



## Surfer Self-Paced Training Guide

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# I. Introduction to Surfer

## What Surfer can do

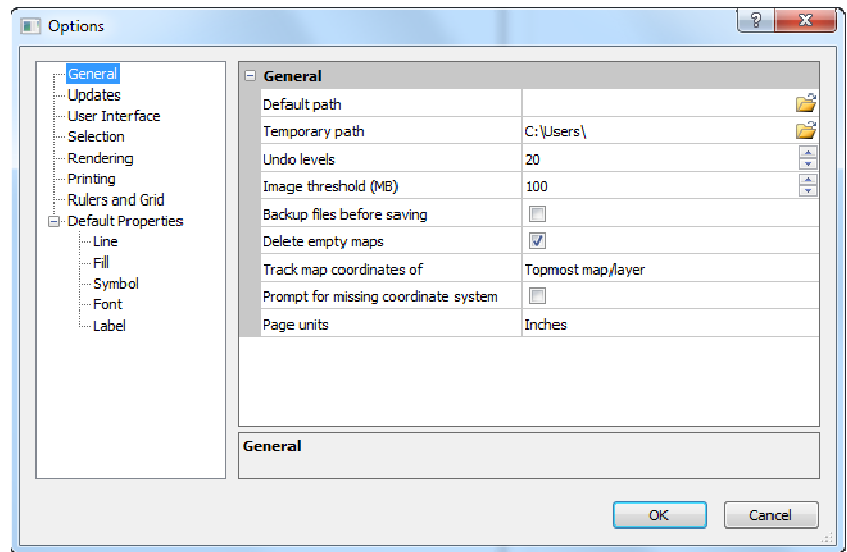
Surfer is a software package written for Windows. System requirements can be found on our website (<http://www.goldensoftware.com/products/surfer#system-requirements>). Surfer displays data to create base maps, contour maps, post and classed post maps, contour maps, image maps, shaded relief maps, vector maps, watershed maps, 3D wireframe maps and 3D surface maps. It can create profiles, calculate length and areas, and calculate volumes.

Types of files that can be imported and exported can be found listed on our website (<http://www.goldensoftware.com/surfer-supported-file-formats?ml=1?ml=1>).

## Setting options

You can set all the user preferences under **Tools | Options**. The **General** section allows you to set the basic window features, such as the default file path and number of *Undo levels*, changing page units to centimeters (default is inches), or prompt for missing coordinate systems. The **User Interface** section allows you to specify plot and window settings, such as changing the interface style, showing the page rectangle or page margins, or showing the splash screen at startup.

To set a specific map setting, click **Tools | Defaults**. Under *Settings*, open the category you would like to change the default for, and select the particular option. Enter in the new default for the *Setting Value* and specify the *Setting Persistence*.



- *Always Reset* does not update the default setting when it is changed manually in a dialog. Every time the dialog is invoked, the setting is reset to the value in the setting file.
- *Current Session Only* saves changes made to the setting within the dialog during the current session only. The settings are not written to the setting file and are not used the next time Surfer is started.
- *All Sessions* saves the changes made to the setting within the dialog during the current session, and writes the changes to the setting file to be used the next time Surfer is started.

For example, to have the post map remember the last used columns, click **Tools | Defaults**. Scroll down to the *Map Post* heading, and click on the "+" to expand the section. Click on the *pXcol* setting, and change the *Setting Persistence* to *Current Session Only*. Repeat for the other columns as needed, click *OK* and save the changes. When the post map columns are changed, the changes will be remembered until you close Surfer.

## II. Preparing a Base Map and Post Map

### Importing a base map

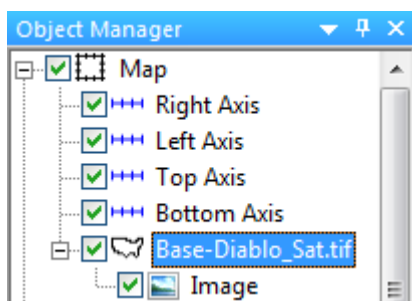
Surfer provides two ways to import basemap files, the **Map | New | Base Map** menu, and the **File | Import** menu.

- The **Base Map** option lets you use the map coordinates in the file for your base map. For vector base maps (e.g. DXF, GSB, SHP, BLN) you can change the attributes of all objects of the same type (all lines, fills, text fonts, symbols), or you can select and edit, reshape or delete individual objects. You can enter the base map group to add more objects or move objects. Use this option if you wish to overlay the base map with other maps types, such as contours, a 3D surface, or post maps.
- The **Import** option lets you break apart a base map to also access individual items separately; however it does not support the use of map coordinates. If you import a file, the items are simply drawn objects and are not part of a map. Use this option to import images like company logos for use in title blocks or headers.

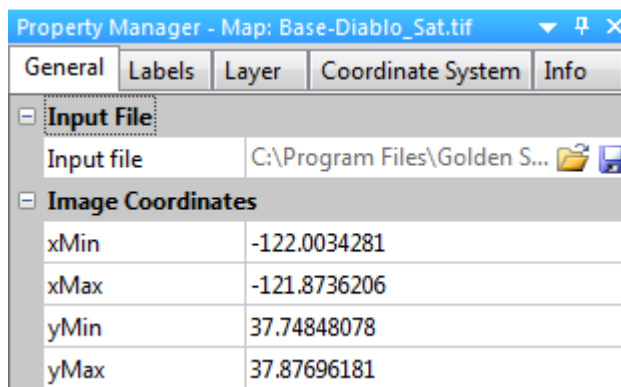
### Georeferencing an image base map

You can import a georeferenced image as a base map and the image will be imported in the correct real world XY coordinates.

If the image is not currently georeferenced (i.e a scanned image or other non-georeferenced image), you can still load it as a base map with the **Map | New | Base Map** option. As long as the edges of the map are parallel with the axes (not rotated), you can recalibrate the image to use real world map coordinates. After you load the image as a base map, click on *Base* in the **Object Manager** to display the **Map: Base** properties in the **Property Manager**. On the **General** tab, the *Image Coordinates* section contains edit boxes for the X and Y minimum and maximum coordinates. Enter the correct real world coordinates for the lower left and upper right corners of the map. An image base map must be georeferenced to combine it with other map types correctly.



*Click on Base in the **Object Manager** to open the **Map: Base** properties in the **Property Manager**.*



*In the **Map: Base** properties in the **Property Manager**, in the *Image Coordinates* section, enter in real world coordinates for xMin, xMax, yMin and yMax.*

**Adding drawing objects to a base map**

You can draw and add objects to any base map. To do this, select the base map and click **Arrange | Enter Group**. Use any of the drawing tools to draw points, polylines, polygons and text. The objects will be added to the base map. Then use **Arrange | Exit Group** to exit the base map group. You can click on each individual object in the base map to edit its properties in the **Property Manager**.

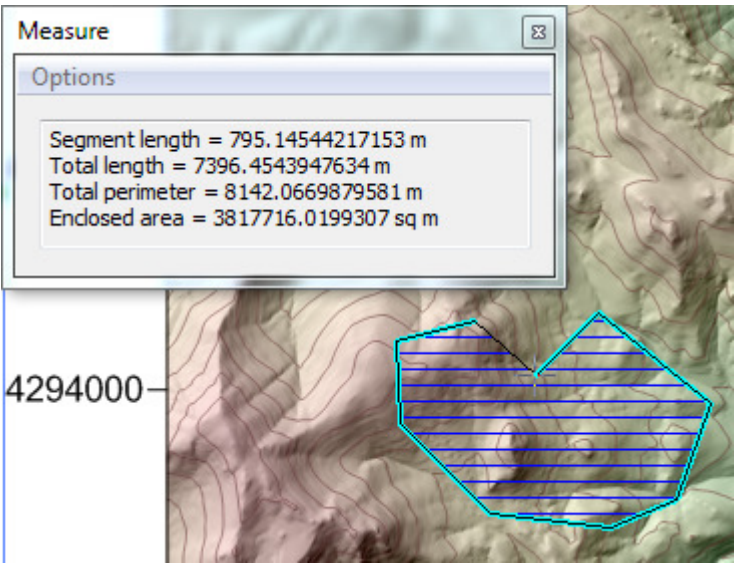
**Calculating area and length**

There are two ways to calculate length and area in Surfer: using the **Measure** tool, and viewing the properties for polylines and polygons in a base map.

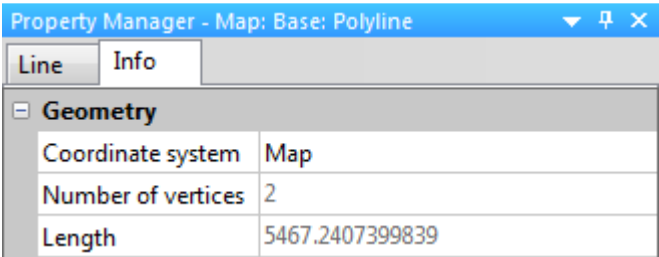
To use the **Measure** tool, right click over any map and click **Map | Measure**. Draw the line or area you wish to measure on the map. Double click to finish measuring. The results are reported in the **Measure** window. These results can be copied and pasted into other programs or windows.

The area and length of polylines and polygons in a base map are automatically calculated in Surfer. Simply click on a polyline or polygon object in a base map, and in the **Property Manager** click the **Info** tab to see the results.

To measure the distance between two (or more) points, and show the points and line on the map, add an empty base map object to your map (select the map and click **Map | Add | Empty Base Layer**), and click **Arrange | Enter Group** to enter the group. Click **Draw | Polyline** and click on the points to draw the polyline. Click **Arrange | Exit Group** to exit the group. Click on the polyline, click the **Info** tab in the **Property Manager**, and make sure the *Coordinate System* is set to *Map*. The *Length* of the polyline between the points you clicked is displayed.



