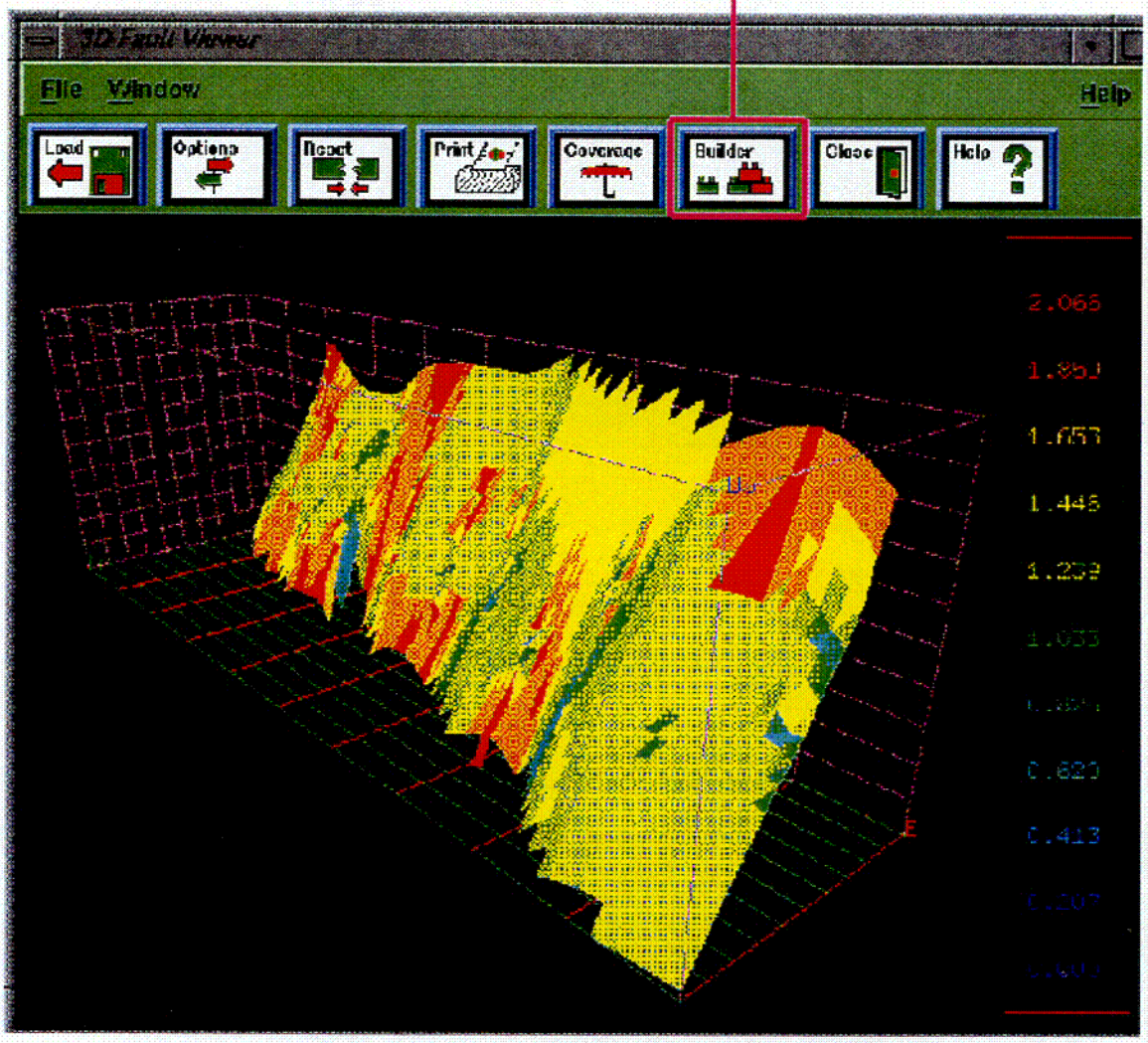
The user may also build faults using the 3D Fault Viewer's Fault Builder tool. The user may access the Fault Builder by clicking on the Builder Button at the top of the 3D Fault Viewer Window.



Upon pressing the Builder Button, the user will be presented with the Fault Builder Window. If a fault file is already loaded in the 3D Fault Viewer, the user may add to it. If no fault file is loaded, the user is presented with a default bounding box and may create a fault from scratch. The user should use the bounding box as a reference to the geographical coordinate system.

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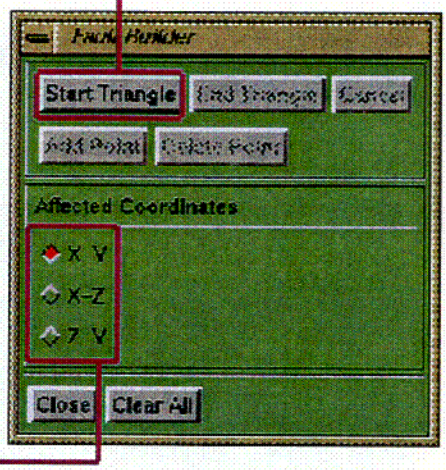
C01

To add a triangle to the fault, click the Start Triangle button. A new triangle will appear with vertices on the corners designated N, E, and Up by the bounding box. To adjust any one of the vertices, hold down the control key and select the vertex with the left mouse button while dragging the vertex with the mouse.



The three buttons designated Affected Coordinates control the plane in which the vertices are allowed to move. For example, to move a vertex along the X-Y plane, select the X-Y button. X, Y, and Z correspond to a right-handed coordinate system with +Z coming out of the screen. Thus, +X runs horizontal from right to left across the screen, and +Y runs vertically from top to bottom. This coordinate system is distinct and independent of the geographical coordinate system defined by the loaded fault and coverage files.

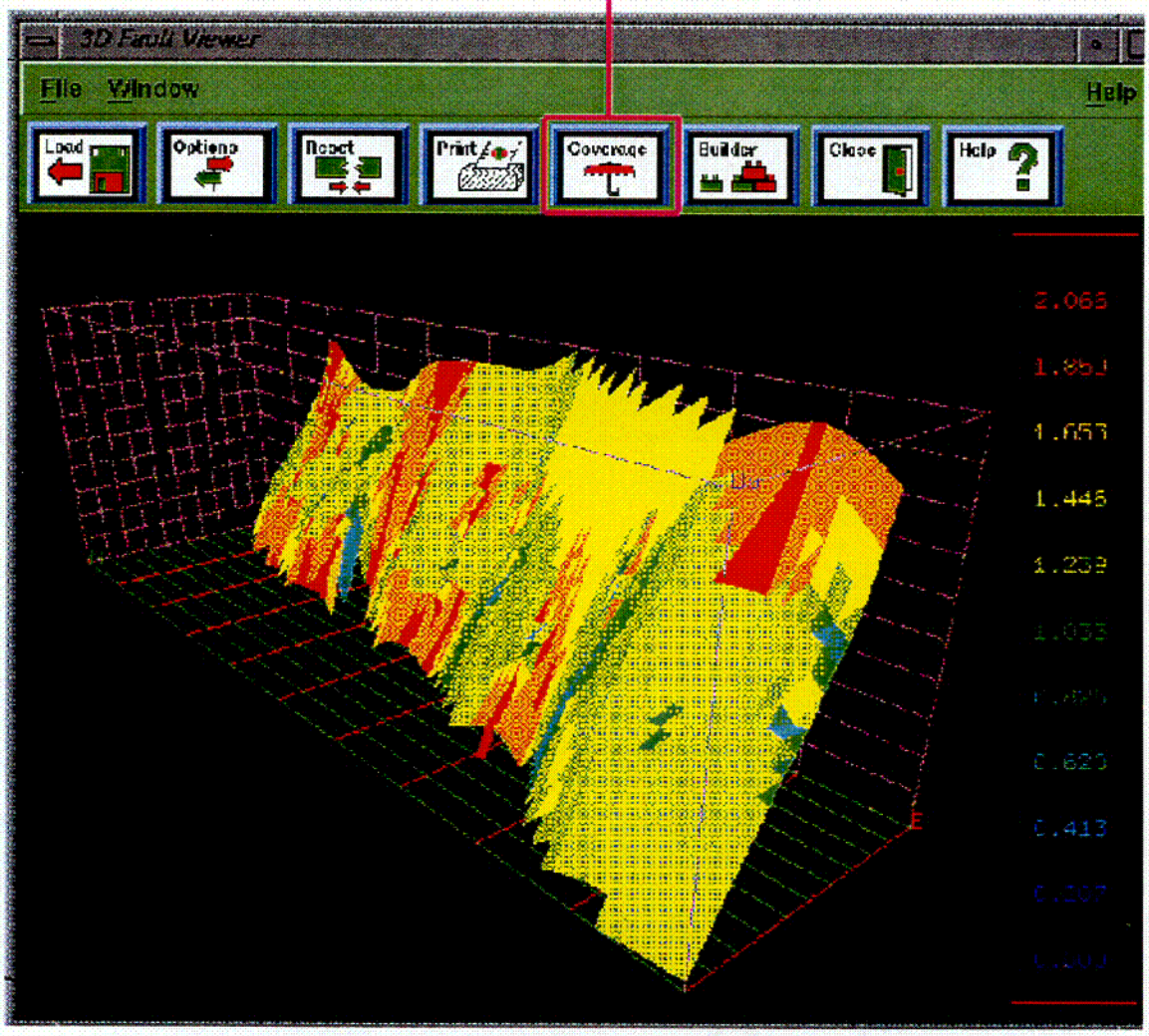
Points may be deleted and added to the triangle using the Delete Point and Add Point buttons, located directly below the triangle buttons. The current fault in progress may be aborted by clicking the Cancel button, located directly to the right of the End Triangle button. When finished, click the End Triangle button, located directly to the right of the Start triangle button. To remove all Fault-Builder produced polygons, click the Clear All button.

