Al-Karkh University for Sciences
College of Remote Sensing and Geophysics
Geophysics Department

Introduction to Course Sallybas:

Lecture ONE

by

Dr. Rami M. Idan

Introduction to Course Sallybas:

Reliable geological models are the foundation stones upon which optimal field development is built for exploration and/or production.

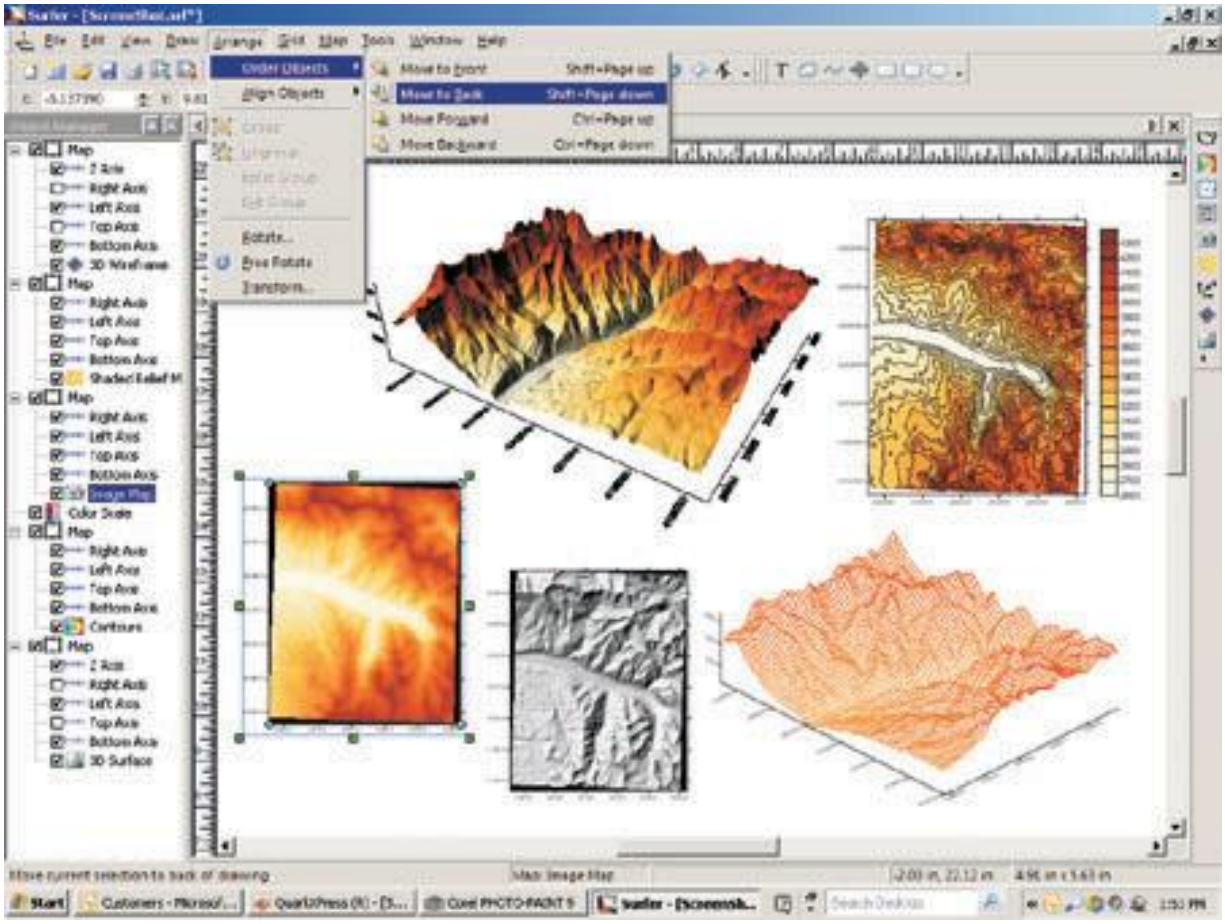
Programming of geology solutions provide you tools for achieving maximum performance from your data, regardless of geology, location or complexity.

The software helps you accelerate the field study by allowing multiple disciplines to work together on a common reservoir model in parallel, resulting in better decisions through a shared understanding of the studied problems.

Surfer

Is a full-function 3D visualization, contouring and surface modeling package that runs under Microsoft Windows. Surfer is used extensively for terrain modeling, bathymetric modeling, landscape visualization, surface analysis, contour mapping, watershed and 3D surface mapping, gridding, volumetric, and much more.
Surfer's sophisticated interpolation engine transforms your XYZ data into publication-quality maps. Surfer provides more gridding methods and more control over gridding parameters, including customized variograms (A variogram is a description of the spatial continuity of the data.), than any other software package on the market. You can also use grid files obtained from other sources, such as USGS DEM files or ESRI grid files. Display your grid as outstanding contour, 3D surface, 3D wireframe, watershed, vector, image, shaded relief, and post maps. Add base maps and combine map types to create the most informative display possible. Virtually all aspects of your maps can be customized to produce exactly the presentation you want. Generating publication quality maps has never been quicker or easier.

Surfer is a contouring and 3D surface mapping program that runs under Microsoft Windows. It quickly and easily converts your data into outstanding contour, surface, wireframe, vector, image, shaded relief, and post maps. Virtually all aspects of your maps can be customized to produce exactly the presentation you want. Producing publication quality maps has never been quicker or easier.



Surfer easily creates a multitude of map types to visualize your data.
Top row left to right: surface map, contour map
Bottom row: shaded relief map, image map, wireframe map

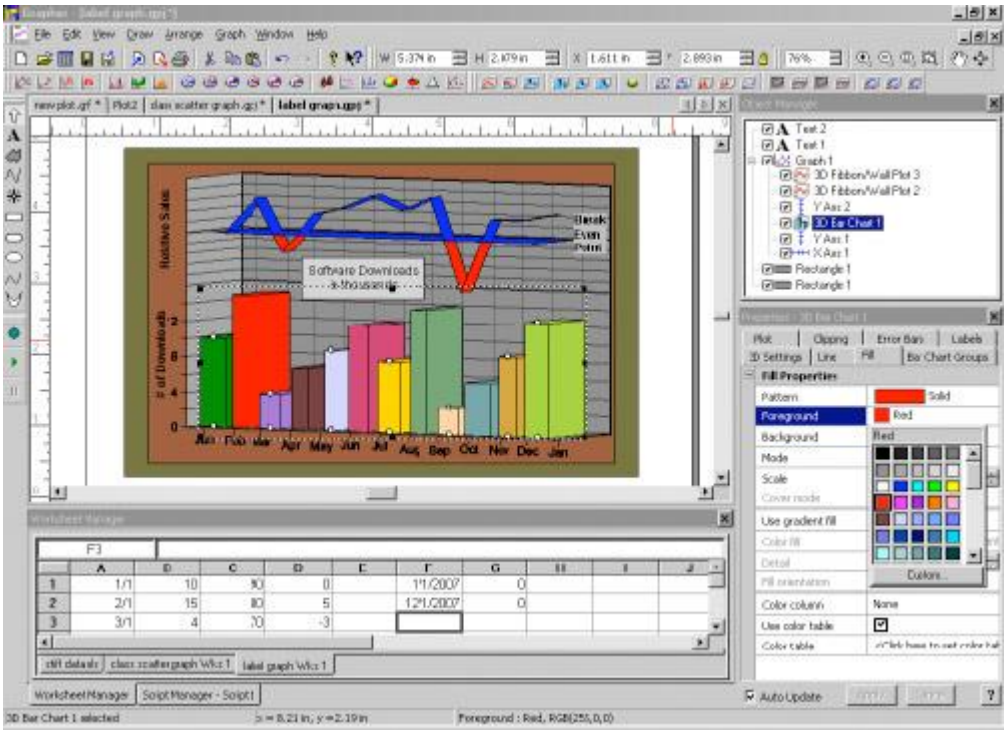
Main Features

Contour Maps	Map Layers
3D Surface Maps	Superior Gridding
3D Wireframe Maps	Variograms
Vector Maps	Faults and Breaklines
Image Maps	Using USGS and STRM Data
Shaded Relief Maps	Active X Automation
Post Maps	Worksheet
Base Maps	Object Manager

Grapher

Is an easy to understand technical graphing package for anyone who needs to create publication-quality graphs quickly and easily. With Grapher, creating graphs is quick and easy.

Create one of more than 40 unique 2D or 3D graph types in Grapher. Customize any portion of any graph to make the graph completely unique to your situation! There are four different types of 2D graphs that can be created in Grapher: linear, bar, polar, and specialty graph types. In addition, many of these graph types are available with a 3D aspect. If you need an extra variable plotted on your graph, try one of the 3D XYZ graphs, the contour maps, or surface maps!



Create any graph you want in Grapher 8! Edit it quickly and easily with the always-available Property Inspector.

Didger

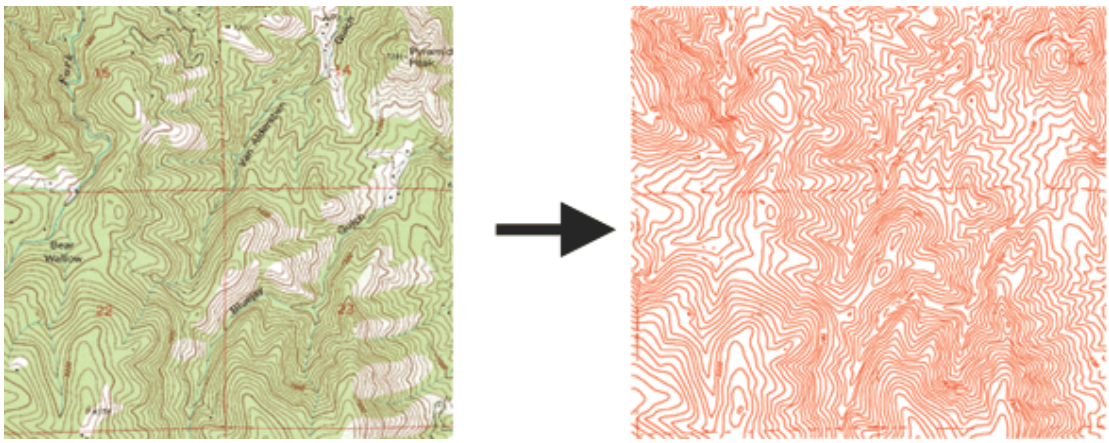
There has never been a more comprehensive, powerful, all-in-one software solution that provides an easy-to-use and intuitive user interface for digitizing, geographic referencing, reprojection, tiling, and mosaicking. Didger solves the problem of combining data files in different coordinate systems, by providing extensive tools to transform

the data into one cohesive coordinate system. You can use Didger to precisely convert paper maps, graphs, aerial photographs, or any other plotted information into a versatile digital format that you can use with other software. Didger can create new maps from the ground up or edit any map, drawing, image, or data set imported into it.

Uses for Didger

Start processing your data quickly and accurately with Didger. Some applications for Didger include:

- digitizing points, polylines, and polygons, such as oil and gas wells, monitoring wells, wireline logs, graphs, contour lines, aerial photographs, satellite images, seismic lines, roads, property boundaries, buildings, sample locations, faults, rock formations, vegetation boundaries, and animal habitats
- calculating areas of polygons, such as watershed or lake areas
- calculating lengths of polylines, such as shorelines, roads, streams, or migratory routes
- georeferencing and/or mosaicking aerial photos or scanned images
- converting the projection of scanned images, vector files, data files, or Surfer GRD or DEM files
- overlaying vector, data, and image files to create a complete map
- and much more!



Abbreviations

ASCII	*American Standard Code for Information Interchange*
LAS	*Log ASCII Standard*
DEM files	*Digital Elevation Models*
ESRI grid files	*Is a raster GIS file format developed by Esri.*

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Introduction to Surfer

Lecture TWO

by
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Introduction to Surfer

Surfer: is a grid-based graphics program. Surfer interpolates irregularly spaced XYZ data into a regularly spaced grid. Grids may also be imported from other sources, such as the United States Geological Survey (USGS). The grid is then used to produce different types of maps including contour, vector, wireframe, image, shaded relief, and surface maps. Many gridding and mapping options are available allowing you to produce the map that best represents your data.

Maps can be displayed and enhanced in **Surfer** by the addition of boundary information, posting data points, combining several maps, adding drawings, and annotating with text.

An extensive suite of gridding methods is available in **Surfer.** The variety of available methods provides different interpretations of your data, and allows you to choose the most appropriate method for your needs. In addition, data metrics allow you to-gather information about your gridded data.

The grid files themselves can be edited, combined, filtered, sliced, queried, and mathematically transformed. For example, a color-filled contour map can be drawn from a grid of groundwater surface elevations. This grid can then be numerically differentiated, and a gradient-based vector map subsequently generated. Vector map can then be drawn as an overlay on the contour map. The resulting graphic shows not only the contours, but also the flow paths.

Surface area, projected planar area, and volumetric calculations can be performed quickly in **Surfer.** Cross-sectional profiles can also be computed and exported.

The **Scripter™** Program, included with **Surfer,** is useful in creating, editing, and running script files that automate **Surfer** procedures. By writing and running script files, simple mundane tasks or complex system integration tasks can be performed precisely and repetitively without direct interaction. **Surfer** also supports ActiveX Automation using any compatible client, such as Visual BASIC. These two automation capabilities allow **Surfer** to be used as data visualization and a map generation post-processor for any scientific modeling system.

User Interface Features

- Bitmaps, image maps, and shaded relief maps can be rotated and transformed.
- Property dialogs are modeless. This means you can open a property dialog and continue working with Surfer. The property dialog updates when the selection changes.
- Can rotate, tilt, and change the field of view with the Map-Trackball command.
- Edit - Paste and Edit - Paste Special automatically pastes the object in the center of the page.
- The View - Pan Realtime allows you to easily move the contents of the plot window.
- The Zoom Realtime tool allows you to zoom in and out by dragging the mouse.
- Map scale, view, limits, and background have been moved to the map property dialog for easier access.
- Bitmaps are now compressed in [SRF] files, resulting in smaller files and faster saving and loading times.
- Create maps quickly by selecting the map tool. The default map properties are used and these properties can be edited by opening the new property dialog.
- Use the Help - Feedback Command to send a problem report, suggestion, or information request by e-mail.
- Multithreading allows for a smoother redraw and more responsive user interface.
- The arrow keys can now be used to "nudge" the selected objects one pixel at a time for precise positioning.

Surfaces

- 30 rendered surfaces have been added to Surfer.
- All planar map types and other surfaces can be overlaid on surfaces.
- Bitmaps can be overlaid on surfaces.
- Control the color, lighting, mesh, base, and overlay color blending of surface.
- Added many new color spectrum files.

Gridding

- Filter grids using over 60 pre-defined filters or define your own filter.
- Load large data files faster when gridding (there is no pre-sorting or pre-duplicate checking). Use *Data Metrics* to gather information about the data and create a grid of this information.
- The Grid - Mosaic command combines multiple adjacent or overlapping grids.
- Use the new *Cross Validate* option to assess the quality of the selected gridding method.
- A map of the Delaunay triangulation can be created when gridding with the Triangulation with Linear Interpolation or Natural Neighbor methods.
- Added Moving Average and Local Polynomial gridding methods.
- Faults are retained in grids after blanking.
- Added Cubic and Pentaspherical variogram models.

Volume

Adding a Z scale factor to volume calculations allows you to set a scaling factor when your XY units are not the same as the Z units.

Calculating Volumes and Areas

Use the **Grid | Volume** command to calculate net volumes, cut and fill volumes, planar areas, and surface areas.

1. Click the **Grid | Volume** command.
2. In the **Open Grid** dialog, specify the name of the grid file to use in the volume and area calculations. This can be the grid file for either the upper or the lower surface.
3. Click OK and the **Grid Volume** dialog is displayed. The specified grid file is shown for both the upper and lower surface.
4. Specify the Upper Surface and Lower Surface parameters.

- The (grid info) button displays information about the grid file used in the volume calculations. The information includes the grid size, the minimum and maximum XYZ values contained in the grid file, and statistics. If the grid file is large, click OK in the message box that appears to create a detailed grid report or click the Cancel button to create a shorter, less detailed grid report.
- The Grid File option is used to specify a grid to use as the upper or lower surface. To use the grid file for the surface, click the Grid File option. To change the grid file for either the upper or lower surface, click the Grid File option and click the (open) button to select another grid file.

- The Constant option is used to specify the level of the planar surface to use as the upper or lower surface. Specify the level of the planar surface by entering the value into the Z = box. The specified value is in Z data units.

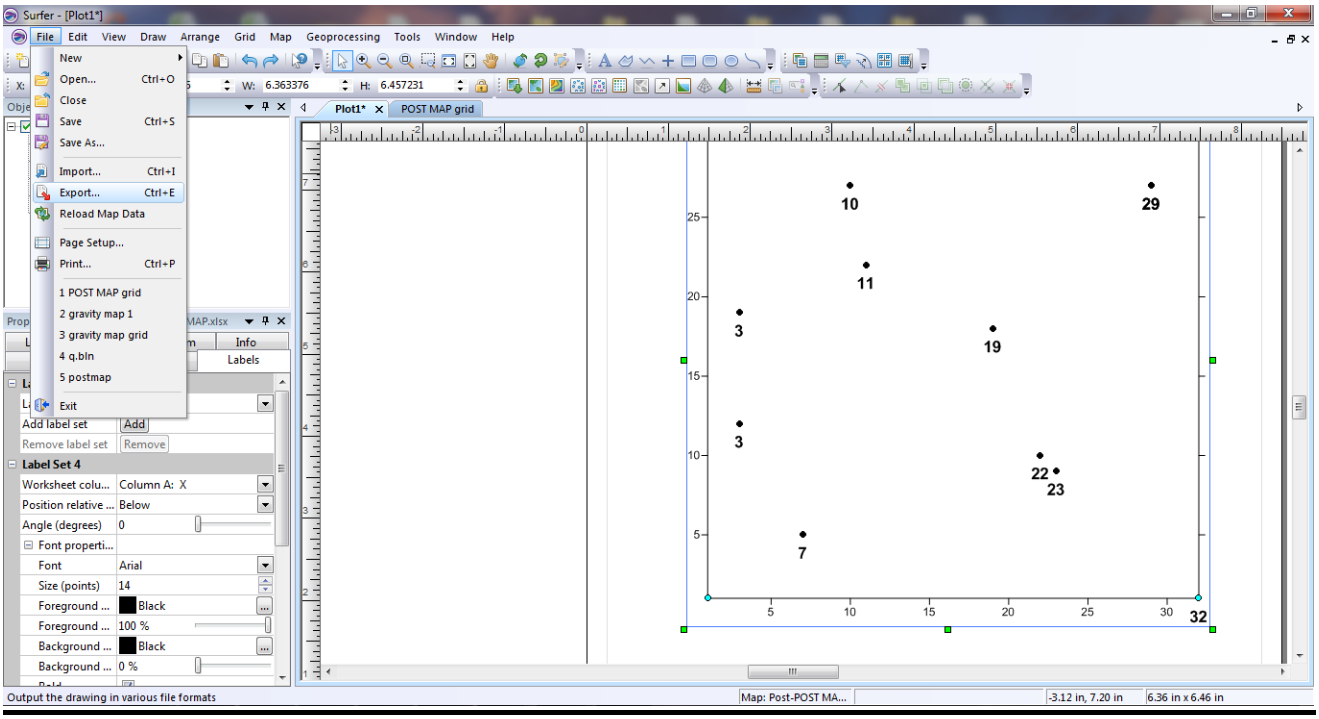
5. If the X, Y, and Z units are different, the resulting volume calculations are meaningless. If, for example, your XY values are in meters but your Z values are in feet, the volume results are square meters times feet, rather than cubic units. Z Scale Factor can be used to adjust for this problem. In this example, setting the Z Scale Factor to 0.3048 (number of meters in a foot) results in cubic meters for volume calculations. You will need to know the conversion factor to use this field.
6. Click OK in the **Grid Volume** dialog and the results are displayed in a report.
7. Click **File | Save As** to save the report, or you can copy the information to the clipboard and paste it into another application.

Digital Elevation Models

- Surfer provides native support for the newest SDTS format.
- Digital Terrain Elevation Data (DTED) files can be used where grids are needed in the program.

Import / Export

- A new set of import filters include Enhanced Metafile, Golden Software Interchange, and ESRI ArcInfo Export Format.
- A new set of export filters include Enhanced Metafile, Maplnfo Interchange Format, Golden Software Interchange, and Golden Software Boundary.



Post Map using Export as (PNG file).

Page Setup

- The 32-inch page limit has been eliminated under all operating systems.
- The resolution of graphics operations has been increased by 1000 times, resulting in more accurate output when zoomed in, and when the graphics are exported.

Worksheet

Up to one billion rows and columns are available in the worksheet.

Screen Layout and Window Types

Surfer contains three document window types, the plot window, worksheet window, and grid node editor window. Maps are displayed and created in the plot window. The worksheet window is used to display, edit, transform, and save data in a tabular format. The grid node editor window is used to display and edit Z value for the selected grid.

Object Manager

When Surfer starts, the Object Manager is visible in the plot window by default. It contains a hierarchical list of the objects in the Surfer plot window. The Object Manager is initially docked at the side of the window, giving the window a split appearance; however, it can be dragged and placed anywhere on the screen.

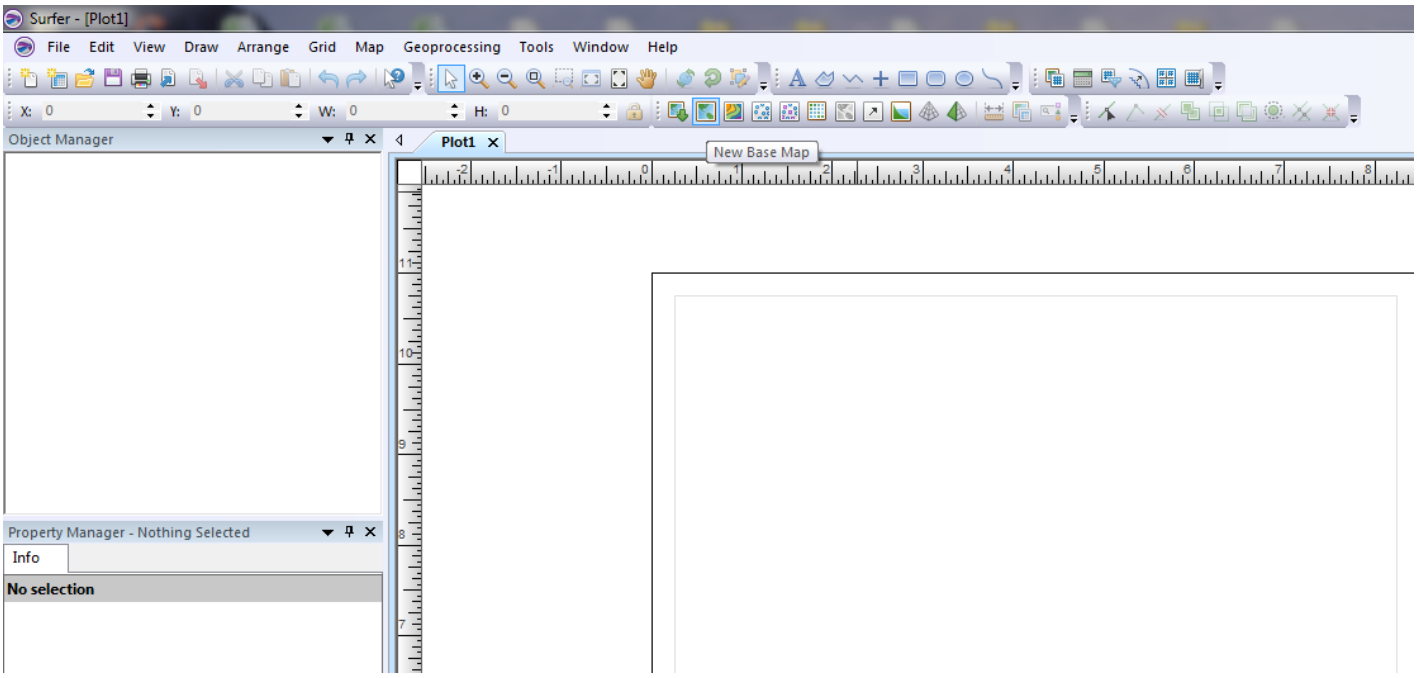
Toolbars

All window types in Surfer include toolbars that contain buttons for many common commands. The toolbars are initially docked, but they also can be dragged and placed anywhere on the screen.

Using Surfer

The general steps to progress from a XYZ data set to a finished, grid-based map are as follows:

1. Create a XYZ data file. This file can be created in a Surfer worksheet window or outside of Surfer (using an ASCII text editor, for example).
2. Create a grid file [GRD) from the XYZ data file using the Grid / Data command.
3. To create a map, select the map type from the Map menu and use the grid file from step two. Grid-based maps include contour, image, shaded relief, vector, wireframe, and surface maps.
4. Use File / Save to save the map as a Surfer file [SRF] that contains all of the information needed to recreate the map, including the data file.



This is the Surfer window with the Object Manager is on the left, the plot window in the center, and the worksheet window is on the right.

File Types

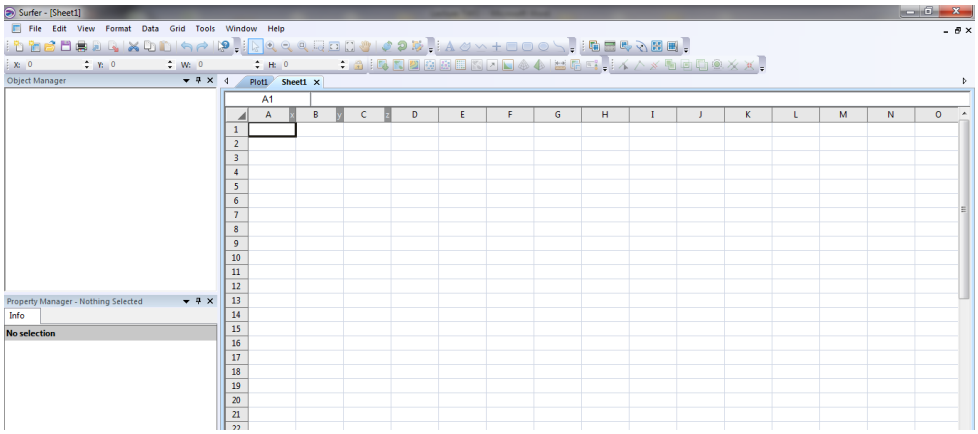
Surfer uses four basic file types: data file, grid file, boundary file, and Surfer files [SRF].

Data Files

Data files contain the input data provided by the user, and are used to produce grid files, post data points on a map, or generate a residuals log. These files are generally referred to as "XYZ data files" or "data files" throughout the documentation. Data can be read from various file types, and must contain numeric XY location coordinates as well as numeric Z values. The Z values contain the variable to be modeled, such as elevation, concentration, rainfall, or similar types of values.

The **Surfer** worksheet can also be used to create a new data file. To open a worksheet window and begin entering data:

1. Click the File | New | Worksheet command, or press CTRL+W on the keyboard. A new empty worksheet window is displayed.

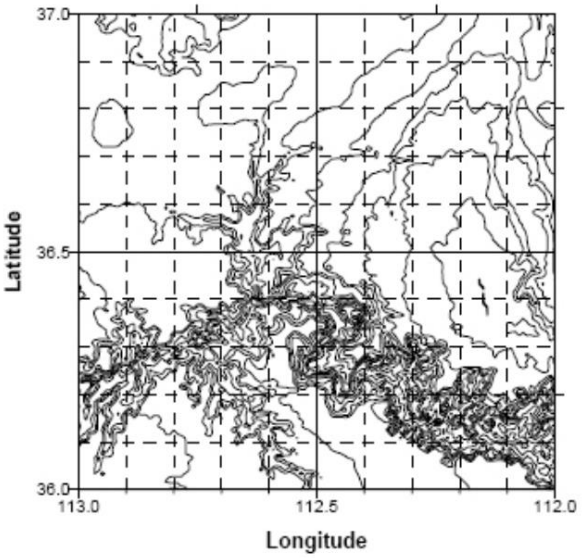


Data are entered into the active cell of the worksheet. Click on the text "A1" or "Active Cell" for the definition of the active cell, active cell location, and the active cell edit box.

2. Data is entered into the active cell. The active cell is selected by clicking on the cell or by using the arrow keys to move between cells. The active cell is indicated by a heavy border and the contents of the active cell are displayed in the active cell edit box. The active cell location box shows the location of the active cell in the worksheet. Letters are the column labels and numbers are the row labels.
3. When a cell is active, enter a value or text, and the information is displayed in both the active cell and the active cell edit box.
4. The BACKSPACE and DELETE keys can be used to edit data as you type.
5. To preserve the typed data in the active cell, move to a new cell. Move to a new cell by clicking a new cell with the pointer, pressing one of the arrow keys, or pressing ENTER. Press the ESC key to cancel without entering the data.

Grid Files

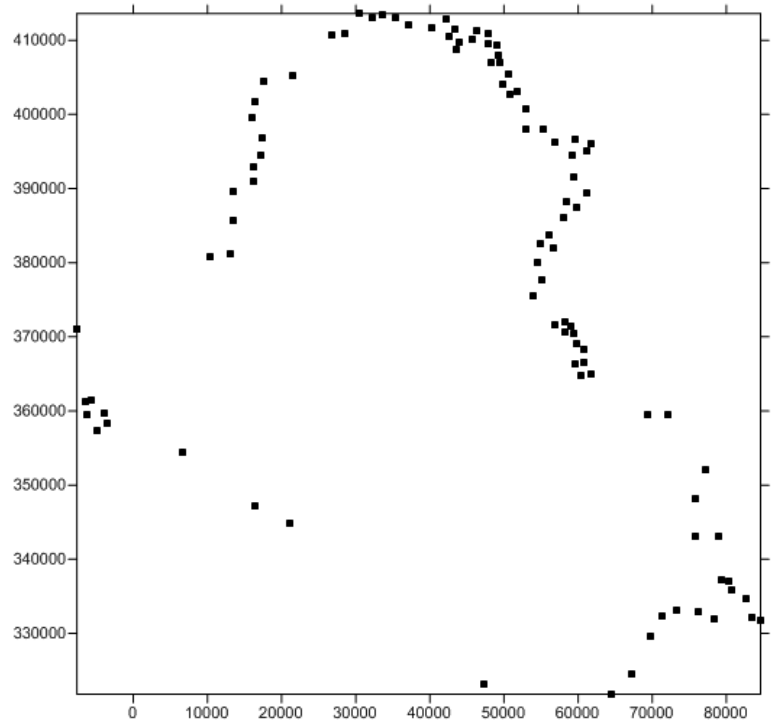
Grid files are used to produce several different types of grid-based maps, to perform calculations such as volume, residuals, and grid math, and to carry out blanking, smoothing, and slice operations. Grid files contain regularly spaced rectangular array of Z data organized in columns and rows. Surfer can also use USGS digital elevation models and DTED files to perform most of the operations that can be performed with grid files.



Grid lines originate from the tick marks. Different line properties can be used for the major and minor grid lines. In this example, major grid lines are solid and minor grid lines are dotted.

