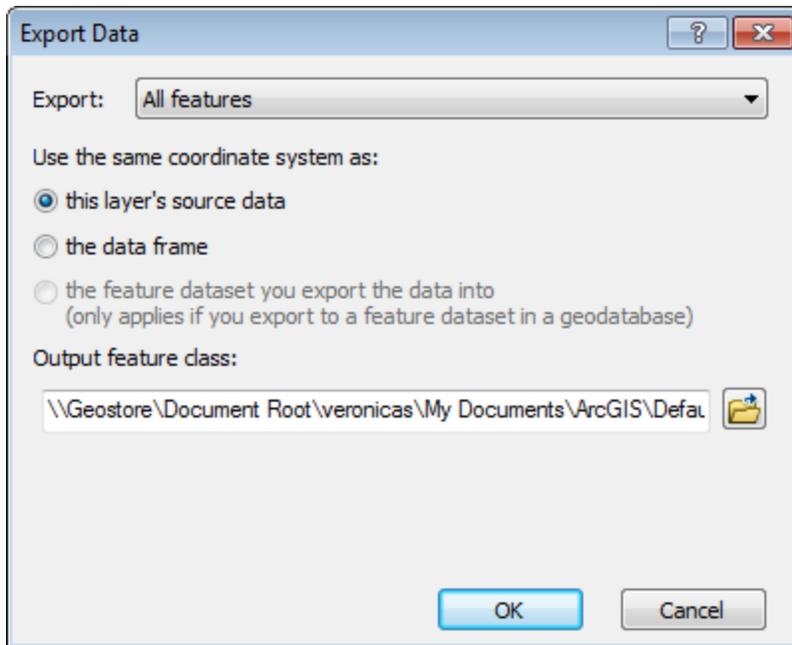
13. Specify the export parameters to save the layer as a shape file (feature class) in your working directory and select the **OK** button. The *ArcMap* dialog appears.
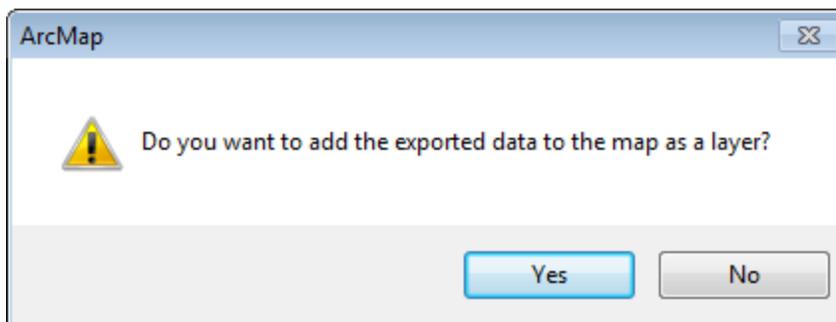

14. This dialog asks if you would like to add the exported data to the map as a layer. Select **Yes** and the file will be saved in your working directory and displayed as a layer on your current map.

Gridding Data using the Minimum Curvature Method

The Minimum Curvature gridding method fits a minimum curvature surface to the data points. A minimum curvature surface is the smoothest possible surface that will fit the given data values.