Use the **Measure** tool to measure length and area for polylines and polygons drawn on a map



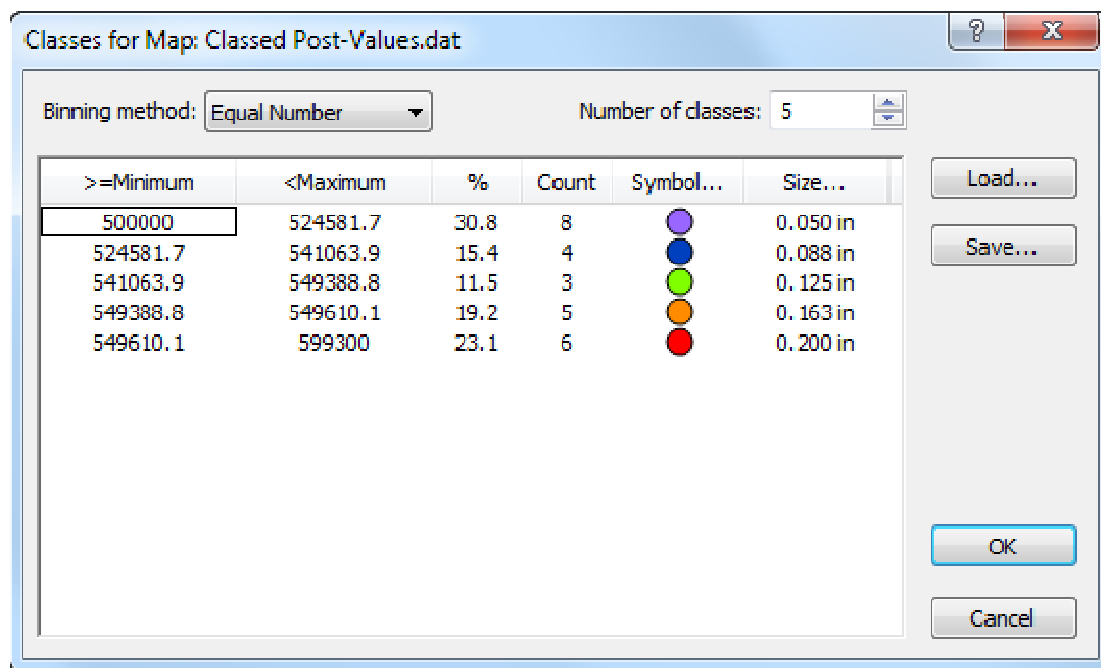
Click on a polyline or polygon object in a base map and view the length and area results on the **Info** tab.

## Posting symbols, values and geophysical information

Post maps and classed post maps are easy ways to get an idea about the spatial distribution of your data points. The **Map | New | Post Map** and **Classed Post Map** commands control the posting of symbols, values, and geophysical information (shot points). The X, Y, and label values must be located in separate columns in the data file or worksheet. Simply click **Map | New | Post Map**, select the data file and click *Open*. The post map is created. Click on the post map to access the post map properties in the **Property Manager**. Specify the X and Y data columns on the **General** tab and specify the labels column on the **Labels** tab.

To post two labels associated with each point, add two sets of labels. Create the post map, select it and in the **Property Manager** click the **Labels** tab. On the **Labels** page, set a *Worksheet column* for the first *Label set* (Set 1). Then click the *Add* button to add an additional label set, Set 2. Specify the *Worksheet column* and label properties for Set 2.

The classed post map can be used to display symbol properties based on a third (Z) column of data in the data file. To create a classed post map, click **Map | New | Classed Post Map**, select the data file and click *Open*. To edit the classes, click the **Classes** tab in the **Property Manager** and click the *Edit Classes* button.



*Specify certain display properties for the symbols based on a third data column using the classed post map.*

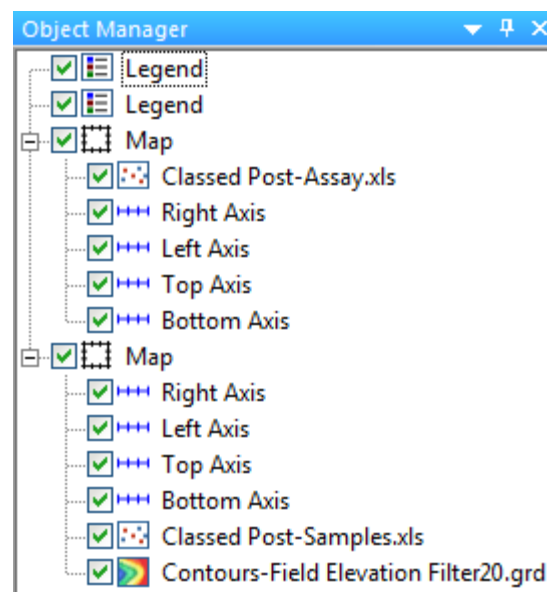
### III. Map Options

#### Selecting objects

The easiest way to select an object is to click the mouse pointer on the object. This method selects the "top" object underlying the pointer. If you would like to select another object underneath the pointer, hold down the *Ctrl* key and click the mouse until the desired object is selected. You can view the selection handles or the name of the selected object in the Status bar to see which object is selected.

You can also select an object in the **Object Manager**. The **Object Manager** lists all objects in your SRF file in an organized hierarchical tree view. Simply click on the object you wish to select. When an object is selected, its properties appear in the **Property Manager**.

The *Ctrl+A* key combination is a shortcut for the *Edit | Select All* menu command.



#### Adding and overlaying maps

You can add new map layers to existing maps, or you can overlay two separate maps into one. You would want to overlay maps into one map frame (one *Map* with one set of axes) if you want them to be spatially related to each other and overlay in their respective positions.

To add new map layers, create your first map using one of the **Map | New** menu commands. Once the map is created, select the map and use the **Map | Add** command to add a new map layer to the existing map.

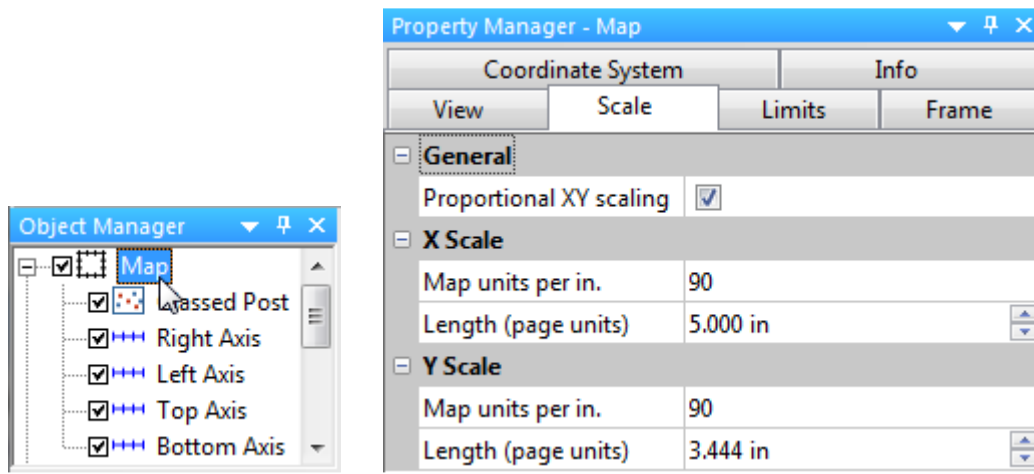
If creating new separate maps in Surfer, note that they are not spatially related to each other. The separate maps are totally separate objects from each other. If you have created two (or more) separate maps, to snap the maps together according to their coordinates you must combine (or overlay) them. You can do this one of two ways:

1. You can select all maps to overlay and click **Map | Overlay Maps**.
2. You can select one of the map layers in the **Object Manager** and drag it from its original map frame into the map frame of the other map layer. Release the mouse button and the map layer is combined with the other map layer.

**Note:** If the map layer you add has different limits than the existing map, then Surfer will ask you if you want to reset the limits and scale of the map. Click *No* to preserve any custom limits or scaling. Click *Yes* to have Surfer automatically recalculate the limits and scale.

## Scaling a map

The **Scale** page in the **Map** properties in the **Property Manager** controls the scaling of a map. Simply click on **Map** in the **Object Manager** to open the **Map** properties in the **Property Manager**, and click the **Scale** tab. The units are in map units (whatever units your map is in) and the *Length* is in page units (cm or in).



*Click on the Map in the  
**Object Manager** to  
open the **Map**  
properties in the  
**Property Manager**.*

*In the **Property Manager**, click the **Scale** tab to  
adjust the scale of the map.*

For example, if your page units are cm and your map units are meters, and you want to specify a dimensionless scale, such as 1:50,000, convert the scale to the corresponding units:

1:50,000

1cm = 50,000cm

1cm = 500m (so enter 500 for *Map units per cm*)

**Pitfall:** Objects that are not part of the map (such as drawn objects or separate maps) will not be moved when you change the scale. To move and scale drawn objects with a map, follow the instructions in our Issue 48 newsletter at: <http://www.goldensoftware.com/newsletter/Issue48ExportMapUnits.shtml>

Alternatively, you can draw the objects on the map inside a base map. To do this, select the map and use **Map | Add | Empty Base Layer** to create an empty base map layer in the map frame. Select the empty base layer and click **Arrange | Enter Group**. Use any of the drawing tools to draw points, polylines, polygons and text. The objects will be added to the base map. Then use **Arrange | Exit Group** to exit the base map group.



## Making a scale bar

You can create a scale bar for a map by selecting the map and clicking **Map | Add | Scale Bar**. The scale bar is created with default properties.

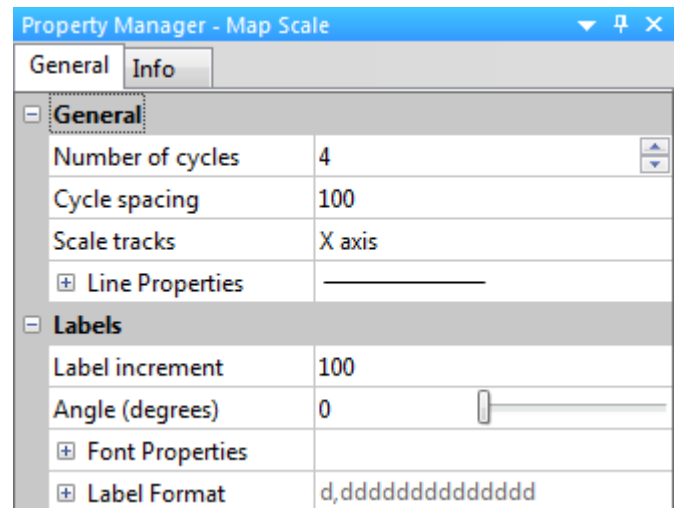
To edit the scale bar, click on it and edit the properties in the **Property Manager**. *Cycle Spacing* is the value in map units between cycles. The *Label Increment* lets you specify a value for the labels that is not based on map units. If your scale bar uses the same units as the map, the cycle spacing and label increment is the same. But if you want a scale bar in kilometers and your data are in latitude/longitude, you can specify different values in the **Property Manager**.