Boundary Files

Boundary files contain XY areal data such as state boundaries, rivers, or point locations. Boundary files are used to overlay a base map on another map, or to specify the boundary limits for blanking, faults, break lines, and slice calculations. Boundary files can be vector files, metafiles, or bitmap files.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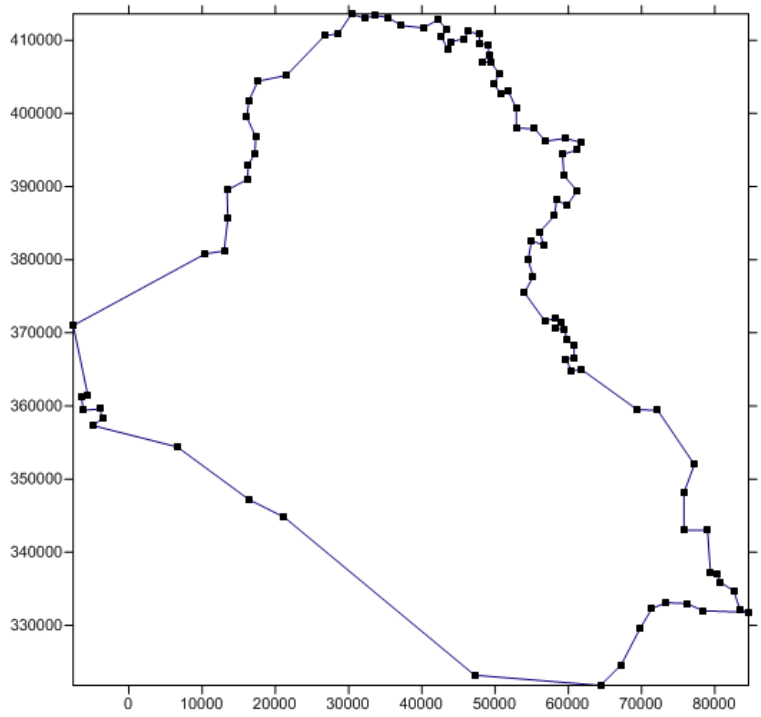
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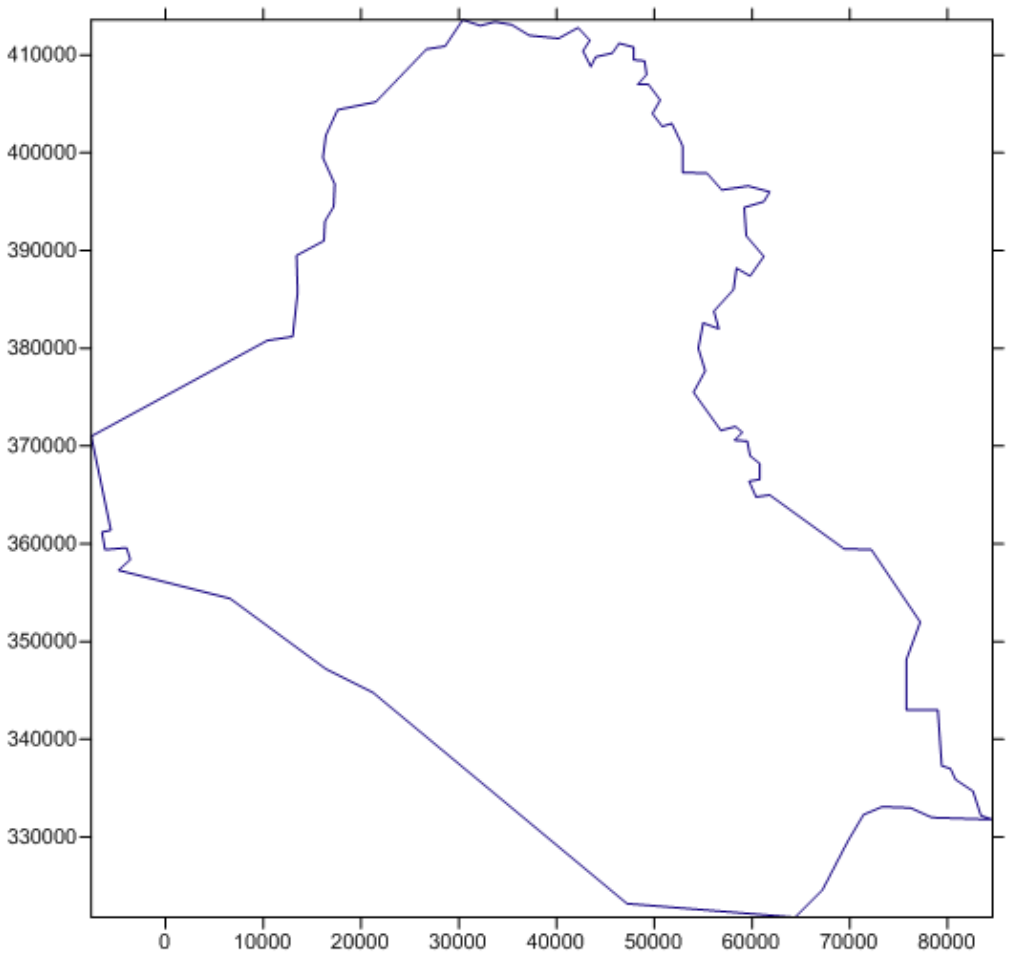

Surfer Files

Surfer files [SRF] preserve all the objects and object settings contained in a plot window. These files are called Surfer files [SRF] throughout the documentation.

References:

- Surfer® 13 Quick Start Guide.
- Surfer® User's Guide.
- https://support.goldensoftware.com/hc/enus/articles/231472848-What-Surfer-training-videos-are-available-and-where can-I-find-them-

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Map Types in Surfer

Lecture THREE

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Gridding

Gridding is the process of taking irregularly spaced XYZ data and generating a regularly spaced grid of Z values at each grid node by interpolating or extrapolating the data values. In addition to gridding data, **Surfer** can also use a variety of other grid files directly. For a list of these, refer to the online help. A grid is a rectangular region comprised of evenly spaced rows and columns. The intersection of a row and column is called a grid node. Rows contain grid nodes with the same Y coordinate. Columns contain grid nodes with the same X coordinate. Contour, image, shaded relief, vector, view-shed, watershed, 3D surface, and 3D wireframe map layers all require grids in **Surfer**.

Grid Menu Commands

There are many ways to manipulate grid files in **Surfer**. The **Grid** menu contains commands used to blank, convert, create, extract, filter, mosaic, slice, smooth, and transform grid files. In addition, volume calculations, variogram generation, calculus operations, cross section creation, and residual calculations can be performed using the commands under the **Grid** menu.

Creating a Grid File

Click the **Grid | Data** command to grid data in **Surfer**. With this command, you can specify the parameters for the particular gridding method and the extents of the grid. The gridding methods define the way in which the XYZ data are interpolated when producing a grid file.

Gridding Methods

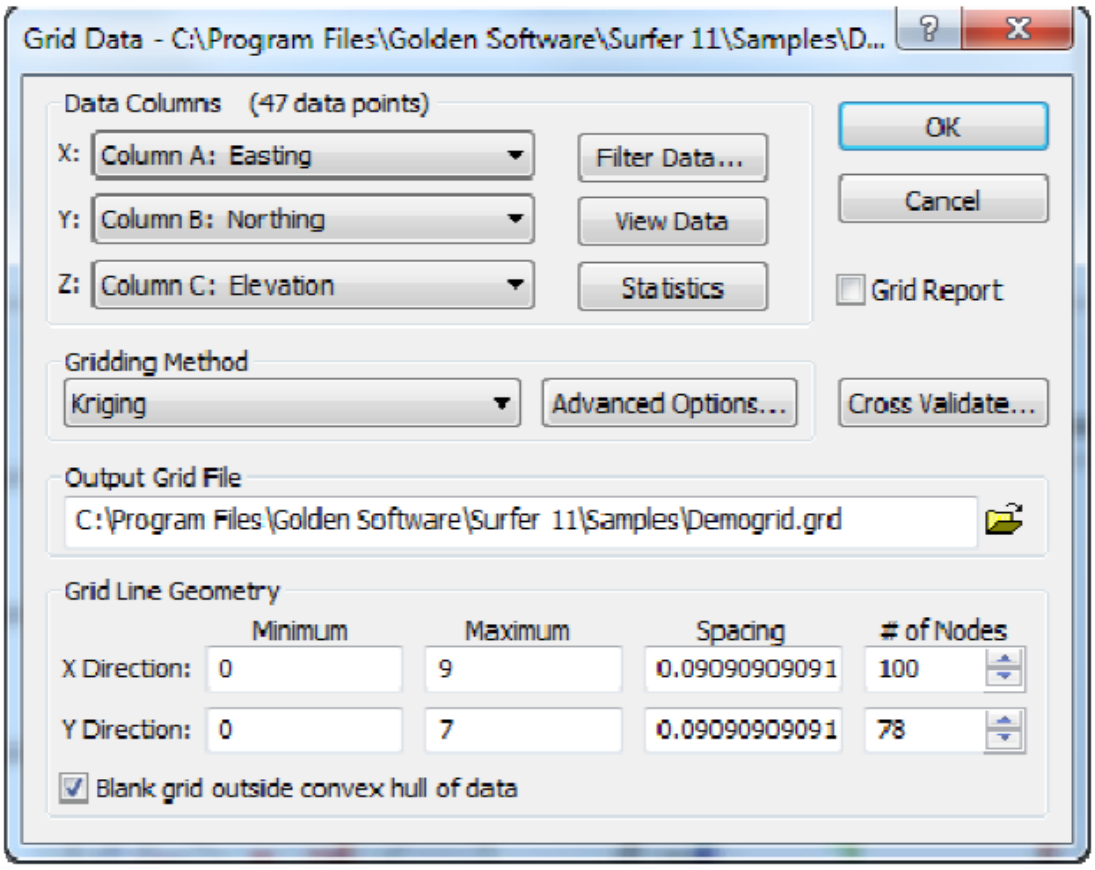
Gridding the data produces a regularly spaced, rectangular array of Z values from irregularly spaced XYZ data. The term *irregularly spaced* means that the points follow no particular pattern over the extent of the map, so there are many holes where data are missing. Gridding fills in these holes by extrapolating or interpolating Z values at those locations where no data exists. The gridding method determines the mathematical algorithms used to compute the Z value at each grid node. Each method results in a different representation of your data. It is advantageous to test each method with a typical data set to determine the gridding method that provides you with the most satisfying interpretation of your data.

Grid Line Geometry

The grid line geometry defines the grid limits and grid density. Grid limits are the *Minimum* and *Maximum* X and Y coordinates for the grid. Grid density is defined by the *# of Nodes* in the X and Y direction of the grid. The grid limits and the number of lines define the *Spacing*, the distance in data units between adjacent grid nodes. The intersection of the X line with the Y line is referred to as a grid node.

Surfer automatically computes reasonable values based on the minimum and maximum X and Y values of the XYZ data file. The number of nodes

is determined by the direction that covers the greater extent. By default, the larger distance is assigned 100 grid nodes. The number of grid nodes in the other direction is computed so that the grid line *Spacing* in the two directions are approximately the same. Any of the items in the *Grid Line Geometry* section can be altered.



Set the Grid Line Geometry values to control the grid extents and grid density by entering the appropriate values. This grid will have different spacing in the X and Y directions.

Convex Hull

If the grid should not extrapolate areas outside the data, check the *Blank grid outside convex hull of data* option. Leave the box unchecked to extrapolate the data to the minimum and maximum grid extents.

The *Inflate convex hull by* option expands or contracts the convex hull. When set to zero, the boundary connects the outside data points exactly. When set to a positive value, the area blanked is moved outside the convex hull boundary by the number of map units specified. When set to a negative value, the area blanked is moved inside the convex hull boundary by the number of map units specified. Values are in horizontal (X) map units. When the value is set to a large positive value, the contours will extend all the way to the minimum and maximum X and Y

limits of the grid. When the value is set to a large negative value, the entire grid will be blanked, resulting in no grid file being created.

Grid Z Limits

Some gridding methods result in values smaller than the data minimum or larger than the data maximum. For example, negative values cannot exist for many physical properties, such as concentration, but a grid created with the Kriging gridding method may include negative Z values. If the grid Z values should be limited to a minimum value, such as 0 or the data minimum, click the current selection next to *Minimum* and select *Data min* or *Custom*. Click the current selection next to *Maximum* and select *Data max* or *Custom* to limit the grid Z values to a maximum value. Any interpolated value outside the specified range will be automatically changed to the user-defined limit.

Z Transform

The *Z Transform* option changes how the Z values are gridded. *Linear* uses the Z values in the worksheet for gridding. No transformation is applied to the Z values. The *Log, save as log* takes the log (base 10) of the Z values and uses the log value for gridding. The grid is then saved with the log (base 10) values. The *Log, save as linear* takes the log (base 10) of the Z values and uses the log value for gridding. The grid is then converted back to the linear Z values by taking the antilog of the gridded results. The grid is then saved with the linear values.

Breaklines

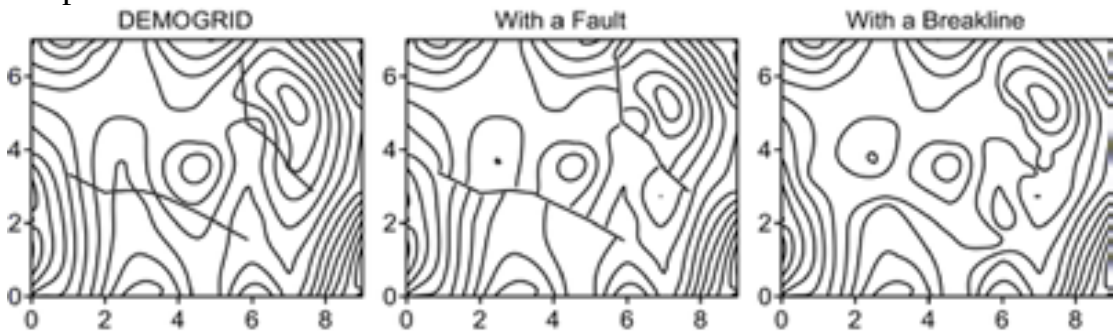
Breaklines are used when gridding to show discontinuity in the grid. A breakline is a three-dimensional .BLN boundary file that defines a line with X, Y, and Z values at each vertex. When the gridding algorithm sees a breakline, it calculates the Z value of the nearest point along the breakline, and uses that value in combination with nearby data points to calculate the grid node value.

Surfer uses linear interpolation to determine the values between breakline vertices when gridding. Breaklines are not barriers to information flow, and the gridding algorithm can cross the breakline to use a point on the other side of the breakline. If a point lies on the breakline, the value of the breakline takes precedence over the point. Breakline applications include defining streamlines, ridges, and other breaks in the slope.

Faults

Faults are used to show discontinuity when gridding, similar to breaklines. A fault is a two-dimensional boundary file in .BLN format that defines a line with X and Y values at each vertex. Faults do not contain Z values. And, unlike a breakline, faults are barriers to information flow. Data on one side of a fault is not used when calculating grid node values on the other side of the fault. If the fault line is a closed

polygon, the gridding algorithm shall grid the data on the side of the polygon where the data is located. If the fault is not a closed polygon, gridding 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.



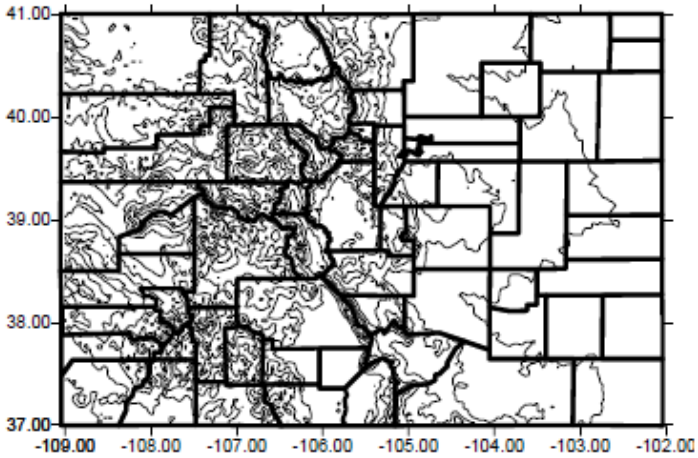
All three maps were gridded with the Minimum Curvature *gridding method. The lines on the far left image were used as a fault and breakline in the other two images. Note the contours stop at the fault line and cross the location where the breakline would be.*

Map Types

Several different map types can be created, modified, and displayed with **Surfer**. These map types include base, contour, post, classed post, image, shaded relief, vector, watershed, 3D surface, and 3D wireframe maps. A description and example of each map is listed below.

Base Map

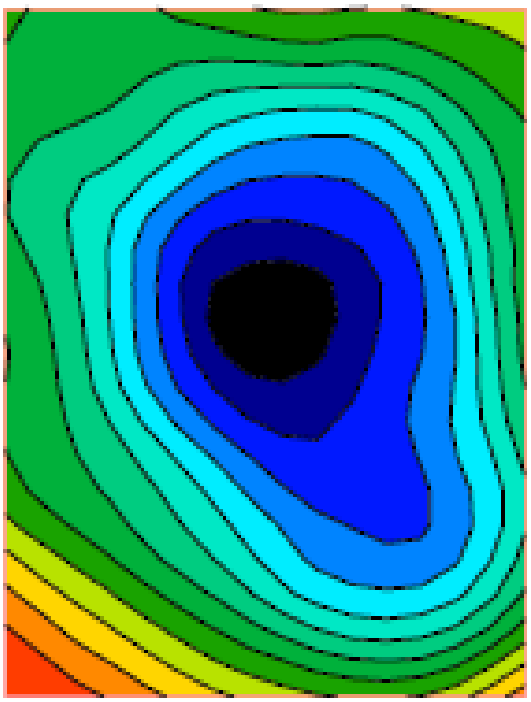
Base maps display boundaries on a map and can contain polygons, polylines, points, text, images, or metafiles. Base maps can be overlaid with other map layers to provide details such as roads, buildings, streams, city locations, areas of no data, and so on. Base maps can be produced from several file formats. Individual base map objects can be edited, moved, reshaped, or deleted. Empty base maps can be created and used for drawing objects on other maps. Base maps can be downloaded from online mapping servers.



A base map, consisting of Colorado county boundary lines, is displayed on top of a contour map of Colorado.

Contour Map

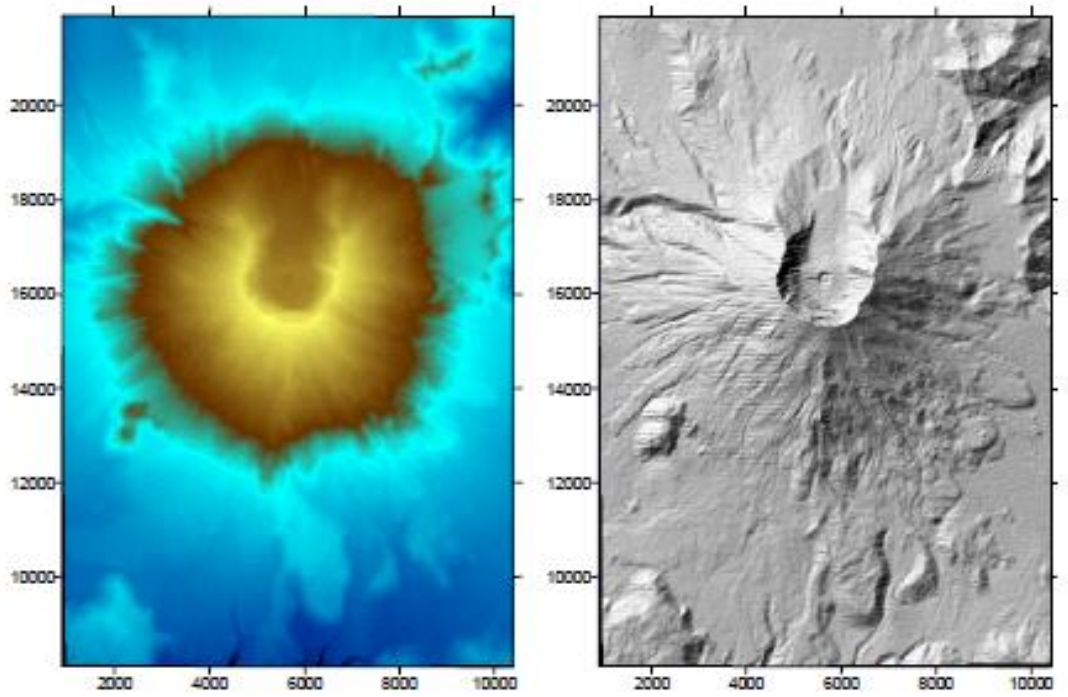
Contour maps are two-dimensional representations of threedimensional data. Contours define lines of equal Z values across the map extents. The shape of the surface is shown by the contour lines. Contour maps can display the contour lines and colors or patterns between the contour lines. Contours can be linearly or logarithmically spaced, or a custom spacing can be set between each set of lines.



This is a filled contour map showing different colors for various Z levels.

Image Map

Image maps are raster images based on grid files. Image maps assign colors based on Z values from a grid file. Blanked regions on the image map are shown as a separate color or as a transparent fill. Pixels can be interpolated to create a smooth image. Hill shading can be applied to the image map to enhance its depth and appearance.



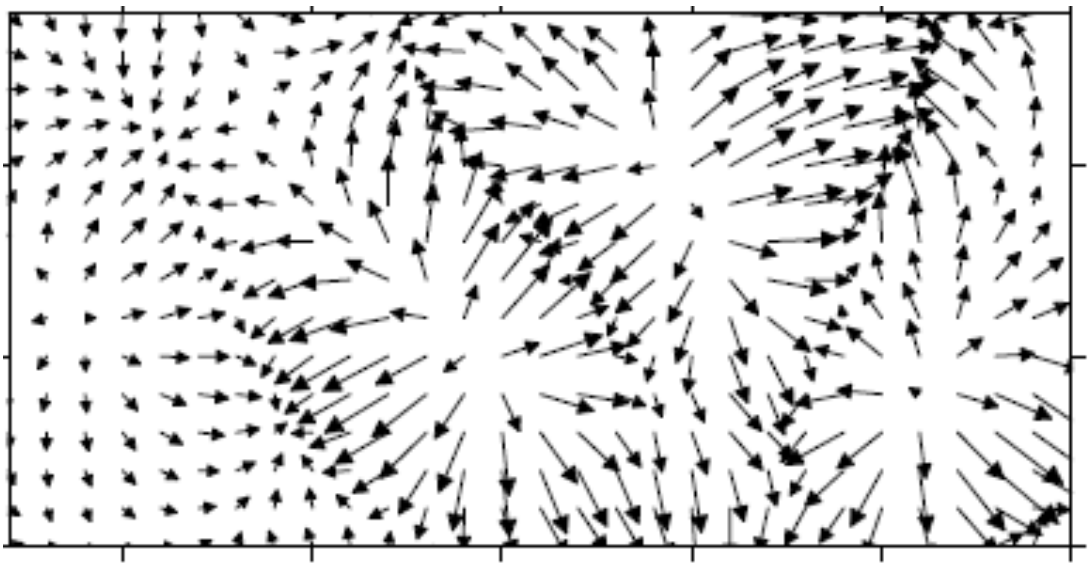
The same DEM file was used to create the image map on the left and the shaded relief map on the right.

Shaded Relief Map

Shaded relief maps are raster images based on grid files. Shaded relief maps assign colors based on slope orientation relative to a light source. **Surfer** determines the orientation of each grid cell and calculates reflectance of a point light source on the grid surface. The light source can be thought of as the sun shining on a topographic surface.

Vector Map

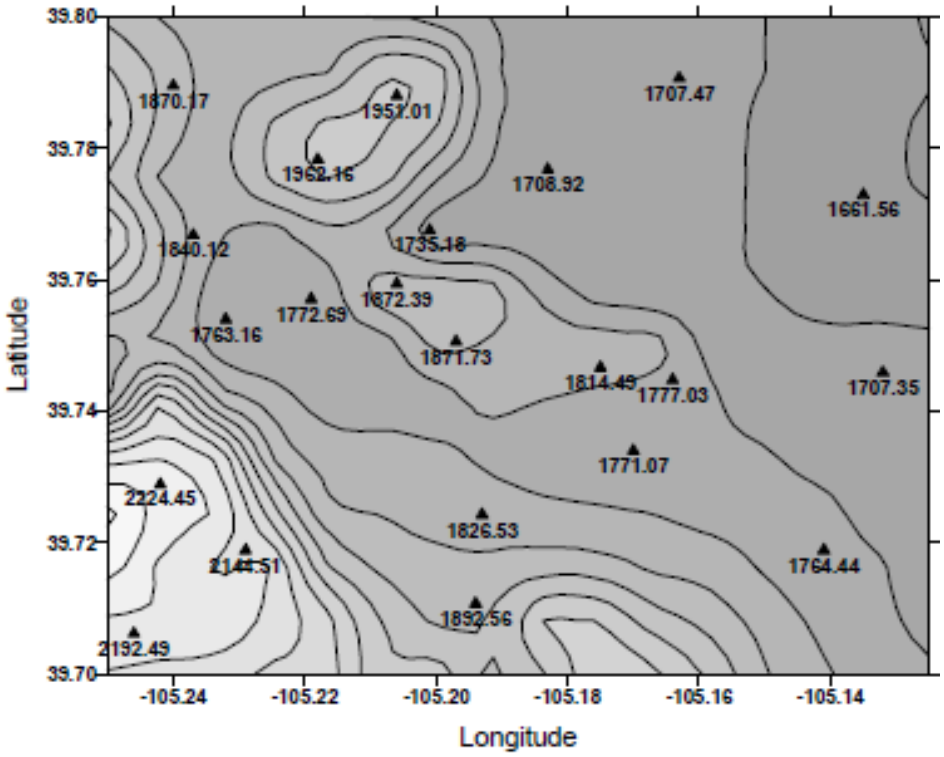
Vector maps display direction and magnitude data using individually oriented arrows. At any grid node on the map, the arrow point in the downhill direction of the steepest descent and the arrow length is proportional to the slope magnitude. Vector maps can be created using information in one grid file (i.e. a numerically computed gradient) or two different grid files (i.e. each grid giving a component of the vectors).



This is an example of a vector map.

Post Map and Classed Post Map

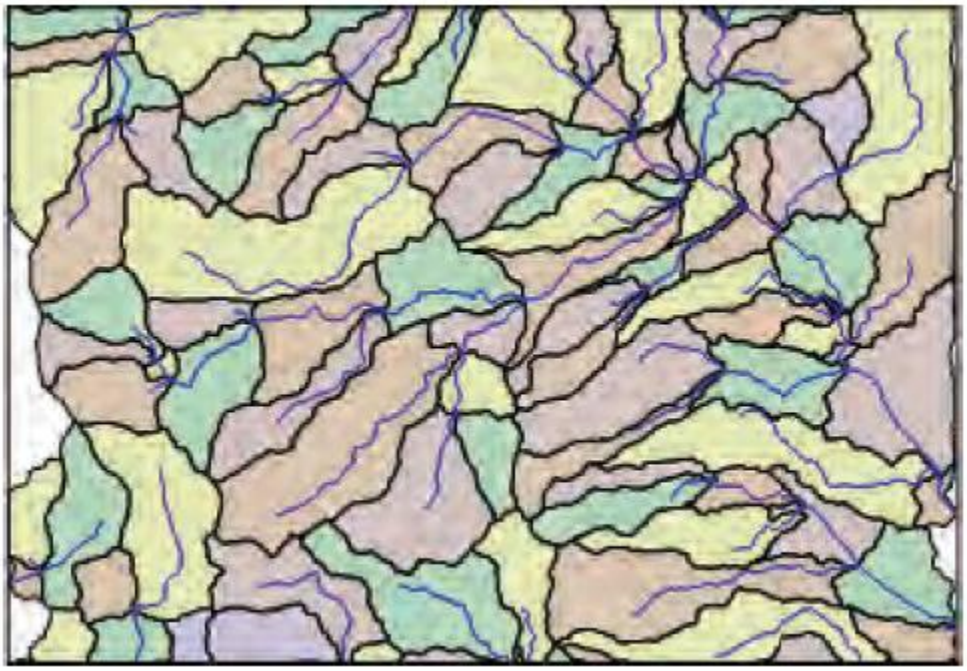
Post maps and classed post maps show data locations on a map. You can customize the symbols and text associated with each data location on the map. Each location can have multiple labels. Classed post maps allow you to specify classes and change symbol properties for each class. Classes can be saved and loaded for future maps.



This is a post map combined with a filled contour map.

Watershed Map

Watershed maps display the direction that water flows across the grid. The watershed map breaks the grid into drainage basins and streams. Colors can be assigned to the basins and line properties can be associated with the streams. In addition, depressions can be removed by filling the depression.



This is a watershed map showing drainage directions.

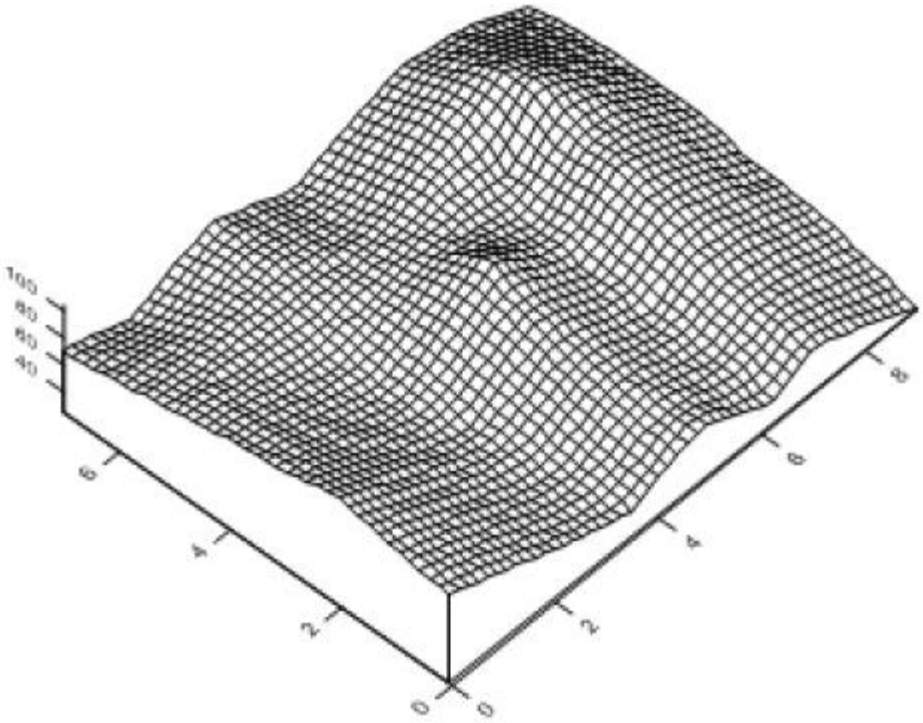
3D Surface Map

3D surface maps are color three-dimensional representations of a grid file. The colors, lighting, overlays, and mesh can be altered on a surface. Multiple 3D surface maps can be layered to create a block diagram.