Closing the window accepts modifications, but these are not saved untill the user saves the file to disk via the 3D Fault Viewer's file pulldown menu.

page 2 page 4

C02

The user should also note that coverages may be placed over 3D objects. To access the coverage tool, the user should click on the Coverage Button located at the top of the 3D Fault Viewer Window.



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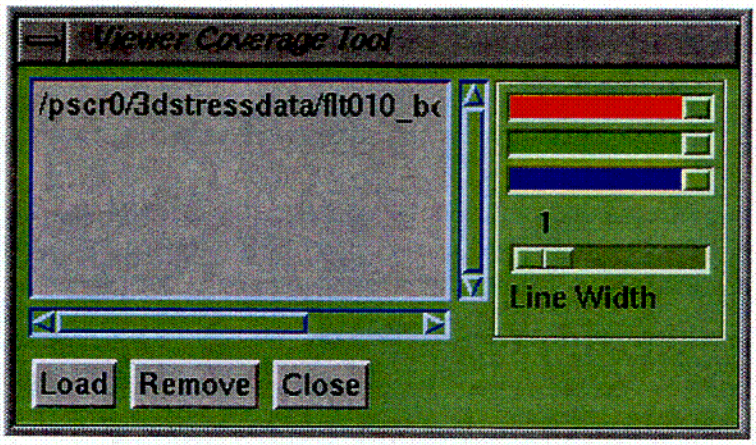
C03

Upon clicking the Coverage Button, the user is presented with the Coverage Tool.



To load a coverage file, click the **Load** button and a file selector will appear. After selecting a coverage file, the name of the file is displayed in the Viewer Coverage Tool. Each loaded coverage may be manipulated by clicking on the coverage name, then adjusting the color sliders or adjusting the Line Width slider. To remove a coverage select the name and click the Remove button.

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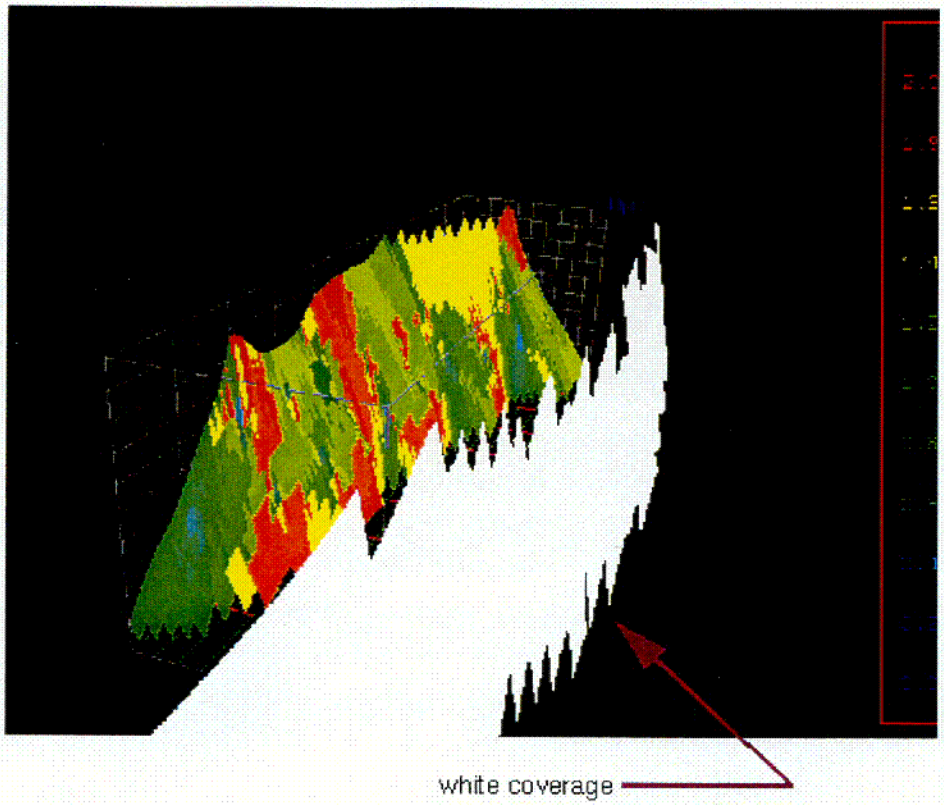
C04

An example of a coverage and a normal fault file loaded at the same time appears below. Note that the coverage is white and the normal fault file is shaded according to stress.



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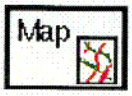
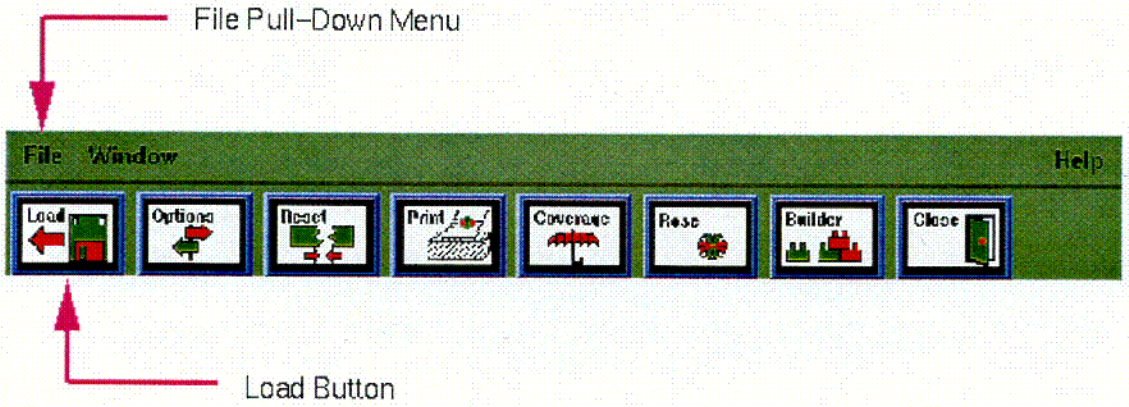
C05

Map Viewer



The Map Viewer is used to display files of faults displayed as lines and overlay those images with coverages. To load a file, either choose Load from the File pull-down menu at the top of the Map Viewer window, or click on the Load button just below the File pull-down menu.