To Grid using the Minimum Curvature Method

1. On the *Target Surface* toolbar , select the **Geosoft Minimum Curvature Gridding Tool** button ( ).
   The *Select Table or Feature Class* dialog appears.
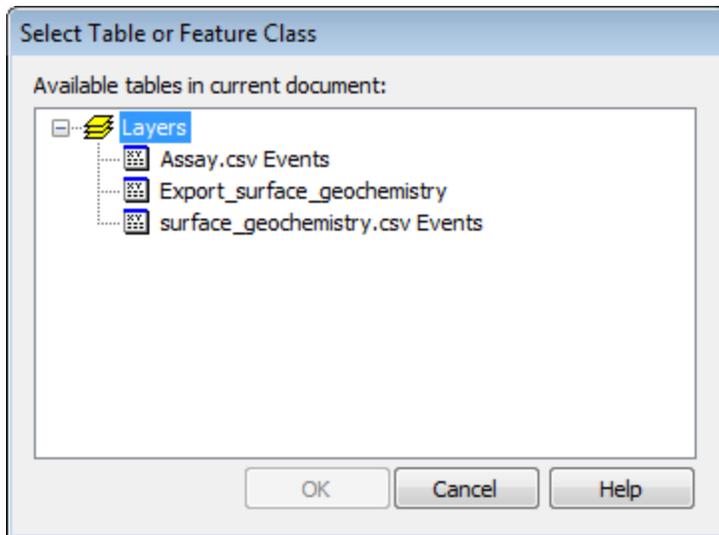
2. In the *Available tables in current document* box, select your Event table and select the **OK** button. The *Minimum Curvature Gridding of attribute using feature positions in layer* dialog appears.
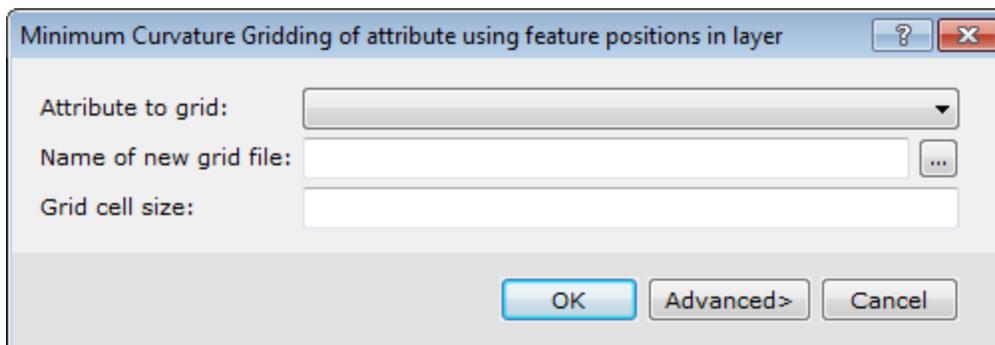
3. Using the *Attribute to grid* dropdown list, select your attributes.

4. In the *Name of new grid file* field, specify a new grid file name.

⚠️   *Select the **Help** button for more information on G rid cell size or any other Minimum Curvature Gridding advanced parameter.*

5. To access the advanced parameters, select the **Advanced>** button or to accept the intelligent defaults, select the **OK** button. The data will be gridded, saved in your working directory and displayed in the data frame.

Kriging Overview

The statistical gridding method (Esri_KRIGRID GX) uses the method of Kriging to determine a value at each grid node based on the XYZ data. Kriging first calculates a variogram of the data, which shows the correlation of the data as a function of distance.

Simply speaking, the further data points become, the less correlation we expect between points. A variogram shows this phenomena for a given dataset, and based on the variogram, you are able to select a model that best defines the variance of the data. The technique of Kriging uses this model to estimate the data values at the nodes of the grid. A significant by-product of Kriging is the ability to estimate the error of the data at each grid node.

Geosoft supports ordinary Kriging as well as universal Kriging. Universal Kriging differs from ordinary Kriging in that it allows the data to contain a regional trend. For a more in-depth understanding of geostatistical analysis and Kriging, refer to Mining Geostatistics written by A.G. Journal and C.J. Huijbregts, 1978.

Kriging has the following capabilities:

> Applies de-aliasing filter.

> Applies linear and logarithmic gridding options.

> Blanks un-sampled areas.

> Calculates a variogram from the input data channel.

> Output grids up to any size.

> Processes unlimited number of input observation points.

> Supports linear, power, spherical, Gaussian, exponential and user defined models.

⚠️ *The actual maximum size of the grid that you can use depends upon the available free disk space of your computer.*

Grid Data using the Kriging Method

To perform Kriging, you must supply a data channel, output grid name and control file. In addition, you also have a variety of options, including the ability to:

> Specify grid cells size, data limits and clipping

> Grid the original data or log of the data (using cutoffs or a data range)

> Specify desampling values (for low-pass filtering) and blanking distance (for removing values beyond a certain distance)

> Apply trend removal

> Choose from multiple variogram models (power, spherical, gaussian, exponential or user-defined)

> Specify the average error for each data point (nugget)

> Specify the level at which the variogram becomes uncorrelated (sill) and distance (range) at which the variogram model meets the sill

Kriging outputs consist of a grid, an error grid and a Kriging report (KRIGRID.LOG). The error grid contains the standard deviation of the estimation at each grid node. The report gives details about the input data, the parameters that were used for processing, the calculated and model variogram and grid parameters.