Surfaces show grids in 3D color.

3D Wireframe Map

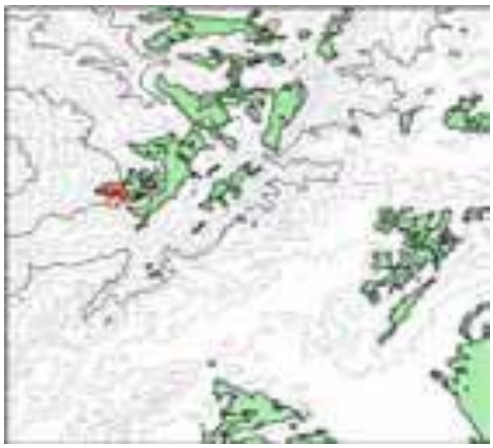
3D wireframe maps are three-dimensional representations of a grid file. Wireframes are created by connecting Z values along lines of constant X and Y.



3D wireframe maps in three-dimensional representations.

Viewshed Layer

Viewshed layers indicate visible or invisible regions of a map from a point location. Viewshed layers can be added to any grid-based map layer, except 3D wireframe maps and tilted or rotated 3D surface maps. Viewsheds can be limited to a specific distance and angular range. Transmitter, receiver, and obstruction height can also be specified for the viewshed.



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, it's properties appear in the **Property Manager**.

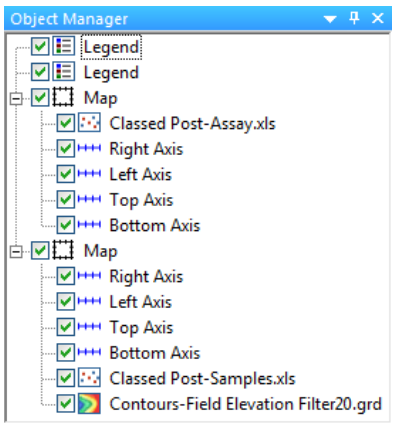
The *Ctrl+A* key combination is a shortcut for the *Edit* | *Select All* menu command.

Adding and overlaying maps

You can add new map layers to existing maps, or you can overlay two separate maps into one. 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. When you first create new maps in Surfer, they are not spatially related to each other. If you have created two 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:

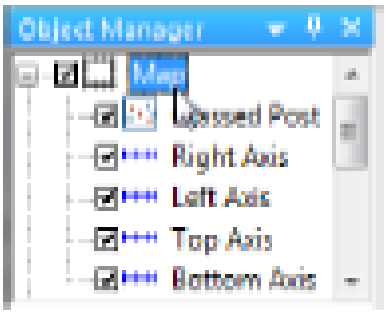
1. You can select both map and go to **Map | Overlay Maps**.
2. You can select one of the map layers in the **Object Manager** and drag it from its original map frame into the map frame of the other map layer. Release the mouse button and the map layer is combined with the other map layer.

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.

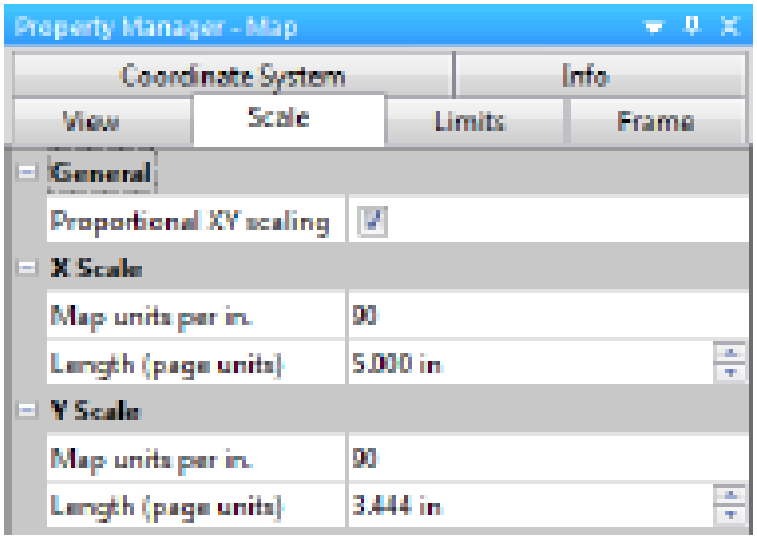


Scaling a map

The **Scale** tab 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 go to 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, go to the Scale tab to adjust the scale of the map.

For example, if your page units are cm and your map is in 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

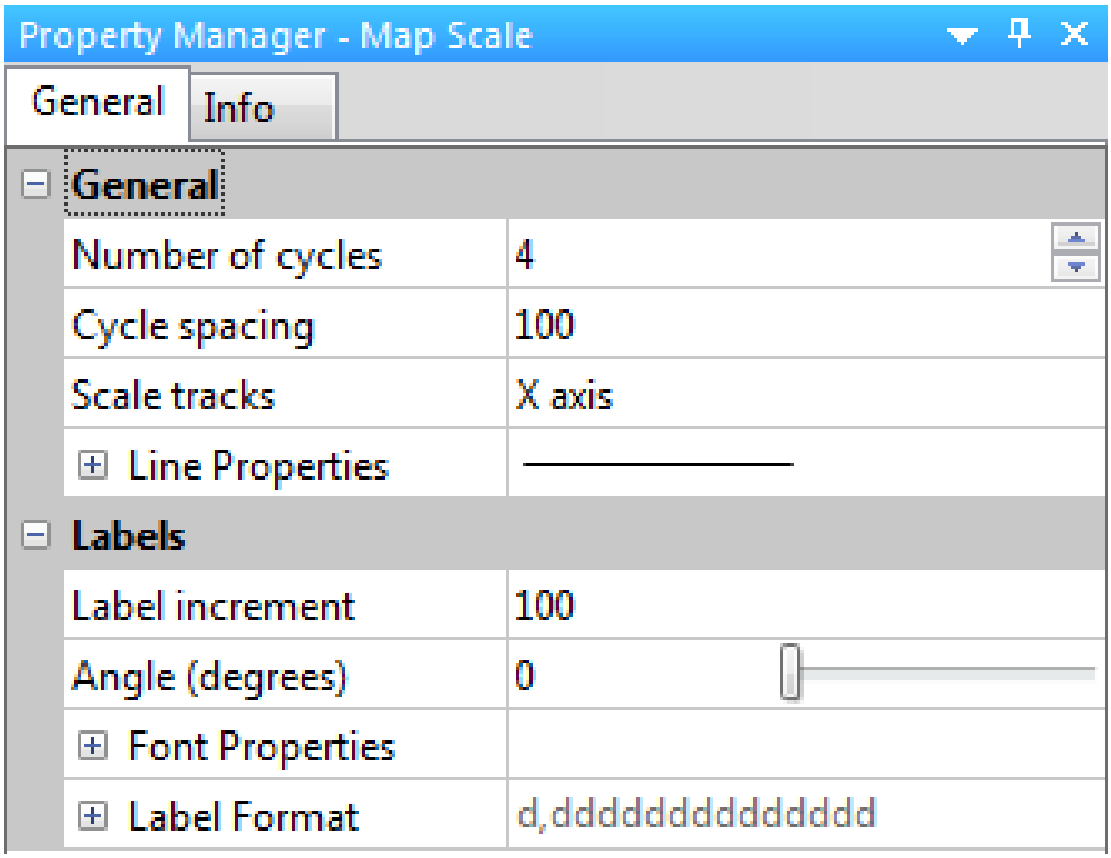
Alternatively, you can draw the objects on the map inside a base map. To do this, select the map and use **Map | Add | Empty Base Layer** to create an empty base map layer in the map frame. Select the empty base layer and go to **Arrange | Enter Group**. Use any of the drawing tools to draw points, polylines, 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 going to **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:
1° latitude = 110.6 km,
1° longitude = 111.3 km · cos(lat)
= 111.3 · cos(51°)
= 70.04 km
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° = 70.04 km, or 1 km = 0.014°, or 1000 km = 14°. Click on the scale bar to enter the **Map Scale** properties in the **Proper 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.
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 61 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.

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Map Layers and Coordinate system

Lecture FOUR

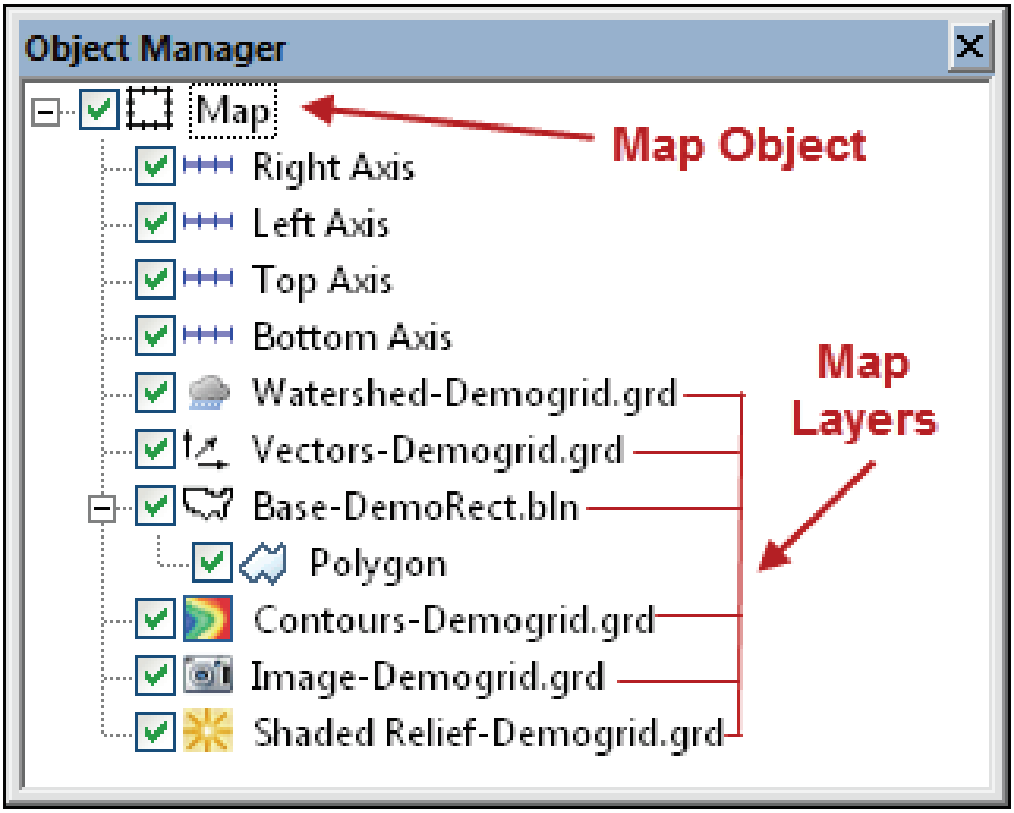
by
Dr. Rami M. Idan

Introduction to Map Layers

A map layer is a single map type contained in a larger map object. The map layer may be a contour map, a post map, a base map, or any other map type that **Surfer** can create. The larger map object contains all of the individual map layers and axes used to create the entire map. Map layers can be created separately or created in a single map object.

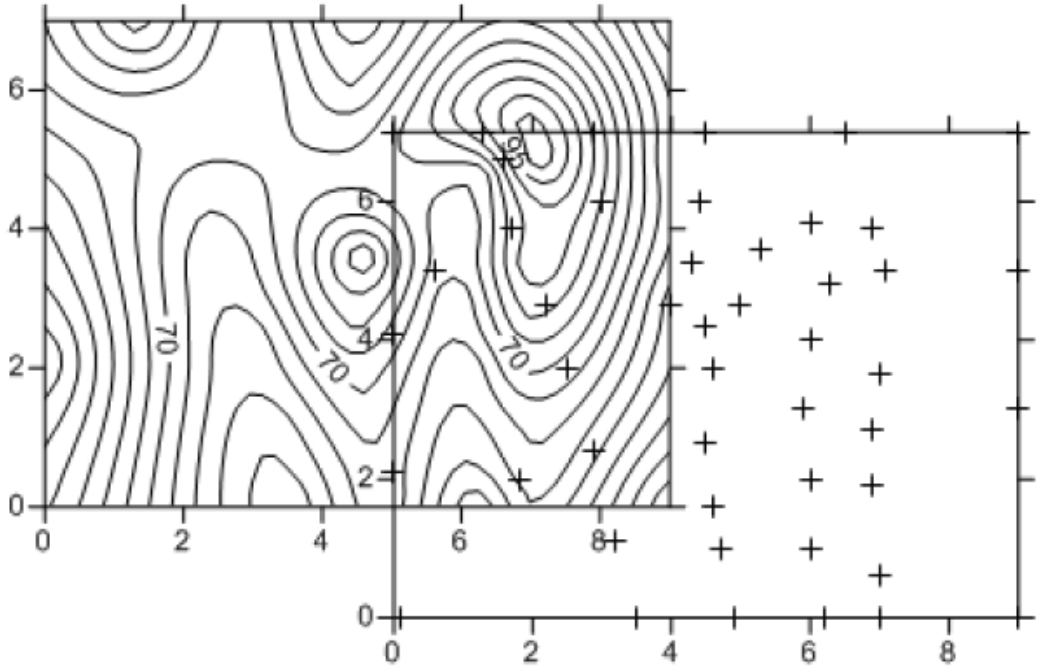
There are multiple ways to overlay map layers in **Surfer**. If you only have two maps with one map layer each, you can drag a map layer from one map object to another map object in the **Object Manager**. If you only have a single map created and need to add map layers to it, you can select the map and use the **Map | Add** command to add a map layer to the existing map. If you have many separate map layers which already created, you can select all of the maps and use the **Map | Overlay Maps** command.

This moves all of the map layers to a single map object. It is possible to combine several maps created from related data to create one map object with multiple map layers. You can add any combination of contour, base, post, image, shaded relief, vector, or 3D surface maps. Maps can contain only one 3D wireframe layer, however.



This one map object contains six map layers. There is a watershed layer, vector layer, base layer, contour layer, an image layer, and a shaded relief layer.

Maps can be combined to create one map object with multiple layers. The **Map | Add** command adds a map layer to the selected map. You can add any combination of contour, base, post, image, shaded relief, vector, viewshed, watershed, or 3D surface maps. You can add any combination of contour, base, post, vector, and watershed maps with 3D wireframe maps.



*The contour map layer and the post map layer are displayed in separate map objects in the **Object Manager** and the plot window.*

Using Map Layers

When you use map layers, the layers use a single set of X, Y, and Z axes and the maps are positioned according to the map object coordinate system. If two or more maps use the same limits, they will overlay on top of one another. If maps cover adjacent areas, adding a map layer places them in the correct position relative to one another and creates a single set of axes that span the entire range. Layered maps become a single object and are moved and scaled as a single entity.

Consider a contour map and a base map that displays the outline of a lake on the contour map. The limits of the base map are the X, Y extents of the lake and are not the same as the contour map limits. If you create both the base map and the contour map in a single plot window as separate maps by using the **Map | New** command for both maps, they do not overlay correctly because the maps have different scaling. In addition, each map uses a different set of X, Y axes. The two maps can be overlaid to correctly position the lake on the contour map by dragging the base map layer to the other map object that has the contour layer. The result will be

a map object with a base map layer and contour map layer. Alternatively, if you create the contour map and then added a base map layer with the **Map | Add | Base Layer** command, the two maps are automatically scaled and combined into a single map using a single set of axes. The lake is correctly positioned on the contour map.

Layers and 3D Wireframes

When you layer a contour, post, or base map on a 3D wireframe, the maps are draped over the wireframe. The wireframe is drawn in the usual fashion but the base, vector, or contour maps are "molded" over the top of the wireframe lines. Hidden lines are not removed from maps layered on wireframes. For example, contour lines are not hidden when the contour map lies over a wireframe.

Layers and 3D Surfaces

When you layer maps on top of 3D surface maps, hidden lines are removed and the maps are "molded" on the surface. Surface maps and images, vector files, and even other surface maps can be overlaid onto a single map object. The Overlays page in the surface properties dialog contains options for handling color in these cases.

Layer Exceptions

The **Map | Add** command allows you to add a map layer to the selected map. Most combinations of map types can be layered. The exceptions are combining a 3D wireframe and 3D surface map, adding a raster map layer to a wireframe, and adding multiple wireframe layers. Raster maps include shaded relief maps, image maps, surfaces, and base maps containing an image. The options under the **Add** command change to fit the existing map. For example, if a 3D wireframe map is selected, the **Map | Add | 3D Surface Layer** command is grayed out.

Method 1: Adding a Map Layer to an Existing Map Frame

1. Create a new map with the **Map | New** command. For example, you can choose **Map | New | Contour Map** to create a contour map.
2. Select the map and use the **Map | Add** command to add a map layer. Select the map layer type to add to your existing map. For example, select the contour map and use the **Map | Add | Post Layer** command to add a post map layer to the contour map.
3. The maps are combined in the correct position based on their coordinates and limits. For example, in the **Object Manager**, you will see one map object with a contour map layer and a post map layer.

Method 2: Overlaying Two Existing Map Layers

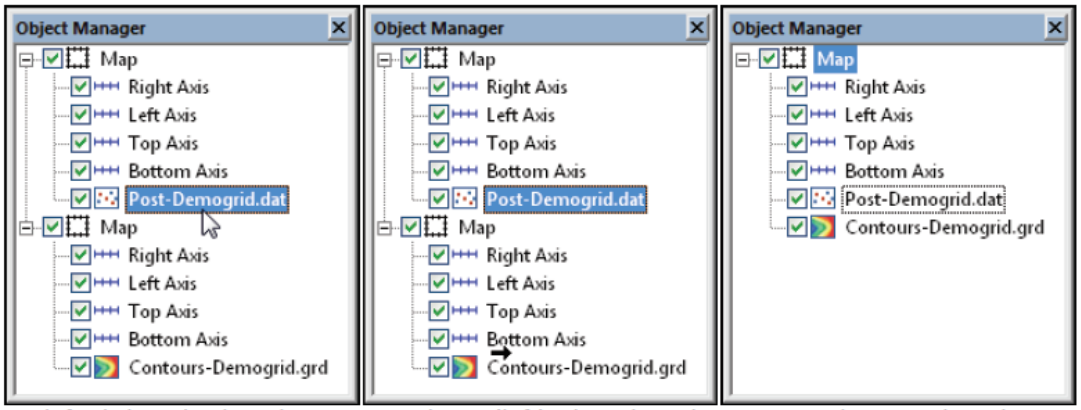
1. Create a map with the **Map | New** command. For example, you can click **Map | New | Contour Map** to create a contour map.
2. Create a second map with the **Map | New** command. You could create a post map with the **Map | New | Post Map** command.

3. Note that each map has an independent set of axes.
4. Click **Edit | Select All** to select both the contour and post maps.
5. Click **Map | Overlay Maps**. The two maps are combined onto a single map object with a single set of axes. The empty map object is automatically deleted. This method works well when you have multiple map layers that you want to combine.

Method 3: Combining Two Existing Map Layers in the Object Manager

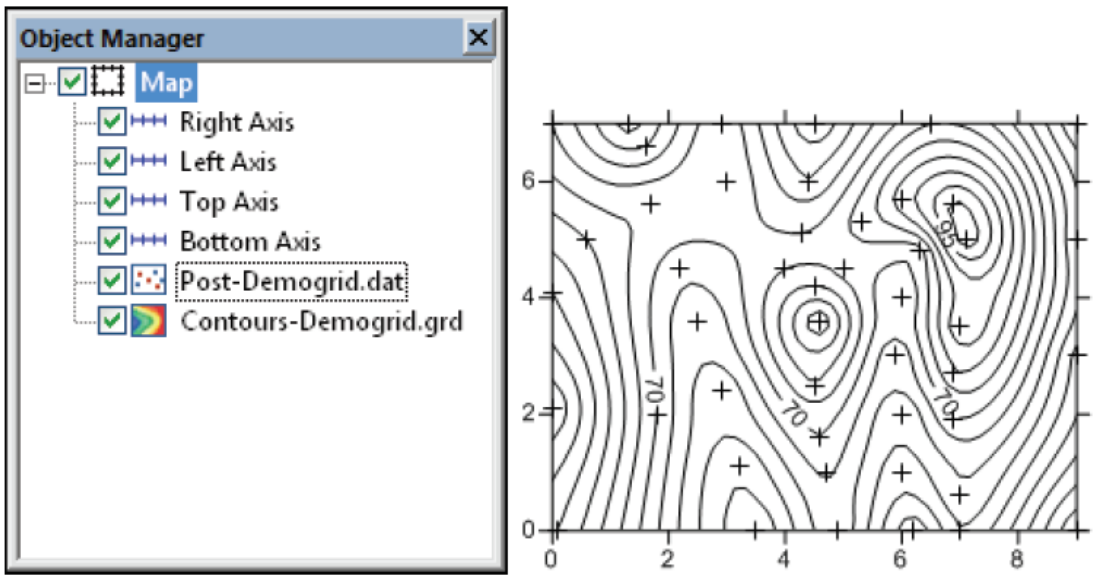
If two maps already exist, you can move (or overlay) a map layer from one map frame into the other map frame by dragging and dropping in the **Object Manager**.

1. Create a map with the **Map | New** command. For example, you can choose **Map | New | Contour Map** to create a contour map.
2. Create a second map with the **Map | New** command. You could create a post map with the **Map | New | Post Map** command.
3. Note that each map has an independent set of axes.
4. Select the post map layer in the **Object Manager** and drag it to the contour map object. To do this, left-click and hold the left mouse button while you drag the map layer to a new map frame. When the cursor changes to a horizontal arrow, release the left mouse button and the map layer is added to the contour map's map frame. The post map will now be overlaid on the contour map. An empty map frame may remain after removing the last map layer from the map object, depending on your options.



First left-click and select the post map layer (left), then drag the post map layer to the other map object. When the cursor is a horizontal arrow (middle), release the mouse button to drop the map layer in the new location (right).

5. If an empty map frame exists, select the empty map frame and press DELETE on the keyboard to remove the empty map frame. The end result is a single map object with two map layers: a post map layer and a contour map layer. Additional map layers can be added with the **Map | Add** command.



The result of this method is one Map object with two map layers.

Layer Map Limits

If a map layer is added to a map frame and the map layer exceeds the current map limits, a **Surfer** warning message will be displayed allowing you to adjust the map limits to include all layers. Select *Yes* to adjust the map to include all layers. Select *No* to leave the current map limits.

Editing a Map Layer

To edit individual layers in a multi-layer map, select the map layer (i.e. *Contours*) in the plot window or **Object Manager** and use the **Property Manager** to edit the properties. Make the desired changes in the map layer properties, and the map layer is redrawn with the specified changes.

Hiding a Map Layer

After adding map layers, it is possible to hide one or more of the layers. To temporarily hide a map layer, uncheck the visibility box next to the map layer name (i.e. *Contours*) in the **Object Manager**. The map is redrawn without the selected overlay. To make the overlay visible again, recheck the visibility box. Note that if a surface is made invisible, the overlays are also made invisible.

Removing a Map Layer

Select the map layer and use the **Map | Break Apart Layer** command to remove a map layer from a map object. Alternatively, right-click on the map layer and select **Break Apart Layer**.

Deleting a Map Layer

To delete a map layer from a map frame, select the map layer in the **Object Manager** and press the DELETE key on the keyboard. Alternatively, you can select the map layer and use the **Edit | Delete** command or right-click the map layer and select
Delete.

Coordinate Systems

A coordinate system is a method of defining how a file's point locations display on a map. Different types of coordinate systems exist that control how the coordinates are shown on the map. In **Surfer**, a map can be in local coordinates, in a geographic latitude and longitude system, or in a known projection and datum. Each data set, grid, map layer, and the map frame can have an associated coordinate system. All coordinate systems for individual layers are converted "on the fly" to the map's target coordinate system. This allows maps with different coordinate systems to be easily combined in **Surfer**. A local coordinate system is considered unreferenced by **Surfer**. All map layers should contain the same X and Y coordinate. You can specify the map units for unreferenced systems in the **Assign Coordinate System** dialog.

A geographic coordinate system uses a spherical surface to define locations on the earth. Geographic coordinate systems are commonly called unprojected lat/long.

Surfer has several predefined geographic coordinate systems available. Each system has a different datum. The same latitude and longitude value will plot in different locations depending on the datum.

A projected coordinate system consists of a projection and a datum. Each projection distorts some portion of the map, based on the ellipsoid and datum specified.

Coordinates can be lat/long, meters, feet, or other units. Different projections cause different types of distortion.

It is recommended that you do not use projected coordinate systems if you do not need to convert between coordinate systems or if all your data are in the same coordinate system.

Source Coordinate System - Map Layer

Maps can be created from data, grids, or base map files in any coordinate system. The *Source Coordinate System* is the coordinate system for the data, grid, or base map file used to create the map layer. Each map layer can reference a different projection and datum. When a map layer has a source coordinate system different than what you want the map to display, the map is converted to the map's *Target Coordinate System*.

3D surface maps and wireframe maps do not have an associated coordinate system. When a map with a coordinate system is overlaid onto either of these map types, the map coordinate system is removed and the maps are displayed in the Cartesian coordinates.

Target Coordinate System - Map

Maps can be displayed in any coordinate system. The map is displayed in the coordinate system defined as the *Target Coordinate System*. A coordinate system normally has a defined projection and datum. When a map layer uses a different *Source Coordinate System* than the map's

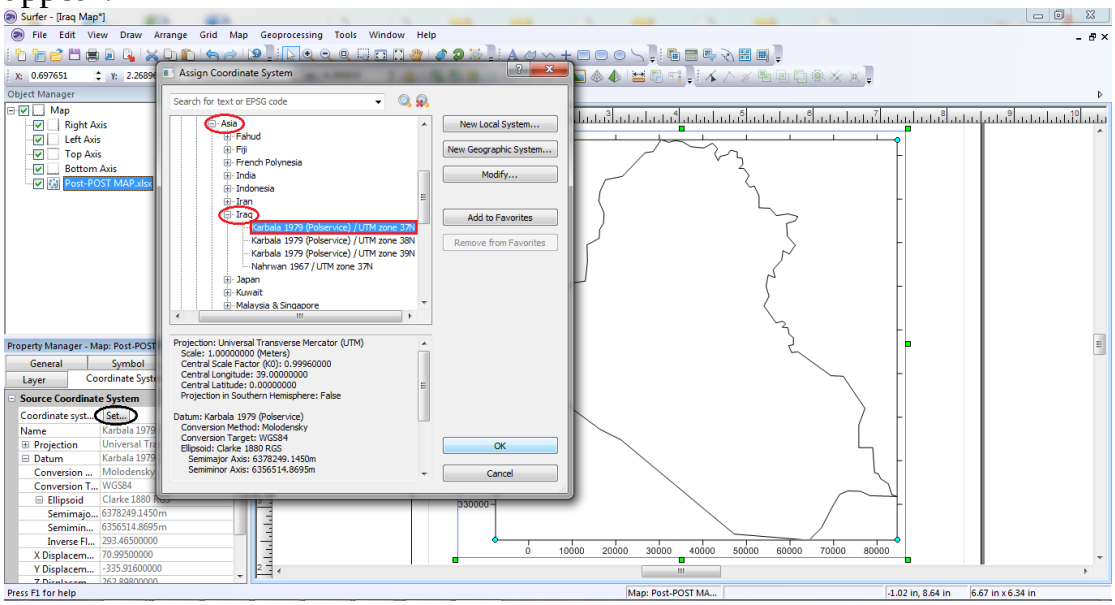
Target Coordinate System, the map layer is converted to the map's *Target Coordinate System*.

Using Coordinate Systems with Multiple Map Layers

The standard procedures for creating maps in a specific coordinate system are,

1. Create the map by clicking on the appropriate **Map | New** command.
2. Click on the map layer to select it. In the **Property Manager**, click on the **Coordinate System** tab.
3. If the *Coordinate system* is not correct, click the *Set* button next to *Coordinate system*. The **Assign Coordinate System** dialog opens.
4. Make any changes in the dialog. This is the initial coordinate system for the map layer. When finished making changes, click *OK*.
5. To change the coordinate system in which the map is displayed, click on the *Map* object in the **Object Manager**.
6. In the **Property Manager**, click on the **Coordinate System** tab.
7. If the *Coordinate system* is not the desired output system, click the *Change* button to set the desired target coordinate system. When finished, click *OK*.
8. All of the map layers are converted on the fly to the target coordinate system. The entire map is now displayed in the desired target system.

Surfer does not require a map projection be defined. Maps can be created from unreferenced data, grid, and map layers. As long as all map layers have the same X and Y ranges, coordinate systems do not need to be specified. If you do not specify a source coordinate system for each map layer, it is highly recommended that you do not change the target coordinate system. Changes to the target coordinate system for the map can cause the unreferenced map layers to appear incorrectly or to not appear.



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Tutorial of Surfer 13

Lecture FIVE

by
Dr. Rami M. Idan

Tutorial

The tutorial is designed to introduce basic **Surfer** features and should take less than an hour to complete. After you have completed the tutorial, you will have the skills needed to create maps in **Surfer** using your own data. The tutorial can be accessed in the program by clicking the button and navigating to the *Tutorial* book or by clicking *Tutorials* in the **Welcome to Surfer** dialog.

If you find you still have questions after you have completed the tutorial, you should consider reviewing the material in **Surfer's** extensive in-program help. The help is also available on the web. The Golden Software website contains a knowledge base of questions and answers, an interactive forum, and training videos. Usually, the answers to your questions are found in one of these locations. However, if you find you still have questions, do not hesitate to contact Golden Software's technical support team. We are happy to answer your questions before they become problems.

Tutorial Overview

The following is an overview of lessons included in the tutorial.

Starting Surfer shows you how to begin a new Surfer session and open a new plot window.

Lesson 1 - Viewing and Creating Data opens and edits an existing data file and creates a new data file.

Lesson 2 - Using the Map Wizard creates a grid file, the basis for most map types in **Surfer**, and a map with contour, post, and color relief layers.

Lesson 3 - Changing Layer Properties edits the contour, post, and color relief layer properties.

Lesson 4 - Modifying an Axis edits the axis tick labels and axis title properties.

Lesson 5 - Creating a Profile creates a profile line on the contour map and displays the profile.

Lesson 6 - Saving a Map saves your map and all the information it contains to a **Surfer** .SRF file.

Lesson 7 - Creating a 3D Surface Map creates and edits 3D surface map.

Lesson 8 - Adding Transparency, Color Scales, and Titles changes the transparency of various objects, adds a color scale, and adds a map title.

Lesson 9 - Creating Maps from Different Coordinate Systems loads multiple map layers from different coordinate systems and sets the target coordinate system for the entire map.

A Note about the Documentation

Various font styles are used throughout the **Surfer** quick start guide and online help. **Bold** text indicates commands, dialog names, tab names, and page names. *Italic* text indicates items within a dialog or the **Contents** or **Properties** windows such as section names, options, and field names. For example, the **Save As** dialog contains a *Save as type* list. Bold and italic text may occasionally be used for emphasis.

Also, commands appear as **Home | New Map | Contour**. This means, "click or scroll to the **Home** tab at the top of the plot window, then click on the **Contour** command within the **New Map** command group." The first word is always the menu or ribbon tab name, followed by the command group, and finally the command name within the menu list or on the ribbon.