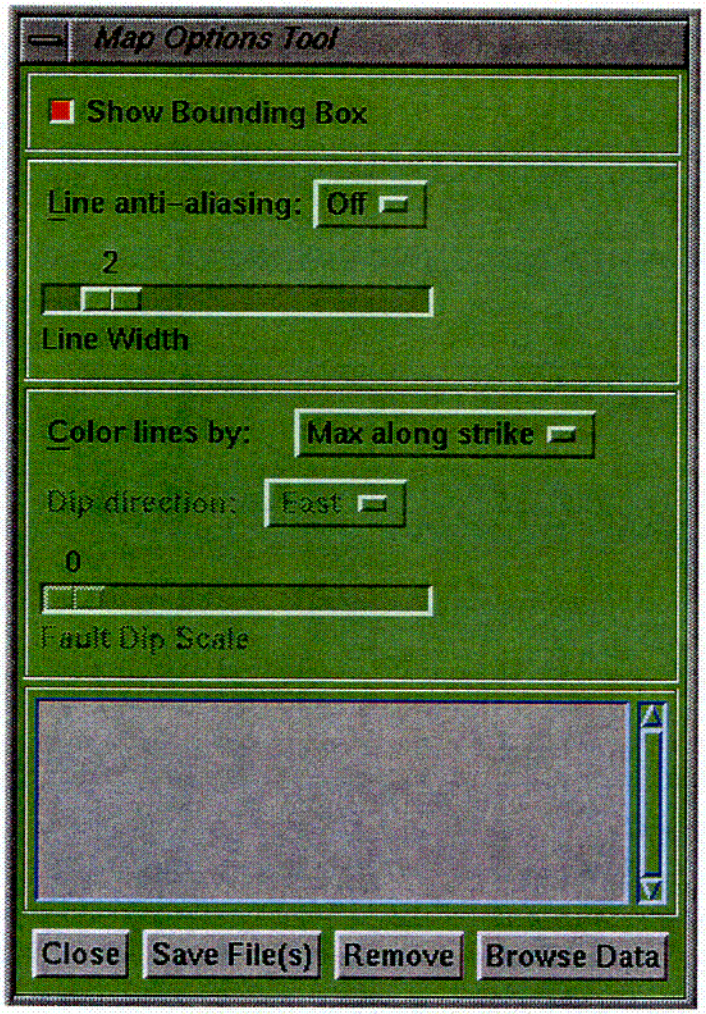


A File Selection box will then appear prompting for the selection of a map. Use this dialog box to navigate the file-system and select the appropriate file as described in the Appendix.

page 2

C06

The Options tool may be used to toggle display of the bounding box, toggle anti-aliasing, set line width, set the color scheme, set the dip direction, set the fault dip scale, and browse the data file. The Options tool may be accessed in a similar manner to the Load File dialog box. Either select Options from the File pull-down menu or click the Options button just below the Window pull-down menu. Upon loading a file, the filename will appear in the text box in the Options window. Multiple files may be loaded, and to remove one simply highlight the file and press the remove button below the text box. The files may also be saved as one .lin file by pressing the Save File(s) button.



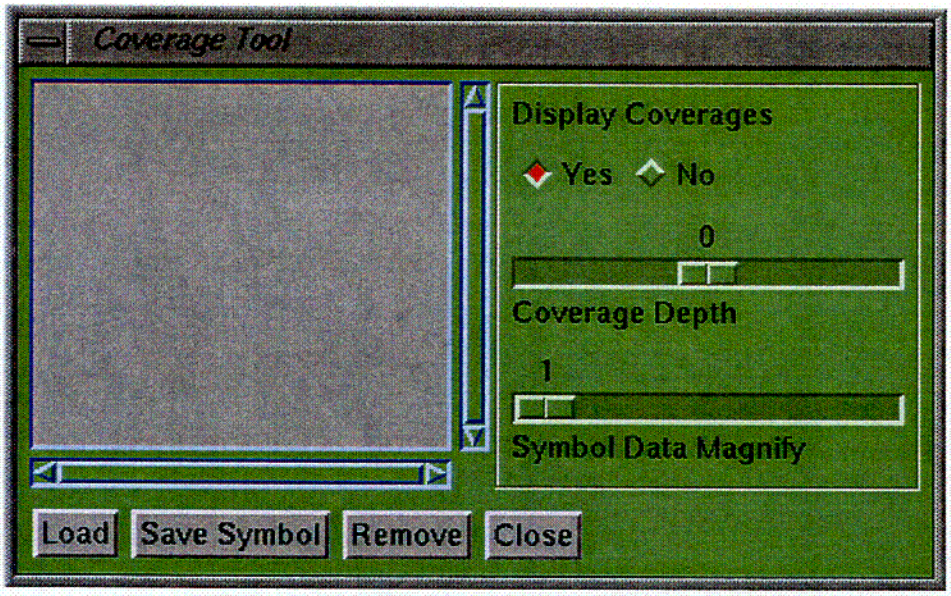
The Reset feature is used to reset the point-of-view in the Map Viewer window to the default, start-up location. Either select Reset from the File pull-down menu or click the Reset button just below the Window pull-down menu to reset the point-of-view.

The Print feature is used to print the Map Viewer window to an SGI RGB file. Either select Print from the File pull-down menu or click the Print button just below the Window pull-down menu to access the Save File dialog box. Use this dialog box to navigate the file-system and select the apropriate filename to call the saved image.

page 1 page 3

C07

The Coverage tool is used to overlay a coverage image on top of the fault image. To access the coverage tool, either choose Coverage from the Window pull-down menu at the top of the Map Viewer window, or click on the Coverage button just below the pull-down menu bar. With the coverage, the user may load several files at once and toggle the displaying of each loaded file individually. Also, coverage depth may be set, the degree of magnification of the symbol data may be set. Symbols may be saved, and coverage files may be removed from the list. To load a coverage file, click on the Load button at the bottom of the Coverage Tool window. A dialog box will then appear prompting for the selection of a file. Use this dialog box to navigate the file-system and select the appropriate file.



A rose diagram is displayed by pressing the Rose button below the pull-down menu bar or selecting Rose from the Window pull-down menu. See the Rose Diagram chapter for more information on the Rose Viewer.

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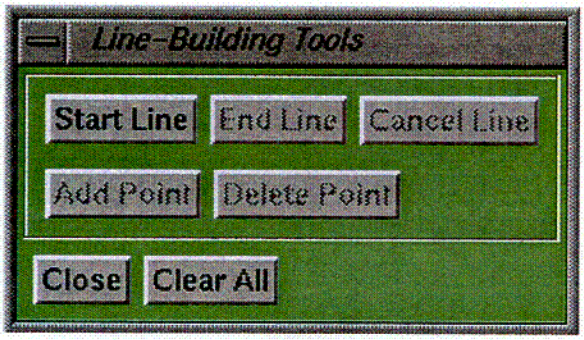
C08

The Line-Building Tools dialog box may be used to place lines on existing maps. To begin a line, click the Start Line button. A new line will appear along the left edge of the bounding box with its end points at the corners. To select a point and move it, hold down the control key while clicking and dragging the point with the left mouse button. Points may also be added and deleted using the Add Point and Delete Point buttons. Added points always appear in the lower left corner of the bounding box. The point currently selected is the one deleted. A point may be selected by holding the control key and clicking the left mouse button over it. The selected point is displayed as yellow.



The user may remove all lines produced via the Line Builder by pressing the Clear All button. To exit the Map Viewer, select Close from the File pull-down menu or click the Close button below the pull-down menu bar. To access the online help for 3DStress, use the Help pull-down menu or click the Help button below the pull-down menu bar.

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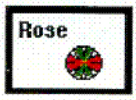
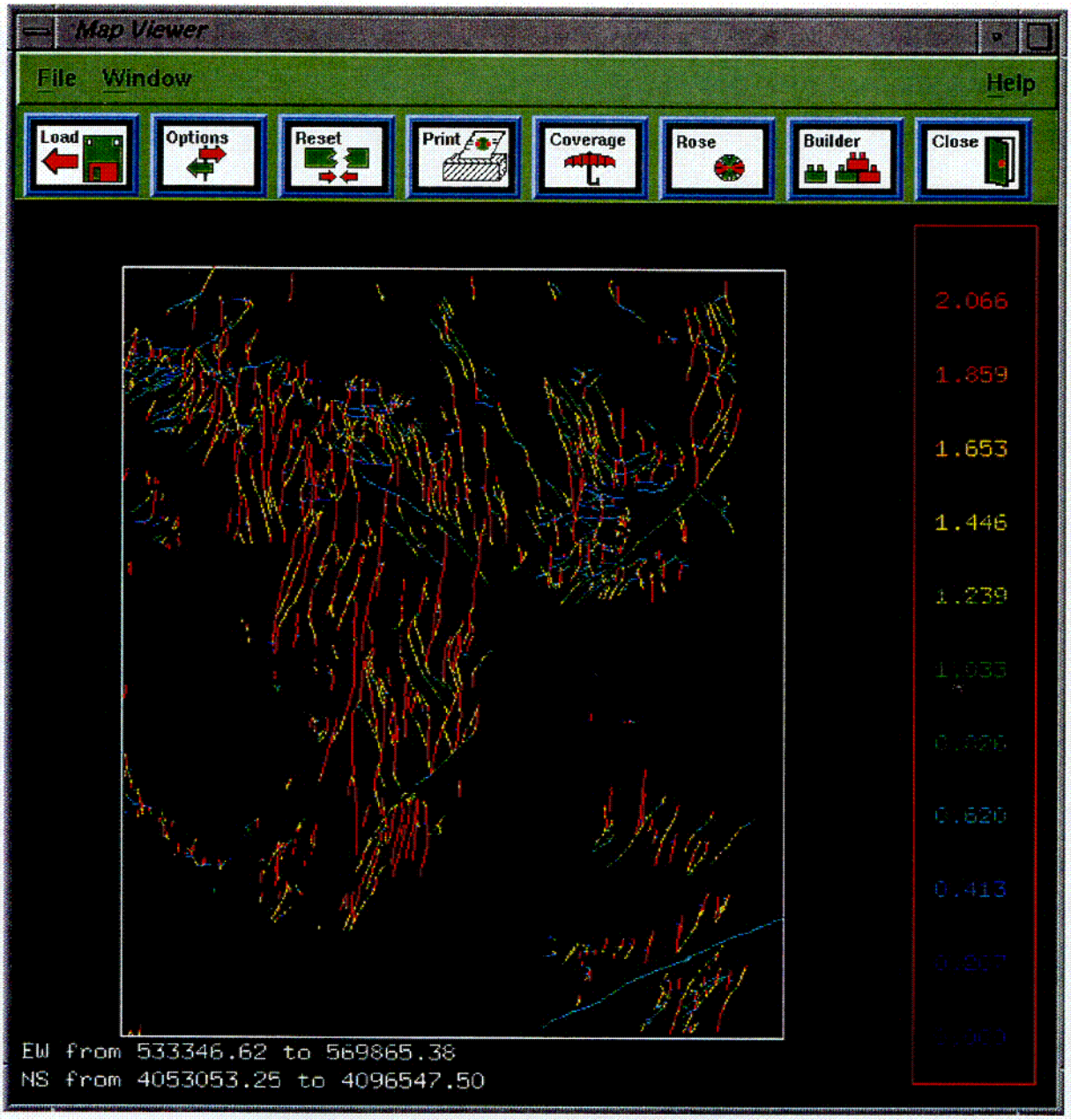
C09

