

Gridding and Contouring in Geochemistry for ArcGIS

The Geochemistry for ArcGIS extension includes three gridding options: Minimum Curvature Gridding, Kriging and a new Inverse Distance Weighting algorithm. Also included is a contour option that provides the ability to create contour layers from a gridded dataset.

This *Gridding and Contouring in Geochemistry for ArcGIS* How-To Guide demonstrates gridding using two of the Geochemistry for ArcGIS gridding methods, Minimum Curvature and Kriging, and then shows you how to plot contours to your map.

Geosoft provides sample data for you to use when working through these How-To Guides. These data files can be found in your "...\\Geosoft\\Oasis montaj\\resourcefiles\\data\\geochemistry" folder.

Minimum Curvature Gridding Overview

To perform minimum curvature (random) gridding, you must specify the X, Y and Data fields, an output grid name and a grid cell size (optional). In addition, you also have a variety of options, including the ability to:

- 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 beyond 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

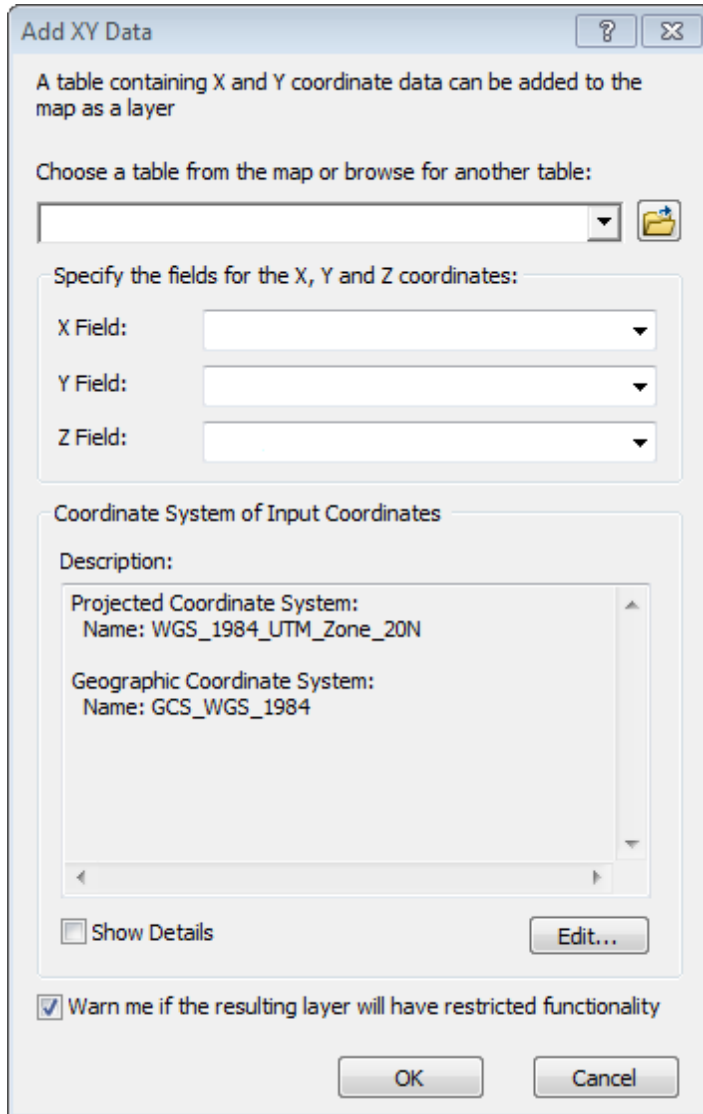
The Minimum curvature gridding algorithm generates a grid file (*.GRD) and grid report file (RANGRID.LOG).