To Perform Kriging

1. Select the table and/or XY event data you want to grid from the ArcMap table of contents window and then select the **Geosoft Krigrid Tool** (⬛) from the *Geosoft Toolbar*.

2. The *Kriging* dialog will be displayed.

3. From the dropdown lists, select the *X*, *Y* and *Field to grid*. Then, specify the *Name of new grid file* and *Grid cell size* (Note that, this can be left to the default).

4. If you want to use the more advanced options (i.e. log option, Low-pass Desampling factor, etc.) click the **Advanced>** button.

5. Click **OK**. The system processes the data and displays the grid file in the map window.

⚠️   *For more detailed information on the gridding parameters, click the **Help** button on the Kriging- Advanced Options dialog.*

Inverse Distance Weighting Gridding Overview

The Inverse Distance Weighting (IDW) algorithm is a moving-average interpolation algorithm that is usually applied to highly variable data. For certain types of data (e.g. soil geochemistry, surface/groundwater chemistry) it is possible to return to an existing measurement site and record a measurement that is statistically different from the original, but within the general trend of all measurements within the area. In this case it is not usually desirable to honour local data minima or maxima, but instead to look at a moving average of surrounding data points and estimate local trends."

"IDW calculates a value for each grid node by examining surrounding data points that lie within a user-defined search radius. The node value is calculated by averaging the weighted sum of all the points, where the weighting inversely corresponds to distance from the grid node.

Anti-aliasing

Prior to gridding (and after any log or log-linear transformation), data is pre-processed using an anti-aliasing technique. All values falling inside any single grid cell are averaged, and the data is then represented by the single averaged value at the grid cell centre. Any error in the spatial representation of features introduced by this step will never exceed one-quarter of the Nyquist wavelength, which is equal to 2 cell sizes.

The Inverse Distance Weighting Function: Defining the Weighting Slope and Power

The inverse distance weighting function assigns averaging weights based on distance, out to the defined search radius:

1 / (distance^power + 1/slope)

Where distance is in multiples of the horizontal cell size.

Using the default of 2 for the power, and 1 for the slope produces a bell-shaped weighting function. Requiring a slope > 0 ensures that the weight remains finite at zero distance. Decreasing the slope tends to flatten the bell, resulting in greater weighting of points away from the grid cell, and hence greater smoothing. Choosing a power less than 2, or a slope less than one, may result in over-smoothing the data.

The following table shows the effect of various slopes on the weighting given at various distances away from the centre cell. The weights have been normalized so the weight at the cell centre is equal to 1.

	weighting of centre cell	weighting 1 cell away	weighting 2 cells away	weighting 3 cells away	weighting 4 cells away
P = 2, S = 0.2	1	0.83	0.55	0.36	0.24
P = 2, S = 0.5	1	0.67	0.33	0.18	0.11
P = 2, S = 1	1	0.5	0.2	0.1	0.56
P = 2, S = 2	1	0.33	0.11	0.053	0.03

Clearly, as the slope increases, the weighting is more tightly concentrated about the centre cell. The search radius should also be chosen based on the fall-off of the weighting function. Increasing the search radius beyond where the weighting function is significant will have little effect on the results, and may result in large increases in processing time, since the processing time varies in proportion to the cube of the search radius. (Remember that the search radius is specified in ground units, not as a multiple of cell sizes.)

⚠️ *For additional information, you can click the **Help** button on any of the gridding dialogs.*

Contouring Using Geosoft's Contouring Tool

To create a contour plot (layer), you must supply an input grid file, specify contouring option and up to 8 contouring levels. In addition, you also have a variety of options, including the ability to:

- Make a layer for display in the ArcMap window
- Make a shape file with Z attributes (*.SHP) for use in ArcMap
- Contour options including; smoothing, suppression, suppression density (mm), annotations, labeling, etc
- Line styles including; line colour and weight, line styles (solid, dashed etc.) and line labels

Plotting Contours

Contours are lines drawn at specified intervals or multiples of intervals on your map based on a gridded dataset. After you create a grid, you may want to generate contours and display these contours on your map. In Target for ArcGIS, contouring is specially designed to handle the very large dynamic data ranges that characterize geoscientific datasets.