Rose Diagram



A rose diagram is displayed by pressing the Rose button on the map viewer. A rose diagram may only be displayed if a fault trace file or coverage is currently loaded.



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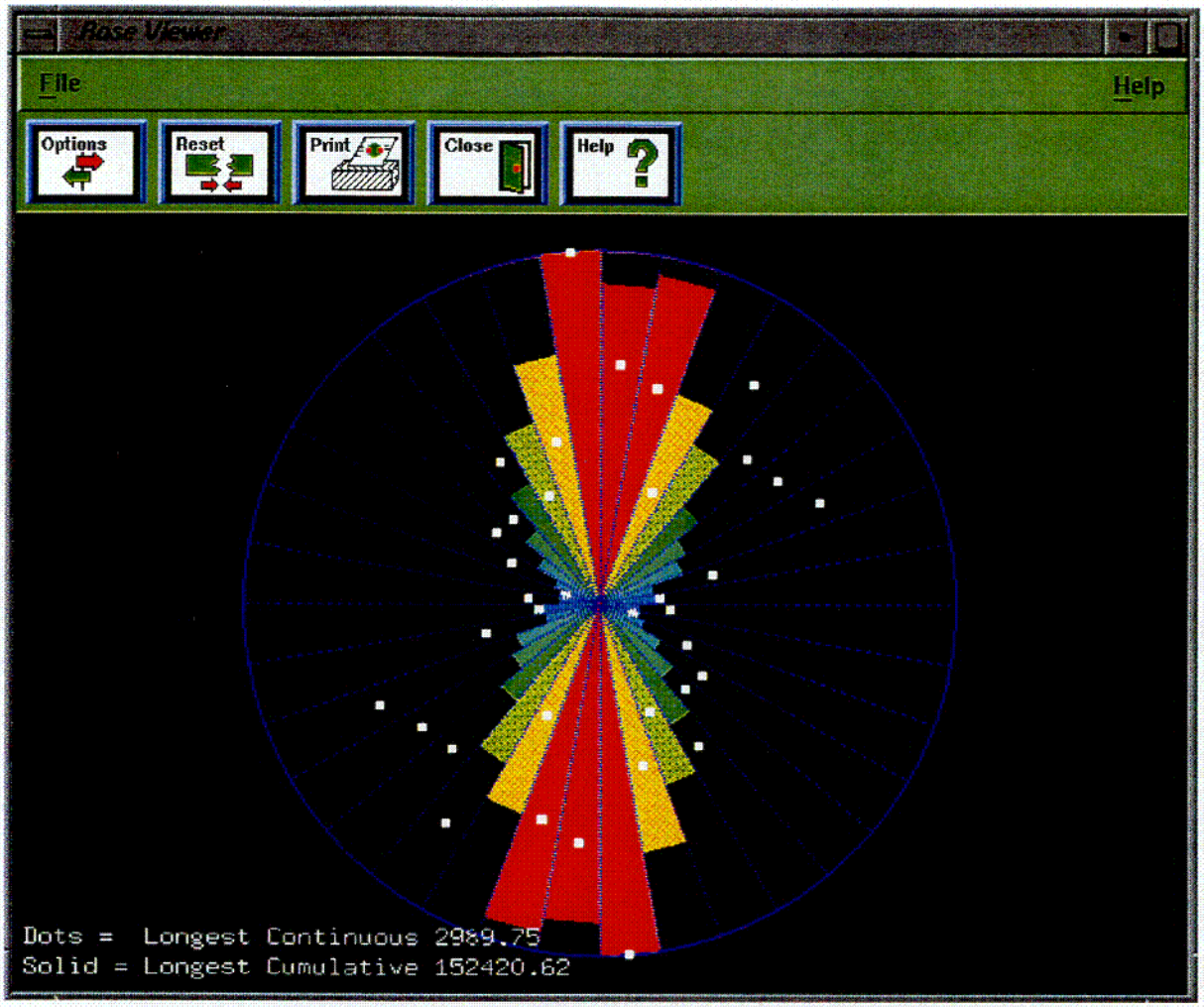

The Rose diagram window displays two statistical plots using the currently loaded fault coverage. The solid polygons represent the cumulative lengths of faults for each 10 degree range of strike orientations. The polygons are colored by slip tendency, dilation tendency, or leakage factor.

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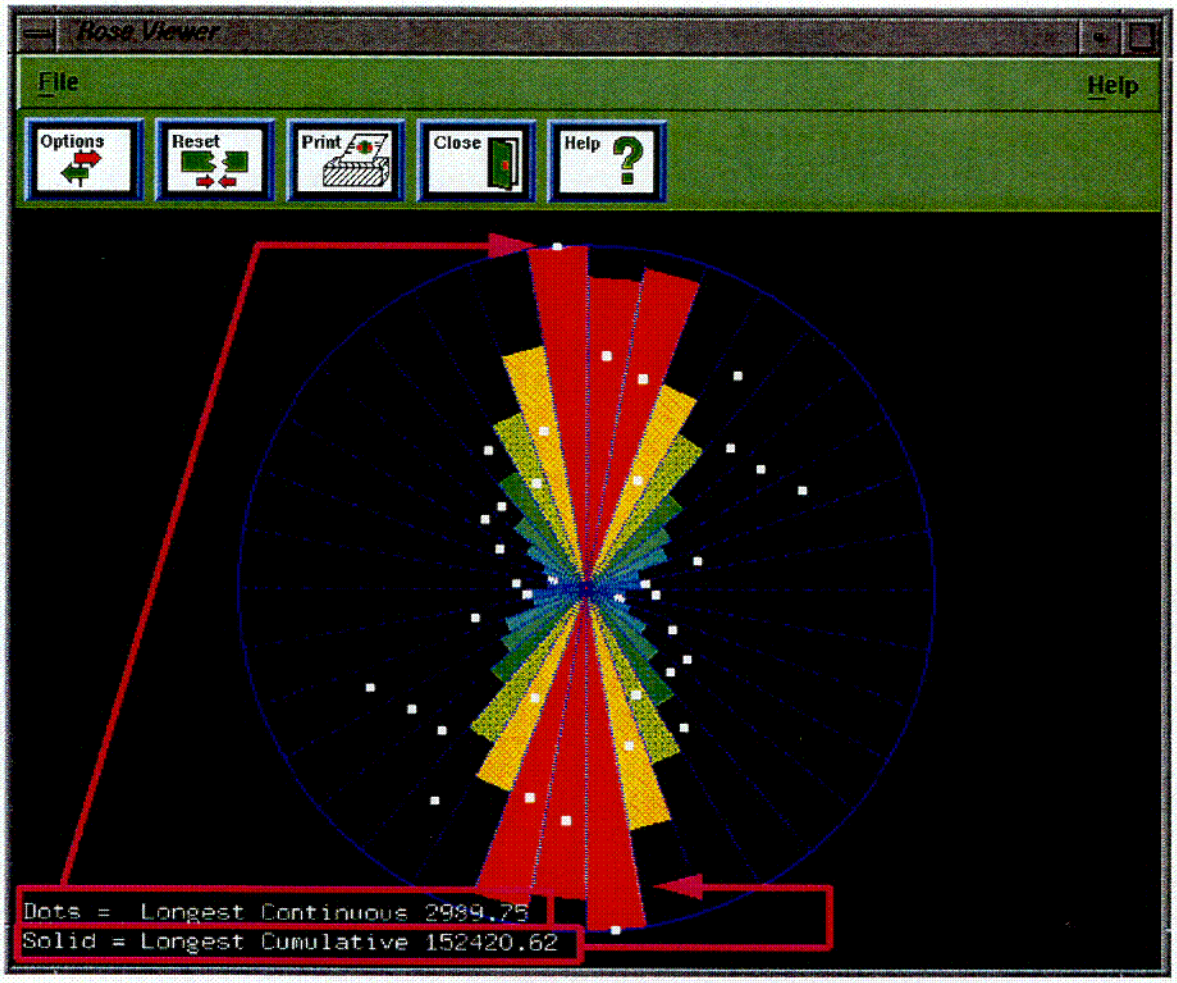
The dots represent the longest continuous fault length for each 10 degree range of strike orientations. At the bottom of the window, the maximum values for all fault strike orientations are displayed. The values represent lengths and are in the same units as the currently loaded fault coverage.