For example, consider a lat/long map of Canada. Using the formulas:

$$\begin{aligned} 1^\circ \text{ latitude} &= 110.6 \text{ km}, \\ 1^\circ \text{ longitude} &= 111.3 \text{ km} \cdot \cos(\text{lat}) \\ &= 111.3 \cdot \cos(51^\circ) \\ &= 70.04 \text{ km} \end{aligned}$$

the ratio of scales between Y and X is  $110.6 / 70 = 1.58$ . Turn off the proportional XY scaling, and multiply the default Y scale by 1.58.

To create a scale bar in kilometers for this map, the X equivalence is  $1^\circ = 70.04 \text{ km}$ , or  $1 \text{ km} = 0.014^\circ$ , or  $1000 \text{ km} = 14^\circ$ . Click on the scale bar to enter the **Map Scale** properties in the **Property Manager**. Change the *Cycle Spacing* to 14 (degrees) and the *Label Increment* to 1000 (km).



## Adding a legend and north arrow

You can use the drawing tools to add a legend or title box to your map. For best results, draw the legend rectangles and text as the last step in creating your final map. The **Arrange | Align Objects** commands will help greatly in aligning your legend objects exactly with respect to each other.

You can add a north arrow to the map using the **Draw | Symbol** tool:

1. Click **Draw | Symbol** and the pointer changes to cross-hairs.
2. Click the mouse to drop the default symbol at the desired location. Press ESC to exit drawing mode.
3. Click on the symbol to display the **Symbol** properties in the **Properties Manager**.
4. On the **Symbol** tab, click in the *Symbol* field box and select the desired symbol from the drop down list (i.e. Number 68 in the *GSI Default Symbols* symbol set, or you can change the *Symbol Set* to *GSI North Arrows* and choose from a variety of north arrow styles).
5. If the map is rotated, you can select the symbol and use the **Arrange | Rotate** or **Arrange | Free Rotate** menu commands to rotate the symbol to the desired angle.

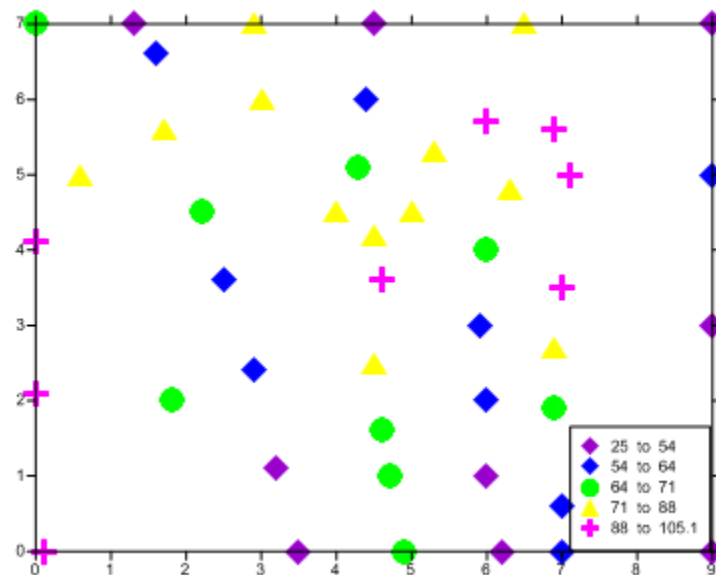
## IV. Gridding Data

### Loading a data file for gridding

If you have a data file with XYZ data in it, then you can go directly to the **Grid | Data** menu command, select the data file and click *Open*.

If you are unsure about the column layout or spatial distribution of your data file, there are a number of ways to familiarize yourself with the data. In the **Grid Data** dialog box, you can click the *Statistics* button to generate a statistics report. It can help you spot anomalous values in a particular column, such as negative values in a thickness or isopach column.

To illustrate the spatial distribution of your data, you can also make a post map or a classed post map of the data prior to going to **Grid | Data**. The classed post map displays the location of your data points and provides a way to display the location of various ranges of Z values. Data point labels can also be used if the data set is small.



*Create a classed post map of your data to visualize the spatial distribution of the data.*

## Grid Data

Once you click **Grid | Data**, select a data file and click *Open*, the **Grid Data** dialog box appears. This dialog box is the control center for gridding.

### Data Columns

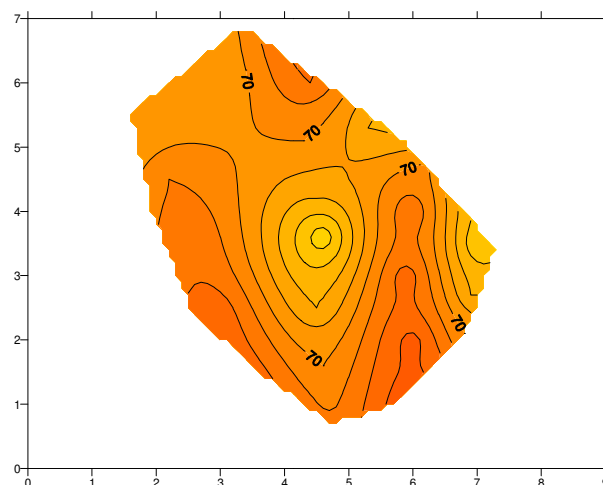
The *Data Columns* let you specify the columns containing the X, Y, and Z values. If you are not sure which columns to use, click the *View Data* button to examine the data file. The *Statistics* button can also give you a look at the data, showing the *Count* (or number of data points) as well as the minimum, maximum and other statistical information. If these values are not what you expect, open the data file in a worksheet to verify that Surfer is reading the file properly.

### Grid Line Geometry

The *Grid Line Geometry* section of the **Grid Data** dialog box is where you can change parameters concerning the size of the resulting grid file. Of particular importance is the *Spacing* in the X and Y directions. The *Spacing* is directly linked to the *# of Nodes* (grid lines). The *# of Nodes* is the number of grid lines. The *Spacing* is the size for the grid cells (the spacing between the grid lines). The smaller the grid spacing, the higher the number of lines. By default, Surfer enters 100 for the number of lines in the longest direction.

However, these values could be set to a value that better reflects the desired results of the map. If you wish to honor every data point, the ideal situation is to have a grid line intersection at each point. If this geometry results in too large a grid file from having too many grid lines, a good compromise is to set the grid line spacing to the closest data point spacing. This value can be estimated by examining a post or classed post map, or by using the **Map | Digitize** menu on the post map to get more exact XY data point values from which you can calculate the spacing using the formula:  $\sqrt{\Delta x^2 + \Delta y^2}$

In addition, since the grid line spacing affects the size of the grid cell, the smoothness of a blanking boundary will also be affected. A large grid cell size will produce a coarse, "stair-step" or serrated boundary. You can reduce the grid cell size by reducing the *Spacing* or increasing the *# of Nodes* values. The more grid lines are used to create the grid, the finer the grid "mesh" will be and the smoother the contour map will be.



*Large grid cell spacing produces a serrated boundary around blanked areas.*

## Blanking Outside the Convex Hull

The convex hull can be thought of as a rubber band that encompasses all data points. The rubber band only touches the outside points.

Check the box next to the *Blank grid outside convex hull of data* to automatically blank the grid nodes outside the convex hull of the data. Areas inside the convex hull, but without data, are still gridded. Leave the box unchecked to extrapolate the data to the minimum and maximum grid limits, regardless of whether data exists in these areas.

## Z Transform

The Z transform option allows you to grid the logarithm of the Z values, and save the grid with either the logarithmic Z values or values converted back to linear values. This is extremely useful when your Z data spans several orders of magnitude, such as concentration data where the Z values can range from very small values (i.e. 0.001) to very large values (i.e. >10000). In such cases, gridding with a linear scale biases the grid to the high Z values and thus loses detail in areas with the lower Z values.

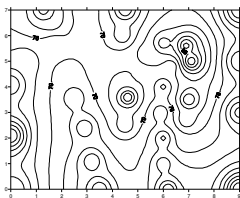
The options for *Z Transform* are:

1. *Linear*. This is the default, and how all previous versions of Surfer gridded data. It will treat the Z value in the data as linear, grid the linear values, and save the linear Z value back to the grid file. If your data is not logarithmically distributed (i.e. the Z value in the data does not span multiple orders of magnitude), choose this option.
2. *Log, save as log*. This will automatically take the log of the Z values in the data file, grid the log values, and save the grid. The Z of the grid is the log of the original data in the data file. Choose this option if your data spans several orders of magnitude and you want the resulting Z value in the grid file to be in logarithmic units.
3. *Log, save as linear*. This will automatically take the log of the Z values in the data file, grid the log values, convert the log values in the grid back to linear values, and save the grid with the Z being in the original linear data units. Choose this option if your data spans several orders of magnitude and you want the resulting Z value in the grid file to be in the same units as your original data.

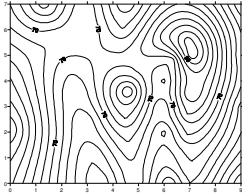
## Gridding Methods

Unless you have specific information about your data set, we recommend using the default gridding method, which is kriging with a linear variogram. This method was selected as the default because it does a good job of gridding a wide variety of data sets. However, this method doesn't always produce the desired results with every data set, so it sometimes pays to consider the other gridding methods.

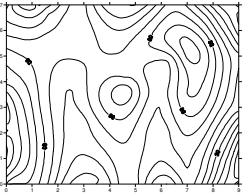
To get a quick idea of what your data set would look like with the various gridding methods, open the sample script *GridData\_Comparison.bas* (found in the \Samples\Scripts folder in the Surfer installation directory) in the Scripter program, which comes with Surfer. In Scripter, click **Script | Run**. Select your data file and click *Open*, enter your XYZ data columns and click *OK*.



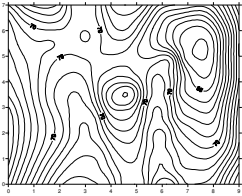
The **inverse distance** method uses a "simple" distance weighted averaging method to calculate grid node values. It does not extrapolate values beyond those found in the data file, but it tends to draw circles or bulls-eyes around each data point.



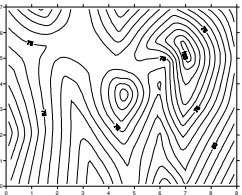
The **kriging** method uses trends in the map to extrapolate into areas of no data, sometimes resulting in minimum and maximum Z values in the grid that are beyond the values in the data file. This could be acceptable in a structure map or topography map, but not in an isopach map where the extrapolation produces negative thickness values.



The **minimum curvature** method attempts to fit a surface to all the data values using an iterative approach. One drawback to this method is a tendency to "blow up", or extrapolate extremely large or small values, in areas of no data. Minimum curvature can extrapolate values beyond your data's Z range.