Sample File Location

The sample files used in the tutorial lessons are located in the **Surfer** SAMPLES folder. The SAMPLES folder is located by default at C:\Program Files\Golden Software\Surfer 14\Samples. Note, if you are running the 32-bit version of **Surfer** on a 64-bit version of Windows, the SAMPLES folder is located at C:\Program Files (x86)\Golden Software\Surfer 14\Samples, by default.

Starting Surfer

To begin a **Surfer** session:

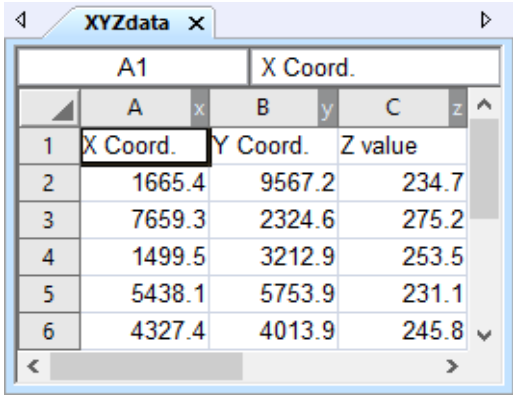
1. Navigate to the installation folder, which is C:\Program Files\Golden Software\Surfer 14 by default.
2. Double-click on the Surfer.exe application file.
3. The **Welcome to Surfer** dialog appears. Click *New Plot* to open a new blank plot window.
4. A new empty plot window opens in **Surfer**. This is the work area where you can produce grid files, maps, and modify grids.

If this is the first time that you have opened **Surfer**, you are prompted to license Surfer. Activate your Single-User product key, select a license server, or continue using the trial. Your product key is located in the download instructions email. You may also access your product key at your Golden Software My Account page.

If you have already been working with **Surfer**, open a new plot window before starting the tutorial. To open a new plot window, click the **File | New | Plot** command.

Lesson 1 - Viewing and Creating Data

An XYZ data file is a file containing at least three columns of data values. The first two columns are the X and Y coordinates for the data points. The third column is the Z value assigned to the XY point. Although it is not required, entering the X coordinate in column A, the Y coordinate in column B, and the Z value in column C is a good idea. **Surfer** looks for these coordinates in these columns by default. You can customize the default columns for XYZ data with the Assign XYZ Columns worksheet command. **Surfer** requires the use of decimal degree Latitude (Y) and Longitude (X) values when using Latitude and Longitude values.



A simple XYZ data file. Notice that the X, Y, and Z data are placed in columns A, B, and C respectively.

Creating a New Data File

The **Surfer** worksheet can also be used to create a new data file. To open a worksheet window and begin entering data:

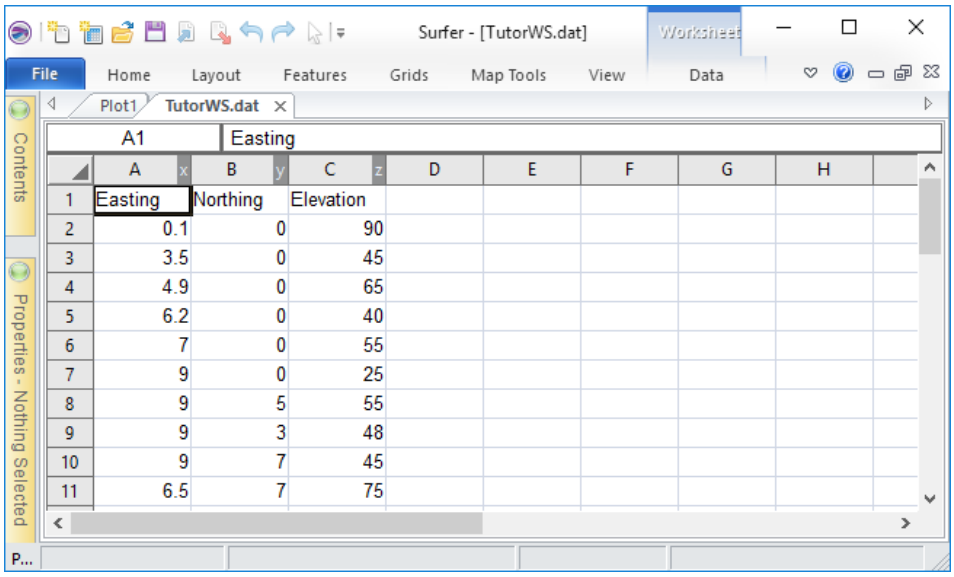
1. Click the **File | New | Worksheet** command, click the  on the quick access toolbar, or press CTRL+W on the keyboard. A new empty worksheet window is displayed.
2. Data is entered into the active cell. The active cell is selected by clicking on the cell or by using the arrow keys to move between cells. The active cell is indicated by a heavy border and the contents of the active cell are displayed in the active cell edit box. The active cell location box shows the location of the active cell in the worksheet. Letters are the column labels and numbers are the row labels.
3. When a cell is active, enter a value or text, and the information is displayed in both the active cell and the active cell edit box.
4. The BACKSPACE and DELETE keys can be used to edit data as you type.
5. To preserve the typed data in the active cell, move to a new cell. Move to a new cell by clicking a new cell with the pointer, pressing one of the arrow keys, or pressing ENTER. Press the ESC key to cancel without entering the data.

Opening an Existing Data File

To look at an example of an XYZ data file, you can open any sample data file in a worksheet window:

1. Click the **File | Open** command, click the  button on the quick access toolbar, or press CTRL+O on the keyboard to open the **Open** dialog.
2. If you are not in the *Samples* folder, browse to it. By default, the *Samples* folder is located in C:\Program Files\Golden Software\Surfer 14. In the list of files, click *TutorWS.dat*.
3. Click *Open* to display the file in the worksheet window.

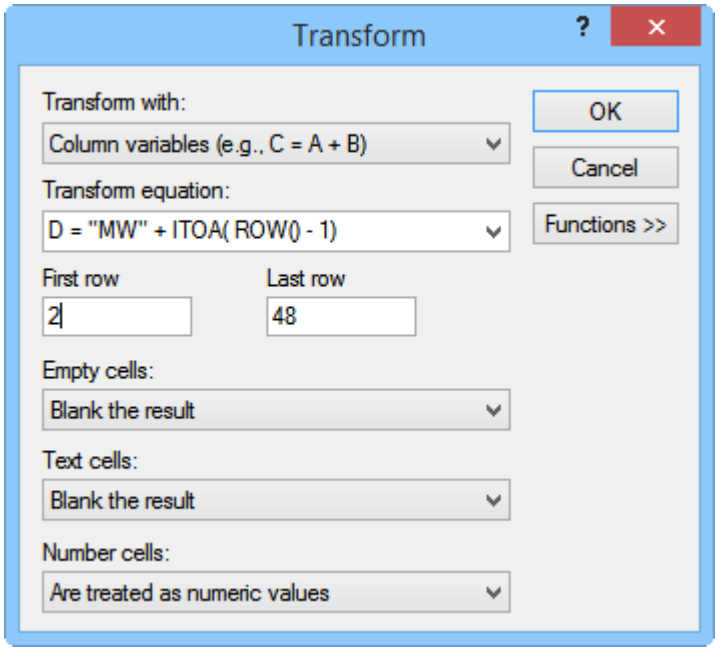
Notice that the X coordinate (Easting) is in column A, the Y coordinate (Northing) is in column B, and the Z value (Elevation) is in column C. Although it is not required, row 1 contains header text, which is helpful in identifying the type of data in the column. When a header row exists, the information in the header row is used in the **Properties** window when selecting worksheet columns.



When a data file is displayed, the name of the file is shown in the title bar and in the worksheet tab. In this file, row 1 contains descriptive information about each column of data.

Adding New Data

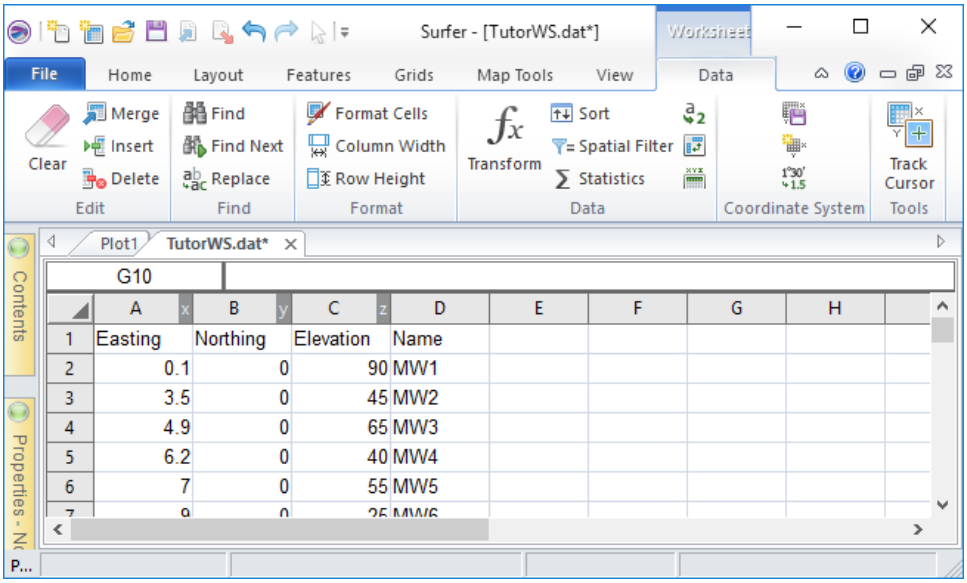
To edit any value, click in the cell to select it. Type information and the existing value is overwritten. Data can be transformed, sorted, or filtered in this window. New columns can be added. For instance, an ID column can be added which labels each row with a unique identifier. To do this,



*Set the options in the **Transform** dialog as above to add a unique identifier to each row.*

1. Click in cell D1.
2. Type the text *Name*.
3. Press ENTER to save the text and move the active cell to cell D2.
4. Click the **Data | Data | Transform** command.
5. In the **Transform** dialog, set the *Transform with* to *Column variables (e.g., C = A + B)*.
6. Set the *Transform equation* to *D = "MW" + ITOA(ROW() - 1)*. This equation will use a prefix of “MW” before a number. The number is the row number minus 1 for each row. The ITOA function converts the ROW() -1 number to text.
7. Set the *First row* to 2.
8. Set the *Last row* to 48 (the last row in the worksheet).
9. Leave the *Empty cells*, *Text cells*, and *Number cells* set to the defaults.
10. Click *OK* and each row will have a unique identifier.

The worksheet should now have a unique identifier column.



The new column contains a unique identifier for each row. This can be used for labels later in the tutorial.

Saving the Data File

When you have completed entering all of the data, the file can be saved.

1. Click the **File | Save As** command. The **Save As** dialog is displayed.
2. Navigate to the folder in which you wish to save the tutorial, for example the *Documents* folder.
3. In the *Save as type* list, choose the *DAT Data (*.dat)* option.
4. Type *Tutorial* into the *File name* box.
5. Click the *Save* button and the **Data Export Options** dialog opens.
6. Accept the defaults in the **Data Export Options** dialog by clicking *OK*.

The file is saved in the *Data .DAT* format as *Tutorial.dat*. The name of the data file appears in the title bar and on the worksheet tab.

Lesson 2 - Using the Map Wizard

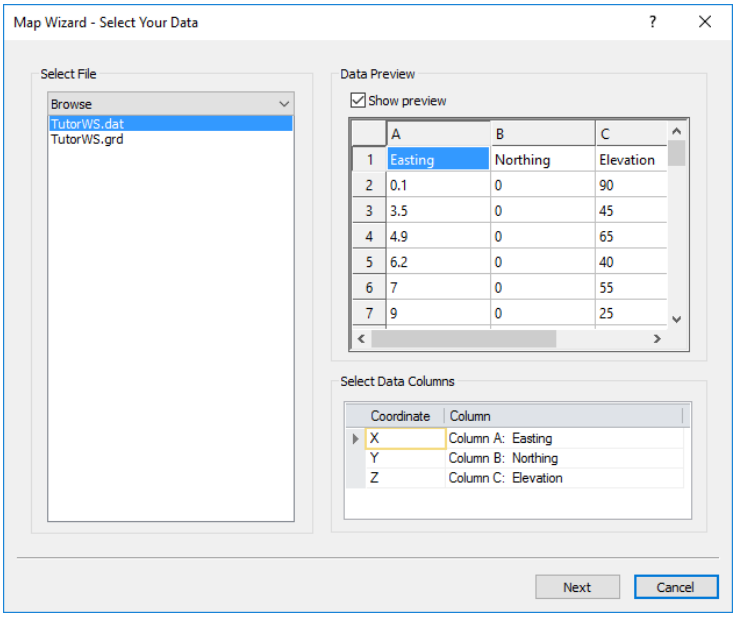
Now that we have saved the data file, we will use the **Map Wizard** to create a grid and a map with contour and post layers. The **Map Wizard** steps through the map creation process from raw data to a map with one or more layers. The **Map Wizard** is useful for creating multiple map types from a single data file. The **Map Wizard** can use a data, grid, or boundary file as an input file.

1. If you have the worksheet window open, click on the **Plot1** tab above the worksheet window. Alternatively, you can create a new plot window with the **File | New | Plot** command.
2. Click the **Home | Wizard | Map Wizard** command.

The **Map Wizard** opens to the first page, the **Select Your Data** page. The remaining topics in Lesson 2 will step through the pages of the Map Wizard.

Select Your Data

The first page in the **Map Wizard** is the **Select Your Data** page. Here you select the data, grid, base map, or image file you wish to use to create your map.

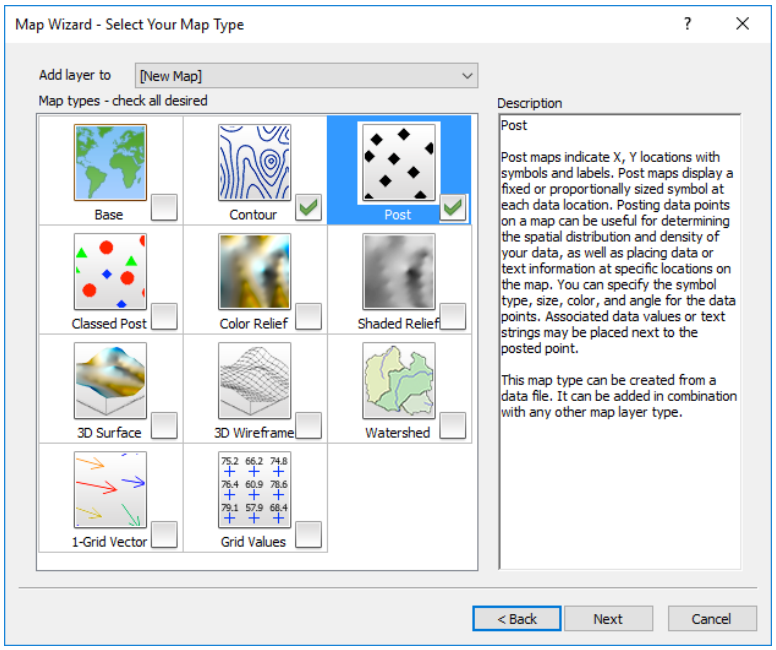


*Select the data file from Lesson 1 in the **Select Your Data** page.*

1. By default, the **Map Wizard** displays the sample files in the *Select File* list. Click *Sample files* and select *Browse* from the list. The **Open** dialog is displayed.
2. In the **Open** dialog, navigate to the *Tutorial.dat* file you saved in *Lesson 1 - Saving the Data File*.
3. Select the *Tutorial.dat* file and click *Open*. The *Tutorial.dat* file is loaded in the *Data Preview* section. The column letters and header row information is displayed in the *Select Data Columns* list. By default the *X* coordinate is column A, the *Y* coordinate is column B, and the *Z* coordinate is column C. Any other valid input files in the folder are also displayed in the *Select File* list.
4. Click *Next* in the **Map Wizard**.

Select Your Map Type

Now that you have selected a data file and specified the data columns, we can select which map layers will be included in the map on the **Map Wizard - Select Your Map Type** page.



*Select the map layers you wish to create with the **Map Wizard**.*

XYZ data files are the most flexible input file type. All of the layers are available in the **Select Your Map Type** page when an XYZ data file is selected on the **Select Your Data** page. Some map types will be unavailable after choosing an image, vector, or grid file on the **Select Your Data** page. The data file type and the map type selections determine if a map is created after the **Select Your Map Type** page or if a grid must be created first.

For this tutorial we will include a contour and post layer in our map:

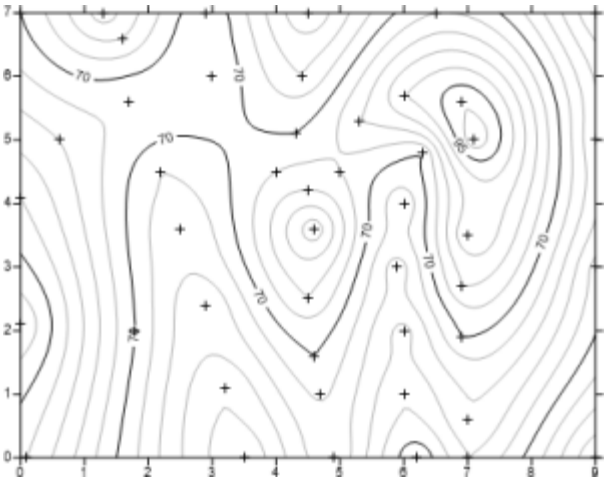
1. Click the *Post* map in the *Map types - check all desired* list to select it. Notice a description is displayed in the *Description* field.
2. Click the *Contour* map in the *Map types - check all desired* list to select it. The *Finish* button changes to *Next*. This is because we must create a grid from the XYZ data file before we can create a contour map.
3. Click *Next*.

Select Gridding Parameters

Grid files are required to produce a grid-based map. Grid-based maps include contour, color relief, shaded relief, vector, viewshed, watershed, 3D wireframe, and 3D surface map layers. If necessary, grid files are created with the **Map Wizard**. Grid files can also be created at any time by using the **Home | Grid Data | Grid Data** command.

A grid must be created from the *Tutorial.dat* file to display a contour map. The **Map Wizard - Select Gridding Parameters** page controls the gridding options and output grid file name. The **Select Gridding Parameters** page displays a preview color relief map for you to quickly compare gridding methods. We will create a grid with the default gridding method and options.

1. Verify that the *Gridding method* is set to *Kriging*. If it is not, click the current gridding method and select *Kriging* from the list.
2. Verify that the *Output grid file* is named *Tutorial.grd* and in the desired directory, for example your *Documents* folder.
3. Click *Finish*.



A map is created with default contour and post layers.

The grid is created and saved, and a map is created in the plot window with a contour and post layer. The map uses the default display properties. The **Map Wizard** is a useful tool for quickly creating maps and grids. However, it is not necessary to use the **Map Wizard**. Grids can be created with the **Grid Data** command, and maps and layers can be created with the **Home | New Map** and **Home | Add to Map | Layer** commands.

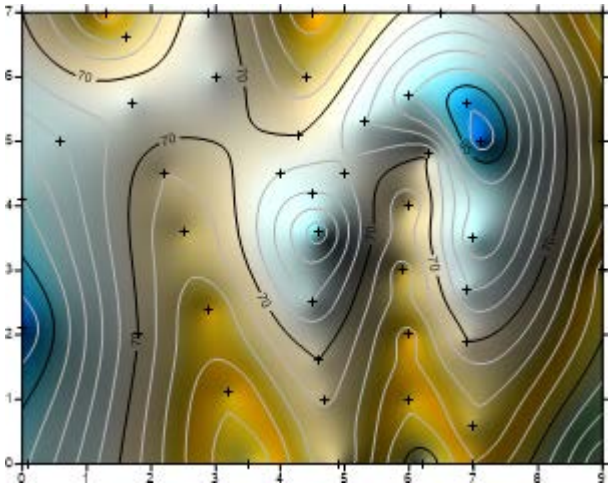
Adding a Color Relief Layer

Map layers allow you to add multiple maps to an existing map to create one map object displaying a variety of map types. The map uses a single set of axes and the map layers are positioned according to the target coordinate system. For example, if you have a contour map of weather data created, you can add a post map layer displaying the location and station names of each data collection station.

Multiple map layers can be created at one time when using the **Map Wizard**. However, map layers can also be added to an existing map by selecting the map and using the **Home | Add to Map | Layer** command, by dragging an existing map layer from one map object to another, or by selecting all maps and using the **Map Tools | Map Tools | Overlay Maps** command. Now we will add a color relief layer to the map:

1. Click on the *Map* object in the Contents window, or click on the map in the plot window, to select it.
2. Click the **Home | Add to Map | Layer | Color Relief** command. The **Open Grid** dialog is displayed.

3. Navigate to the *Tutorial.grd* file you created in *Select Gridding Parameters* and select it.
4. Click *Open* to add the color relief layer to the map.



Now a color relief layer is also displayed in the map.

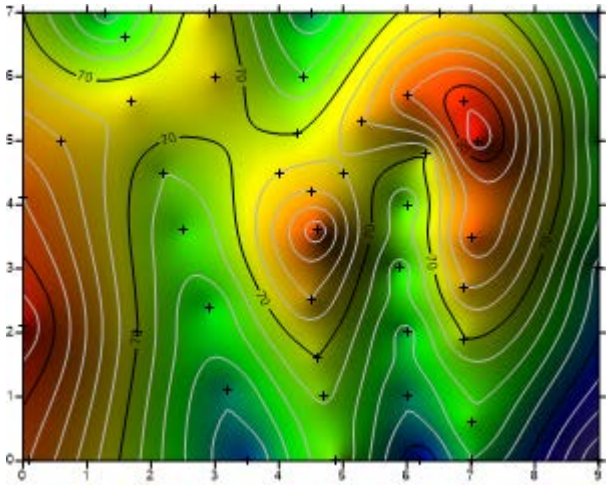
The color relief layer is added to the map and uses the default display properties. In Lesson 3, we will edit the appearance of the map by changing the color relief, contour, and post layer properties.

Lesson 3 - Changing Layer Properties

The map's appearance is mainly determined by the properties of the map layers. This lesson will demonstrate a few of the common properties for controlling the display of contour, post, and color relief layers. However, each map type has many properties and display options. A description and explanation is included for every property in the help.

We will begin by changing the color relief layer's colors:

1. Click the *Color Relief-Tutorial.grd* layer in the Contents window to select it. When multiple layers are overlaid in a single map, it is often easier to select the desired layer in the **Contents** window. When the color relief layer is selected, the color relief layer properties are displayed in the **Properties** window.
2. Click the **General** tab in the **Properties** window to display the **General** page.
3. If necessary, click the ⊞ button next to *General* to expand the *General* section.
4. The *Colors* property determines the colormap used in the color relief map. The default colormap is *Terrain*. Click *Terrain* and select *Rainbow* from the *Colors* list.



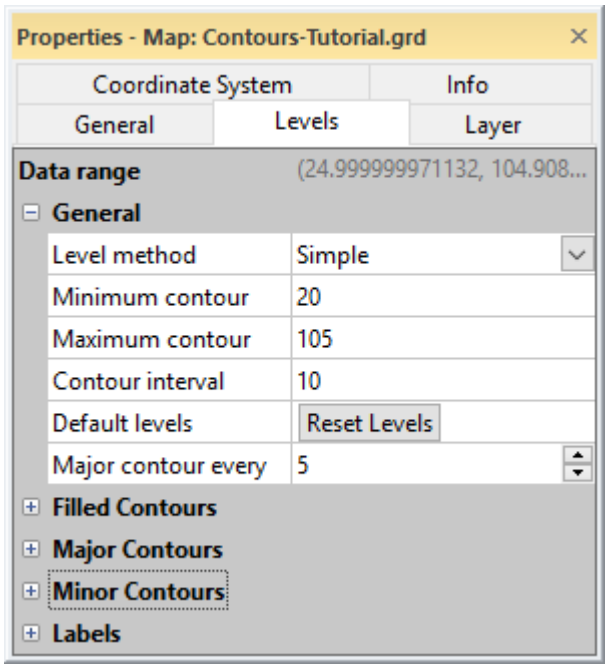
This color relief layer uses the Rainbow *colormap.*

Now the color relief layer is using the *Rainbow* colormap. You can click the ... next to the *Colors* property to customize the colormap in the **Colormap** dialog.

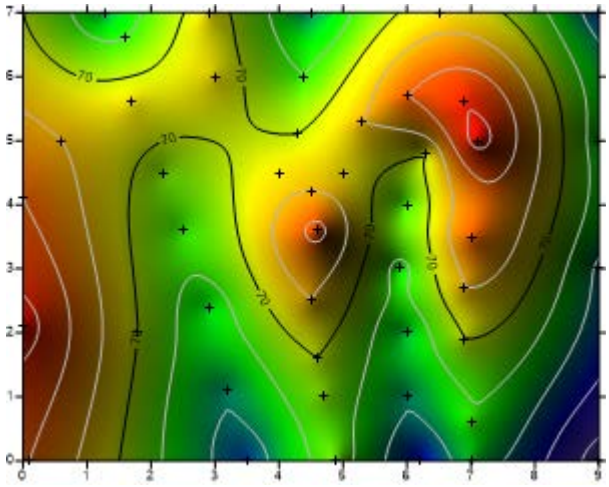
Changing Contour Levels

You can easily modify any of the contour map features. For example, you might want to change the contour levels displayed on the map. To change the contour levels:

1. Click on the *Contours-Tutorial.grd* object in the **Contents** window. When the contour layer is selected, the contour properties are displayed in the Properties window.
2. In the **Properties** window, click the **Levels** tab to display the contour levels and contour line properties for the map. In this example, the contour levels begin at Z = 20. This is displayed next to *Minimum contour*. The *Maximum contour* level is Z = 105.
3. To change the contour range, click in the box next to *Minimum contour* or *Maximum contour*. Highlight the existing value and type a new value. The *Data range* of the grid file is displayed at the top of the **Levels** page, making selecting an appropriate range easier. For best results, select values for *Minimum contour* and *Maximum contour* that are in or near this *Data range*.
4. The *Contour interval*, or the frequency of contour lines, is five. This means that a contour line will be displayed every five Z units. We should see contour lines at 20, 25, 30, 35, etc. up to 105. Click in the *Contour interval* box, highlight the value 5, and type the value 10.
5. Press ENTER on the keyboard. The map automatically updates to show contour lines every 10 Z units. The minimum contour level is Z = 20, and the largest contour level is Z = 100.



*Go to the **Levels** page to display the contour level properties.*



The contour map is redrawn using new contour levels based on a contour interval of 10.

Changing Contour Line Properties

You can set any of the options in the list on the **Levels** page to customize the contour map. The *Major contour every* value allows the setting of two different line styles, the major and minor contour lines, for the contour map. By default, the major contour lines are black and labeled and the minor contour lines are gray and unlabeled. The number of minor contour lines and the line properties for both the major and minor contours can be changed.

Setting the Major Contour Value

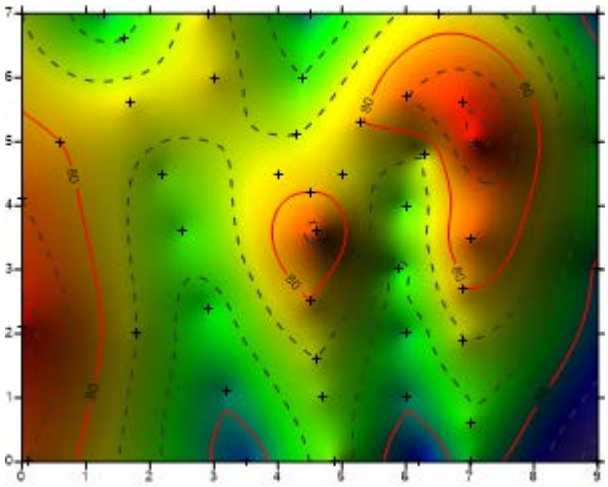
1. Highlight the number in the box next to *Major contour every* and type in a new value of 3.
2. Press ENTER on the keyboard and every third line is a major contour line.

Changing the Major Contour Line Properties

1. Click the ⊞ next to *Major Contours,* if it is not already open.
2. Click the ⊞ next to *Line Properties* in the *Major Contours* section. The major line properties appear.
3. Click the *Black* color box next to *Color*. Select another color, such as *Red*, from the list. The map automatically updates.
4. Click the ▲▼ next to *Width* and change the value to 0.03 inches. Thick red lines now appear at the major contours.

Changing the Minor Contour Line Properties

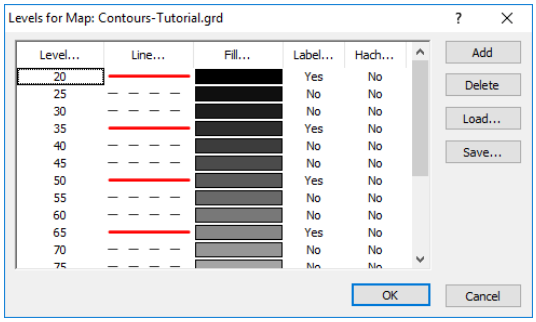
1. Click the ⊞ next to *Minor Contours,* if it is not already open.
2. Click the ⊞ next to *Line Properties* in the *Minor Contours* section. The minor line properties appear.
3. Click the *30% Black* color box next to *Color*. Select another color, such as *80% Black*, from the list.
4. Click in the box next to *Style* and select a dashed line from the list. Dashed gray lines now appear at the minor contours.



The contour map should look similar to this example after changing the major and minor line properties.

Advanced Contour Level Properties

Contour map level properties can be set in one of three methods: *Simple*, *Logarithmic*, or *Advanced*. As seen is the previous topic, the *Simple* method is easy to use and quick to adjust. The *Logarithmic* method is very similar to the *Simple* method, but it uses a logarithmic scale rather than a linear scale. When using the *Advanced* method, each contour line is individually controlled.



*The **Levels for Map** dialog is used to adjust level properties with the* Advanced *level method.*

Control advanced settings for the *Level, Line, Fill, Label,* and *Hach* properties of the contour map in the **Levels for Map** dialog. Properties can be adjusted for all contours at once by clicking on the column buttons, or for individual contours by double-clicking on the specific contour level.

The changes that can be made by clicking the **Levels for Map** dialog header buttons include the following:

- Set the minimum, maximum, and contour interval by clicking the *Level* button.
- Set the line properties for all lines to a uniform or gradational color and style by clicking the *Line* button.
- Set the *Colormap* for the foreground and background color and the fill pattern between all contour lines by clicking the *Fill* button.
- Set the label properties for all contour labels or contour labels on a frequency basis by clicking the *Label* button.
- Set the hachure properties for all contours or on a frequency basis by clicking the *Hach* button.

Individual level changes that can be made include the following items:

- Set an individual level value by double-click on the level value to enter a new Z value.
- Set the individual line properties for a single level by double-clicking the line style for that level.
- Set the fill color or pattern for a single level by double-clicking on the fill pattern for that level.
- Set the label properties for a single contour label by double-clicking on the *Yes* or *No* under the *Label* column for that level.
- Set the hachure properties for a single contour level by double-clicking on the *Yes* or *No* under the *Hach* column for that level.