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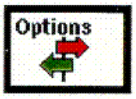
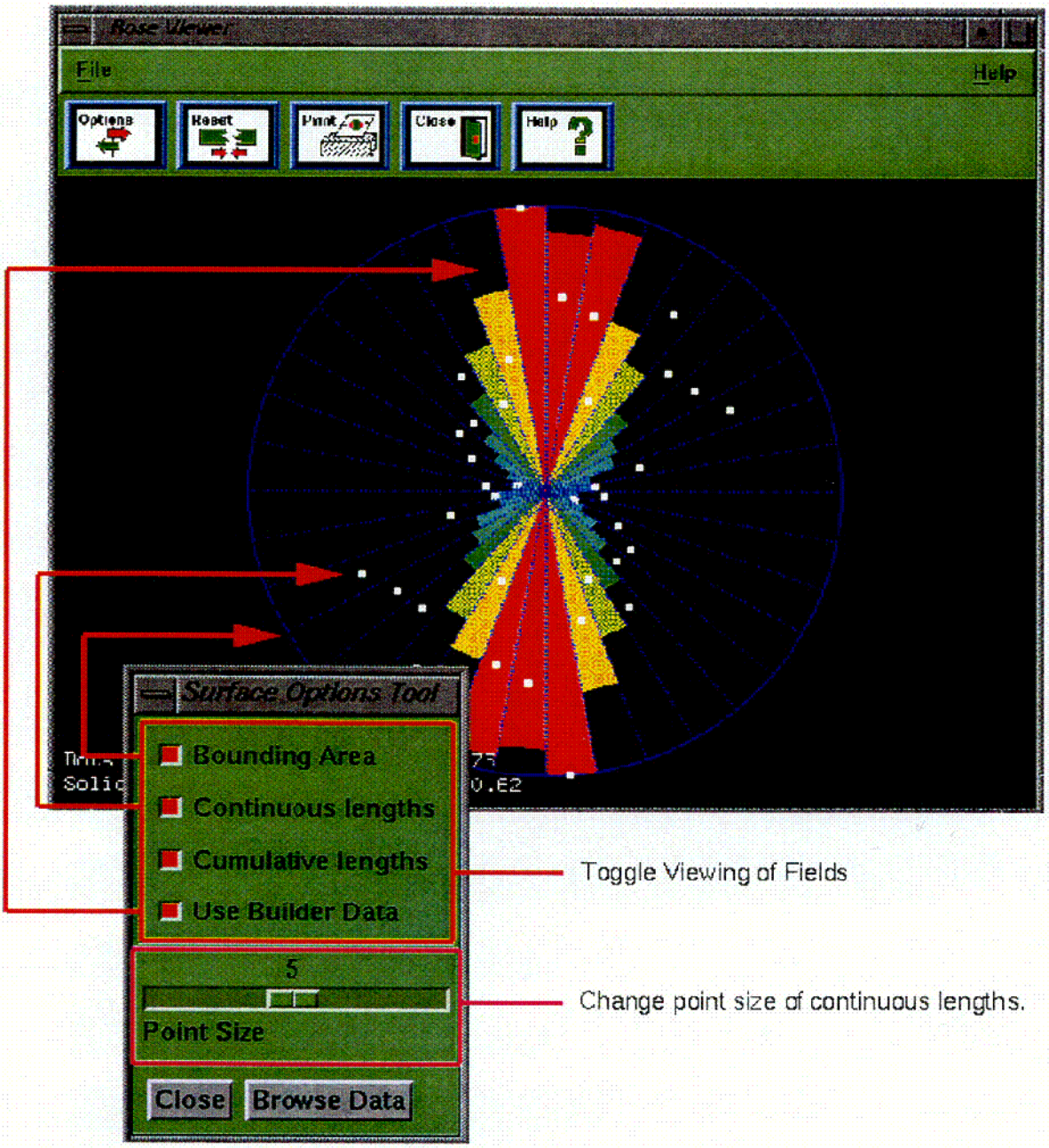
Rose Diagram Options

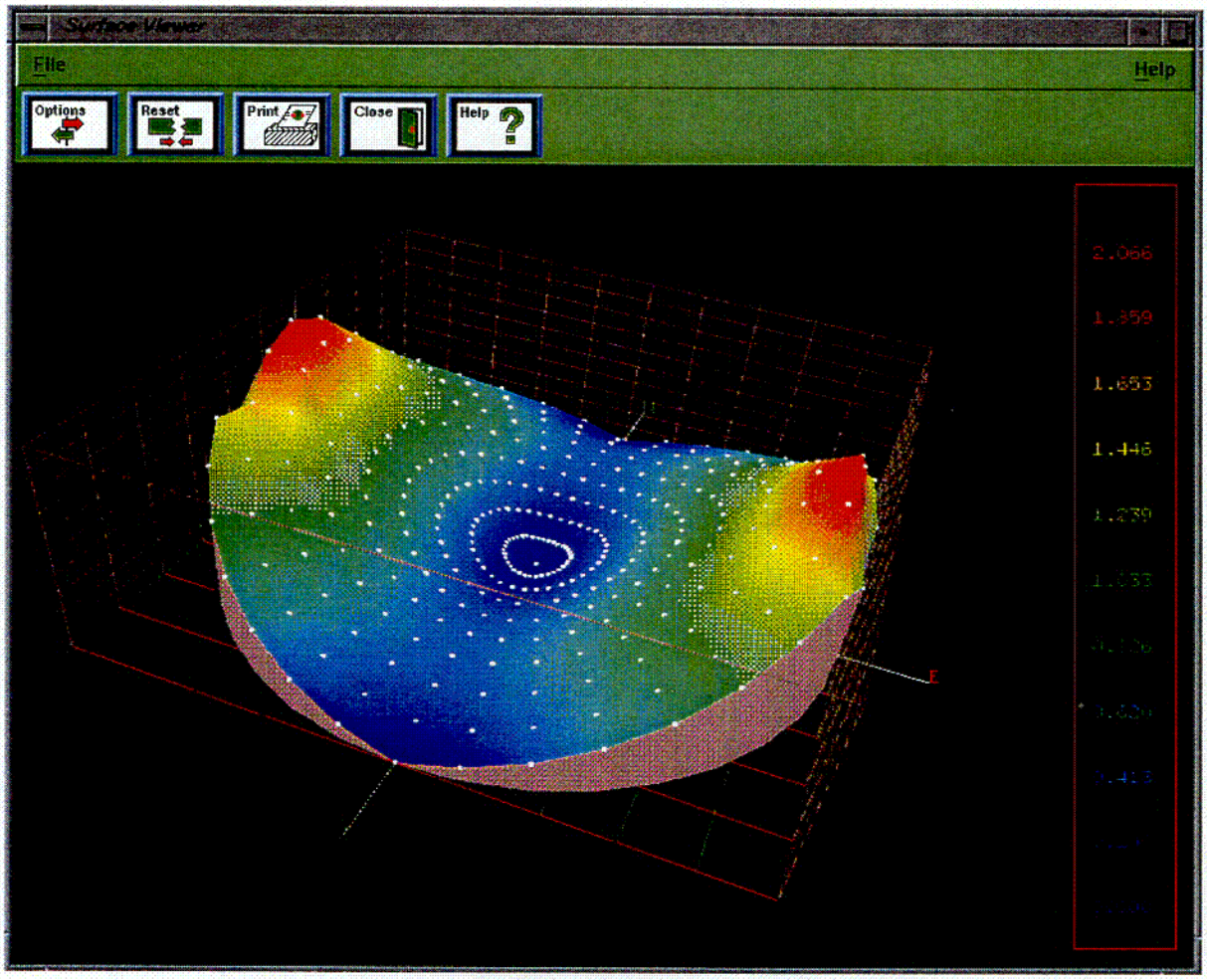




C13

Surface Viewer

The surface viewer displays slip tendency, dilation tendency, or leakage factor values computed in the Tendency Plot window as a 3D surface. The height and color of the surface represent the computed slip tendency, dilation tendency, leakage factor values. The vertical exaggeration of the surface is controlled by buttons on the Options window.