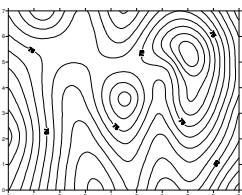
The **modified Shepard's method** attempts to combine the inverse distance method with a spline smoothing algorithm. It tends to accentuate the bulls-eye effect of the inverse distance method. It can extrapolate values beyond your data's Z range.



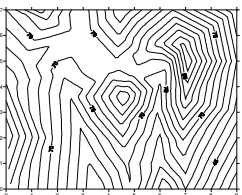
The **natural neighbor** gridding method uses a weighted average of the neighboring observations. This method generates good contours from data sets containing dense data in some areas and sparse data in other areas. It does not generate data in areas without data and does not extrapolate Z grid values beyond the range of the data.

The **nearest neighbor** method uses the nearest point to assign a value to a grid node. It is useful for converting regularly spaced (or almost regularly spaced) XYZ data files into grid files. This method does not extrapolate Z grid values beyond the range of the data.

The **polynomial regression** method processes the data so that underlying large-scale trends and patterns are shown. This is used for trend surface analysis. This method can extrapolate grid values beyond your data's Z range.



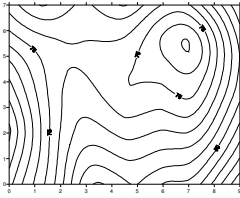
The **radial basis function** method is similar to kriging, but produces slightly different results.



The **triangulation with linear interpolation** method computes a unique set of triangles from the data points, and uses linear interpolation within each triangle for the calculation of the grid nodes. It tends to produce angular contours for small data sets, but it can often handle difficult situations, such as man-made features like terraces and pits. This method does not extrapolate Z values beyond the range of data.

The **moving average** is most applicable to large and very large data sets (e.g. >1000 data points). It extracts intermediate-scale trends and variations from large noisy data sets. This gridding method is a reasonable alternative to Nearest Neighbor for generating grids from large, regularly spaced data sets.

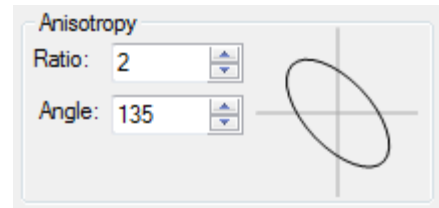
The **data metrics** gridding method is used to create grids of information about the data.



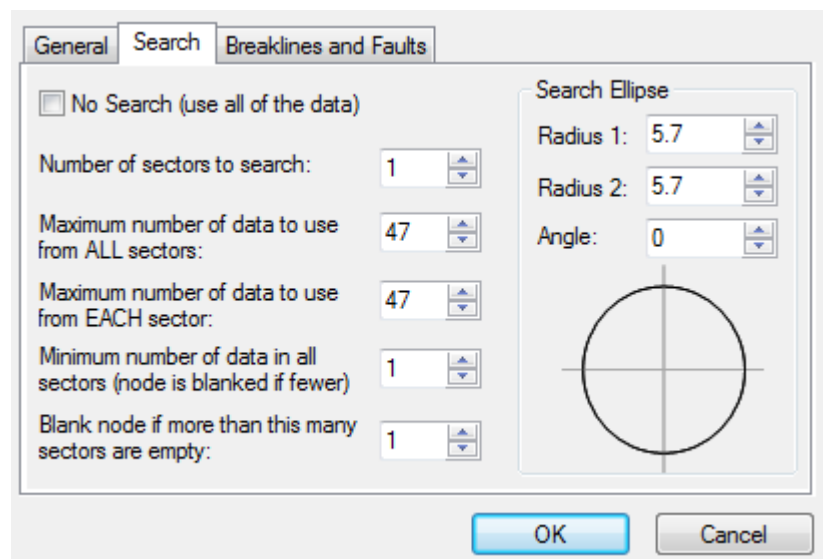
The **local polynomial** gridding method is most applicable to data sets that are locally smooth (i.e. relatively smooth surfaces within the search neighborhoods).

### Advanced Options: Anisotropy vs. search radius

Anisotropy is used to introduce a bias or trend direction when calculating the grid. For example, if the local trend direction for carbonate mounds is NW-SE, then you can apply a 135° anisotropy direction when gridding. Data points that are further away in the direction of anisotropy will have the same weight as closer data points perpendicular to the anisotropy direction. The *Anisotropy* option can be found by clicking the *Advanced Options* button next to the chosen gridding method. Different gridding methods will display this option in different locations, and some gridding methods do not support this option.



Also under the *Advanced Options* button are the *Search* options. The radii of the search ellipse can also be changed to limit the extent of the search for data points, often to blank out areas that are a certain distance from the data. Changing the search radii can produce an ellipse that appears similar to the anisotropy ellipse, but the search ellipse does not change the weight of data points when calculating grid nodes. Unless you have specific reasons for changing the search ellipse, we recommend using the same values for *Radius 1* and *Radius 2* to produce a circular search area.



A common use of the *Search* options is to force the program to search in four quadrants or "directions" away from the grid node when calculating the grid node value. This can be a useful feature when gridding geophysical or other data sets that have a close spacing of data points along a line, with much greater distances between lines.

### Blanking values (null values) in a grid

When a grid node is blanked, Surfer uses a special "blanking value" for that grid node (1.70141E+038).

Occasionally, you may want to use a different value for the blanking value, for example, if you are exporting the grid to a modeling program, or if you wish to display the blanked area differently. To change the blanking value:

1. Click **Grid | Math**.
2. In the **Grid Math** dialog, click the *Add Grids* button, select the grid file and click *Open*.
3. Set the *Blank Handling* to *Remap to*.
4. Set the *Remap Value* to 0 (or whatever value you wish to change the blanking value to).
5. Clear the function equation.
6. Click *OK*.

## Variograms




Surfer includes an extensive variogram modeling subsystem. The primary purpose of the variogram modeling subsystem is to assist users in selecting an appropriate variogram model when gridding with the Kriging algorithm. Surfer's variogram modeling feature is intended for experienced variogram users. You walk through the Variogram Tutorial, located in the Help. Click **Help | Contents**, and on the **Contents** page, navigate to **Gridding | Grid Operations | Variograms | Variogram Tutorial**.

## V. Contour Maps

### Creating and editing contour maps

After creating a grid file, use the **Map | New | Contour Map** menu command, select the grid file and click **Open**. The contour map is displayed with the default settings. To change the settings, click on the contour map to open the **Map: Contours** properties in the **Property Manager**.

#### General tab

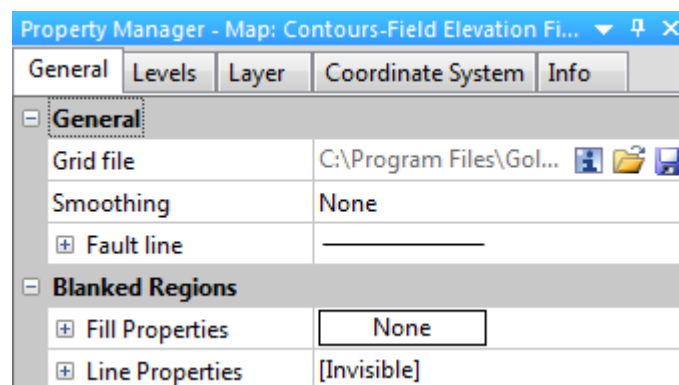
Fill the contours, display a color scale, smooth the contours, or specify properties for blanked regions and fault lines on the **General** tab in the **Property Manager**. We generally don't recommend the use of contour smoothing, because it slows down the display of the contour map and it is possible to get crossing contour lines (not realistic!). The best way to smooth contours is to either grid the data with a denser grid or to use the **Grid | Spline Smooth** or **Grid | Filter** (matrix smooth) commands. The **Open Grid** button  lets you replace the current grid file with a new grid file, while keeping all the contour map settings. The **Grid Info** button  gives you a report about the grid file, including X, Y, and Z ranges. The **Save Grid** button  lets you save the grid file from the map.

#### Levels tab

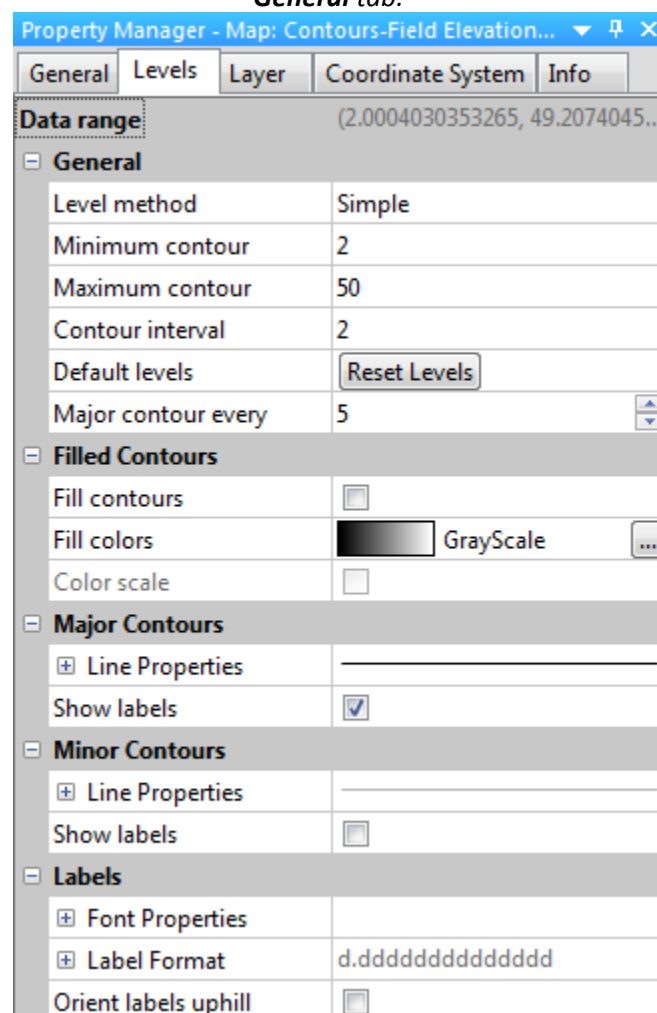
Surfer attempts to pick a good contour interval based on the minimum and maximum Z values in the grid file. To change any of the properties for the contour levels, click the **Levels** tab.

For most users, the *Level method of Simple* is sufficient:

- You can easily change the contour minimum value, the contour maximum value, and the contour interval.
- You can also separate major and minor contour levels. For example, setting *Major contour every* to 5 will make every 5<sup>th</sup> contour line a major contour.
- If the contour map is filled, select a predefined color ramp from the *Fill colors* drop down menu, or create



Set general settings for the contour map on the **General** tab.