Now we will apply the *Advanced* level method and customize the contour levels with some bulk changes:

1. In the **Contents** window, click once on the *Contours-Tutorial.grd* contour layer to select it.
2. In the **Properties** window, click on the **Levels** tab.
3. Change the *Level method* by clicking on the word *Simple* next to *Level method* and selecting *Advanced* from the list.
4. Click the *Edit Levels* button next to *Contour levels* to open the advanced **Levels for Map** dialog.
5. Clicking the column header buttons makes bulk changes at regular intervals. Click on the *Label* button. The **Labels** dialog opens.
6. Change the *First* value to 2, the *Set* value to 1, and the *Skip* value to 2.

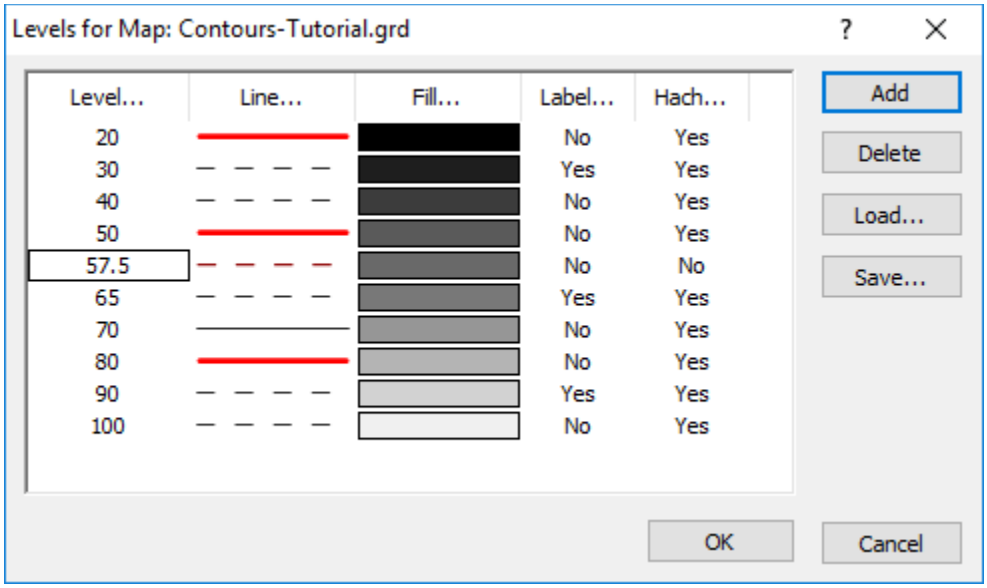
- The *First* value tells **Surfer** which contour line to first change. This says to set the label format for the second contour line (Z=30).
- The *Set* value tells **Surfer** how many lines to set with this style. This says to set only one line with the label format.
- The *Skip* value tells **Surfer** how many lines to skip before setting the next contour line. This says to skip two contour lines. So, the Z=40 and Z=50 contours are not set. The next contour line Z=60 uses the label format. Z=70 and Z=80 are skipped. Z=90 is set. Z=100 is skipped.

7. Click the *Font* button. The **Font Properties** dialog opens.
8. Set the *Size (points)* to 12.
9. Set the *Foreground color and opacity* color to White.
10. Click *OK* in the **Font Properties** dialog.
11. Click *OK* in the **Labels** dialog. Notice how the label status is changed in the **Levels for Map** dialog.
12. Click on the *Hach* button. The **Hachures** dialog opens.
13. Set the *First* to 1, the *Set* to 1, and the *Skip* to 0.
    - The *First* value tells **Surfer** to set the hachure setting for the first contour line, Z=20.
    - The *Set* value tells **Surfer** to set only one contour line to the hachure style.
    - The *Skip* value tells **Surfer** how many contours to skip. In this case, no contours are skipped. This means that all of the contours will have the hachure style.
14. Check the *Hachure Closed Contours Only* box, if it is not already checked.
15. Change the *Direction* to *Uphill*.
16. Click *OK* in the **Hachures** dialog. This changes all of the items under *Hach* to Yes. All closed contours will have hachure marks.
17. Click *OK* in the **Levels for Map** dialog and the bulk changes are made to the contour map.

Now we will open the **Levels for Map** dialog again and set properties for individual contour levels:

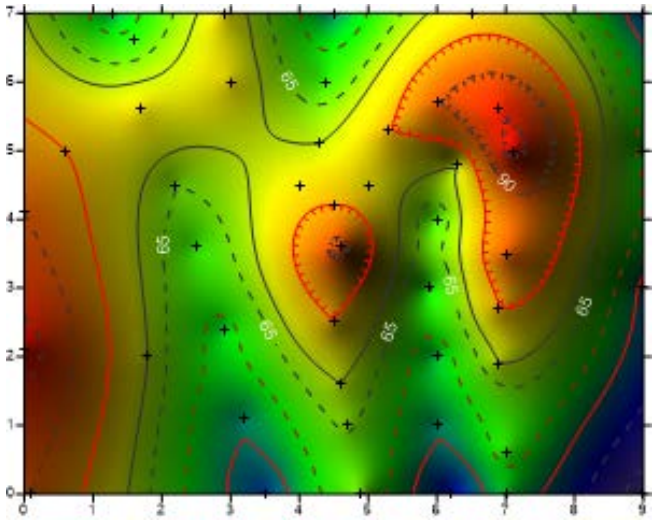
1. In the **Contents** window, click once on the *Contours-Tutorial.grd* contour layer to select it.
2. In the **Properties** window, click on the **Levels** tab.
3. Make sure that the *Level method* is set to *Advanced*.
4. Click the *Edit Levels* button next to *Contour levels* to open the advanced **Levels for Map** dialog.
5. In the **Levels for Map** dialog, you can double-click an individual Z value in the list underneath the *Level* button to change the Z value for that particular contour level. Let's double-click on the number 60.
6. In the Z Level dialog, highlight the value 60 and type in 65.
7. Click *OK* in the **Z Level** dialog, and the contour line level changes to 65.
8. You can also double-click the line style for an individual level to modify the line properties for the selected level. This provides a way to emphasize individual contour levels on the map. Double-click on the line style next to the level 70.
9. In the **Line Properties** dialog, change the *Style* to a solid line by clicking on the dashed line and selecting the *Solid* line from the list.
10. Click *OK* in the **Line Properties** dialog.
11. Let's add a single contour line halfway between two existing values. Click on the number 65 under the *Level* column.

12. Click the *Add* button. The value 57.5 is added between the 50 and the 65.



*Use the **Levels for Map** dialog to make bulk and individual changes to contour levels.*

13. Click *OK* in the **Levels for Map** dialog and the individual settings are made to the contour map.



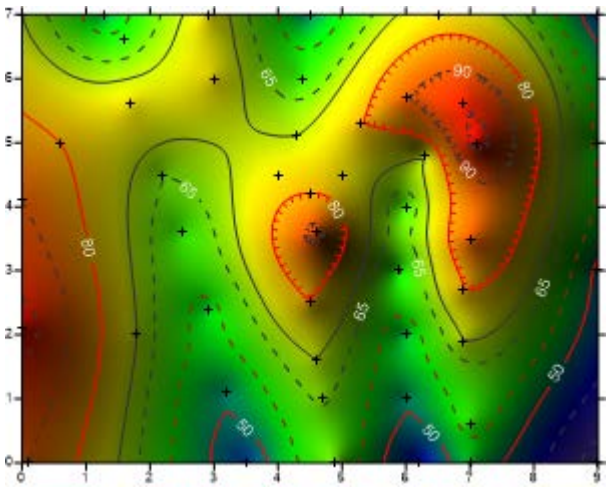
Now the advanced level properties have been applied to the contour map.

Adding, Deleting, and Moving Contour Labels

Contour label locations can be changed on an individual basis. Labels can be added, deleted, or moved. This section will demonstrate adding, deleting, and moving contour labels:

1. Select the contour layer by clicking the *Contours-Tutorial.grd* object in the **Contents** window.
2. Click the **Map Tools | Edit Layer | Contour Labels** command or right-click on the contour map and select **Edit Contour Labels**. The cursor changes to to indicate that you are in edit mode. Contour labels have rectangular boxes around them in edit mode.

3. To delete a label, click on the label and press the DELETE key on the keyboard. For example, left-click on one of the 65 labels and press the DELETE key on your keyboard.
4. To add a label, press and hold the CTRL key on the keyboard and left-click the location on the contour line where you want the new label to be located. The cursor changes to a black arrowhead with a plus sign + to indicate you are able to add a new label. Add several contour labels to the red lines.
5. To move a contour label, left-click on the label, hold down the left mouse button, and drag the label. Release the left mouse button to complete the label movement.
6. To duplicate a label, hold the CTRL key while clicking and dragging an existing label. The duplicate label will be dragged to a new location along the line.
7. To exit the *Edit Contour Labels* mode, press the ESC key, click the **Home | Selection | Select** command, or click the **Map Tools | Edit Layer | Contour Labels** command.



*Contour labels can be moved, added, or deleted with the **Map Tools | Edit Layer | Contour Labels** command.*

Exporting 3D Contours

When you have completed a contour map in the plot window, you can export the contour lines with associated Z values to an AutoCAD DXF, 2D SHP, 3D SHP, or TXT file. To export contour lines to a DXF, 2D or 3D SHP, or TXT file:

1. Select the contour map layer by clicking *Contours-Tutorial.grd* in the Contents window.
2. Click the **Map Tools | Layer Tools | Export Contours** command.
3. In the **Save As** dialog, type *Tutorial contours* in the *File name* box.
4. Select AutoCAD DXF File (*.dxf), 2D Esri Shapefile (*.shp), 3D Esri Shapefile (*.shp), or Text format (*.txt) in the *Save as type* list.
5. Click *Save* and the file is exported to the current directory. This creates a file titled *Tutorial contours.dxf*, *Tutorial contours.shp*, *or Tutorial contours.txt* depending on what file type you selected. Additional files may also be created that accompany the DXF or SHP file.

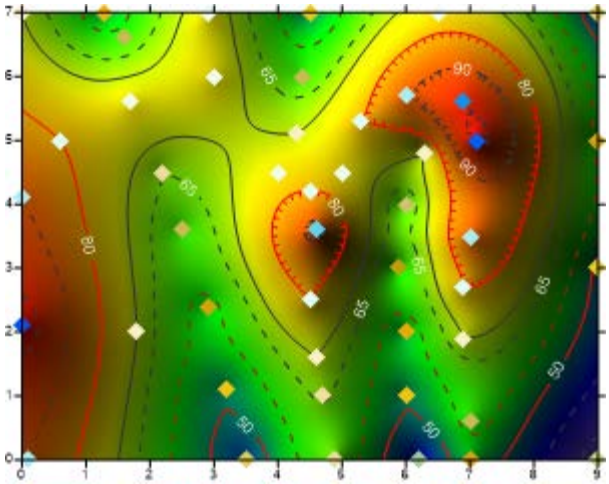
The contours are exported as polylines or polygons. The labels and gaps are removed. The exported file can be used in **Surfer** as a base map, or used in other applications. The **File | Export** command can also be used to export 2D or 3D contours. A comparison between the **Export Contours** and **Export** commands is available on the *Export Contours* help topic.

Changing the Post Layer Properties

Symbols in a post map can all be the same or can be selected with a worksheet column. Symbol sizes can all be the same or have proportional sizes. Symbol colors can all be the same or have color based on a column. Now we will edit the post map layer properties:

1. Click on the *Post-Tutorial.dat* layer in the **Contents** window.
2. In the **Properties** window, click on the Symbol tab.
3. Click the ⊞ next to *Symbol*, if the *Symbol* section is not already expanded.
4. Click the ⊞ next to *Symbol Properties* to open the Symbol Properties section.

5. Click the selected symbol next to the *Symbol* property. In the list, click on the filled diamond symbol (*Symbol set: GSI Default Symbols, Number: 6*) from the symbol palette.
6. Click the ⊞ next to *Symbol Size* to open the *Symbol Size* section.
7. Highlight the value next to the *Symbol size* option and type 0.15 in.
8. Press ENTER on the keyboard. The symbols update with the new symbol size.
9. Click the ⊞ next to *Symbol Color*.
10. To change the symbol colors based on a worksheet value, click on the *None* next to the *Color column* option and select *Column C: Elevation*.
11. Verify that the *Color method* is set to *Numeric via colormap*.
12. Click the colormap next to the *Symbol colors* and select the desired colormap, such as *Terrain*.



The updated post map is displayed overlaid on the contour layer and color relief layer.

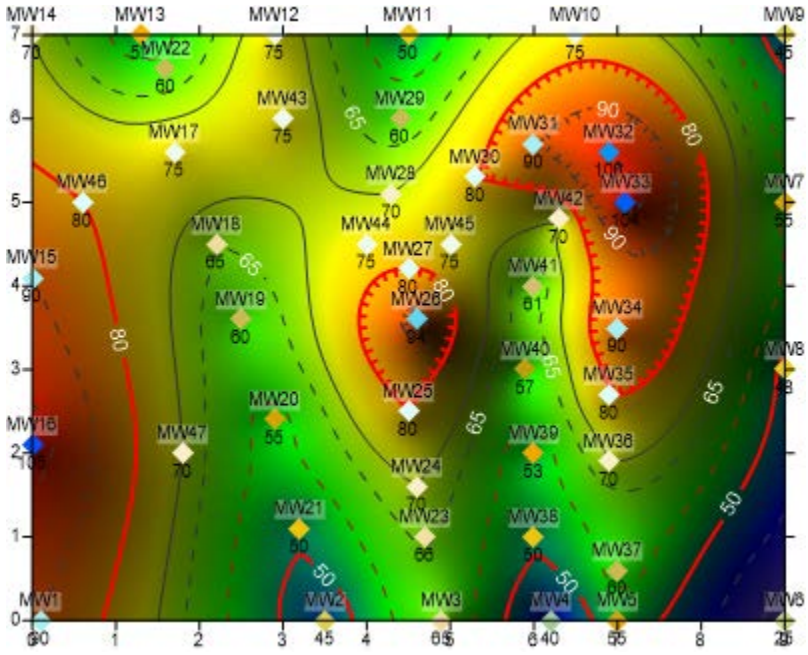
If the post map is not visible, ensure that the post layer is on top of the contour layer in the **Contents** window. The order the layers are listed in a map object is the order the map layers are drawn in the plot window. To move the post layer in the **Contents** window, left-click and drag the post layer above the other layers in the map object. Alternatively, select the post layer and click the **Layout | Arrange | Bring to Front | Bring Forward** command, or right-click the post layer and select **Order Objects | Move Forward**.

Adding Labels to the Post Layer

You can add labels to the data points on post maps and classed post maps. Multiple labels can be added to display all of the information desired in the map. We will add labels showing the elevation and names for the data points:

1. Click on the *Post-Tutorial.dat* layer in the Contents window.
2. In the **Properties** window, click on the **Labels** tab.
3. Click the ⊞ next to *Label Set 1*, if the section is not already open.
4. Next to *Worksheet column*, click the word *None*. A list displaying all of the columns in *Tutorial.dat* are displayed. Select *Column C: Elevation* from the list.
5. For the *Position relative to symbol* option, click on the existing option and select *Below* from the list.
6. Click the *Add* button next to the *Add label set* option to add a second label to the post map.
7. Next to *Worksheet column*, click the word *None*. A list displaying all of the columns in *Tutorial.dat* are displayed. Select *Column D: Name* from the list.
8. For the *Position relative to symbol* option, click on the existing option and select *Above* from the list.
9. Click the ⊞ next to *Font Properties* to open the *Font Properties* section.
10. Change the *Background opacity* to *33%*. This places a semi-transparent white box around the names.

The post map layer is automatically redrawn with labels on each of the data points.

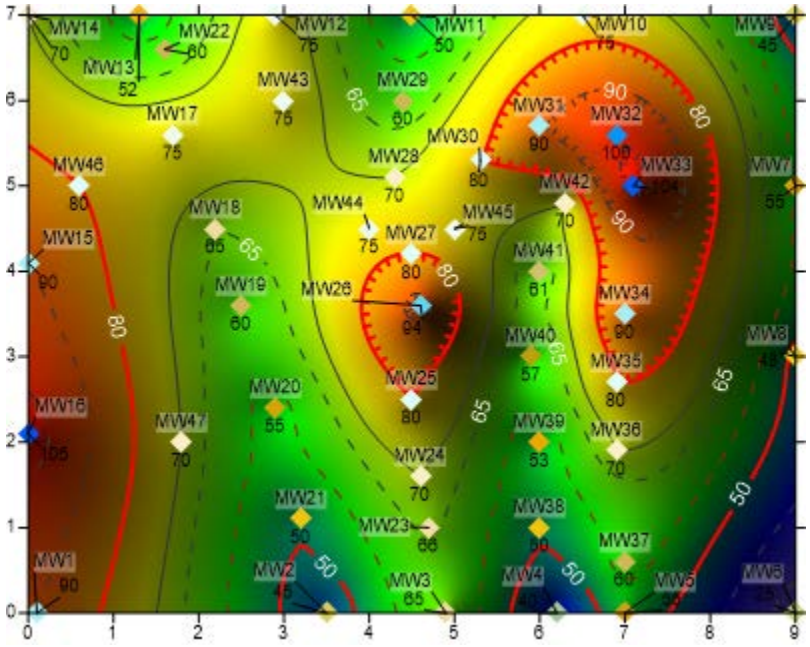


*Add labels to post maps in the **Properties** window on the **Labels** tab.*

Moving Individual Post Labels

You can move individual labels on post maps and classed post maps with the **Map Tools | Edit Layer | Post Labels** command. Alternatively, add labels, and then right-click the post map and select **Edit Post Labels** to enter edit mode. A customizable line is automatically added from the data point label to the actual X, Y data point location.

1. Select the *Post-Tutorial.dat* layer in the **Contents** window.
2. Click the **Map Tools | Edit Layer | Post Labels** command or right-click on the selected map and select **Edit Post Labels**. The cursor will change to to indicate you are now in post label editing mode.
3. Left-click on a label, hold the left mouse button down, and drag the label to a new location. With the left mouse button held down, the arrow keyboard keys can be used to nudge the label location. Release the left mouse button to place the label in the new location. A leader line will be added from the point location to the new label location by default. The leader line visibility and line properties are controlled on the **Labels** page in the **Properties** window when the post layer is selected.
4. Press the ESC key to exit the post label editing mode.



*Customize the post map labels with the **Edit Post Labels** command.*

Lesson 4 - Modifying an Axis

Every map is created with four map axes: the bottom, right, top, and left axes. 3D maps also have an additional Z axis. You can control the display of each axis independently of the other axes on the map. Additional left, right, top, bottom, or Z axes can be added to a map with the **Map Tools | Add to Map | Axis** commands. You can control the display of each axis independently of the other axes on the map. In this example, we will change the axis label spacing and add an axis title:

1. Move the cursor over one of the axis tick labels on the bottom X axis and left-click the mouse. In the status bar at the bottom of the plot window, the words "Map: Bottom Axis" are displayed. The *Bottom Axis* object is selected in the **Contents** window. This indicates that you have selected the bottom axis of the map. Additionally, blue circle handles appear at each end of the axis, and green square handles appear surrounding the entire map. This indicates that the axis is a "sub-object" of the entire map.
2. The bottom axis properties are displayed in the Properties window. Click on the **General** tab.
3. Click the ⊞ next to *Title* to open the *Title* section if it is not already open.
4. Click in the box next to *Title text*. Type *Bottom Axis* and press the ENTER key on the keyboard. This places a title on the selected axis. Alternatively, click the Σ button. Type the text in the **Text Editor** and click *OK*.
5. If you cannot see the axis title, click the **View | Zoom | Selected** command. The map automatically increases its size to fill the plot window.

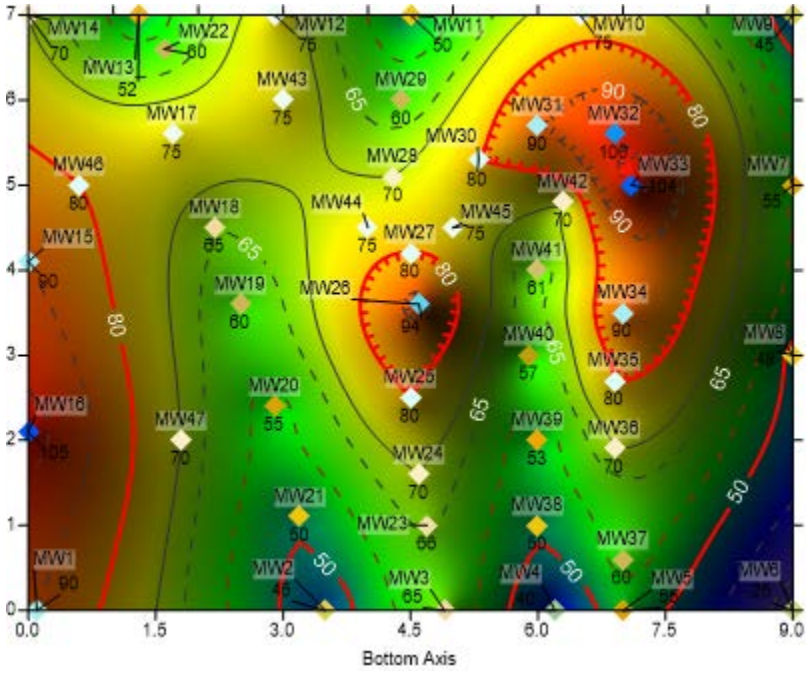
Changing the Tick Label Properties

All properties of the axis can be edited, including the tick label format and frequency. We will change both format and frequency in this example:

1. In the **Properties** window, click on the **Scaling** tab to display the axis scaling options.
2. In the *Major interval* field, highlight the value 1 and type the value 1.5.
3. Press ENTER on the keyboard to place 1.5 X map units between tick marks. This spacing automatically updates on the map axis.

4. Click on the **General** tab in the **Properties** window.
5. Click the ⊞ next to *Labels*, if it is not already open.
6. Click the ⊞ next to *Label Format* to open the *Label Format* section.
7. In the *Label Format* section, select *Fixed* for the *Type*.
8. Click in the box next to *Decimal digits.* Highlight the existing value and type the value 1.
9. Press ENTER on the keyboard. This indicates that only one digit follows the decimal point for the axis tick labels.

The map is updated immediately after every change, showing the axis tick spacing, labels, and the axis title.



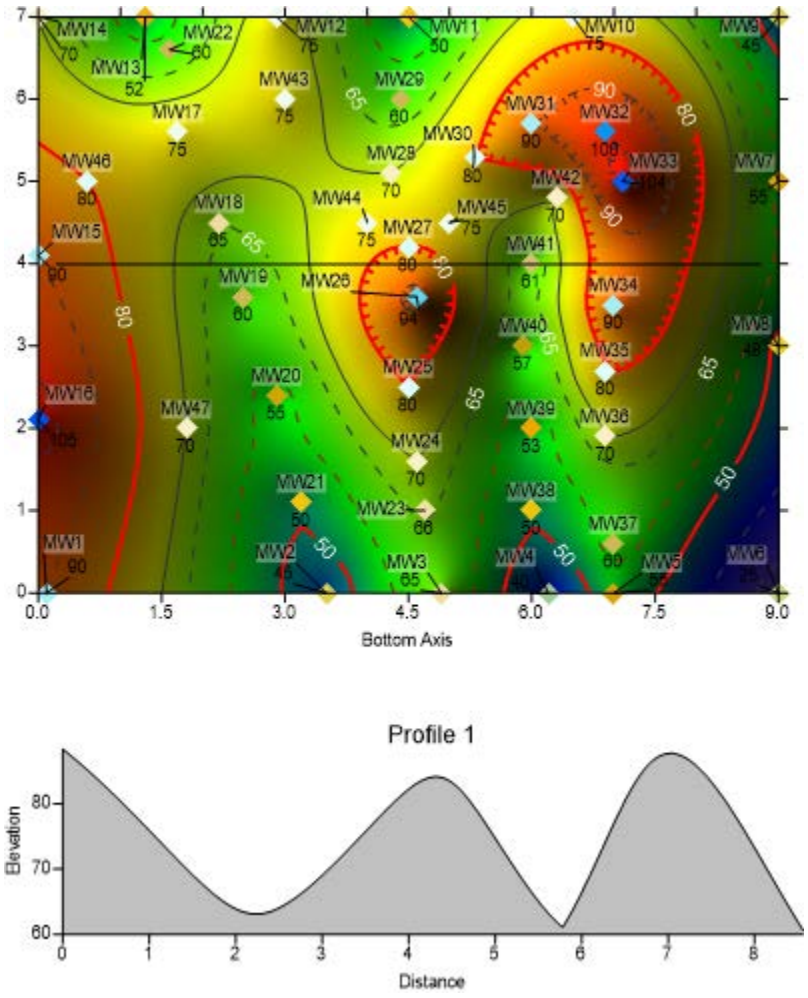
You can use the axis properties to change the tick mark and axis title properties.

Lesson 5 - Creating a Profile

The ability to slice a grid file in **Surfer** to create a file of data points along a specified line of section is a very powerful tool. The sliced data can be visually displayed as a profile in **Surfer**, or multiple profiles can be combined to display a cross section. However, if being able to quickly see the profile on the map and on a graph is the desire, the **Map Tools | Add to Map | Profile** command provides an excellent quick method. The profile line will be drawn directly on the map:

1. Click once on the *Contours-Tutorial.grd* contour layer to select it.
2. Click the **Map Tools | Add to Map | Profile** command. The cursor changes to a ⌖ to indicate that you are in the drawing mode.
3. Click inside the contour map near the (0,4) and (9,4) coordinate locations. The exact coordinates of the cursor are displayed in the status bar for reference.
4. After the second point has been clicked, a line connects the points. Press ENTER on the keyboard to end drawing mode.
5. Click the **View | Zoom | Fit to Window** command to see the entire map and profile.

The base map layer is automatically added to the contour map and the profile graph is automatically created. The properties can be edited by clicking on the *Profile 1* object in the **Contents** window and adjusting the properties in the **Properties** window.



The location of the profile is displayed on the map.
The actual profile is displayed in a graph below the contour map.

Lesson 6 - Saving a Map

When you have completed the map in the plot window, you can save the map to a **Surfer** .SRF file. **Surfer** .SRF files contain all the information necessary to reproduce the project. When you save a map as a .SRF file, all the scaling, formatting, and map properties are preserved in the file. An asterisk (*) next to the file name in the title bar and tab indicates the file has been modified and the modifications have not yet been saved.

1. Click the **File | Save** command or click the  button on the quick access toolbar. The **Save As** dialog is displayed because the map has not been previously saved. Set the *Save in* directory to any directory on your computer.
2. In the *File name* box, type *Tutorial*.
3. Make sure that the *Save as type* is set to **Surfer** Document (*.srf).
4. Click *Save* and the file is saved to the current directory with a .SRF extension. The saved map remains open and the title bar changes to reflect the name change. There is no longer an asterisk next to the file name.

If desired, the *Save as type* can be set to *Surfer 11 Document (*.srf)*, *Surfer 12 Document (*.srf)*, or *Surfer 13 Document (*.srf)* if the file is to be shared with users using **Surfer 11**, **Surfer 12**, or **Surfer 13**. After selecting the format, click *Yes* in the dialog. Any **Surfer 14** specific features are lost when saving to a previous **Surfer** version format.

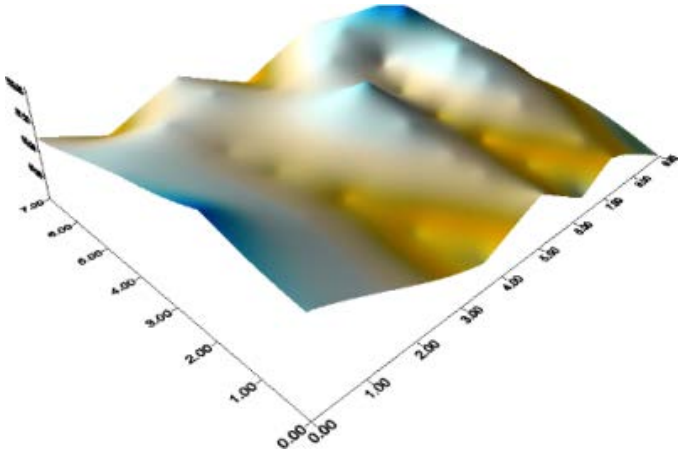
Lesson 7 - Creating a 3D Surface Map

Surfaces are three-dimensional shaded renderings of a grid file. Surfaces provide an impressive visual interpretation of data. Surfaces can be layered with other surfaces, so that the surfaces will intersect with each other. Surfaces can also have layers of other map types, excluding 3D wireframes. Surfaces allow you to generate an elevation model of your area of interest and then add layers of data on the top of the surface. You can control the color, lighting, overlay blending, and wire mesh grid of a 3D surface.

For example, if you have location (X, Y) and temperature (Z) data for a region and you have the same location (X, Y) and corresponding elevation (Z) data for the area, you could create a grid file with the Z variable being elevation and a grid file with the Z variable being temperature. You could create a 3D surface of the elevation grid to represent topography, then add a contour map of the temperature variation. You could continue to add map layers, such as a classed post map layer with the temperature collection stations that have different symbols depending on the elevation.

We are going to use the same grid file you used to create the tutorial contour map. The 3D surface map will provide a new perspective to the contour map you have already created. Although we are going to create this map in a new plot window, the surface map could easily be added to the existing plot window.

1. Click the **File | New | Plot** command or click the  button on the quick access toolbar to open a plot document.
2. Click the **Home | New Map | 3D Maps | Surface** command.
3. In the **Open** dialog, select the grid file *Tutorial.grd* from the list of files. The *Tutorial.grd* file was created in Lesson 2 - Using the Map Wizard.
4. Click *Open* and the 3D surface is created using the default settings.



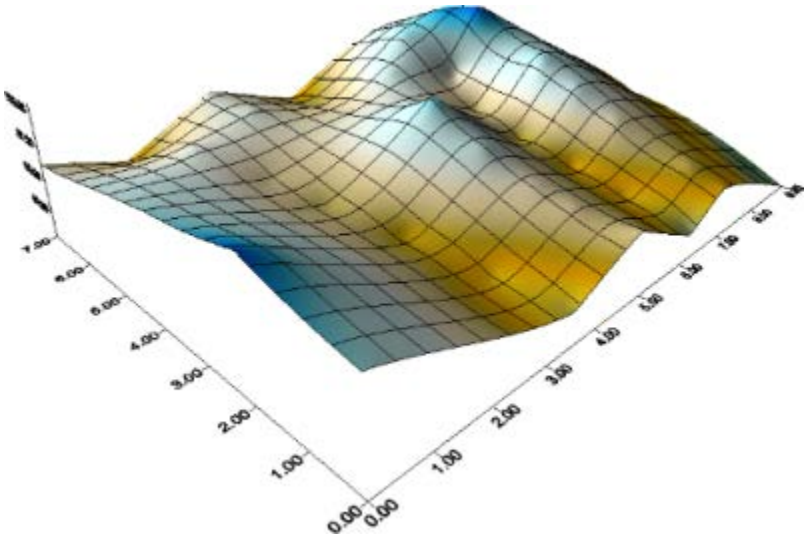
The 3D surface map shows the grid with a 3D aspect and color filled areas.