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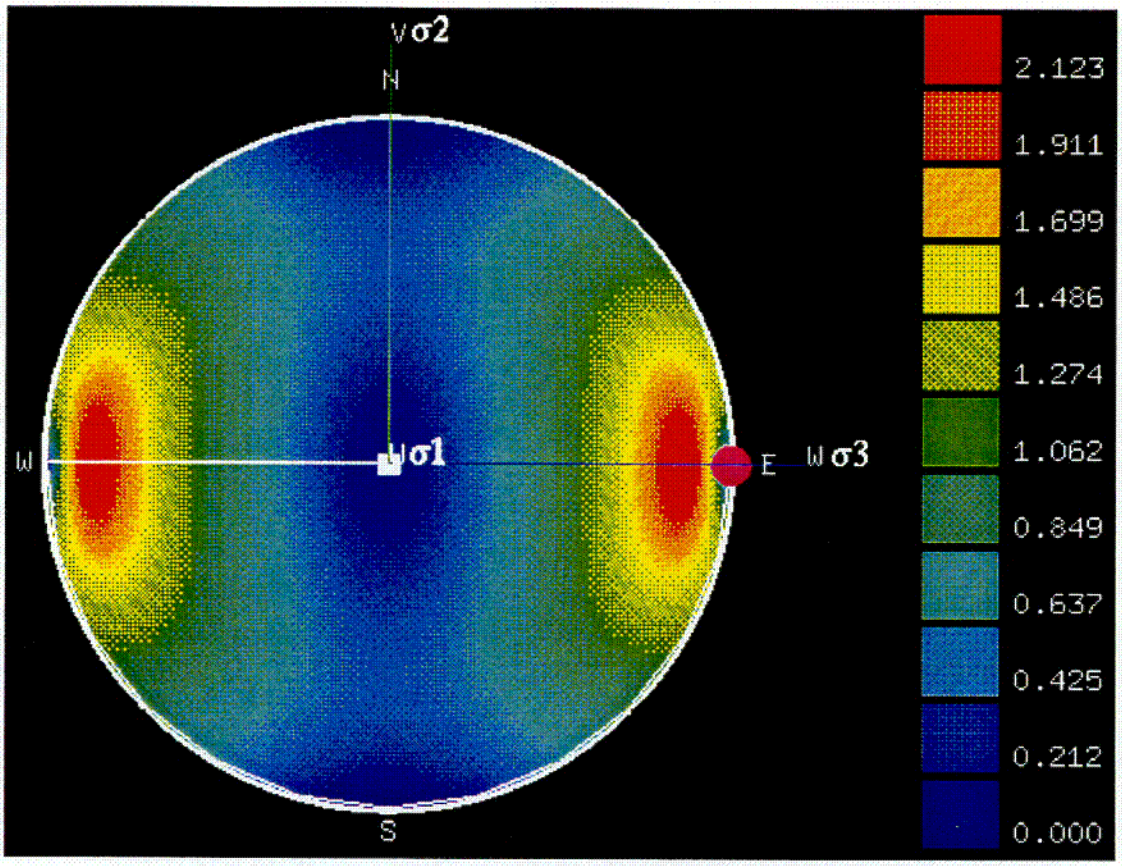
V σ2
N
W
W σ1
E
W σ3
S
2.123
1.911
1.699
1.486
1.274
1.062
0.849
0.637
0.425
0.212
0.000

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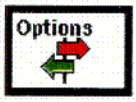
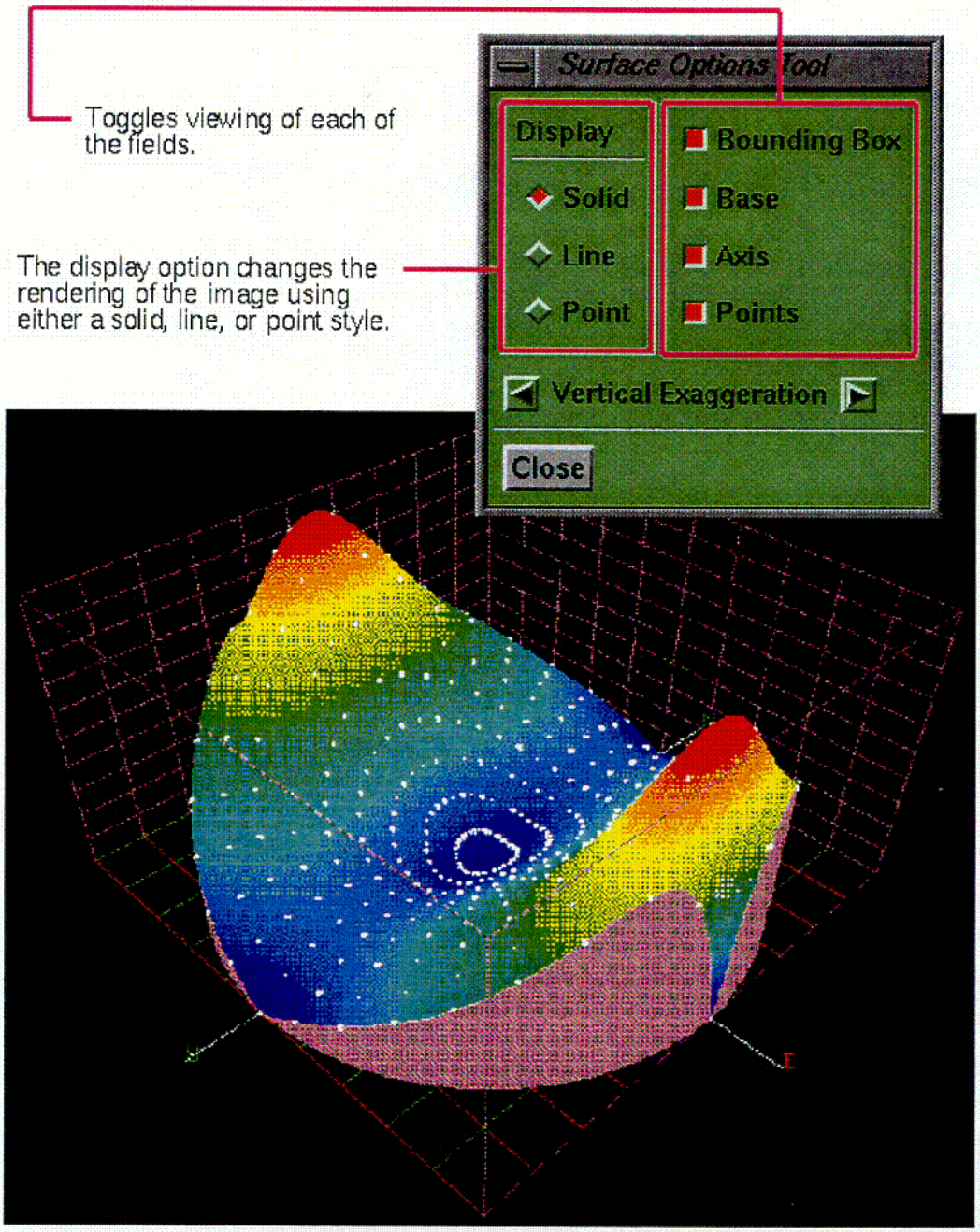
Surface Viewer Options



Toggles viewing of each of the fields.

The display option changes the rendering of the image using either a solid, line, or point style.