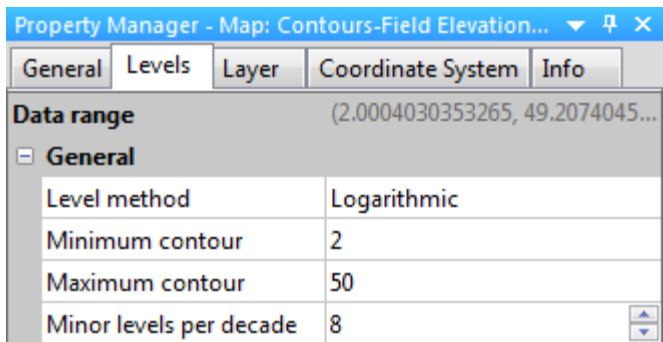


Click the **Levels** tab to adjust the properties for the contour levels

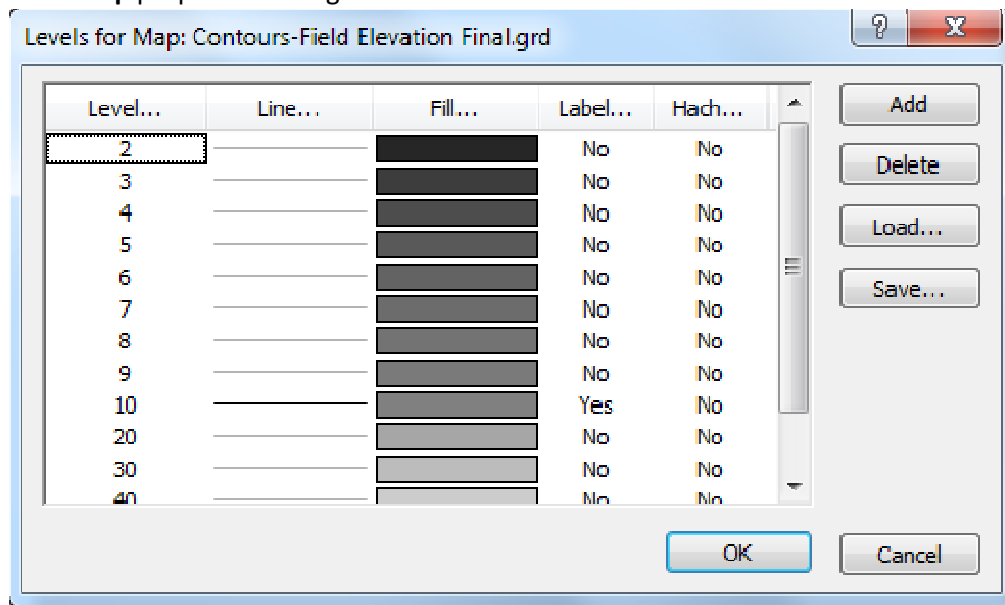
your own by clicking the *Custom* button at the bottom of the list.

- You can open the *Line Properties* section under the *Major Contours* or *Minor Contours* to change the line properties for the major and minor contour lines.

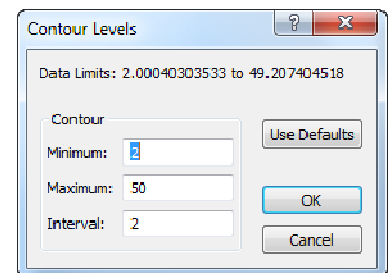
If you gridded the data with a *Z Transform* of *Log*, *save as Linear*, then you would want to display the contours with log-distributed levels. Change the *Level method* to *Logarithmic*. The *Minimum contour* value must be >0, and you have the option to display minor levels per each log decade.



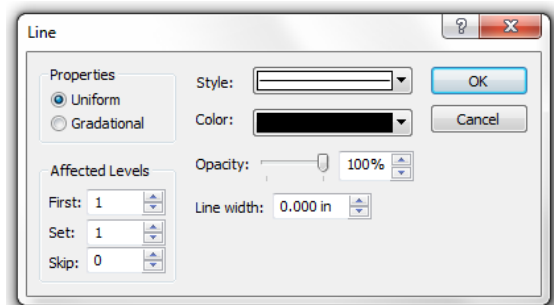
For more advanced level editing, change the *Level method* to *Advanced* and then click the *Edit Levels* button to open the **Levels for Map** properties dialog:



To change the contour interval, click on the *Level* button. In the **Contour Levels** dialog, you can specify the minimum and maximum contour values, as well as the contour interval. Click *OK* to create the new levels. In addition, you can double-click on each level in the **Levels** tab to enter a different level value, and use the *Add* and *Delete* buttons to insert new levels or delete unwanted levels.

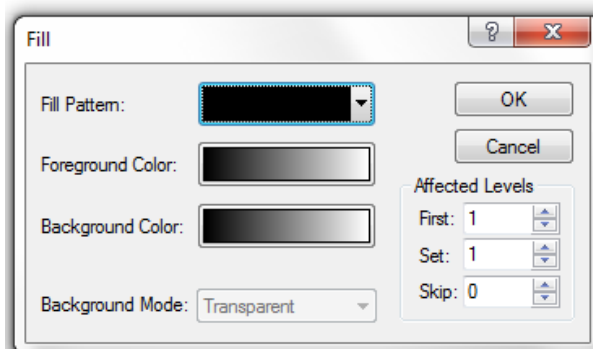


The *Line* button opens the **Line** dialog and lets you choose *Uniform* or *Gradational* for the contour line properties. If you choose, *Gradational*, you can set line colors for the minimum and maximum Z values, and calculates a color gradient between the two end points. Choose *Uniform* if you do not want a graded color for the contour line. Use the *Affected Levels* section if you do not want to set the properties for every contour line, but perhaps every other or every third contour line.

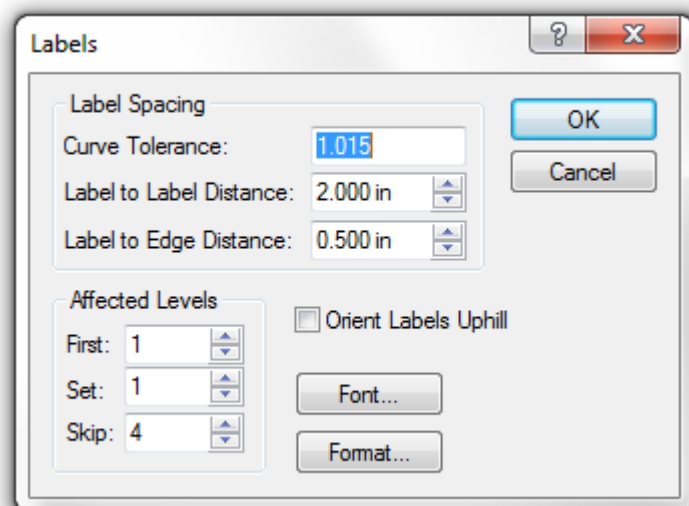




The fill colors for a contour fill are set with the *Fill* button. You have the option for specifying fill pattern, foreground color, and background color (for transparent fill patterns). You can click on the button to the left of *Foreground Color* to set a multi-color gradational contour fill, load a color spectrum file, or save a color spectrum file. You can set which contour levels you are filling using the *Affected Levels* section. You can also double-click on any color listed in the list on the **Levels** tab, and change it individually. The contour fills are not enabled in the map until you click the *Fill Contours* check box on the **General** tab in the **Property Inspector**.



The *Labels* button controls the frequency, placement, and orientation of the contour labels. Normally, the labels are oriented so the top of the labels points to the top of the page, but you can select the *Orient Labels Uphill* to have the top of the label indicate the direction of increasing Z value. The *Curve Tolerance* setting can prevent a label from being drawn if it deviates from being a straight line by a certain factor. That factor is expressed as the ratio of the length of the contour divided by the length of the label. *Label to Label Distance* sets the distance between labels on a single contour. The *Label to Edge Distance* sets the distance between the first label and the edge of the map for contours that start at the edge of the map. These three *Label Spacing* settings are the

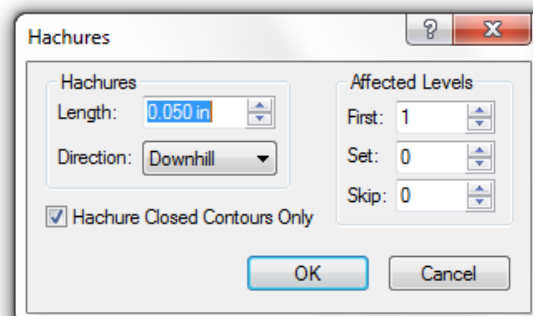


ones to change when you wish contours to appear on the map, but none are displayed. Increase the *Curve Tolerance* to an arbitrarily large number, e.g. 1000, and decrease the label spacing values to 0.01. In addition, decreasing the size of the *Font* can help display contour labels when none appear by default. You can also add custom contour line labels to the map interactively by right-clicking over the map and going to **Edit Contours Labels**. You can drag labels to new positions along the contour line, you can *Ctrl-click* to add contour labels anywhere on the map, or you can select a contour label and delete it.

The *Font* button in the *Labels* dialog box provides control of the font "Face" or name, size in points, style, color and background color.

The *Format* button in the *Labels* dialog box provides additional options for the display of the labels.

Back in the level **Properties** dialog box, the next button is the *Hach* button, which controls the display of tick marks drawn perpendicular to the contour line. Often these are drawn inside closed lows only, but they can also be drawn on any contours to indicate the side of the contour below or above the Z value of the contour. As with the contour label controls, you specify the lowest level as level 0, and the frequency can also be specified.



## Layers tab

The **Layer** tab lets you set the opacity of the entire contour map layer. This will change the opacity of the contour lines, fill and text labels. If you just want to change the opacity of the contour fill, not the lines or labels, click the **Levels** tab, set the *Level method* to *Advanced* and click *Edit Levels*, click on the *Fill* button, click on the *Foreground Color* button and change the opacity for the colormap.