Adding a Mesh

Mesh lines can be applied to surfaces. 3D surface maps have more capability than 3D wireframe maps. 3D surfaces can be combined with more map types, and the surface map limits can be changed. Adding mesh lines to a 3D surface map simulates a 3D wireframe map. We will add a surface mesh to the map:

1. Click once on *3D Surface-Tutorial.grd* in the **Contents** window to select it. The 3D surface properties are displayed in the **Properties** window.
2. Click the **Mesh** tab.
3. Check the box next to the *Draw lines* option in both the *Lines of Constant X* and *Lines of Constant Y* sections.
4. Change the *Frequency* in both the *Lines of Constant X* section and *Lines of Constant Y* section to 5.

The mesh is automatically added to the selected 3D surface.



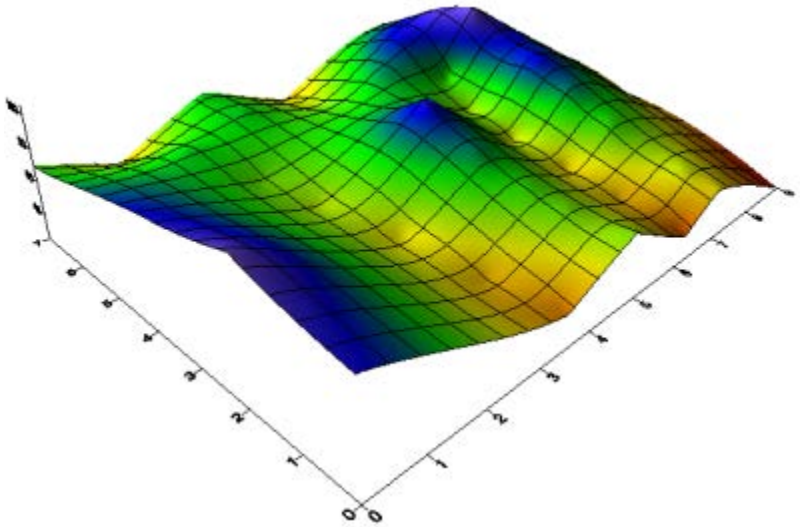
The mesh lines indicate lines of constant X and Y on the 3D surface.

Changing the 3D Surface Layer Colors

Changing color schemes on 3D surfaces is similar to changing colors on other map types such as color relief maps or contour maps. A colormap is used to load previously defined color schemes or to create your own color schemes. In this example, we will use a modified *Rainbow* colormap:

1. Click on the *3D Surface-Tutorial.grd* layer in the **Contents** window to select it.
2. In the **Properties** window, click on the **General** tab.
3. Click the ⊞ next to *Material Color* to open the section if it is not already open.
4. Click the ... button to the right of the selected colormap for *Upper*. The **Colormap** dialog opens.
5. In the **Colormap** dialog, select the *Rainbow* colormap from the *Presets* list. The *Presets* list contains a variety of predefined color schemes.
6. The *Rainbow* preset has six nodes that range from purple to red. You can add, remove, apply opacity, customize the nodes, or accept the default selections. To reverse the color order, click the *Reverse* button.
7. Click *OK* in the **Colormap** dialog to update the surface map properties with your color changes.

You can continue to experiment with the colors by selecting other color spectrums from the list next to *Upper*. Or, click the button to the right of the colormap and make changes in the **Colormap** dialog. You can experiment with selecting custom node locations and colors.



This is a 3D surface map with a mesh displayed at a frequency of five.
The 3D surface map is using the reverse of the Rainbow *color spectrum.*

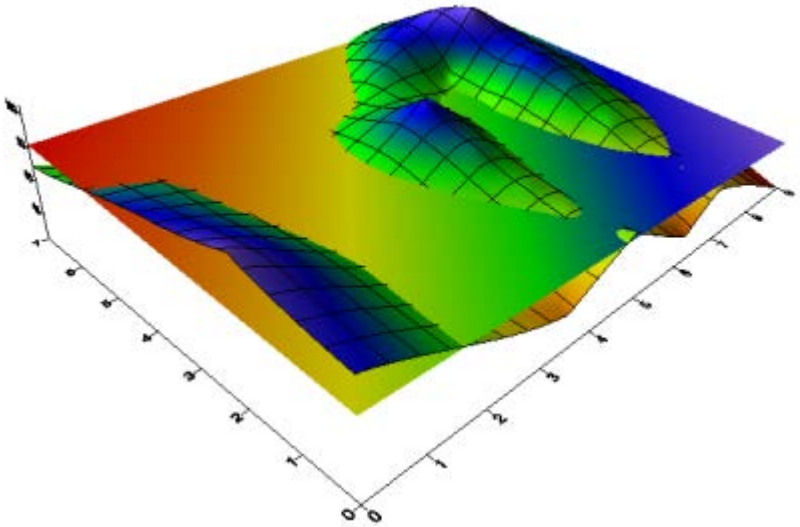
Adding a Surface Map Layer

You can add additional map layers to the 3D surface with the **Home | Add to Map | Layer** command. All map layers, except other 3D surfaces, are converted into a type of image known as a texture map. This texture map is then applied to the surface by stretching it and shrinking it as necessary. When these maps are added to the surface map, you have a choice on how to treat the texture map. You can use the colors from overlays only, from the surface only, or blend colors from the overlays and surface. For example, you could create a color filled contour map, add the contour map and surface, and then use the colors from the contour map only.

When multiple 3D surfaces of differing elevations are added, the surfaces can intersect and overlap each other. If a surface map is added to another surface map with the **Home | Add to Map | Layer | 3D Surface** command and the two maps are adjacent to each other in the X or Y direction, the surfaces are drawn side-by-side. In this example, we will add a planar layer to the surface you just created:

1. Click on the *3D Surface-Tutorial.grd* layer in the **Contents** window.
2. Click the **Home | Add to Map | Layer | 3D Surface** command, or right-click the surface map and select **Add to Map | 3D Surface**.
3. In the **Open Grid** dialog, select the planar grid, *TutorPl.grd* from **Surfer's** *Samples* directory. If you are not in the *Samples* folder, browse to it. By default, the *Samples* folder is located in C:\Program Files\Golden Software\Surfer 14\.
4. Click *Open* and the new surface map layer is added using the default settings.
5. Click on the *3D Surface-TutorPl.grd* surface map layer in the **Contents** window.
6. In the **Properties** window, click on the **General** tab.
7. Click the ⊞ next to *Material Color* to open the *Material Color* section.
8. Click on the color next to *Upper*. Select *Rainbow* in the list to match the *3D Surface-TutorWS.grd* color fill.

If you wish to save your map, click the **File | Save** command. We will create a new plot in the next lesson.



You can overlay two or more 3D surfaces. Depending on each surface's XYZ ranges, the surfaces may overlap or intersect each other. This example shows the intersection of the Tutorial.grd and TutorPl.grd sample files.

Lesson 8 - Adding Transparency, Color Scales, and Titles

The opacity of a map, image, text, line, fill, symbol, or entire layer can be customized in **Surfer**. Opacity is the amount of light that is obscured by an object. An object can be made semi-transparent by adjusting the opacity value. Reducing the opacity of an object makes other objects visible through the less than 100% opaque object. An *Opacity* value of 0% means that the object is invisible. An *Opacity* value of 100% means that the object is fully opaque.

Setting the opacity is useful when creating a semi-transparent map layer. For example, you may want to display a semi-transparent contour map layer over a satellite image base map layer so that both map layers can be seen. Being able to set the opacity of entire layers is especially useful when you have multiple layers with filled objects and you need to see all of the layers.

Creating a Filled Contour Map

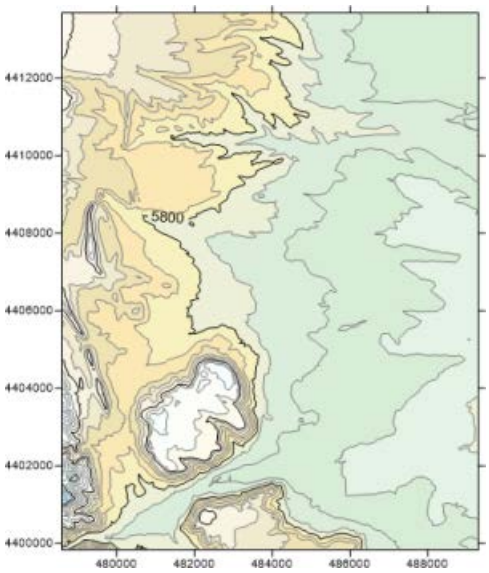
First we will create a filled contour map:

1. Click the **File | New | Plot** command or click the  button on the quick access toolbar. A new empty plot window is displayed.
2. Click the **Home | New Map | Contour** command.
3. Select the grid file *Golden.grd* from the list of files in the **Open Grid** dialog. By default, the *Samples* folder is located in C:\Program Files\Golden Software\Surfer 14.
4. Click *Open.* The map is created using the default settings. Some settings are persistent while **Surfer** is open. If you have completed Lesson 3 in the same session, the map created in this step will have uphill hachures and white-text contour labels.
5. Click on the contour map layer to select it.
6. In the **Properties** window, click on the **Levels** tab.
7. Set the *Level method* to *Simple*, if it is not already *Simple*.

8. Click the ⊞ next to *Filled Contours* to open the *Filled Contours* section, if it is not already open.
9. Check the box next to *Fill contours* to fill the contours with the default color scale.
10. Click the ⊞ next to *Labels* to open the *Labels* section, if it is not already open.
11. Click the ⊞ next to *Font properties* to open the *Font properties* section.
12. If the *Foreground color* is not *Black*, click the current color and select *Black* from the color palette.

Adding Transparency to Map Layers

You can adjust the *Opacity* value of a map layer or of individual contour fill, polygon fill, text, lines, or symbols when the appropriate object is selected. Adjusting the *Opacity* for an entire layer may be useful when you have multiple map layers and need to make one or more layers semi-transparent to best represent your data. For this example, we will adjust the opacity for the contour fill while keeping the contour lines and labels completely opaque.



The contour map is displayed with a partially transparent fill color.

1. Click on the *Contours-Golden.grd* layer in the **Contents** window to select it.
2. In the **Properties** window, click on the **Levels** tab.
3. Click the ··· button next to *Fill colors*. The **Colormap** dialog opens.
4. Click the current selection in the *Presets* list and select *Terrain*.
5. Verify the *Apply opacity to ALL nodes* check box is checked. If it is not checked, click the check box.
6. Highlight the existing *100%* value next to the *Opacity* option and type *30*.
7. Click *OK* in the **Colormap** dialog. The *Terrain* colormap and 30% opacity setting is applied to the contour layer's *Fill colors*. Notice *Custom* is displayed in the *Fill colors* field.

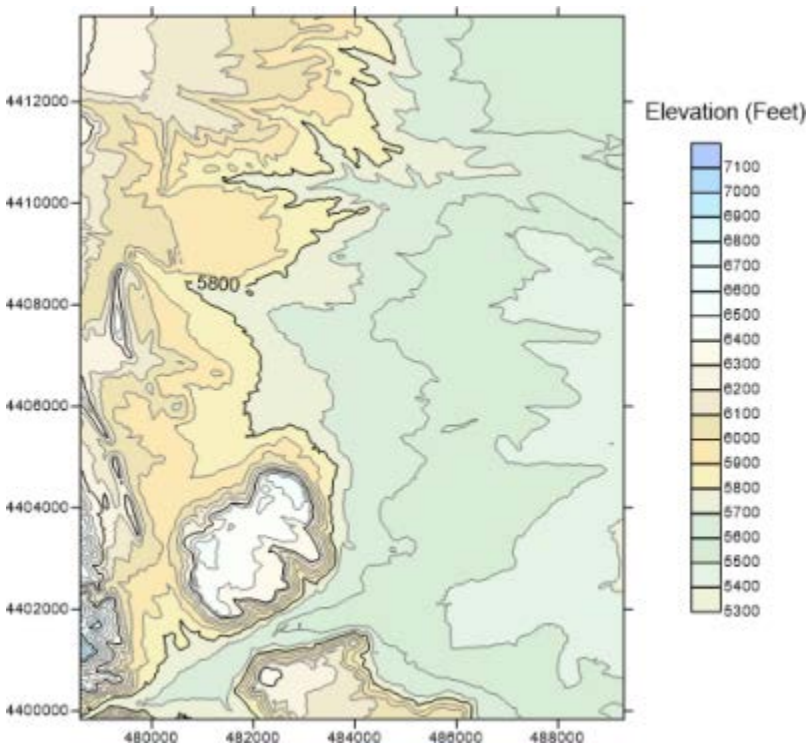
Adding and Editing a Color Scale

Color scales are legends that show the fill colors. Color scales are available for contour, 3D wireframe, 3D surface, color relief, and vector maps. The color scale displays the colors assigned to levels in a filled contour map or 3D wireframe, the colors used in a color relief map or 3D surface, and the fill assigned to vector symbols. Let's add a color scale and color scale title to the contour map

1. Click on the *Contours-Golden.grd* contour layer to select it. The properties are displayed in the **Properties** window.
2. Click on the **Levels** tab in the **Properties** window.
3. Click the ⊞ next to *Filled Contours* to open the *Filled Contours* section, if it is not already open.
4. Select the box next to *Color scale*. A default color scale is created. A new *Color Scale* object is added to the **Contents** window.
5. Click on *Color Scale* in the **Contents** window to select it.
6. In the **Properties** window, click on the **General** tab to edit the color scale properties.
7. Click the ⊞ next to *Title* to open the *Title* section, if it is not already open.
8. Click in the empty box next to *Title text.*
9. In the *Title text* field, type *Elevation (feet)*.
10. Press ENTER. The title is added with the default settings.

11. Change the title position by clicking the current selection next to *Position*. Select *Top* from the *Position* list.

Notice the color scale title moves to the top of the color scale, and the text orientation automatically changes to horizontal. The color scale has the same opacity as the contour layer when transparency is applied to the contour layer *Fill colors* colormap.

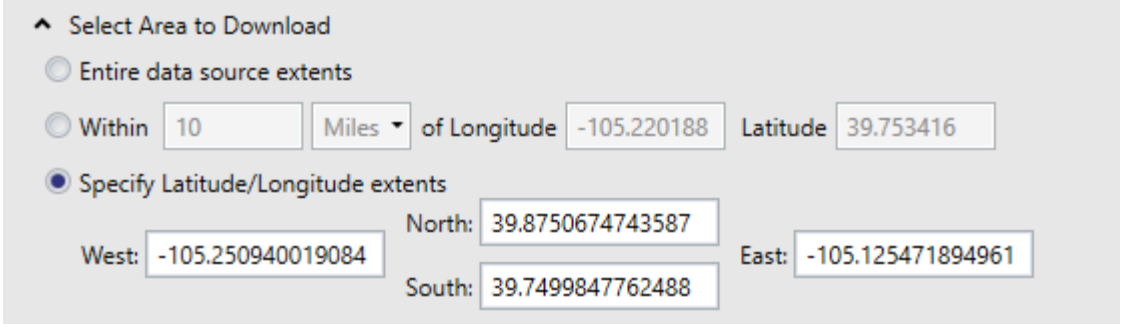


The map and color scale object are shown in this image.

Downloading an Online Base Map Layer

A base map layer can be added below the existing semi-transparent contour layer to enhance the map's appearance. To add a base map layer from an online server,

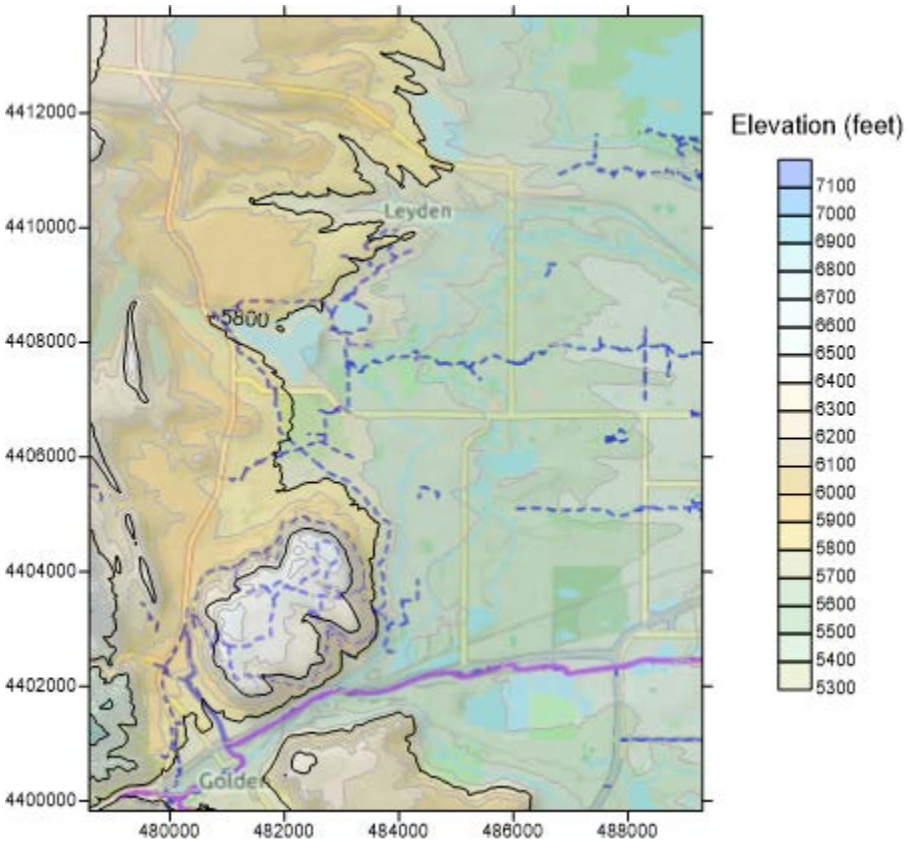
1. Click anywhere on the map to select it.
2. Click the **Home | Add to Map | Layer | Base from Server** command to download an image base map from an online server. The **Download Online Maps** dialog is displayed. **Surfer** can download base layers from WMS, OSM, and WFS servers. **Surfer** can also download grids from WCS servers.
3. In the **Download Online Maps** dialog, click the ▷ next to *OpenStreetMaps Imagery*.
4. Click the *OpenCycleMap* server in the *OpenStreetMaps Imagery* category. A preview is displayed in the preview section.
5. Notice *Specify Latitude/Longitude Extents* is selected, and the values are set to the boundaries of the *Map*. When the map coordinate system is a geographic or projected system and the **Home | Add to Map | Layer | Base from Server** command is used, the area to download will be automatically set to the map extents.



The Specify Latitude/Longitude extents values are automatically filled with the extents of the selected map.

6. For the tutorial, we will use the default setting in the *Select Image Resolution to Download* section.
7. Click *OK* and the base layer downloads. The base layer is automatically placed behind the contour layer. If a **Surfer Warning** dialog appears prompting you to adjust the map limits, click *No*.

Increasing the image resolution will increase the download size when retrieving layers with the **Download Online Maps** dialog. With some servers such as the *OpenCycleMap* server, increasing the resolution will also return a different layer than the one displayed in the preview. Feel free to experiment with different resolutions by repeating steps 2 through 9 and selecting a higher or lower resolution in step 7. You will need to hide previous base layers to view the new one. In the **Contents** window, clear or select the check box next to the *Contours-Golden.grd* or *Base-OpenCycleMap* layers to toggle the visibility of the maps on and off.



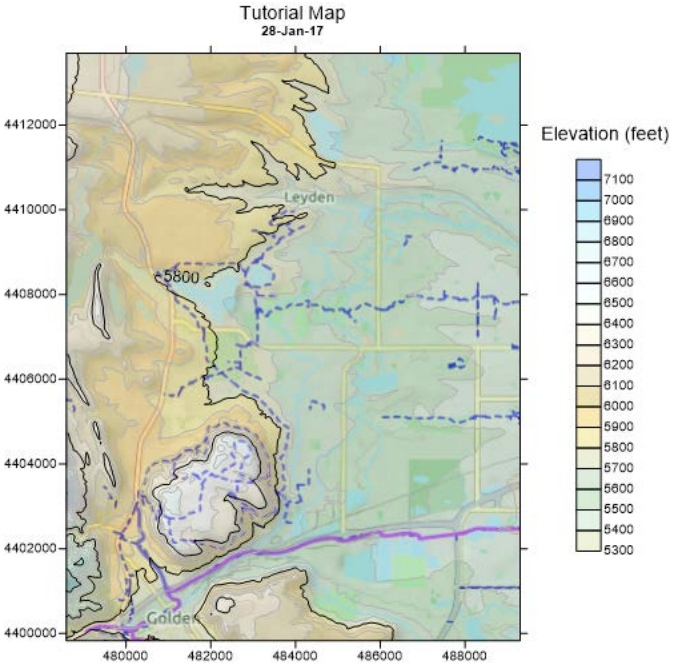
The base map is visible behind the partially transparent contour map.

Adding a Map Title

Adding a title to a map is a great way to stay organized and create publication quality maps.

1. Click once on the *Top Axis* in the **Contents** window to select it.
2. In the **Properties** window, click on the **General** tab.
3. Click the ⊞ next to *Title*, if the section is not already open.
4. In the box next to *Title text*, click the Σ button to open the **Text Editor**. The **Text Editor** provides more control over the text appearance than the **Properties** window.
5. Type *Tutorial Map* and press the ENTER key on the keyboard.
6. On the second line, we will use a dynamic predefined math text instruction to insert the current date. Click the button.
7. In the **Date/Time Format Builder** dialog, select the desired date/time format in the *Predefined date/time formats* list. For instance, select *dd-MMM-yy*.
8. Click *Insert* next to the selected date/time format in the *Predefined date/time formats* list. Notice the format in the *Date/Time format* field updates to the selected format.
9. Click *OK* in the **Date/Time Format Builder** dialog. Today's date is added to the **Text Editor**.
10. Select the date in the **Text Editor** by double-clicking the date or by clicking and dragging across the date.
11. Click the **B** button to make the highlighted text bold.
12. Select the *Tutorial Map* text.
13. Change the *Size (points)* to 14. The size is located immediately to the right of the font name.
14. Click the center justification button to center the text.
15. Click *OK* to close the **Text Editor**.

The map is automatically updated with the new map title. Save the project if you wish. We will open a new plot window in the next lesson.



This map contains a semi-transparent contour layer on top of a base layer. A color scale and title were added to the map.

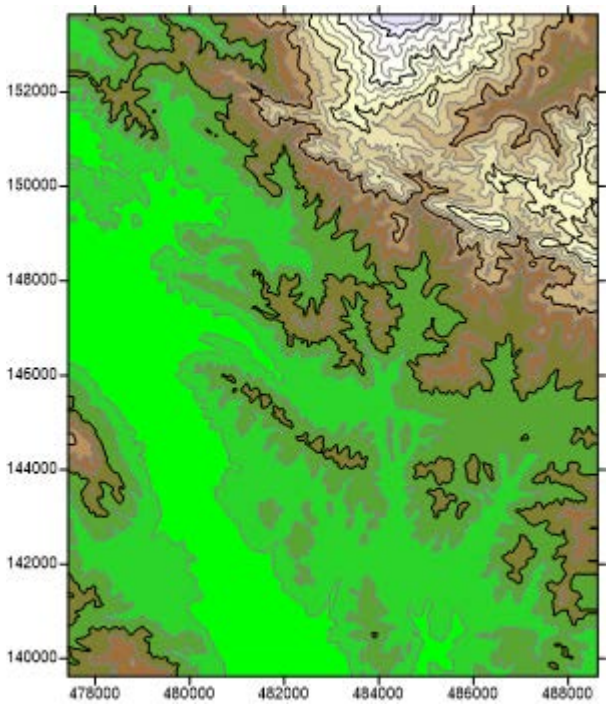
Lesson 9 - Creating Maps from Different Coordinate Systems

Map layers from different coordinate systems can be created in the same map object. **Surfer** converts the source coordinate system for each map layer to the target coordinate system for the entire map. The axes display the target coordinate system. A coordinate system is method of defining how a file's point locations display on a map. Different types of coordinate systems exist that control how the coordinates are shown on the map. In **Surfer**, a map can be unreferenced in local coordinates, referenced to a geographic lat/long coordinate system, or referenced to a known projection and datum.

Creating the First Map

First, we will create a map with a defined coordinate system in **Surfer**:

1. Click the **File | New | Plot** command to open a new plot window.
2. Click **Home | New Map | Contour** to create the map with a contour layer.
3. In the **Open Grid** dialog, click on the *Diablo.grd* file from **Surfer's** *Samples* folder. If you are not in the *Samples* folder, browse to it. By default, the *Samples* folder is located in C:\Program Files\Golden Software\Surfer 14.
4. Click *Open*. The contour map is created.
5. Click on *Contours-Diablo.grd* in the **Contents** window to select the contour layer.
6. Click the **Levels** tab in the **Properties** window. Set the interval, fill, and contour lines properties for the contour map using the methods described in Lesson 3 and Lesson 8.
7. In the **Properties** window, click on the Coordinate System tab. Note that the contour map layer was imported with a coordinate system already specified. This map layer is in the *State Plane 1927 - California III (Meters)* coordinate system.

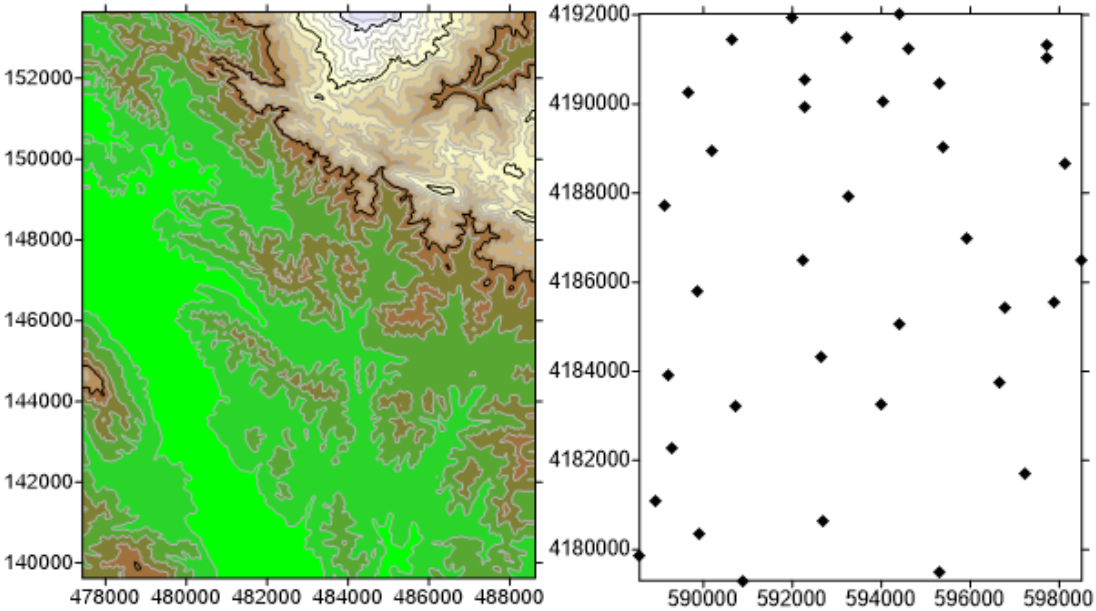


The first map layer is created with a predefined coordinate system.

Adding a Post Map Layer

Maps can be created without predefined coordinate systems and assigned the correct coordinate system in the layer properties.

1. Create a new post map with the **Home | New Map | Post** command.
2. In the **Open Data** dialog, select the *Diablo Example.dat* file in the **Surfer** *Samples* directory. If you are not in the *Samples* folder, browse to it. By default, the *Samples* folder is located in C:\Program Files\Golden Software\Surfer 14.
3. Click *Open*.
4. Click on the *Map* in the **Contents** window that contains the post map to select it.
5. Click and drag the map in the plot window to move the post map. Move the post map until the two maps are side by side. Note that the axes on the two maps have very different coordinates.
6. Click on *Post-Diablo Example.dat* in the **Contents** window to select the post layer.
7. In the **Properties** window, click on the **Coordinate System** tab. Note that the post map does not have a predefined coordinate system.
8. Click the *Set* button to define the coordinate system for the post map. The **Assign Coordinate System** dialog is displayed. Since we know this coordinate system, we can set it.
9. We can use the search bar to reduce the number of projections listed in the **Assign Coordinate System** dialog, since we know the map coordinate system. In the *Search for text or EPSG code* box, type *UTM Zone 10N*.
10. Press ENTER or click the  button.
11. In the **Assign Coordinate System** dialog, click the ⊞ next to *Predefined* to open the *Predefined* section.
12. Click the ⊞ next to *Projected Systems* to open the *Projected Systems* section.
13. Click the ⊞ next to *UTM* to open the *UTM* section.
14. Click the ⊞ next to *North America* to open the *North America* section.
15. Click on the *North America NAD27 UTM Zone 10N* coordinate system to select it.
16. Click *OK*. On the **Coordinate System** tab, the post layer shows the defined coordinate system next to *Name*.



The two maps are displayed side by side with very different coordinates displayed on the axes.

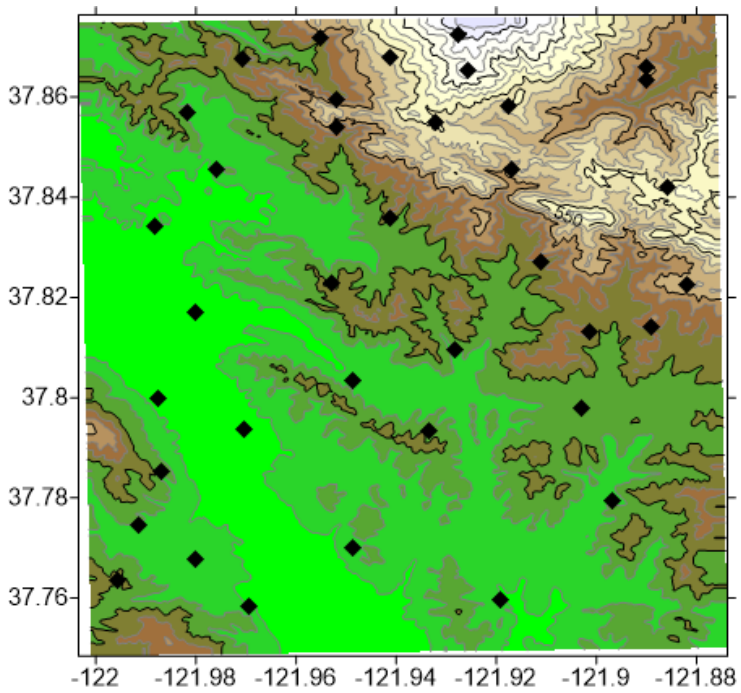
17. In the **Contents** window, click and drag the *Post-Diablo Example.dat* layer into the *Map* just above the *Contours-Diablo.grd* map layer. The two map layers are now overlaid. You can see the posted symbols are located on the contour lines, despite the different coordinate systems.

Setting the Target Coordinate System for the Map

The target coordinate system is the system displayed in the plot and on the map axes. Once all map layers are defined, the target coordinate system can be changed to any desired coordinate system.