Adding Data and Assigning a Projection

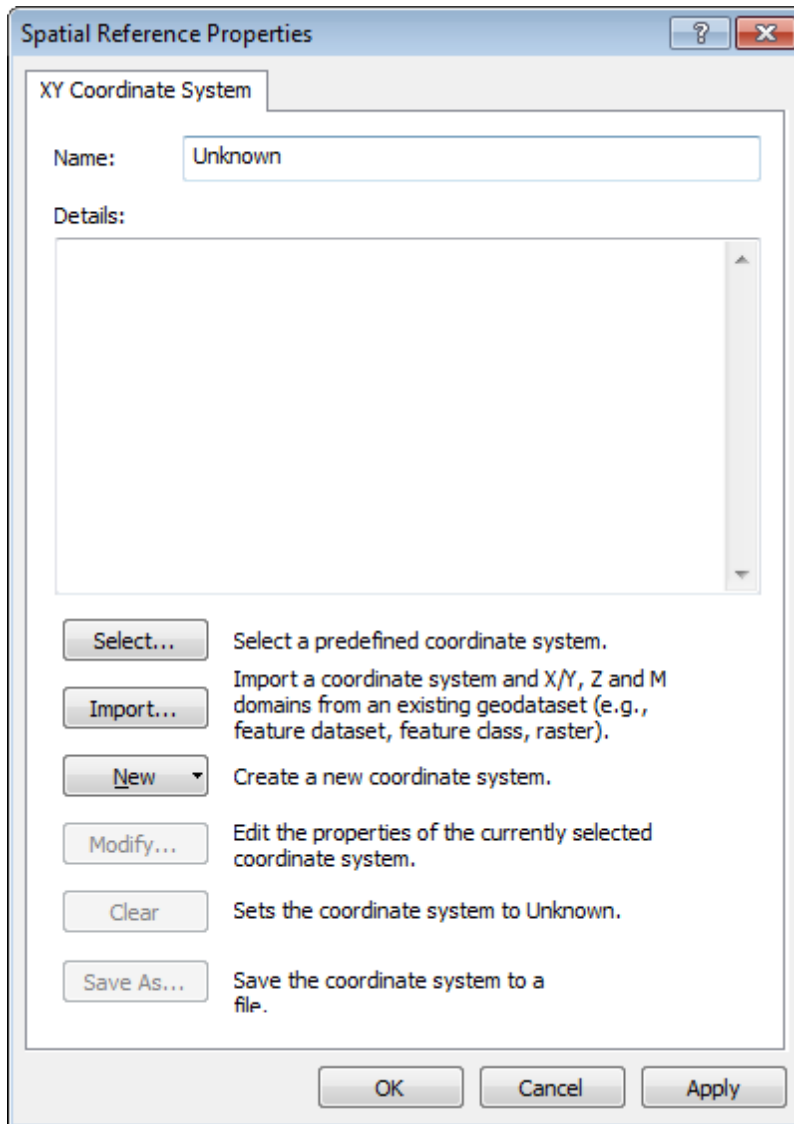
Geochemistry for ArcGIS enables you to grid shape files, event layers and table files. However, in order for the resulting grid to have a projection, you must grid either a shape file or an Event layer that already has a projection assigned to it. The grid will adopt the projection of the source data.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