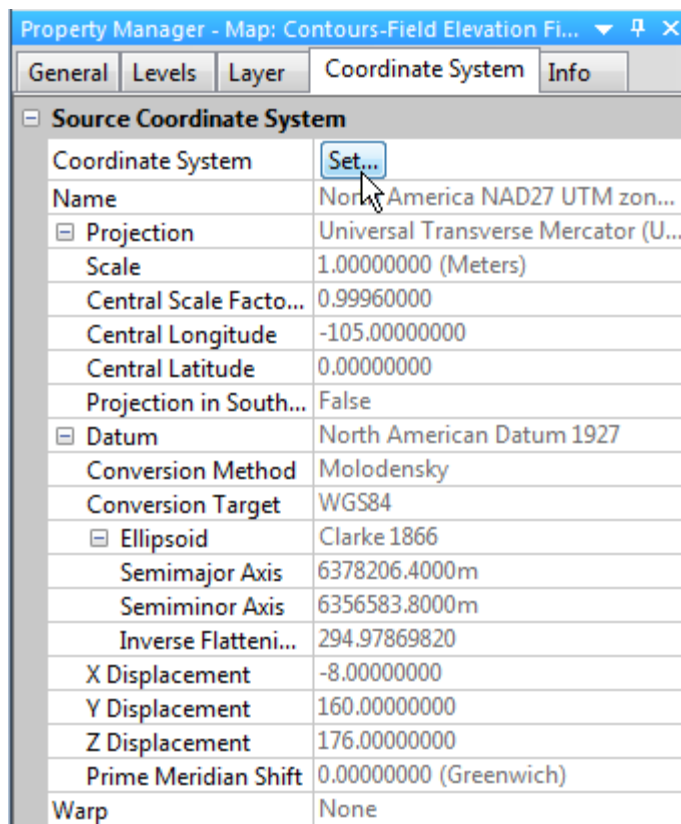
## Coordinate System tab

The **Coordinate System** page lets you assign a coordinate system to the source grid file for the contour map. This is the original coordinate system the grid file data is in. If your grid file already contains projection information (i.e. a PRJ file, GSR2 file, embedded in DEM files, etc), then this information is automatically entered.

For example, if you know your grid file is in UTM coordinates, you would create the map from the grid file, select the map layer, click the **Coordinate System** tab in the **Property Manager**, and click the *Set* button. You would navigate to **Predefined | Projected Systems | UTM**, and select the UTM location and zone your file is in. If this is a coordinate system you will frequently use, we recommend clicking the *Add to Favorites* button to add the coordinate system to your *Favorites*. That way, you can find it much easier the next time you wish to select it. Click *OK* and the coordinate system is entered for the grid file.

Some reasons why you may want to set the source coordinate system for the map layer include:

1. You want to overlay map layers in various coordinate systems. For example, you want to overlay a contour map in UTM coordinates with a base map in State Plane coordinates.
2. You want to create a map from a grid file that is in one coordinate system (i.e. UTM) and have the resulting map be displayed in another coordinate system (i.e. Lat/Long).
3. You want to create a map and export it to a file with the projection information intact. For example, you want to create a contour map in UTM coordinates, and have the UTM projection information saved to a PRJ file when you export the contours to a SHP file. This way, the exported SHP file will import into ArcGIS (or other software) with the correct projection information.



*Set the coordinate system for the source grid file on the **Coordinate System** tab.*

**Note:** This is not where you specify what you want the actual contour map to be displayed in. You can set the coordinate system for the displayed map by selecting *Map* in the **Object Manager** and going to the **Coordinate System** tab for the map properties. Click the *Change* button and change the coordinate system you want the map to be displayed in.

## Editing contour lines

You can use the **Grid | Grid Node Editor** to change individual grid node values in a grid file to change a contour shape, but this method tends to be very labor intensive unless limited to small changes.

## Digitizing contours and gridding

In order to use contours created in software other than Surfer, the contours have to be recorded in a digital format and converted to a file format that Surfer can use. Tablet digitizing and onscreen digitizing a scanned image are two ways of recording data in a digital format.

Tablet digitizing requires a piece of equipment called a digitizing tablet, and software to use with the tablet. The Golden Software Didger software works with a digitizing tablet to store the XYZ coordinates along a contour in an ASCII data file format which you can use for gridding.

If you have a scanner that fits your map, you can scan the contour map, save it as an image file, load it as a base map in Surfer, and assign map coordinates to the corners of the map. You can then use the Surfer **Map | Digitize** command to digitize points along the contours. You will have to manually enter the Z values for each digitized point and save the coordinates to a DAT file. Then, grid the DAT file using the **Grid | Data** command.

Alternatively, you can also import and georeference the scanned image in our Didger software and export the digitized data to a DAT file. Then, grid the DAT file using the **Grid | Data** command. When digitizing data along contours on an image, more data isn't necessarily better. To help Surfer best recreate the contour map, space the data points out along the contours so that you can see the individual points.

AutoCAD and other CAD or GIS packages may store contours as 3D polylines. If you have a 3D DXF file, you can use this in place of a data file with the **Grid | Data** command. The XYZ points in the DXF file are gridded and then you can create a new contour map in Surfer from the grid. The contours may not look exactly like the original lines in the DXF file. You may need to experiment with the gridding parameters to generate a grid that produces the contour lines you want.

## Faults

In Surfer, a fault is a two-dimensional blanking file defining a line acting as a barrier to information flow when gridding. When gridding a data set, data on one side of a fault is not directly used when calculating grid node values on the other side of the fault. If the fault line is a closed polygon, the gridding algorithm grids data on whichever side of the polygon contains the data. If the fault line is not a closed polygon, the gridding algorithm can search around the end of the fault to see a point on the other side of the fault, but this longer distance reduces the weight of the point in interpolating the grid node value. If a point lies directly on the fault line, random round-off error determines which side of the fault captures the point. The following gridding methods support faults under the *Advanced Options* button in the **Grid Data** dialog box:

- Inverse Distance to a Power
- Minimum Curvature
- Nearest Neighbor
- Data Metrics

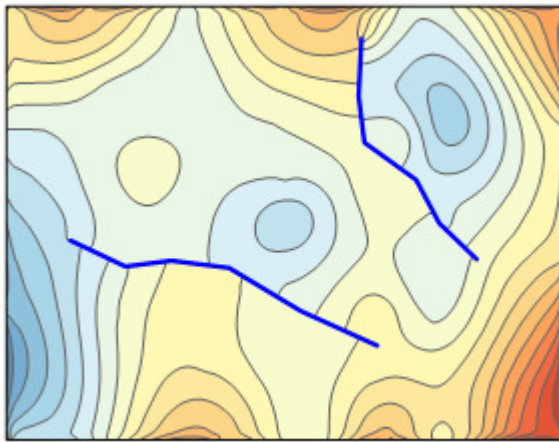
You can create a blanking file (BLN) to define a fault in the Surfer worksheet or any text editor. Enter a header containing the number of vertices in the fault, followed by the XY coordinates of each vertex, one per line. You can contain the coordinates for many faults in a single BLN file. Faults consume memory and increase gridding time in proportion to the square of the number of fault segments.

## Faults vs. Breaklines

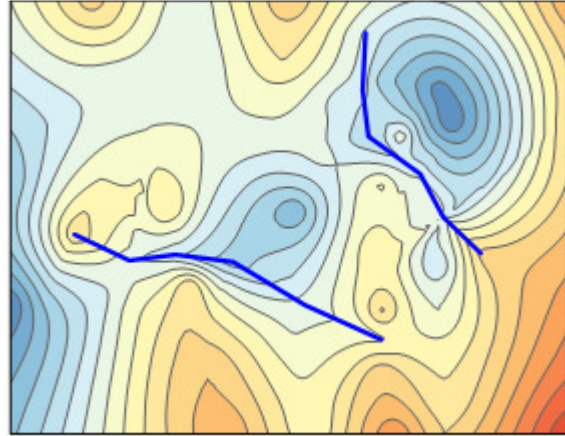
When would you use a breakline and when would you use a fault file?

Faults act as barriers to the information flow, and data on one side of the fault will not be directly used to calculate grid node values on the other side of the fault. Contours can go right into a fault line. You could use a fault when you actually have a fault or any other barrier to flow (a building or concrete wall for example).

Breaklines include Z values. When Surfer sees a breakline, it uses the Z value of the breakline in combination with nearby data points to calculate the grid node value. Breaklines are the only time a Z value is used in a BLN file. Unlike faults, breaklines are not barriers to information flow and the gridding algorithm can cross the breakline to use a point on the other side to calculate a grid node value. You could use a breakline file for controlling contours within a boundary, such as a river or within a lake, or when you have Z data along a break in slope such as a ridgeline.



*Faults*



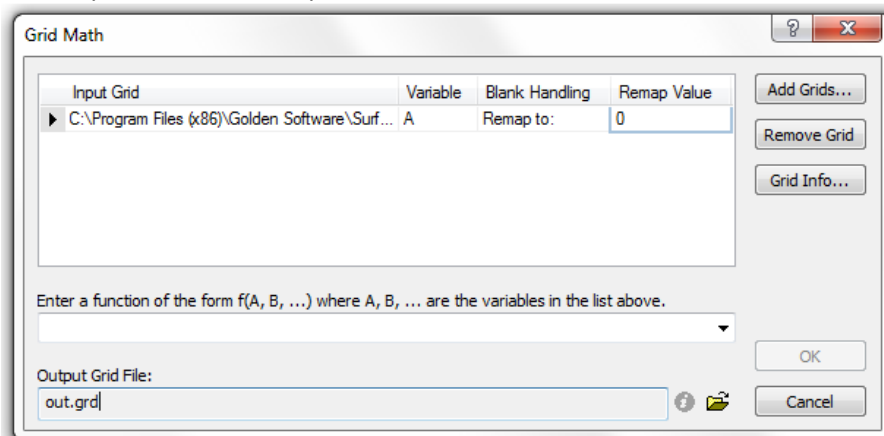
*Breaklines*

## VI. Grid Calculations

### Applications for using the math function

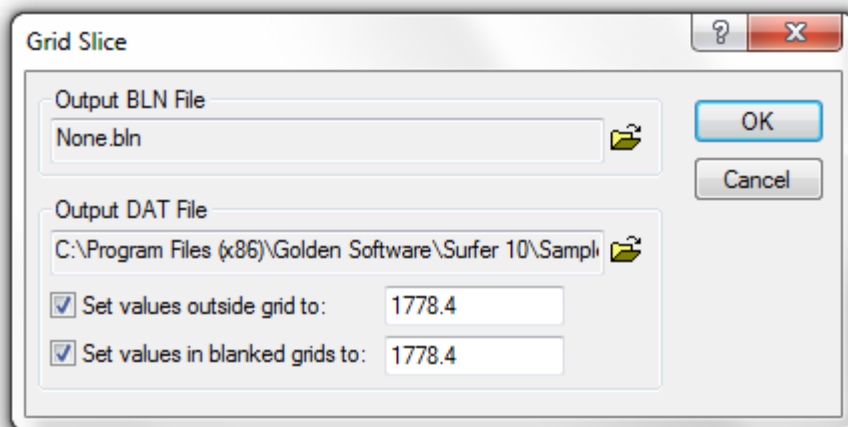
The **Grid | Math** menu command opens the **Grid Math** dialog. You can specify up as many input grid files as you need and a formula for calculating an output grid file. To use this function on multiple grid files, the two grid files must be gridded using the same number of grid lines (same grid spacing) and the same X and Y minimum and maximum values. You can use this function to:

- Calculate the thickness of a formation. Add grids for the top of the formation and the bottom of the formation and use the function  $A-B$  to subtract the lower surface grid file from the upper surface grid file.
- Replace all negative values with 0. Add one grid file and use the function  $\max(A, 0)$ .
- Convert Z values from feet to meters (or perform any unit conversion). Add one grid file and use the function  $A * 3.2808$  to convert the Z values of the grid file from meters to feet.
- Replace the blanking value in a grid file with another value, such as 0. Add one grid file, set the *Blank Handling* to *Remap to*, set the *Remap Value* to 0, and clear the function.