1. Click on the *Map* object in the **Contents** window.
2. In the **Properties** window, click on the Coordinate System tab.
3. Click the *Change* button.
4. In the **Assign Coordinate System** dialog, click the ⊞ next to *Predefined* to open the *Predefined* section.
5. Click the ⊞ next to *Geographic (lat/lon)* to open the *Geographic (lat/lon)* section.
6. Click on *World Geodetic System 1984* near the bottom of the list to select it.
7. Click *OK*.

The map now has a different coordinate system than either the contour or post map layers on the **Coordinate System** page. Notice that the axes are now showing latitude and longitude values as well. In the above section, we did not use the search function in the **Assign Coordinate System** dialog. When searching in the **Assign Coordinate System** dialog, the search string must exactly match a portion of the desired coordinate system name or EPSG code. However, the search string does not need to be the complete name or EPSG code. For example, searching for *System 1984* will return the *World Geodetic System 1984* coordinate system, but searching for *World 1984* returns no results.



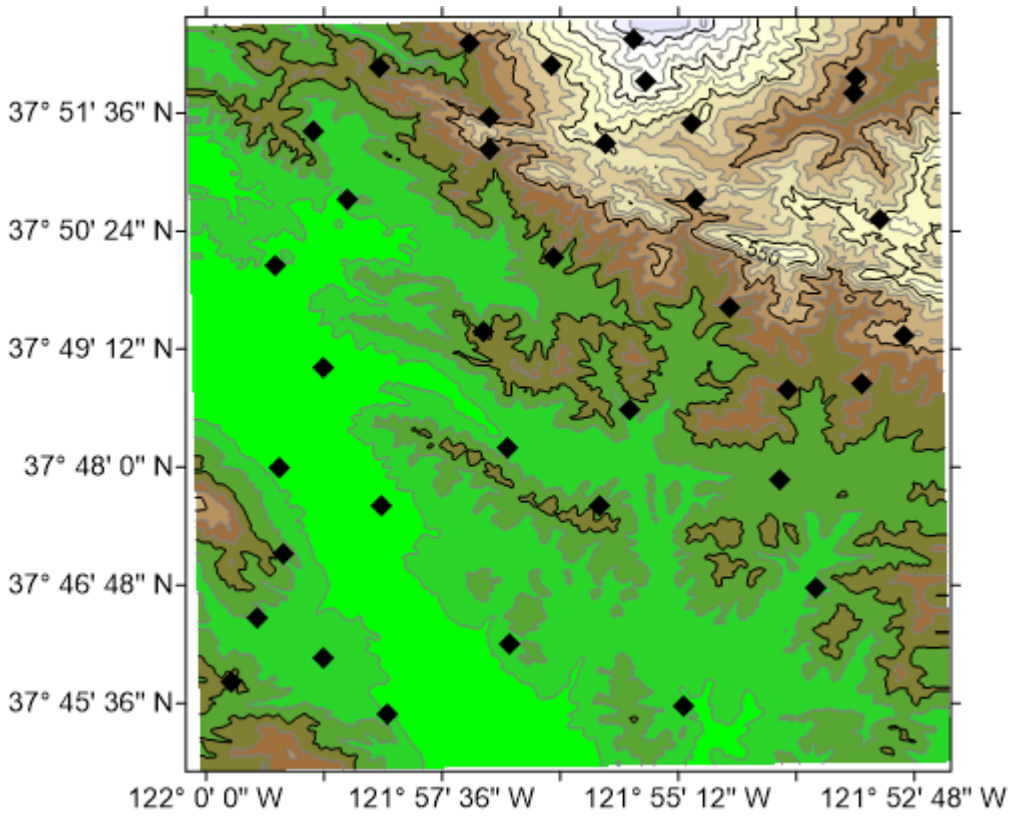
The map axes now display latitude and longitude coordinates.

Changing the Axis Label Format

The axis labels can be displayed in a variety of number formats. We will change the axis labels to Degrees, Minutes, Seconds format.

1. Click on the *Left Axis* object in the **Contents** window.
2. In the **Properties** window, click on the **General** tab to view the **General** page.
3. Click the ⊞ next to *Labels* if the *Labels* section is not already open.
4. Click the ⊞ next to *Label Format* to view the *Label Format* properties.
5. Click the current selection next to *Type* and select *DMS (Lat/long)* from the list.
6. Click on the *Bottom Axis* object in the **Contents** window.
7. Repeat steps 2 through 5 for the *Bottom Axis*.

The axis labels are now in Degrees, Minutes, Seconds format. Many additional edits can be made to the map. You can continue to experiment with the various coordinate systems or editing any portion of the map layers.



The final map contains two overlaid layers, each with different source coordinate systems. The axis labels are in Degrees, Minutes, Seconds format.

References

Surfer ® 13 Quick Start Guide

Surfer ® 13User's Guide

https://support.goldensoftware.com/hc/enus/articles/231472848-What-Surfer-training-videos-are-available-and-where can-I-find-them

Al-Karkh University for Sciences
College of Remote Sensing and Geophysics
Geophysics Department

Didger

Lecture SIX

by

Dr. Rami M. Idan

Introduction

Didger: is a digitizing; image and warping; and coordinate conversion software. You can digitize maps, aerial photographs, graphs, well logs, or any other data with **Didger.** When working with your project, you can digitize onscreen with your computer's mouse, a digitizing tablet, or even digitize with a GPS unit.

Didger provides extensive flexibility in working with your data. It supports creating multiple layers to help to organize your project, warping images, georeferencing images, mosaicking georeferenced images, overlaying vector or data files on georeferenced images, adding graticule (a network of lines representing meridians and parallels, on which a map or plan can be represented) or grid lines to your project, and associating up to 256 data values or text identifiers to each object. **Didger** also includes comprehensive editing tools for digitized objects and images. Data transformation and coordinate conversion capabilities, in addition to over 25 map projections, easily permit re-projection or recalibration of data. **Didger** also imports and exports data, vector, and raster files in the most popular formats.

What is Digitizing?

It is the process of transferring paper document information, image file information, or GPS data to your computer as digital data. This is accomplished with the use of a digitizing tablet, scanner, mouse, or a GPS unit and software such as **Didger.**

By providing the computer with the coordinate necessary to define object locations in relation to other objects, you can create a file of object locations. Object locations are defined by XY coordinates, such as latitude/longitude, UTM (Universal Transverse Mercator), State Plane, or any type of coordinate system. In addition, with **Didger** you can associate text and data with the objects that you digitize.

Usage Examples

The following are a few examples of ways to use **Didger.**

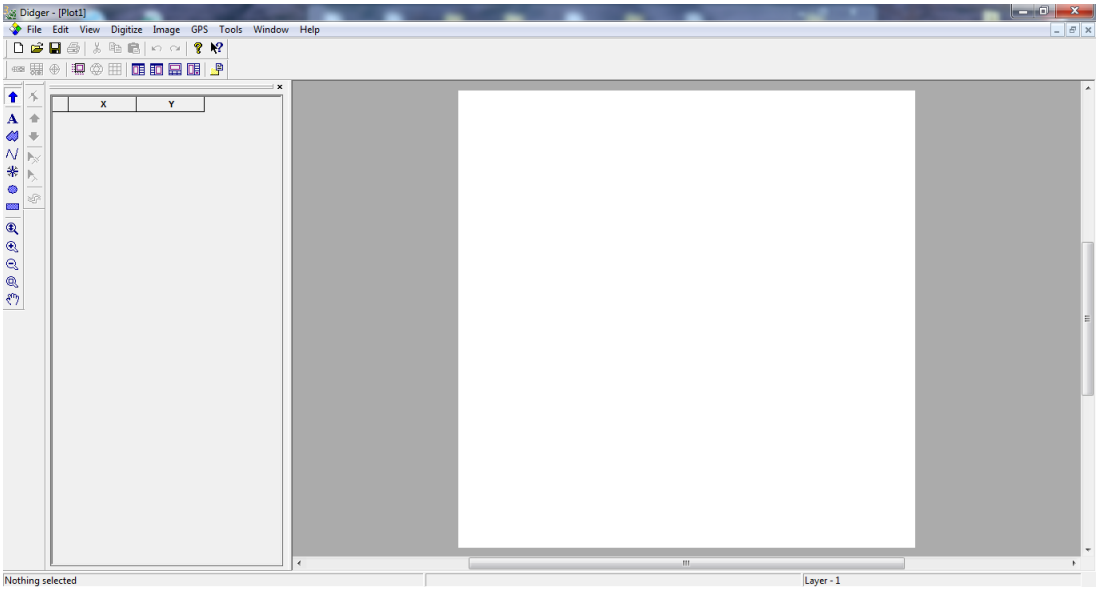
- Digitize contour maps from topographic sheets or hand drawn maps.
- Obtain data from graphs, such as well logs, when you do not have the original data.
- Digitize sample locations, such as oil and gas wells, and

associate them with data Digitize boundaries such as township and range lines or property boundaries Georeference scanned images, aerial photographs, or satellite images.

- Warp images to show their true scaling.
- Digitize points, polylines, or polygons from aerial or satellite photographs Digitize radiation dose calculations from patient films in the medical industry Map archeological sample sites from field maps.
- Digitize geological information from paper maps, aerial photos, or hand drawn cross sections.
- Digitize road and street maps to obtain route length information Digitize wildlife study information such as migratory areas for birds Digitize vegetation boundaries, burn areas, and lumbering areas Determine the area under a curve of a printed graph.
- Resample well log data on regular intervals.
- Digitize seismic section lines with shot point locations Create **Surfer** base maps.
- Merge vector files, georeferenced images, and data files from various data sources into one project.

Didger User Interface

The Didger user interface consists of the title bar, menu bar, toolbars, plot window, managers, and status bar.



Didger Objects

You can transfer paper document information, image file information, or GPS data into a digital format usable by other computer applications with **Didger. In Didger,** you can digitize points, polylines, polygons, circles, rectangles, spline polylines, spline polygons, wrapped polylines, and text from your source documents and associate information such as numeric data with each digitized object. This information can then be exported for use in other programs. You can digitize with a digitizing tablet, a GPS, or with your computer's mouse.

Points:

Points are isolated locations that indicate objects such as well locations, sample locations, benchmarks, and so on. In **Didger,** polygon markers are a special type of point. Post maps, created by importing a data file, also consist of points.

Polylines:

Polylines indicate objects such as roads, streams, and contours. A polyline consists of one or more line segments joined end to end. Poly lines, unlike polygons, are not closed. The beginning and ending points of a polyline are called nodes, and the intermediate ends to each line segment are called vertices. Polyline nodes are displayed as green (beginning) and red (ending) boxes when the *Show Line Nodes* box is checked in:

File I Project I Settings I Tolerance Settings.

Polylines are also called curves or lines. In **Didger,** spline polylines and wrapped polylines are special types of polylines.

Polygons:

Polygons are closed shapes used to represent boundaries such as county or state outlines. Polygon perimeters are defined by a series of straight-line segments joined end to end. A polygon contains at least three line segments, and the beginning of the first line segment is joined to the end of the final line segment to achieve closure. Vertices define the end of each straight- line segment along a polygon. In **Didger,** rectangles, circles, and spline polygons are special types of polygons.

Text:

Text is not associated with other objects and is created for display purposes only. Text objects are not generally used for analysis. The information stored for text includes a text string, the location at which it is displayed, and formatting (color, font, size, etc.).

Images
Raster images, such as a JPG or TIF, are displayed as an array of dots or pixels and contain information on every pixel. The resolution of an image changes when the image is resized or stretched.

Digitizing Objects:

In general, to digitize an object you select the object type from the **Digitize** menu or selected, use the **Property Inspector** to set options such as line color, symbol type, and IDs. Click with the mouse or digitizing puck to create the object. Note that the object properties can also be changed after the object is digitized. The tutorial contains detailed steps on digitizing objects.

Object Properties
Each object contains properties. These properties are viewed, set, and edited through the **Property Inspector.** Refer to the *Property Inspector* topic in the online help for details on using the **Property Inspector.** When a change is made in the **Property Inspector** before digitizing the object, it becomes the default property until the property is changed again.

Item Properties
In the **Property Inspector,** the *Item Properties* section varies depending on the object type. The possible item properties include *Layer, Visible, Length, Area, Point Count, Direction, Image Width, Image Height, Color Format, Geo-Referenced, Clipped Image,* and *File Name.*
Most of these properties are read-only. The *Layer* lists the current layer on which the object exists. The object can be moved to another layer, if other layers exist, by clicking on the current layer name and selecting a new layer from the list. The *Visible* property can be changed between visible *(True)* and invisible *(False).*

Data Attributes
The *Data Attributes* section in the **Property Inspector** includes the object IDs. By default, each object can have a *Primary ID, Secondary ID, Third ID,* and *Fourth ID.* Additional IDs can be added through:
File - Data Attributes.
Symbol Properties
Use the options in the **Property Inspector's** *Symbol Properties* section to choose the type of marker you want to use to represent points. You can change the *Symbol, Symbol Set, Color,* and *Size* in the *Symbol Properties* section. **Didger** includes several symbol sets for common types of digitizing projects.

Line Properties

Line properties are available in polylines, polygons, rectangles, circles, spline polylines, spline polygons, and wrapped polylines. In the **Property Inspector's** *Line Properties* section, you can change the line *Style, Color,* and *Width* for all objects listed above.

Polylines, spline polylines, and wrapped polylines contain the arrowhead options *Start Style, End Style,* and *Scale.* In addition, you can create custom line styles. Refer to the online help topic, *Custom Line Style,* for additional information on creating custom line styles.

Fill Properties

Fill properties are available in polygons, rectangles, circles, and spline polygons. The **Property Inspector's** *Fill Properties* section contains the pattern *(Pattern),* colors *(Foreground/ Background),* transparency *(Mode),* vector and picture pattern scale *(Scale),* and image fill method *(Cover Areas by).* You can create custom fill patterns in addition to the several fill patterns that are included with **Didger.** Refer to the *Custom Fill Pattern* topic in the online help for information on creating custom fill patterns.

Label Properties

In the **Property Inspector,** use the options in the *Label Properties* section to add, position, and format labels. Click *<Click here to modify the labels>* next to *Modify Labels* to open these options.

Text Properties

Use the options in the **Property Inspector's** *Text Properties* section to create and format text. Note that you can add subscripts, superscripts, date/time, and set up formulas with the **Text Editor.** Click *<Click here to modify the text>* next to *Modify Text* to open the text formatting options.

Editing Tools

Didger provides many tools for modifying objects, including images. Many advanced editing opera tions help refine newly created objects.

Editing Polylines, Polygons, and Points

Once a polyline, polygon, circle, rectangle, spline polyline, spline polygon, or wrapped polyline is digitized, it can be edited with one of several commands in the Tools menu. The following sections contain brief descriptions of the editing tools. For more detail, refer to the online help.

Reshape:

The Tools to reshape command or the button lets you move, add, and delete vertices within a selected polyline, polygon, circle, rectangle, spline polyline, spline polygon, or wrapped polyline. This command is available only when a sing le object is selected. Note that an object can also be reshaped by selecting it and then editing the vertex coordinates in the Coordinate Manager.

Resample Polyline:

The Tools - Resample Polyline command allows resampling along either the X or Y axis of a selected polyline, spline polyline, or wrapped polyline. The project must be calibrated with Cartesian coordinates to use this command. Resample Polyline is designed specifically for well log resampling to create a data value at specified depth increments.

This function is not designed to work with polygon-type objects or polylines that loop back on themselves. The polylines should have X or Y values that are ordered and are ascending or descending. If your data are not arranged this way, use the Tools - Thin and Smooth command instead.

Polygon to Polyline

The Tools - Change Boundary Type [Polygon to Polyline command] converts selected polygons into polylines by breaking the polygons at the first and last points defined for the polygons. The new polylines use the original polygon IDs and assume the currently defined line properties.

Connect Polylines

The Tools - Edit Boundaries - Connect Polylines command joins two or more selected polylines into a single polyline. You must select two or more polylines for this command to be active. Polylines are joined by connecting the two closest nodes. The polylines do not have to be within snap tolerance of each other. The line style, width, and color of the new polyline are set to the default settings. After the polylines are connected, one of the polyline's IDs is applied to the joined polyline.

Image Editing Tools

Several tools are available to modify images. Typically, you need to use some of the Processing Filters before vectorizing an image with mage I Vectorize mage.

Image Registration and Warping

The mage - mage Registration and Warping command lets you check the calibration of an image, recalibrate an image, or georeferenced un-referenced image.

Resize Image

The **Image - Resize Image** command changes the image size based on pixels, inches, or resolution.

Mosaic

The **Image - Mosaic** command assembles image files from adjacent areas into a seamless single image file.

Change Color Format

The **Image - Change Color Format** command changes the current color depth of an image.

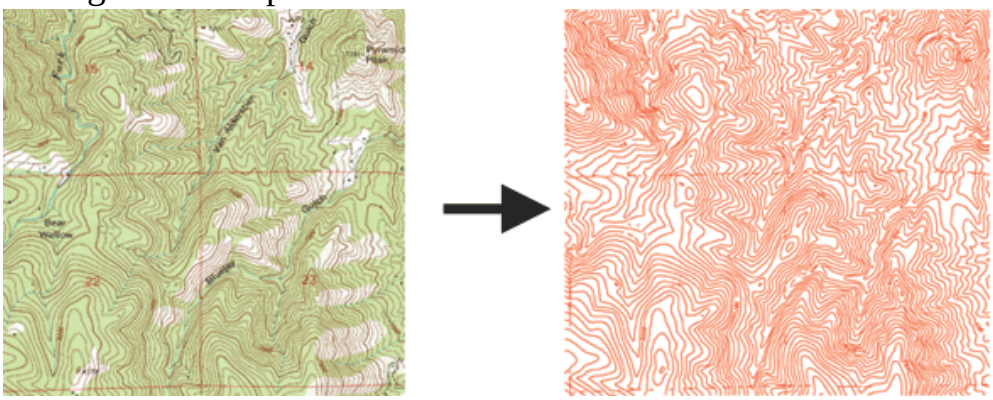
Modify Image Colors

The **Image - Modify Image Colors** command modifies the colors and makes colors transparent in an existing image.

Digitizing Options

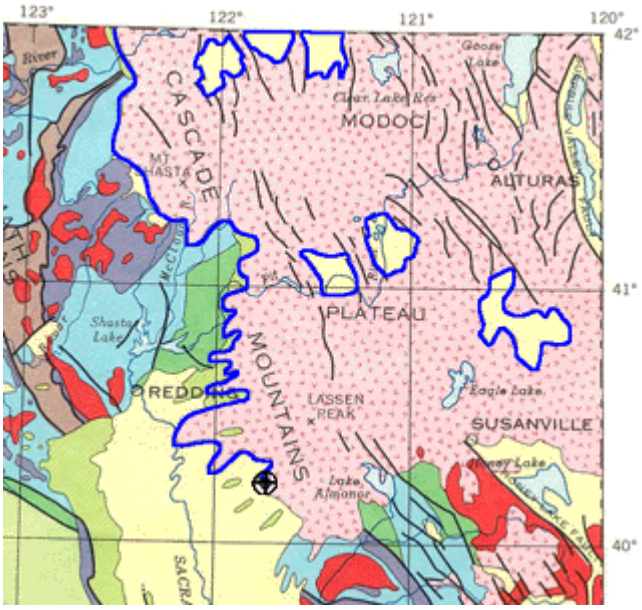
The process of creating new digital information often starts with a paper map, graph or log, or a digital image such as an aerial photo, satellite imagery or scanned paper map. Didger provides an easy and complete solution to digitize vector data from your source documents and files by using a powerful set of manual and automatic tools. You can digitize text, points, polylines, polygons, rectangles, circles, spline areas, spline polylines, and wrapped polylines. Didger supports four ways to digitize information:

1. Full Automatic Digitizing: Didger supports advanced raster to vector conversion for automated map digitizing! This means that one command will automatically convert your scanned map, image, or drawing to vector formats quickly and at high quality. This eliminates the need for slow and inaccurate manual digitizing of detailed lines – let Didger do it for you! The lines and polygons are extracted and displayed right on top of the image for you to verify and edit. Didger also boasts a full line of preprocessing options for finer control over the vectorization process so you can get the best possible results.



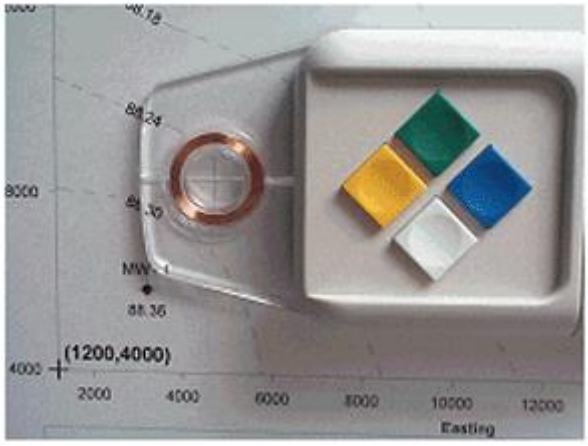
A georeferenced USGS Digital Raster Graphic was imported into Didger 4 (left). The contour lines were detected and automatically vectorized to red polylines (right).

2. Manual Onscreen Digitizing! You can perform onscreen digitizing using an imported vector file or imported image file. Performing heads-up digitizing has never been easier. You simply draw the object on the screen using your mouse. You can zoom in and out, or pan the screen while digitizing so you can always see clearly what you want to digitize.



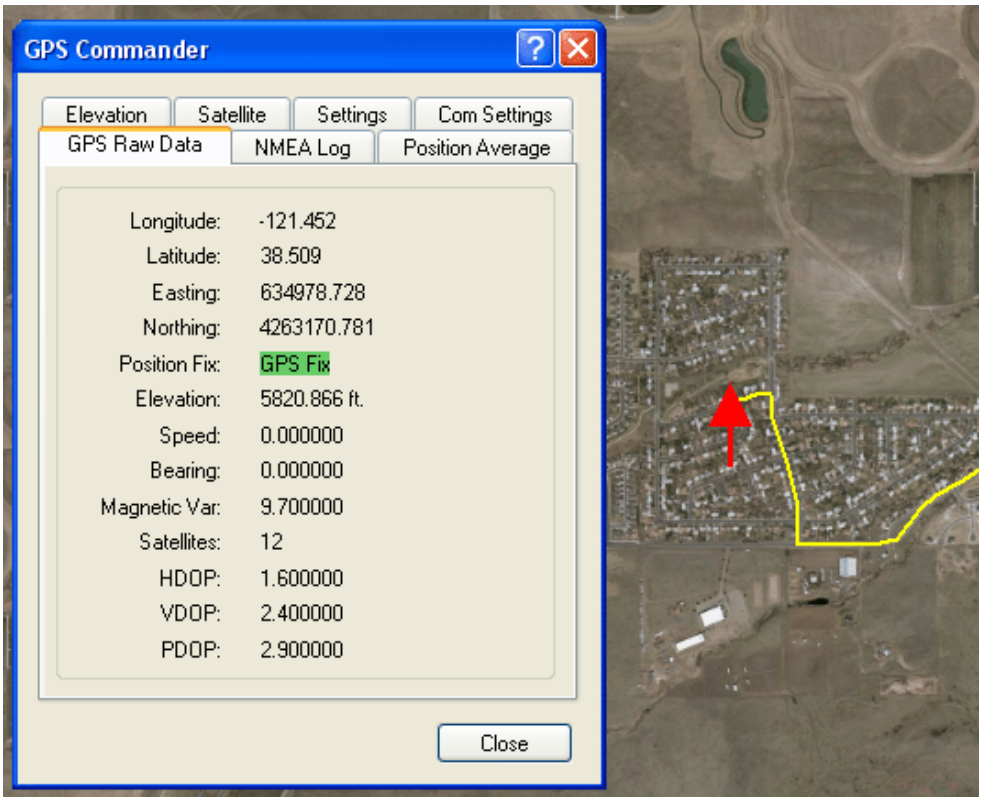
In this example, the boundary of the Modoc Plateau in Northern California being digitized in blue from a calibrated raster image of the geology of California.

3. Tablet Digitizing! You can digitize hard copy documents using any Wintab32 compatible digitizing tablet. Nearly all digitizing tablets work with Didger. Simply put the document on the tablet, step through the intuitive Tablet Calibration Wizard to define a coordinate system, and you are ready to go!



You can digitize paper documents with a digitizing tablet and a puck or stylus.

4. GPS Digitizing! Any NMEA compatible GPS device connected to your computer's serial port can be used as a digitizing device in Didger. Once the GPS is set up to communicate with Didger, you can begin digitizing over any map. Use the GPS for a "moving map" effect to automatically move the map as you travel. You can use your GPS unit to digitize your position, well locations, fence lines, roads, streams, drainage lines, tree lines, crop boundaries, sample locations, trails, or track your route real-time directly onto your map.

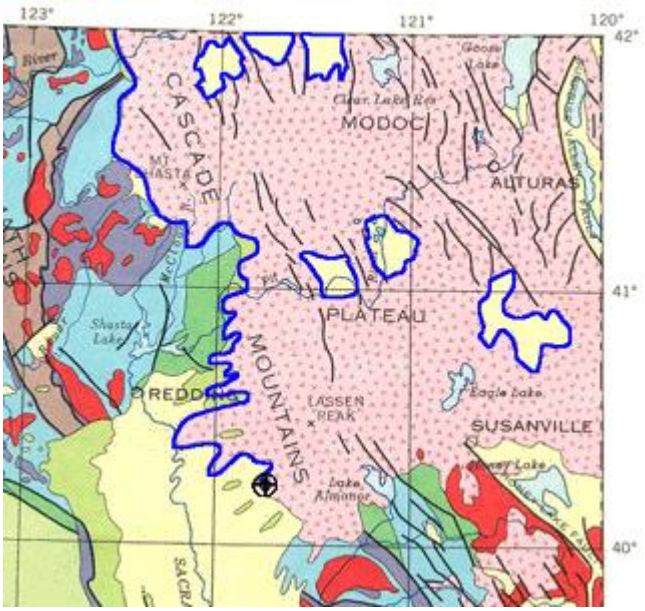


Digitize points, polylines, and polygons with your GPS unit! View your current elevation, see the current position of the satellites that are being used for a lock, display the raw data being sent from the GPS, and set the GPS input datum in the GPS Commander dialog box.

Raster Based Maps

With Didger you can perform onscreen digitizing using an imported bitmap or an image you scanned using Didger's scanning functionality. Performing "Heads-Up" digitizing has never been easier. Didger has all the functionality necessary to import or scan in a bitmap and calibrate the image in real world coordinates using one of ten georeferencing methods.

Once the image has been calibrated, Didger allows you to digitize points, polylines, and polygons with ease. You can export the digitized objects with the image in GeoTIFF format. Or, simply export the digitized objects without the underlying bitmap and still retain the georeferencing information. Use the numerous bitmap filtering options on the bitmap to make identifying and digitizing the objects a breeze.



The graphic above shows the boundary of the Modoc Plateau in Northern California being digitized in blue from a calibrated raster image of the geology of California.

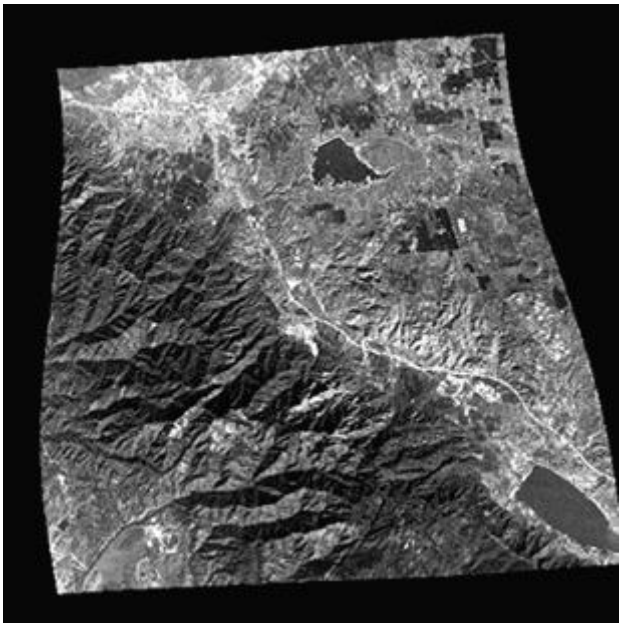
Georeferenced Raster Based Maps

A georeferenced raster image retains all georeferencing parameters. When you import a georeferenced raster image, you can skip the calibration process and start digitizing immediately. You can import a georeferenced raster image into a vector or a raster project.

If you import a georeferenced bitmap into a vector project, you can overlay it with other data or vector files or tile it with other georeferenced bitmaps.

Import georeferenced bitmaps into a vector project and then overlay it with data and vector files.

If you import a georeferenced bitmap into a raster project, you can convert the projection of the bitmap (if it contains a projection) or you can warp (rubber sheet) the image to fit your calibration points.



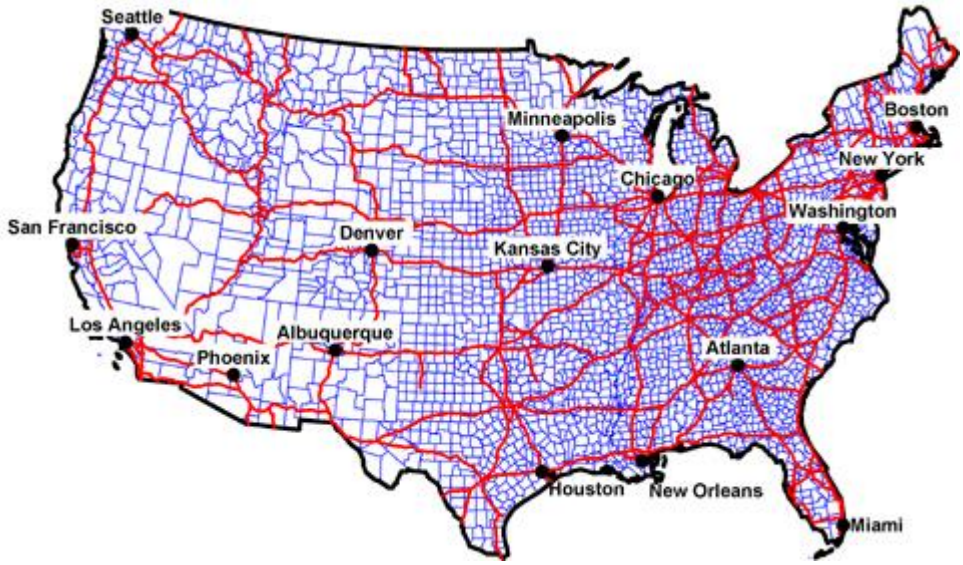
Import a bitmap into a raster project, calibrate it, and warp it to fit the calibration points.

Didger also supports importing and/or exporting ESRI World Files [TFW] and Blue Marble [RSF] files when exporting georeferenced bitmaps. Thisis a powerful and advanced feature of Didger.

Vector Based Maps and Data Files

With Didger you can import a variety of vector based maps and data files in many formats. Create large coverages easily by importing several vector or data files into one project. The files will align according to their coordinate systems. Digitize new features onto an existing vector plot from your digitizing tablet and map, or digitize onscreen. Change line styles, object IDs, and add labels to objects with ease. Even import different files onto separate layers!