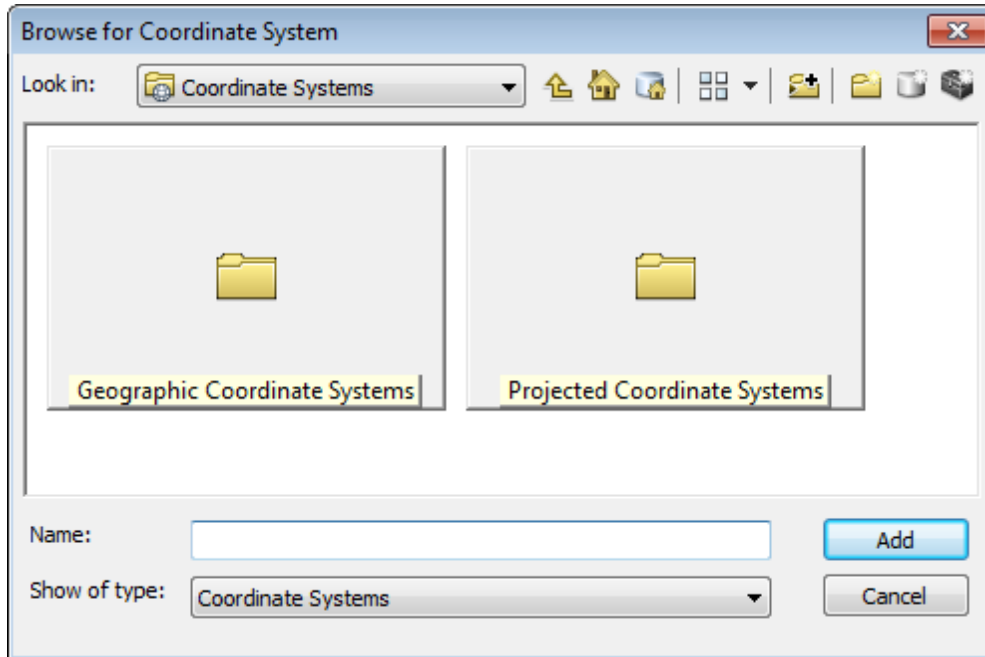
1. Open ArcMap. On the *File* menu, select **Add Data**.
2. Select **Add XY Data**. The *Add XY Data* dialog is displayed.




3. **Browse** to the table to add.
4. Using the dropdown lists, specify the fields for the X and Y coordinates.
5. Click the **Edit** button, located near the lower right of the dialog, and the *Spatial Reference Properties* dialog appears.



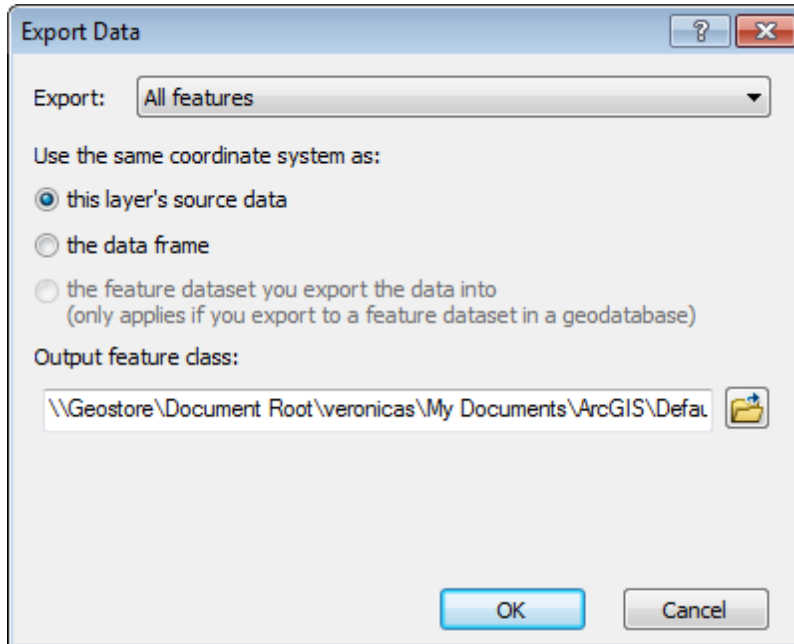
6. Click **Select**. The *Browse for Coordinate System* dialog is displayed.



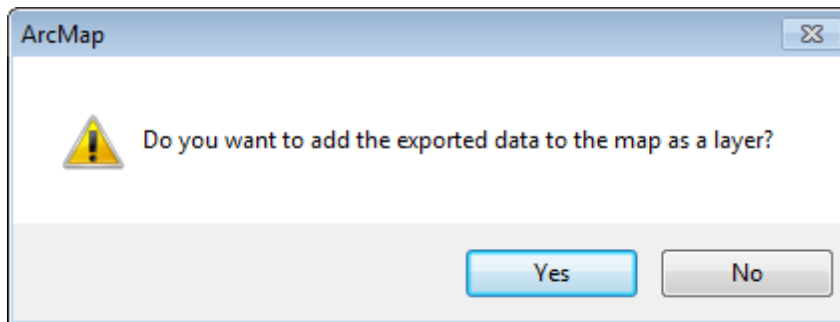
7. Select a coordinate system.
8. Click the **Add** button to return to the *Spatial Reference Properties* dialog.
9. Click **OK** to apply the projection to the XY data and return to the *Add XY Data* dialog.
10. Click **OK** to add the XY Event data to the layer.