## Using the slice function to create a cross section

The **Grid | Slice** function in Surfer uses a grid file and a BLN file which defines the line of section to use. Surfer will create a data file with Z values at every point the trace crosses a grid line. Click **Grid | Slice**, select the grid file and click *Open*, select the BLN file and click *Open*. In the **Grid Slice** dialog box, specify a file name under *Output DAT File* to save the results in a DAT file and click *OK*.



You can either use the resulting DAT file in a graphing software, like Golden Software's Grapher, to display the cross section, or you can modify the DAT file slightly and save it as a BLN file to display it in Surfer. To use Surfer:

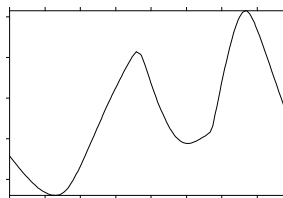
1. Open the DAT file in the Surfer worksheet.
2. In the Surfer worksheet, highlight columns A and B and click **Edit | Clear**.
3. Then move column D to column A and column C to column B.
4. Insert a new line at the top of the file (highlight row 1 and click **Edit | Insert**).
5. In cell A1 add the number of points contained in the file.
6. Click **File | Save As** and save it as a Golden Software Blanking (\*.BLN) file.
7. In a plot document window, click **Map | New | Base Map**, select the BLN file and click *Open*.

If you want to create a cross section in Surfer showing multiple horizons, load the first BLN cross section, select it and use the **Map | Add | Base Layer** option to add each separate BLN file to the map.

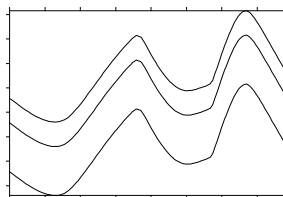
Exact instructions are also found in the Surfer article in Issue 56 of our newsletter at:

<http://www.goldensoftware.com/newsletter/Issue56Scross.shtml>. The article was written for Surfer 8, but also applies to future versions of Surfer.

*Load one BLN file  
to show profile*

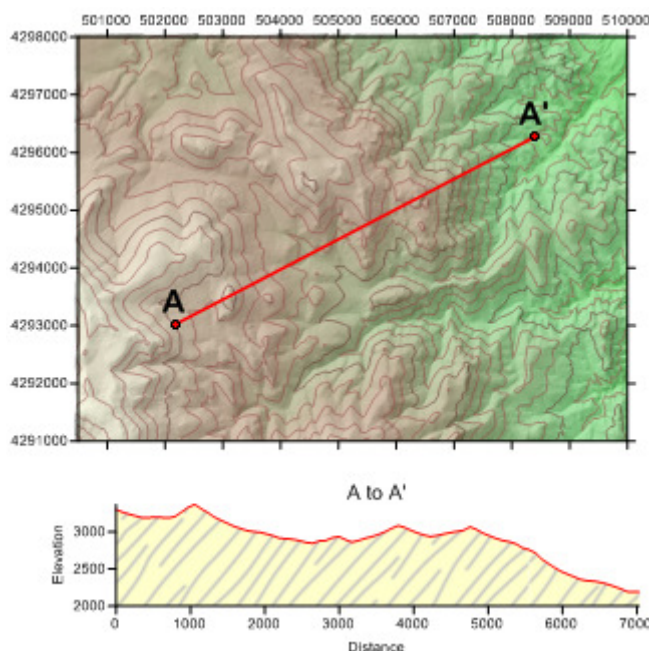


*Load and overlay  
two or more BLN  
files to show true  
cross section*





If you are only interested in seeing a single profile line, and you can draw this line on the map, it is much simpler to simply add a profile. For example, create a map from any grid file. Select the map and click **Map | Add | Profile**. Then click on the map on the starting, ending and any intervening points to draw the profile line. Double click to end the profile line and the profile is automatically created.

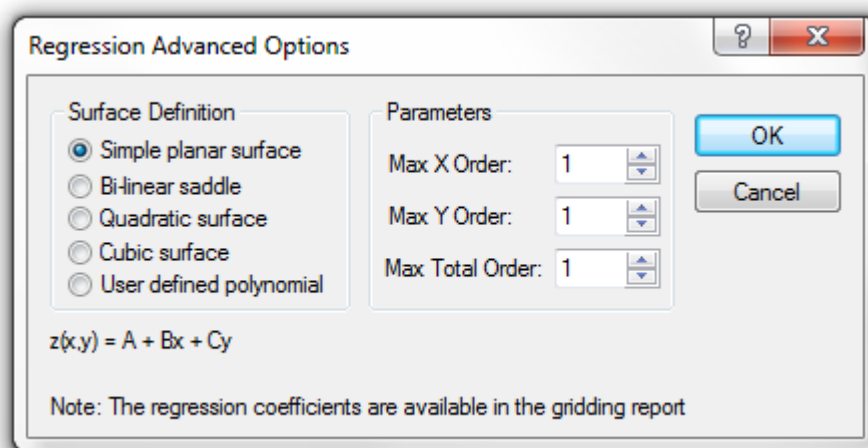


*Quickly create a profile line by adding a profile to the map and drawing the profile line. The profile is automatically created.*

## VII. Trend Analysis, Residual Calculation and Display

### Fitting a trend to data

The polynomial gridding method is a means of calculating a trend surface from the raw data set. Click **Grid | Data**, specify the data file name and click **OK**, and in the **Grid Data** dialog select the **Polynomial Regression** method. Click on the **Advanced Options** button to display the **Regression Advanced Options** dialog box. You can select one of the predefined **Surface Definition** methods, or the **User defined polynomial** to specify the maximum X, Y, and Total Order.



### Subtracting a trend from data

Once you have the trend surface calculated in a grid file, you can subtract this grid from a grid of the data set created with another gridding method (i.e. *Kriging*) to produce a residual map. Use the **Grid | Math** menu command to specify the two input grid files and the name of the output grid file. The grid sizes and XY limits will have to be the exact same for both grids to use the **Grid | Math** command.

## Displaying residual and original data

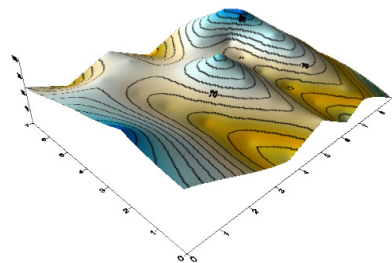
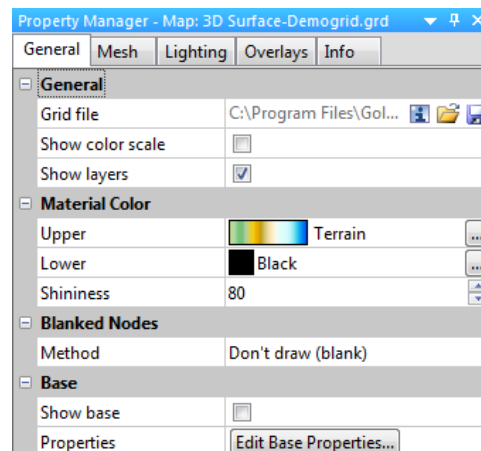
The **Grid | Residuals** menu can be used to calculate the difference between the actual data and the trend surface in the form of XYZ data points. A post map or classed post map with data point labels overlain with a contour map displays the relationship between the two.

## VIII. 3D Surface Views

### The 3D surface map

Besides the usual contour maps, you can use a grid file to create a 3D surface map. The **Map | New | 3D Surface** menu command prompts for a grid file, then displays the surface map. You can click on *3D Surface* in the **Object Manager** and change the properties of the surface map in the **Property Manager**.

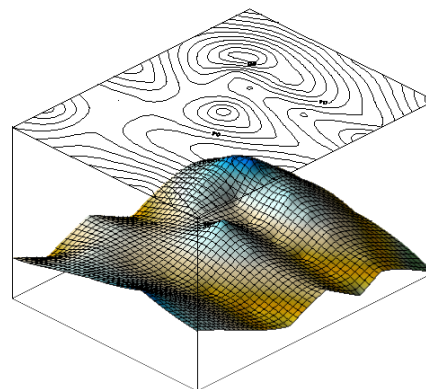
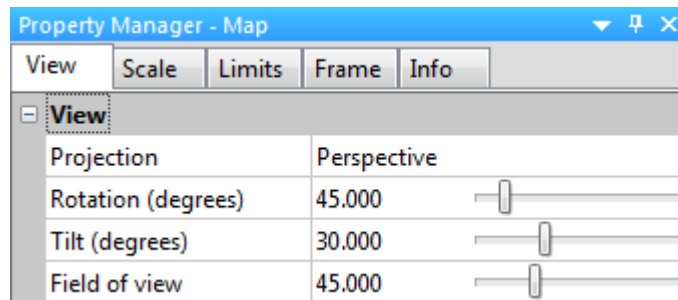
You can click on the button the right of *Upper* to select the color spectrum that fills the surface map from the drop down menu. You can also investigate the other tabs in the **Property Manager** to show a mesh on top of the surface, change the lighting, or the overlay properties (if other maps are overlaid on the surface map). If you want to create a 3D contour map with labels or fills, select the surface map and use **Map | Add | Contour Layer** to add a contour map layer on the 3D surface map.