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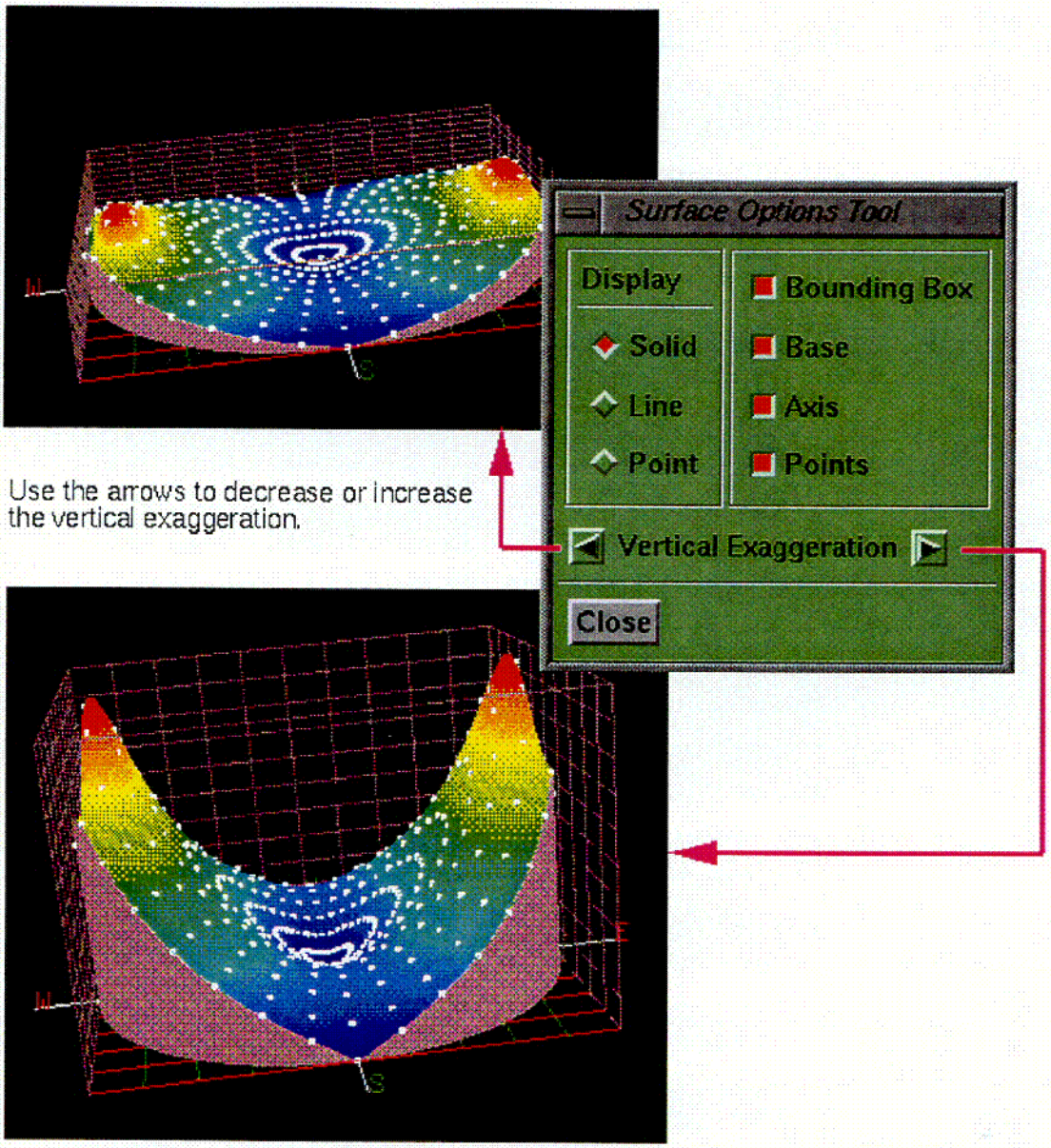

Use the arrows to decrease or increase the vertical exaggeration.

page 1

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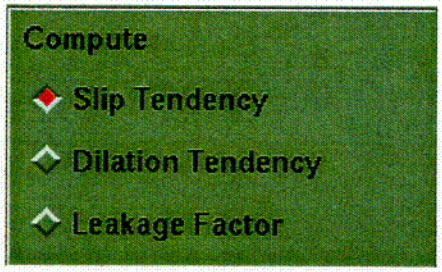
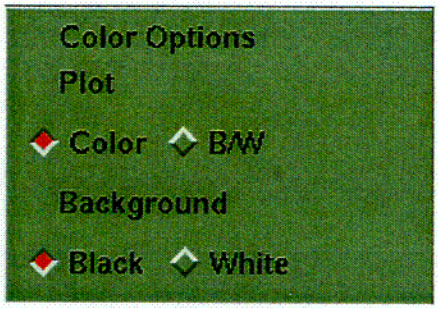
Options

The Options Window may be accessed by clicking on the Options Button on the Command Bar. The tools in this window allow the user to change the variable plotted in the **Tendency Plot**, change the color scheme of the graphics window, change the color detail, change the lighting scheme, change the color threshold, and toggle the verbosity mode.

The user may change the variable plotted in the Tendency plot by clicking on the radio button next to the desired plot-type. See the following figure.

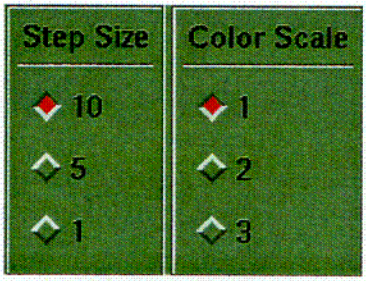


The user may also change the color scheme of the graphics window. The user may toggle between color and black-and-white plots for the graphics displays.



Also, the user may select a white or a black background for the graphics displays.

The user may alter the detail used in the coloring of images by changing the step size setting and the color scale setting.



Step size controls the number of point of data drawn. The smaller the step size is, the more detailed the plot becomes. The color scale setting controls the gradient of the color scale. As the magnitude of the color scale setting increases the range of data colored by the color used for the largest data values increases.

The user may alter certain lighting conditions by enabling the Enable Lighting toggle button.

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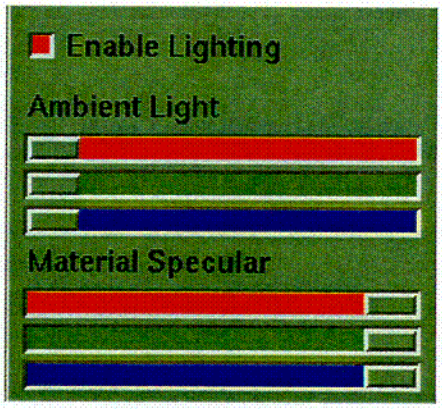
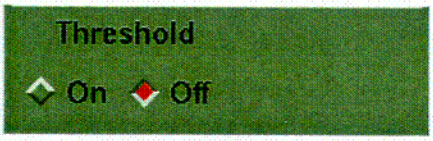
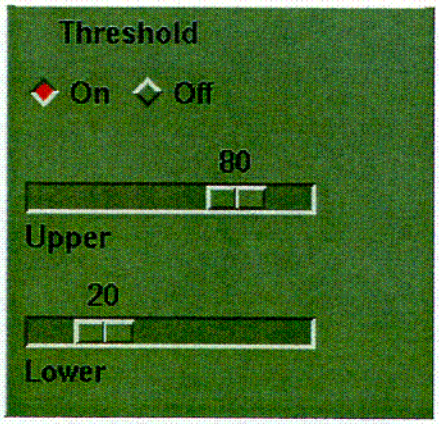
Enabling this toggle causes the lighting controls to appear just below it. The user may then alter the RGB value for the ambient light (light emitted by the objects themselves rather than by an external source) by moving the three sliders representing the amount of red, green, and blue that appear just under the heading "Ambient Light". There are additional sliders for the RGB value of the Specular Color (the color illuminating the whole scene from an external source) of the graphic displays.



The Threshold option is the next option vertically after the Enable Lighting option. Like the Enable Lighting option, the Threshold option is a toggle button, i.e., it can either be set on or off.



The Threshold option is used to control the range of colors used on the legends of the graphics displays. When the toggle is set to "On", the sliders controlling the range of the legend colors appears.



The Verbose toggle button is the final button appearing vertically in the options window. When enabled, this button provides detailed information on the actual inner workings of 3dstress. It is useful in determining the reason for sometimes esoteric system errors.

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☐ Verbose

C20

Hot-Keys for Specific Windows

Within specific windows, certain key-strokes may be used to issue commands. By taking note of the general consistency of these commands from window to window, the users may increase efficiency. This same information may be found in the Quick-Help option of the Help pull-down menus of most windows.

Tendency Viewer Hot-Keys

Mouse:

- <left button> Change slip tendency
- <middle button> Select triangles with similar strikes in 3D Viewer
- <right button> Get the name of a selected overlay

Keyboard:

- (.) Increase strike
- (,) Decrease strike
- (m) Increase dip
- (n) Decrease dip
- (p) Create xwd image of window

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Hot-Keys for Specific Windows

Within specific windows, certain key-strokes may be used to issue commands. By taking note of the general consistency of these commands from window to window, the users may increase efficiency. This same information may be found in the Quick-Help option of the Help pull-down menus of most windows.