 *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 window, select (highlight) the layer, right-click and from the pop-up menu, select **Data**.
12. Select **Export Data**. The *Export Data* dialog is displayed.



13. Specify the export parameters to save the layer as a shape file (feature class) in your working folder and click the **OK** button. The *ArcMap* dialog is displayed.



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

Grid Data Using the Minimum Curvature Method

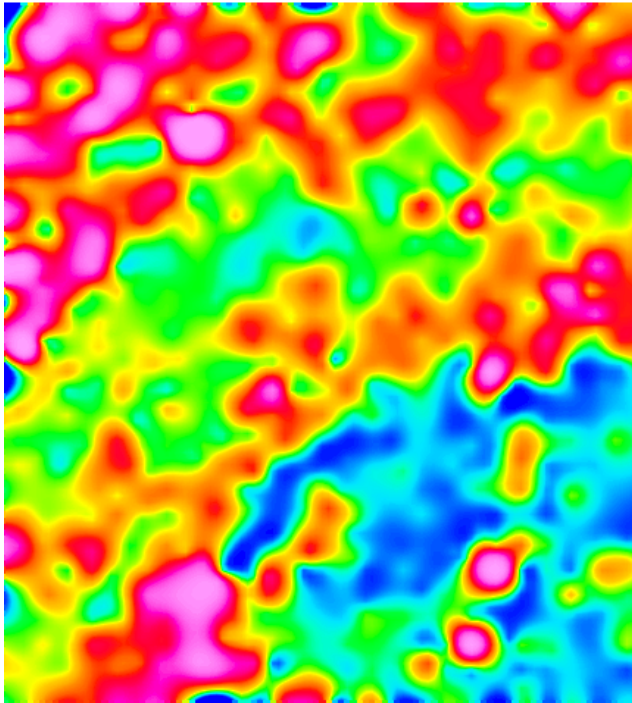
The Minimum Curvature gridding method fits a minimum curvature surface to the data points. A minimum curvature surface is the smoothest possible surface that will fit the given data values.

To Grid Data using Minimum Curvature Gridding:

1. Select the table and/or XY event data you want to grid from the ArcMap Table of Contents window.
2. On the *Geosoft Geochemistry* toolbar, select *Gridding* and then select **Minimum Curvature**. The *Minimum Curvature Gridding* 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 data frame and saves the grid in your working folder.



For more detailed information on the gridding parameters, click the **Help** button on the Minimum Curvature Gridding- Advanced Options dialog.



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. Journé 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:

$$1 / (\text{distance}^{\text{power}} + 1/\text{slope})$$

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.

Geosoft's Contouring Tool

To create a contour 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:

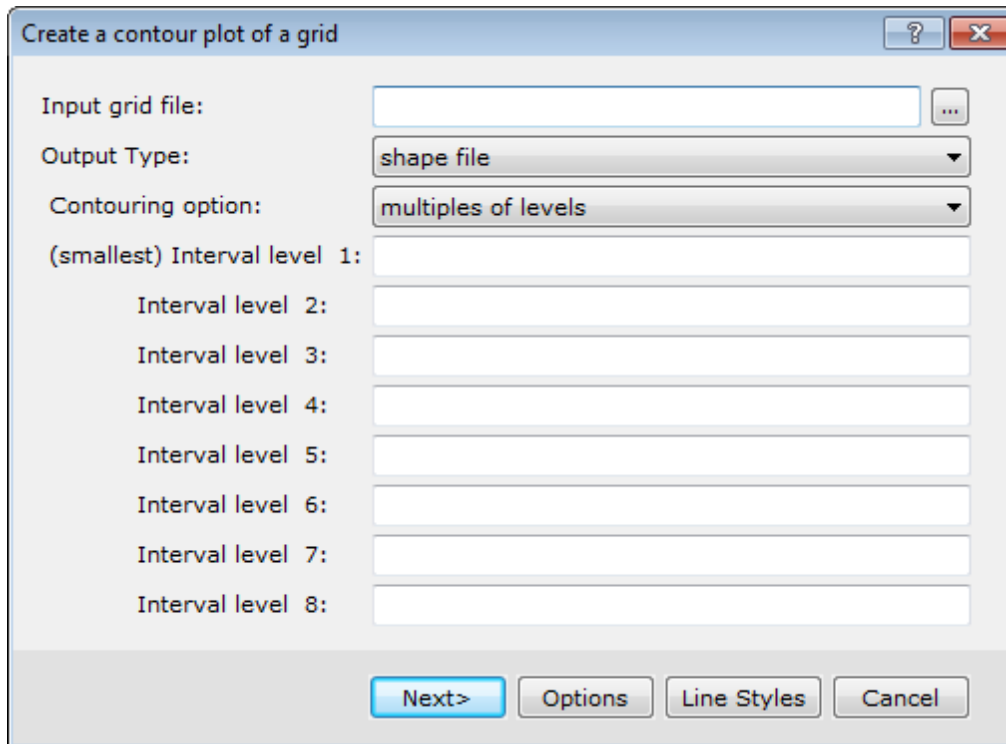
- Make a layer for display in the ArcMap window
- Make a shape file with Z attributes (*.SHP) for use in ArcMap
- Contour options including; smoothing, suppression, suppression density (mm), annotations, labelling, etc
- Line styles including; line colour and weight, line styles (solid, dashed etc.)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

Using the Contouring Tool

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 Geochemistry for ArcGIS, contouring is specially designed to handle the very large dynamic data ranges that characterize geoscientific datasets.

To Create a Contour Plot

1. On the *Geosoft Geochemistry* toolbar, select *Gridding* and then select **Create Contours**.
The *Create a contour plot of a grid* dialog appears.



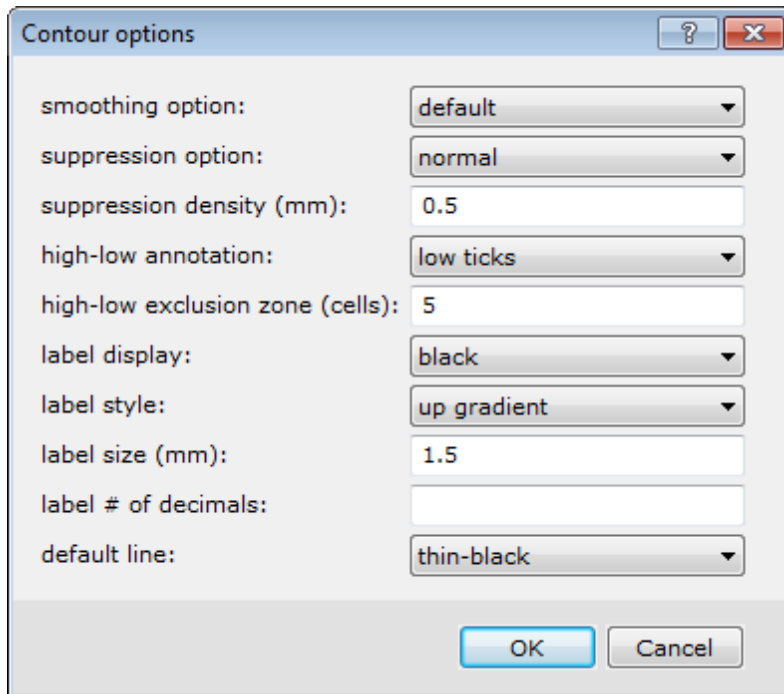
2. Using the **Browse** button, locate the *Input grid file*.
3. Using the *Output Type* dropdown list, select **shape file** or **Geosoft map layer**.