### Stacking maps

The **Map | Stack Maps** command is used to horizontally align the selected maps according to their XY coordinates. To stack a contour map and a surface map:

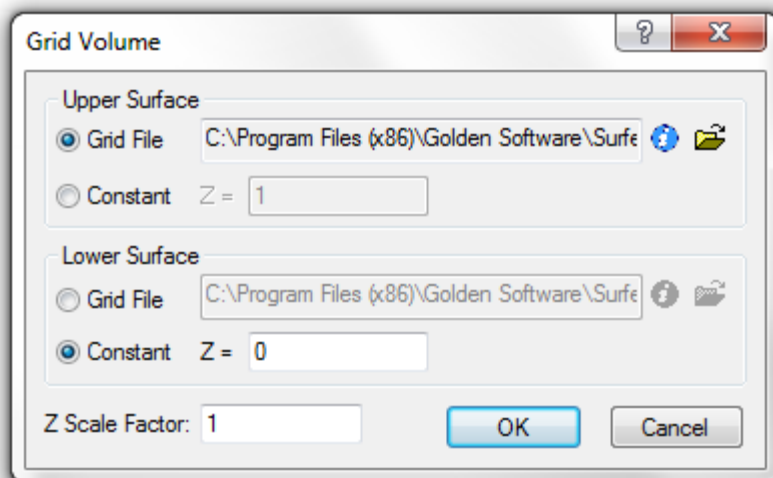
1. Create the surface map by clicking **Map | New | 3D Surface**.
2. Click on *Map* in the **Object Manager** to open the map properties in the **Property Manager**. On the **View** tab, note the *Tilt* and *Rotation* values. By default, the tilt is 30° and the rotation is 45°. For stacked maps, the *Projection* should be set to *Orthographic*.
3. Next, create the contour map by going to **Map | New | Contour Map**.
4. Click on the *Map* for the contours layer. On the **View** tab in the **Property Manager**, set the exact same *Projection*, *Rotation*, and *Tilt* values as the surface map.
5. Drag the contour map above the surface map to the approximate vertical distance you would like the map to be.
6. Select both maps, and click **Map | Stack Maps** to align the maps horizontally.
7. To draw vertical lines at the corners, use the **Draw | Polyline** menu or tool, and hold the *Ctrl* key down while drawing. This limits the line angle to 45° increments, making it easier to draw the vertical lines.



## IX. Volumetric Calculation

### Volume from a grid

For these calculations to work properly, the XYZ units must be alike. After choosing the **Grid | Volume** menu, specify the upper grid file name and click *Open*. The **Grid Volume** dialog box will be displayed. Enter the desired Z value for the lower surface, or click on the *Grid File* selection, then *Browse* to specify a lower grid file name. When you click *OK*, and Surfer generates a report with information about the grid files, and the volume and area calculation results.



The volume is calculated by three different methods including the Cut and Fill calculations. The results from all three methods are shown to give you an idea of the accuracy of the calculations. The *Cut & Fill Volumes* section represent the areas where one surface is above another. The *Positive Volume [Cut]* is the volume of the area where the *Upper surface* (as specified above) is above the *Lower surface*. The *Negative Volume [Fill]* is where the *Lower surface* is above the *Upper surface*. The volume for any blanked regions is not calculated.

The *Planar Areas* represent the horizontal areas where one surface is above another. *Positive Planar Area [Cut]* is the planar area of the locations where the *Upper surface* is above the *Lower surface*. *Negative Planar Area [Fill]* is the planar area where the *Lower surface* is above the *Upper surface*. The area of any blanked regions is also displayed.

The surface area represents the area of the inclined surface, and can be thought of as the size of a piece of plastic that would be needed to drape over the surface. This will typically be larger than the planar area.

### Calculating total volume

For the best results, follow these tips:

- Verify the units of X, Y, and Z, and make sure that all units are alike.
- The accuracy of the volume and area calculations is heavily dependent on the size of the grid cell, so more grid lines or smaller grid cells usually increases the resolution and accuracy.
- Create a contour map or other map of the grids that are used. If the contour map doesn't look right, the volume calculations probably won't be right.

### Gas calculations

Once the final volume is calculated, you can multiply by the porosity to estimate reserves. See the next topic for discussion of blanking if you would like to limit the XY extent of the volume calculation.

Volumes	
Z Scale Factor:	1
Total Volumes by:	
Trapezoidal Rule:	4399.100830503
Simpson's Rule:	4399.732078943
Simpson's 3/8 Rule:	4399.661131782
Cut & Fill Volumes	
Positive Volume [Cut]:	4398.9860093755
Negative Volume [Fill]:	0
Net Volume [Cut-Fill]:	4398.9860093755

Areas	
Planar Areas	
Positive Planar Area [Cut]:	63
Negative Planar Area [Fill]:	0
Blanked Planar Area:	0
Total Planar Area:	63
Surface Areas	
Positive Surface Area [Cut]:	968.90327765942
Negative Surface Area [Fill]:	0

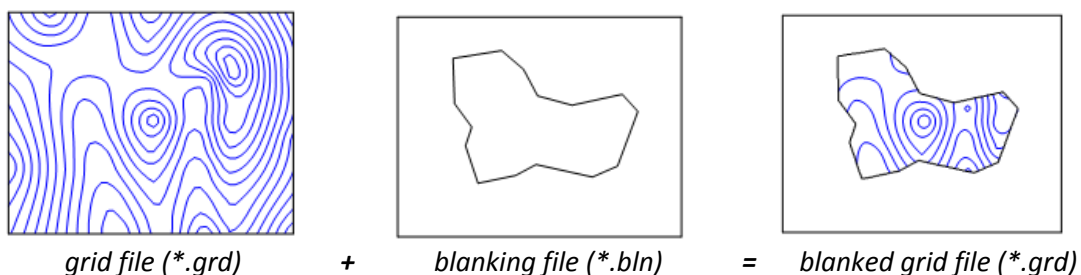


## X. Blanking a Grid

There are several ways to blank a portion of a grid:

1. Use a gridding method that blanks outside the data limits automatically (e.g. *Triangulation with Linear Interpolation* or *Natural Neighbor*).
2. In the **Grid Data** dialog, check the check box to blank the grid outside the convex hull of the data.
3. Reduce the search radii when gridding. The default search radii are set to half the length of a diagonal line drawn through the map. By reducing the search radii values, the grid will blank out when it gets too far away from the data points. If you set the search radii to a very small value, you may blank the entire map. Create a post or classed post map to get an idea of the optimal search radii values.
4. Overlay a boundary file as a base map and specify an opaque fill for the areas inside the polygon(s).
5. Create a blanking file in the BLN format, and blank areas inside or outside the closed polygon(s) in the BLN file with the **Grid | Blank** command. The first step is to create a BLN file of the boundary line.
  - a. If you already have the XY coordinates of the boundary line, you can enter them into the Surfer worksheet. Make sure the first and last set of coordinates are exactly the same to create the closed polygon. Insert a new row at the top. In cell A1 enter in the number of coordinate pairs that follow it. In cell B1, enter a “1” if you want to blank inside the boundary or a “0” if you want to blank outside the boundary.
  - b. If you do not have the XY coordinates of the boundary, you can load a map into Surfer, right-click, and click *Digitize*. Digitize the boundary consecutively (either clockwise or counterclockwise), copy the first set of coordinates and paste it to the bottom of the list, and save the file to a BLN file. Open the BLN file in the Surfer worksheet and confirm that cell B1 has the appropriate number (a “1” if you want to blank inside the boundary or a “0” if you want to blank outside the boundary).
  - c. For more information about creating BLN files, please see this Knowledge Base article: [http://www.goldensoftware.com/index.php?option=com\\_fss&view=kb&prodid=2&kbartid=1095&Itemid=182](http://www.goldensoftware.com/index.php?option=com_fss&view=kb&prodid=2&kbartid=1095&Itemid=182)
  - d. To blank outside multiple polygons, please see this Knowledge Base article: [http://www.goldensoftware.com/index.php?option=com\\_fss&view=kb&prodid=2&kbartid=999&Itemid=182](http://www.goldensoftware.com/index.php?option=com_fss&view=kb&prodid=2&kbartid=999&Itemid=182)

After the BLN file is created, you may want to click **Map | New | Base Map** and load the BLN file as a base map to confirm that the BLN file is in the correct format and in the shape you want. Once you have a BLN file, you can click **Grid | Blank**, specify the grid file you want to blank and click *Open*, specify the BLN file that defines the blanking boundary and click *Open*, specify a file name to save the new blanked grid file as and click *Save*. You can then use this blanked grid file to create maps and perform volume and area calculations.



If the blanking boundary in the blanked grid file is very jagged, this is caused by not enough grid lines in the original grid file. Click **Grid | Data** and regrid the data using more grid lines, then click **Grid | Blank** and blank the new grid file.

## XI. How to Get Help

What do you do when you have a question or want more information?

1. Consult the easy-to-read Quick Start Guide:  
<http://downloads.goldensoftware.com/guides/Surfer12Guide.pdf>
2. View the Surfer FAQs: <http://www.goldensoftware.com/products/surfer#faqs>
3. Browse our Knowledge Base for answers to more technical questions:  
[http://www.goldensoftware.com/index.php?option=com\\_fss&view=kb&prodid=&Itemid=182](http://www.goldensoftware.com/index.php?option=com_fss&view=kb&prodid=&Itemid=182)
4. Post questions and browse answers on the free public Surfer Support forum:  
<http://www.goldensoftware.com/forum/viewforum.php?f=1&sid=dee18d5403304fd37baff849fc015611>
5. Look through some of the past newsletters for helpful articles:  
<http://www.goldensoftware.com/newsletter.shtml>
6. Contact Technical Support by:  
Tel: 303-279-1021  
Fax: 303-279-0909  
Email: [surfersupport@goldensoftware.com](mailto:surfersupport@goldensoftware.com)

## XII. Golden Software Contact and Sales

Surfer is available from Golden Software for US\$849 plus shipping. Upgrades from any previous registered versions are only US\$279 plus shipping. If you place your order direct from Golden Software, we offer a 30-day money back guarantee. If you are not satisfied with Surfer for any reason, simply return it within 30 days for a full refund! You can also download Surfer and the Quick Start Guide (PDF format) from our website and save on the shipping charges – perfect for international customers! Full User's Guides are also available for purchase in PDF format only.

Golden Software, Inc.  
809 14<sup>th</sup> Street  
Golden, CO 80401  
U.S.A.  
Tel: 303-279-1021 or 800-972-1021  
Fax: 303-279-0909  
Email: [info@goldensoftware.com](mailto:info@goldensoftware.com)

Golden Software web page: <http://www.goldensoftware.com/>  
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