If the files are projected and contain different projection information, they will be converted to the projection of the first imported file using a datum transformation. You can also convert vector or data files from one projection to another.



Advanced Editing Features

- Create line intersections from overlapping polylines.
- Snap undershoot polylines and trim overshoot polylines.
- Create polygons by using a polygon locator in the center of linked polyline objects.
- Reshape polylines and polygons.
- Create complex polygons.

- Thin and smooth polylines using one of four different methods.
- Resample polylines to specified intervals.
- Break or Trim polylines.
- Convert polylines to polygons and vice versa.
- Connect polylines.
- Create polygons by locator or by ID.
- Merge two polygons together, or create a polygon from the intersection of two polygons.
- Combine, split, and/or reverse islands and lakes.
- Select up to 256 colors to be transparent for a bitmap.
- Sharpen bitmaps, or adjust the brightness, contrast, and saturation.
- Apply Median or Spatial filters to bitmaps.
- View the coordinates of selected objects in the Coordinate Manager.
- Edit the coordinates of selected objects in vector projects in the Coordinate Manager.

Import and Export Formats

Many sophisticated import and export filters come with Didger, simplifying the transfer of your data and images to and from your other applications.

- Spatially Referenced formats: GeoTIFF, TFW, and RSF.
- Vector Import formats: EMF, GSI, GSB, BNA, DLG, LGO, LGS, DXF, PLT, BLN, CLP, WMF, SHP, MIF, DDF, E00.
- Raster Import formats: TIF, BMP, TGA, PCX, GIF, WPG, DCX, EPS, JPG, PNG, PCT.
- Data Import formats: XLS, SLK, DAT, CSV, TXT, BNA, WKx, WRx, BLN.
- Export formats: LAS, EMF, GSI, GSB, DAT, DXF, SHP, BLN, BNA, GIF, BMP, WMF, CGM, MIF, CLP, TIF, TGA, PCX, WPG, PNG, JPG, PCT, DCX.

References:

http://www.ssg-surfer.com/ssg/detailed_description.php?products_id=133

Didger Getting Started Guide, Copyright Golden Software, Inc. 2007.

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Geophysics Department

Grapher

Lecture SEVEN

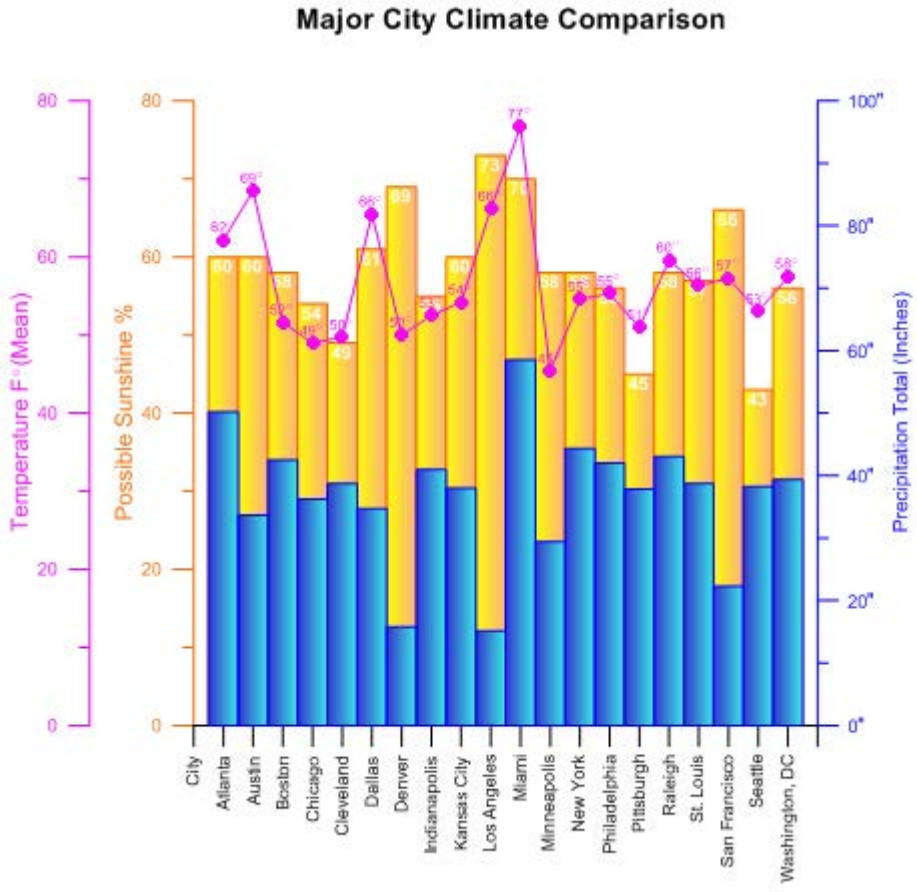
by

Dr. Rami M. Idan

Introduction to Grapher

Welcome to **Grapher™**, the easy-to-use technical graphing package for scientists, engineers, business professionals, or anyone who needs to generate publication quality graphs quickly and easily. **Grapher** is an efficient and powerful graphing program for all of your most complex graphing needs. Create exciting graphs and plots for presentations, papers, marketing, analysis, sales, and more. Capture the interest of your audience with 3D graphs.

With **Grapher**, creating a graph is as easy as choosing the graph type, selecting the data file, and clicking the *Open* button. **Grapher** automatically selects reasonable default settings for each new graph, though all of the graph settings can be modified. For example, you can change tick mark spacing, tick labels, axis labels, axis length, grid lines, line colors, symbol styles, and more. You can add legends, images, fit curves, and drawing objects to the graph. To apply the same custom settings to several graphs, you can create a **Grapher** template containing the preferred styles. Advanced automation is incorporated using Golden Software's **Scripter™** program or any Active X automation program. Once the graph is complete, you can export it in a variety of formats for use in presentations and publications.



***Grapher** is extremely flexible. For example, you can combine multiple plot types, display graph titles, customize axis settings, and more.*

New Features

This is an overview of some of **Grapher 12's** new features.

- New **Date/Time Format Builder** dialog provides more control over the display of date/time values.
- Add scripts to and run scripts from the Ribbon in the **Developer | User Scripts** section.
- Pin documents to the Recent Documents list.
- New keyboard commands for accessing the **Property Manager** and **Object Manager**.
- Enhanced worksheet window appearance.
- Switch and manage open windows.
- Use the docking mechanism to easily position managers within the application window.
- Added space for more commands in the **Quick Access Toolbar**.
- The zoom **In**, **Out**, and **Rectangle** view commands are persistent.

Graph Features

- Create Ternary Bubble Plots
- Add a title to color scales.
- Easily reverse the nodes of a color spectrum.
- Create 2D or 3D X = F(Y) function plots.
- Change the file paths for all worksheet references in a document simultaneously.
- Bar Chart Groups can be plotted adjacent to one another.
- Map Color Gradients to data values.
- Create horizontal box-whisker and notched box-whisker plots
- Move legend titles and entries with the **Move Labels** command.
- Flip the order of the entries in a legend.
- Class plot symbols are different colors by default.
- Only show legend entries for visible plots

Drawing and Digitizing Features

- Distribute objects horizontally or vertically with even spacing between objects.

Data Features

- Include mode when calculating worksheet statistics.
- Quickly convert **Numbers to Text** or **Text to Numbers** in the worksheet.
- Improved **Sort** operation.

Sample Grapher Files

Sample files are a great way to quickly display completed graphs made in **Grapher** by Golden Software. Browse the sample files to get ideas and view different graphing possibilities that **Grapher** has to offer. Samples can be customized and turned into templates for future use. The sample file examples include only some of **Grapher's** many plot types and features. The **Object Manager** is a good source of information as to what is included in each file. Click the following sample file name to see an image and brief description of each sample file.

To view the sample files:

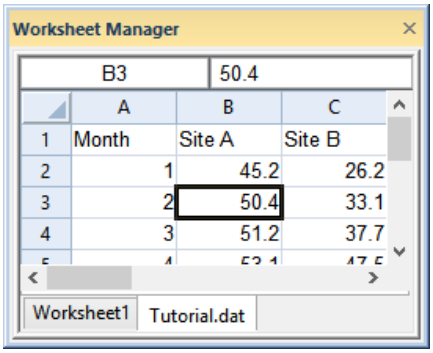
1. Open Grapher.
2. Click the **File | Open** command.
3. In the **Open** dialog, browse to the **Grapher** Samples folder. By default, the Samples folder is located in C:\Program Files\Golden Software\Grapher 12\Samples. If your version of **Grapher** was installed elsewhere, look in that installation folder.
4. Select a .GRF or .GPJ file located and click the *Open* button. The sample file is now displayed. Repeat as necessary to see the files of interest.
5. Click on various parts of the graph, axes, and plots in the **Object Manager**. View the object properties in the **Property Manager**.

Using Grapher

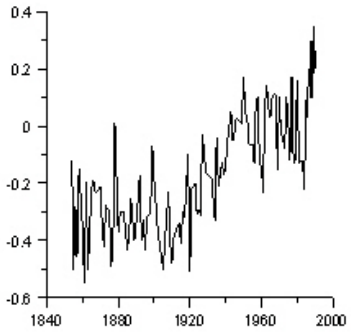
To create graphs in **Grapher**, you will need data. Once data exists, you can use the commands on the **Graphs** tab to create the graph. The **Graph Wizard** can be used to create a new graph in **Grapher**.

To progress from a data file to a finished graph:

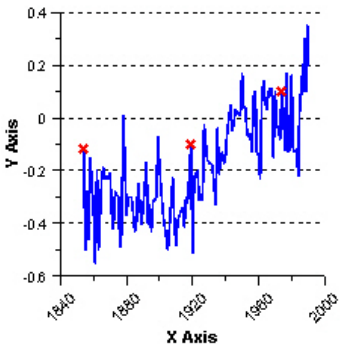
1. Create a data file. This file can be created in **Grapher's** worksheet window or outside of **Grapher** (using as ASCII text editor or Excel, for example).
2. Click the **Graphs** tab to select a graph type directly. For instance, click the **Graphs | Create | Basic | Line Plot** command.
3. In the **Open Worksheet** dialog, select the data file (i.e. Tutorial.dat), and click *Open.* The graph is created from the selected data file, using default graph properties.
4. Adjust the graph properties using the **Property Manager**.



The data can be created in the Grapher worksheet.



The graph is created from the selected data set, using the default graph properties.



Use the Property Manager to customize the graph to fit your needs.

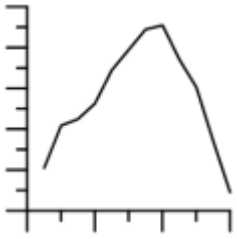
Plot Types

Several unique 2D and 3D plot types can be created, modified, and displayed with **Grapher**. An example of each plot type is shown below. The Graphs tab **Create** commands or the graph wizard are used to create a graph.

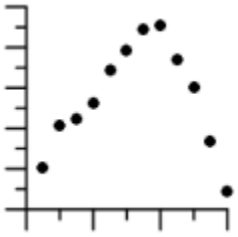
The plot types are organized in the **Graphs** tab by category:

Basic Plots

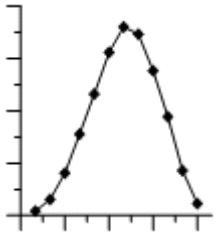
Basic plots are plots that display data as lines, points, and bubbles on two or three axes. All properties of the plot are editable, including the display of symbols and lines. All properties of the containing graph are also editable, including the axes, graph title, and graph background.



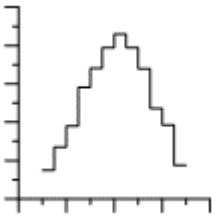
Line Plot



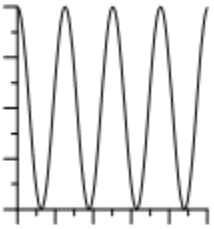
Scatter Plot



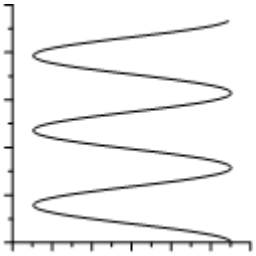
Line/Scatter Plot



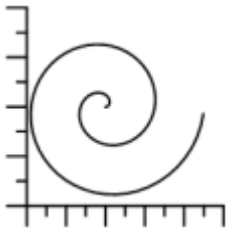
Step Plot



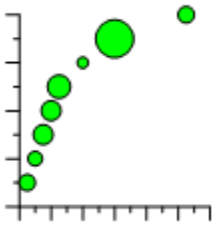
YX Function Plot



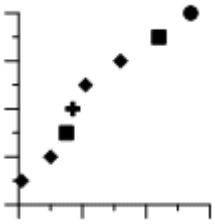
XY Function Plot



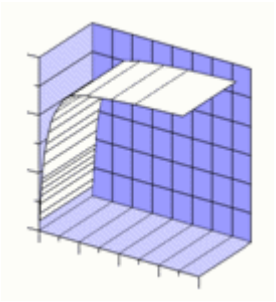
Parametric Function Plot



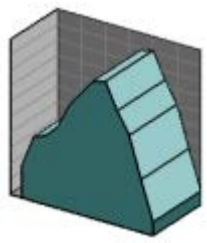
Bubble Plot



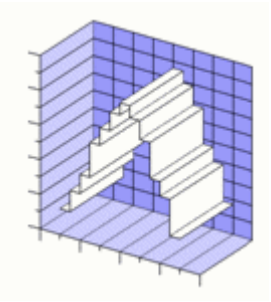
Class Plot



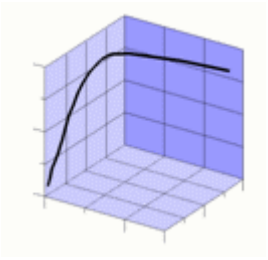
3D Ribbon Plot



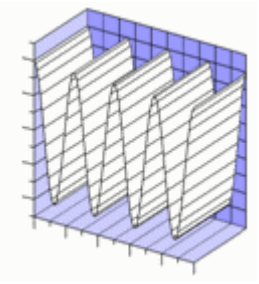
3D Wall Plot



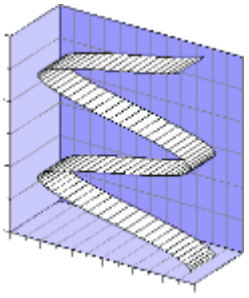
3D Ribbon Step Plot



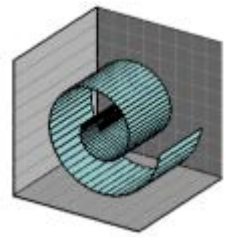
3D XYZ Plot



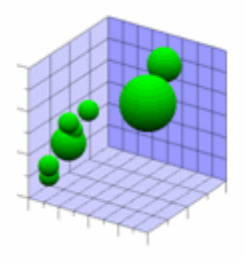
3D YX Function Plot



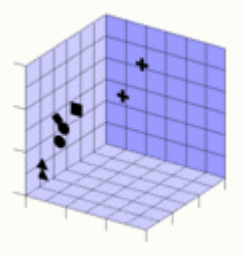
3D XY Function Plot



3D Parametric Function Plot



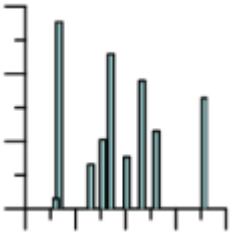
3D Bubble Plot



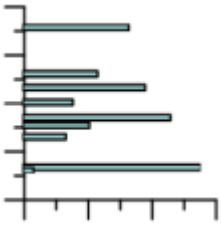
3D Class Plot

Bar Plots

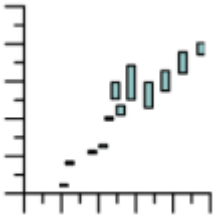
Bar plots display data as bars or floating bars in two and three dimensions. All properties of the plot are editable, including the bar width, bar colors, and number of bars. All properties of the containing graph are also editable, including the axes, graph title, and graph background.



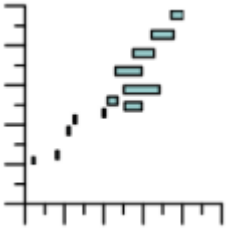
Vertical Bar Chart



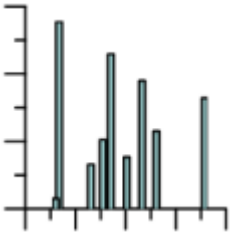
Horizontal Bar Chart



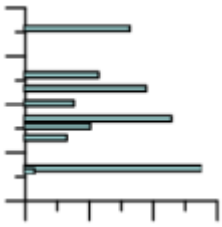
Vertical Floating Bar Chart



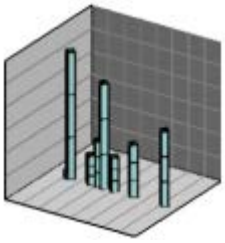
Horizontal Floating Bar Chart



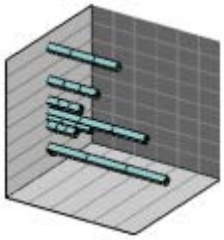
Vertical Category Bar Chart



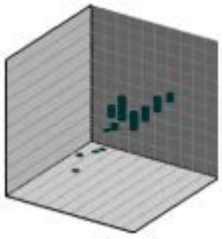
Horizontal Category Bar Chart



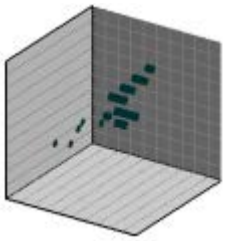
3D Vertical Bar Chart



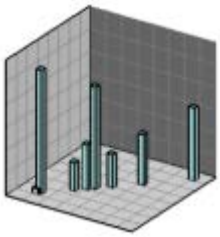
3D Horizontal Bar Chart



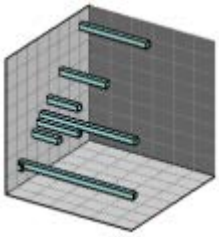
3D Vertical Floating Bar Chart



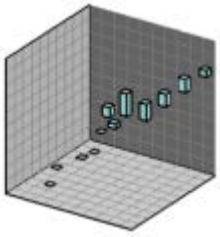
3D Horizontal Floating Bar Chart



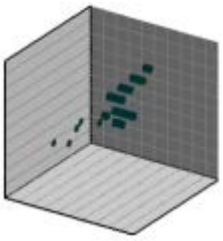
3D XYZ Vertical Bar Chart



3D XYZ Horizontal Bar Chart



3D XYZ Vertical Floating Bar Chart

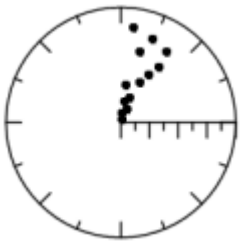


3D XYZ Horizontal Floating Bar Chart

Polar Plots

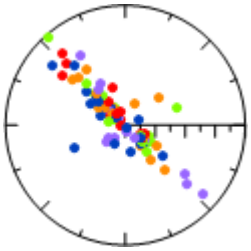
Polar plots display data as lines, points, and bars on polar axes. Data are defined by angle and distance from the center of the plot. Various options exist for each plot type, including setting the axis properties, line properties, symbol properties, and bar properties. Some plots have other properties, such as binning and number of axes.

Polar Line Plot



Polar Scatter Plot

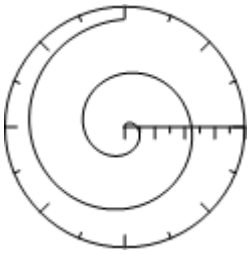
Polar Line/Scatter Plot



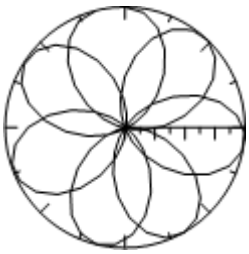
Polar Class Scatter

2 Point Polar Vector Plot

1 Point Polar Vector Plot

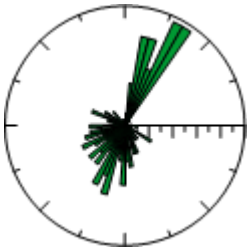


Function Plot

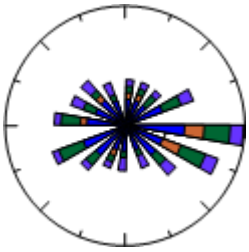


Parametric Function Plot

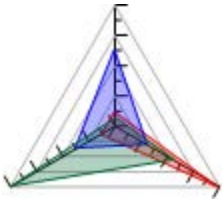
Polar Bar Chart



Rose Chart



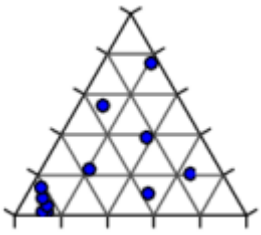
Wind Chart



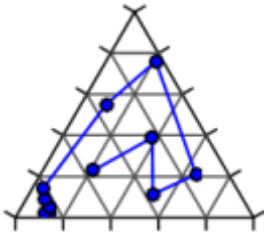
Radar Chart

Ternary Plots

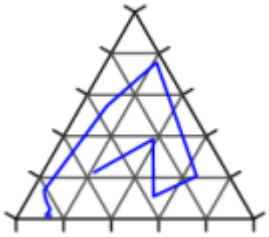
Ternary plots represent relative percentages in a three component system. Ternary class plots are used to show classification information in the plot. Ternary bubble plots add a fourth dimension to the presented information by varying the symbol size. Various properties, including axis properties, line properties, symbol properties, class properties, and bubble properties can be edited.



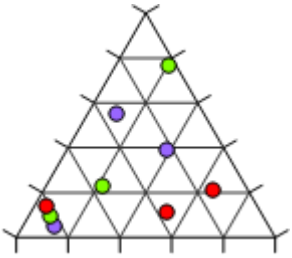
Ternary Scatter Plot



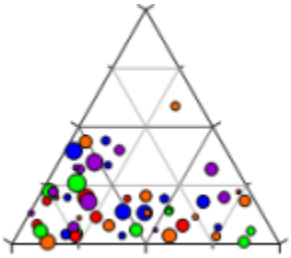
Ternary Line/Scatter Plot



Ternary Line Plot



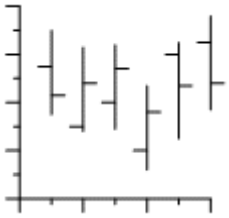
Ternary Class Plot



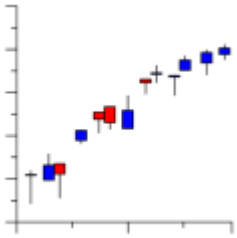
Ternary Bubble Plot

Specialty Plots

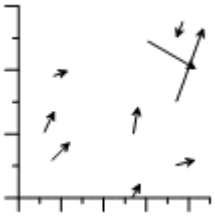
Specialty plots incorporate many different graph types. Various properties, including axis properties, line properties, bar width properties, number of slices, and method of defining the variables can be edited.



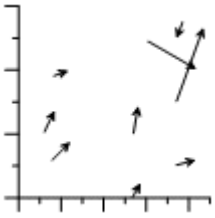
High-Low-Close Plot



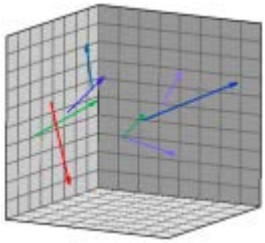
High-Low-Close Candlestick Plot



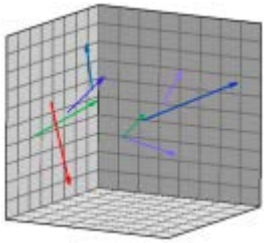
1 Point Vector Plot



2 Point Vector Plot



3D 2 Point Vector Plot

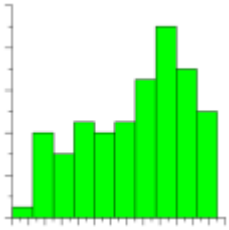


XYZ-dx,dy,dz Vector Plot

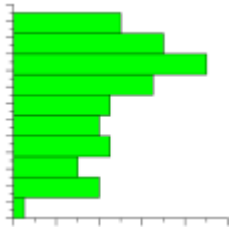
Stiff Plot

Statistical Plots

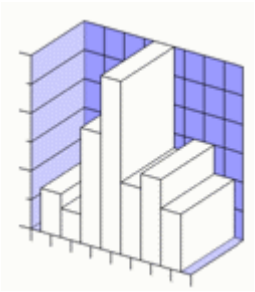
Statistical plots are plots that display data in a format used to determine some statistical property of the data. Statistical plots can be displayed in two or three dimensions and include a variety of plot types. All properties of the plot are editable, including the display of symbols, lines, and bars. All properties of the containing graph are also editable, including the axes, graph title, and graph background.



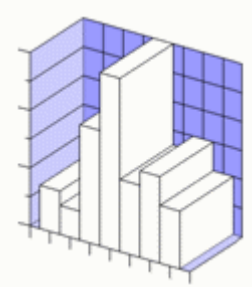
Vertical Histogram



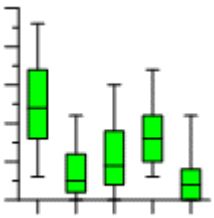
Horizontal Histogram



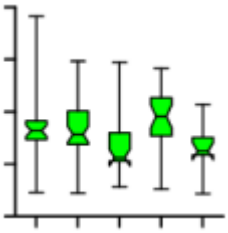
3D Vertical Histogram



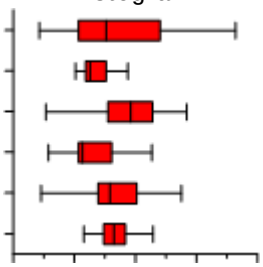
3D Horizontal Histogram



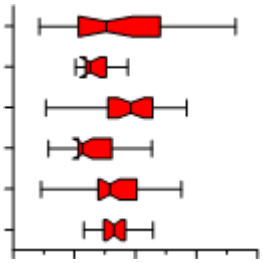
Box-Whisker Plot



Notched Box-Whisker Plot



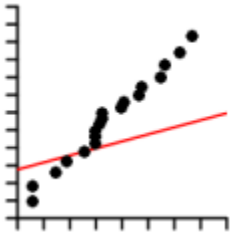
Box-Whisker Plot, Horizontal



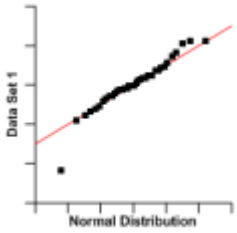
Notched Box-Whisker Plot, Horizontal

Pie Chart

3D XYY Pie Chart

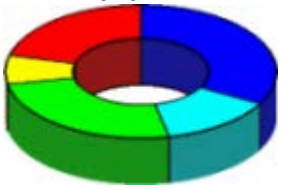


Q-Q Plot



Normal Q-Q Plot

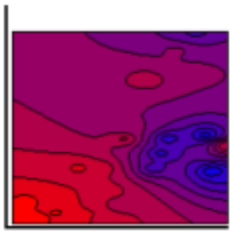
Doughnut Plot



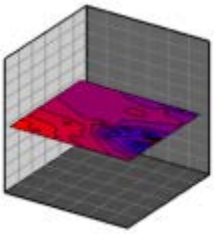
3D Doughnut Plot

Contour Surface Maps

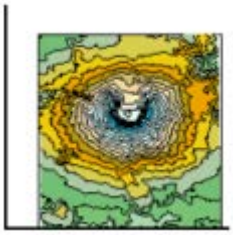
Contour maps include contour data maps, grid maps, and function maps. Contour maps are 2D representations of three variables. The contour line defines the equal Z values across the map. Contour maps can be displayed with an XY or XZ orientation. **Surface Maps** include surface data maps, grid maps, and function maps. Surface maps are 3D color representations of three variables.



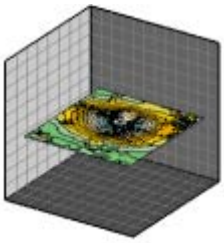
XY Contour Data Map



XZ Contour Data Map

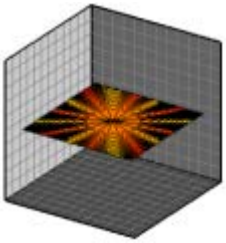


XY Contour Grid Map

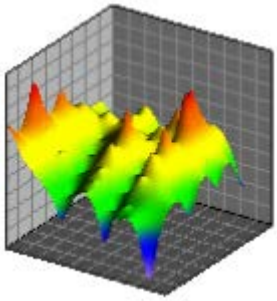


XZ Contour Grid Map

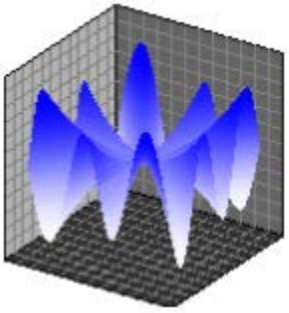
XY Contour Function Map



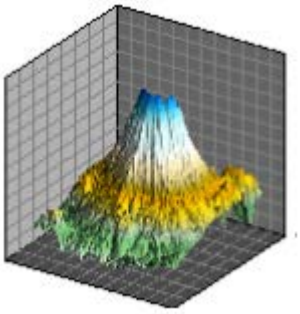
XZ Contour Function Map



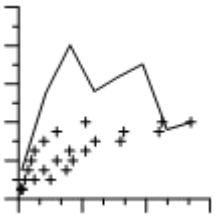
Surface Data Map



Surface Function Map



Surface Grid Map



2D Summation

Creating Graphs

You can create graphs in several ways in **Grapher**. These various methods allow you to create graphs in a manner most comfortable for you. Graphs can be created:

- from the Graphs tab,
- with the graph wizard,
- from the worksheet,
- and from templates.

Additional plots, axes, legends, titles, summation plots, duplicate axes, and magnifiers can be added to the graph after it is created. All properties of the plot can be edited after the graph is created.

Creating Graphs from the Worksheet

If you are working with the data in the worksheet, you can create a graph without switching to the plot window. Simply select the columns you wish to plot and choose the graph type you wish to create.

To create a graph from the worksheet:

1. Open the worksheet using one of the following methods:

- Click the **File | Open** command, select a data file in the **Open** dialog, and click the *Open* button.
- Click the **File | New | Worksheet** command to open a new worksheet. In the worksheet, select **File | Open**, choose a data file in the **Open** dialog, and click the *Open* button.
- Click the  button in the **Quick Access Toolbar** to open a new worksheet.
- Select a plot in the plot window and click the **Graphs | Worksheet | Display** command.
- In the plot window, check the **View | Display | Worksheet Manager** command to view data files already loaded into the program.

2. Highlight the columns to use in the plot.
3. Click the **Graphs** menu. If you are using the **Worksheet Manager**, right-click in the worksheet and select **Graphs** from the context menu.
4. In the Create group, click the Basic, Bar, Polar, Ternary, Specialty, Statistical, or Contour Surface button. In the Worksheet Manager, click the Basic, Bar, Polar, Ternary, Specialty, Statistical, or Contour Surface in the context menu.
5. Select the plot type you would like to create and the graph is created with the default plot properties.

You can change the properties of a selected plot or axis through the **Property Manager**.

References:

http://www.goldensoftware.com/products/grapher

.Didger Getting Started Guide, Copyright Golden Software, Inc. 2007