Shapefiles and Geosoft Map Layers: The *Geochemistry for ArcGIS plotting tools* provide two types of output; shapefiles and Geosoft map layers. The shapefile output includes database (DBF) files populated with attribute information related to the plotted feature. Geosoft map layers are static images ready for printing; they contain Geosoft's pre-defined annotations and legends, and enable you to pre-define colours, patterns and line styles.

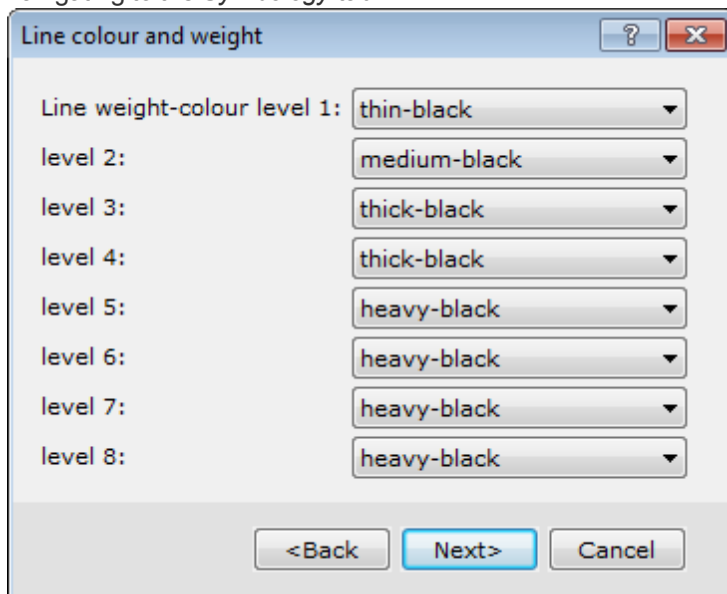
The Geosoft Map Layer is not a typical GIS layer. The ArcMap 'Identify' cursor, symbology and labelling tools are not available. You cannot modify a Geosoft Map Layer; if changes are required, you must create a new Geosoft Map Layer.

4. Click the **Options** button and set the parameters as required.

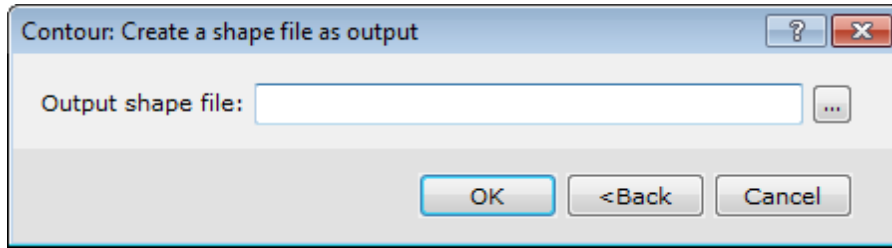


 For detailed information about the Contour options, click the **Help** button.

5. Click **OK** to return to the *Create a contour plot of a grid* dialog.
6. If you selected *Geosoft map layer* output, click the **Line Styles** button to set the line style parameters. If you selected *shape file* output, all line styles and symbology need to be specified after you generated the contours, using the Esri Symbology tab. This tab can be found by right clicking on the output contour layer, selecting *Properties* and navigating to the *Symbology* tab.



7. Click **Next>** to view all the *Line* dialogs and then click **Finish** to return to the *Create a contour plot of a grid* dialog.
8. Click **Next>** and the *Contour: Create a shape file as output* dialog appears.



9. In the *Output shape file* text box, provide a name for the contour file.
10. Click **OK** and the contour shape file will be created, saved in your working directory and displayed in the data frame.

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