To Create a Contour Plot

1. Select the **Create Contours from grid on disk** icon (🟢) on the *Target Surface* toolbar.
   The *Create a contour plot of a grid* dialog appears.
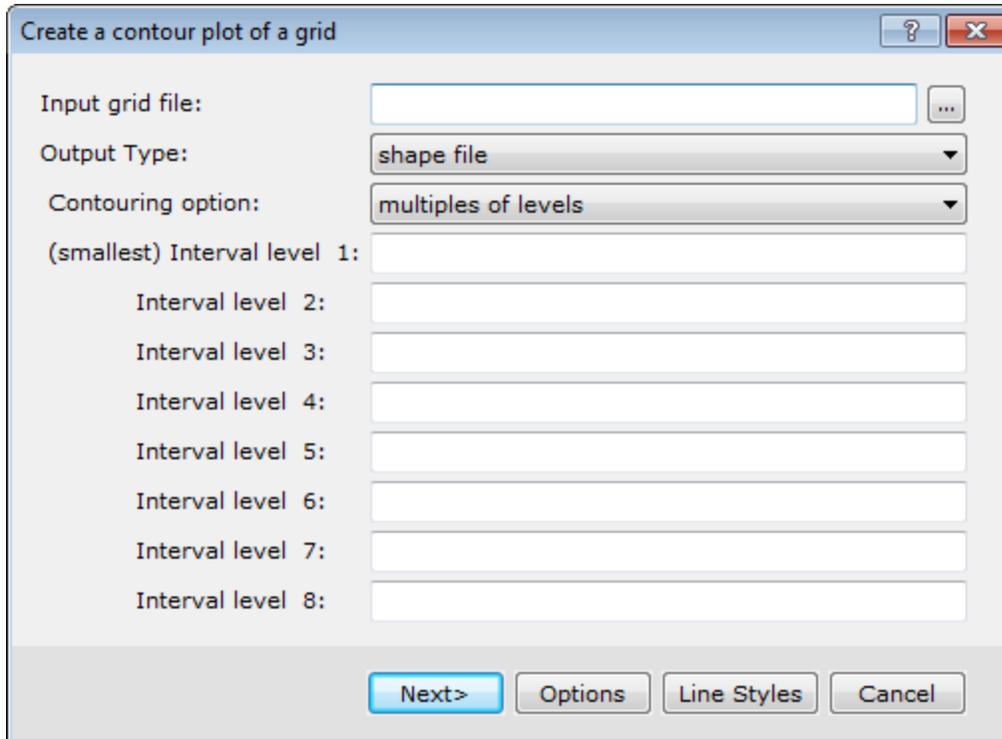
2. Use the *Browse* button to select the *Input grid file*.

3. From the *Output Type* dropdown list, select **shape file** or **Geosoft map layer**.

4. From the *Contouring option* dropdown list, select **multiples of levels** or **exact levels**. Then you can specify the Interval level(s) starting with the smallest level at the top (Note that, you can also leave the levels to the intelligent defaults).

5. Click the **Options** button and set the parameters as required and click the **OK** button to return to the *Create a contour plot of a grid* dialog.

6. Click the **Line Styles** button and set the line style parameters as required, clicking the **Next>** button as required. Then click the **Finish** button to return to the *Create a contour plot of a grid* dialog.

7. Click the **Next>** button and the *Contour: Create a shape file as output* dialog appears.
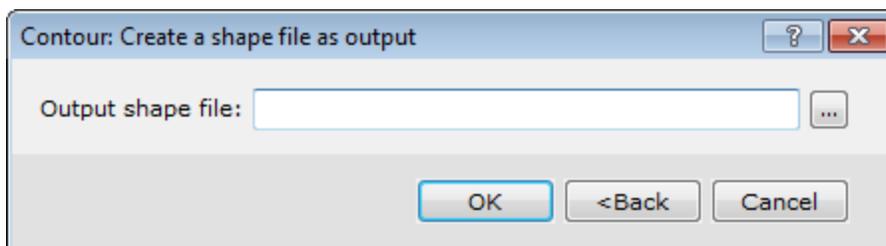
8. Specify the name of the *Output shape file*. The contour shape file will be created, saved in your working folder and displayed in the data frame.

How-To Guide Publication Date: 29/04/2014