3D Viewer Hot-Keys

Mouse:

- <left button> Change position of viewer/selection
- <middle button> Zoom in or out
- <right button> Rotate the viewer

Keyboard:

- (b) Toggle showing of bounding box
- (o) Zoom out
- (i) Zoom in
- (r) Reset viewer
- (Spacebar) Turn selection on
- (a) Toggle showing of axis
- (v) Average selected vectors
- (m) Toggle between rotation modes
- (z) Change render mode
- (p) Create xwd image of window

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Hot-Keys for Specific Windows

Within specific windows, certain key-strokes may be used to issue commands. By taking note of the general consistency of these commands from window to window, the users may increase efficiency. This same information may be found in the Quick-Help option of the Help pull-down menus of most windows.

Map Viewer Hot-Keys

Mouse:

- <left button> Change position of map
- <middle button> Zoom in or out
- <right button> Select fault

Keyboard:

- (b) Toggle showing of bounding area
- (o) Zoom out
- (i) Zoom in
- (r) Reset viewer
- (p) Create xwd image of window

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Hot-Keys for Specific Windows

Within specific windows, certain key-strokes may be used to issue commands. By taking note of the general consistency of these commands from window to window, the users may increase efficiency. This same information may be found in the Quick-Help option of the Help pull-down menus of most windows.

Rose Diagram Hot-Keys

Mouse:

- <left button> change position of map
- <middle button> Zoom in or out
- <right button> Northing

Keyboard:

- (o) Zoom out
- (i) Zoom in
- (r) Reset viewer
- (b) Toggle showing of bounding area
- (c) Toggle showing of continuous lengths
- (s) Toggle showing of cumulative lengths
- (p) Create xwd image of window

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Hot-Keys for Specific Windows

Within specific windows, certain key-strokes may be used to issue commands. By taking note of the general consistency of these commands from window to window, the users may increase efficiency. This same information may be found in the Quick-Help option of the Help pull-down menus of most windows.

Surface Viewer Hot-Keys

Mouse:

- <left button> Nothing
- <middle button> Zoom in or out
- <right button> Rotate the viewer

Keyboard:

- (o) Zoom out
- (i) Zoom in
- (r) Reset viewer
- (,) Increase vertical exaggeration
- (.) Decrease vertical exaggeration
- (a) Toggle showing of axis
- (b) Toggle showing of bounding box
- (u) Toggle showing of base
- (x) Toggle showing of points
- (z) Change render mode
- (p) Create xwd image of window

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Hot-Keys for Specific Windows

Within specific windows, certain key-strokes may be used to issue commands. By taking note of the general consistency of these commands from window to window, the users may increase efficiency. This same information may be found in the Quick-Help option of the Help pull-down menus of most windows.

Graph Hot-Keys

Mouse:

- <left button> Change position of pointer
- <middle button> Nothing
- <right buttong> Change log mode

Keyboard:

- (l) Change log mode
- (p) Create xwd image of window

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Hot-Keys for Specific Windows

Within specific windows, certain key-strokes may be used to issue commands. By taking note of the general consistency of these commands from window to window, the users may increase efficiency. This same information may be found in the Quick-Help option of the Help pull-down menus of most windows.

Mohr Graph Hot-Keys

Mouse:

- <left button> Change position of graph
- <middle button> Zoom in or out
- <right button> Nothing

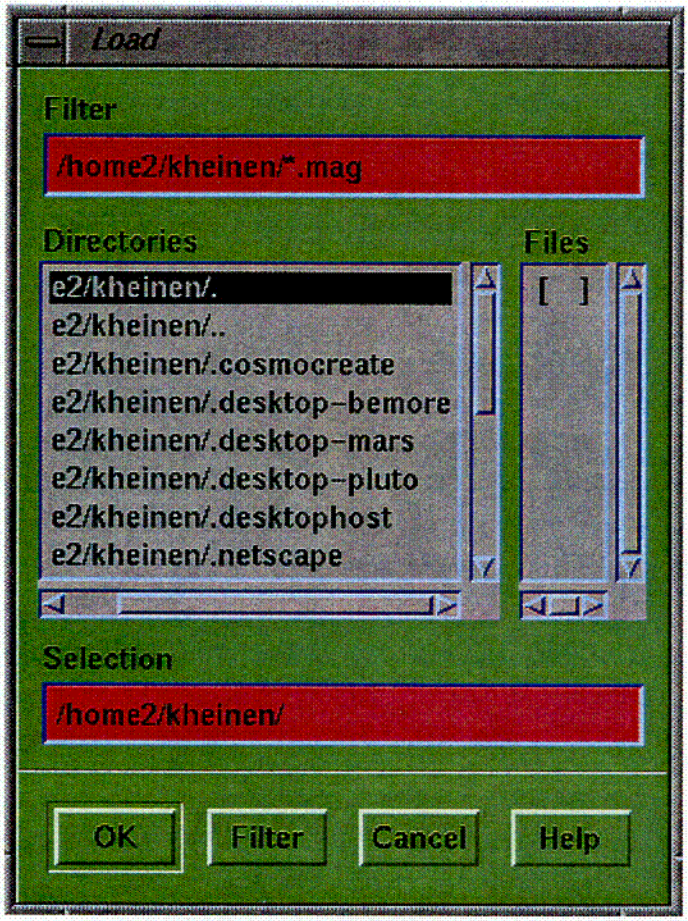
Keyboard:

- (a) Toggle showing of axis
- (i) Zoom in
- (o) Zoom out
- (r) Reset viewer
- (x) Toggle showing of inner circles
- (z) Change render mode
- (p) Create xwd image of window

page 6

File Selector

The file selector allows the loading or saving of files. Files may be selected by typing the name of the file in the **Selection** area or by double clicking on a file name in the **Files** section. Changing directories can be done by navigating through the file system by using the **Directories** section or typing in a new directory as the **Filter**.



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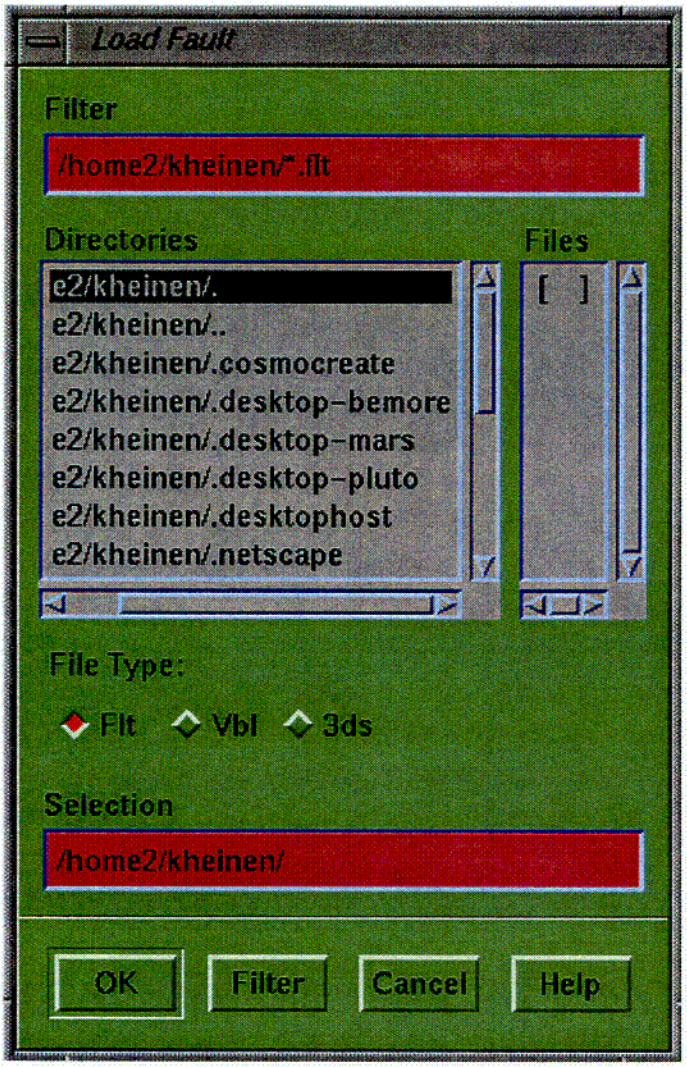
Some of the file selectors may contain a file type section which allows for loading or saving of different file formats by selecting the appropriate file type.



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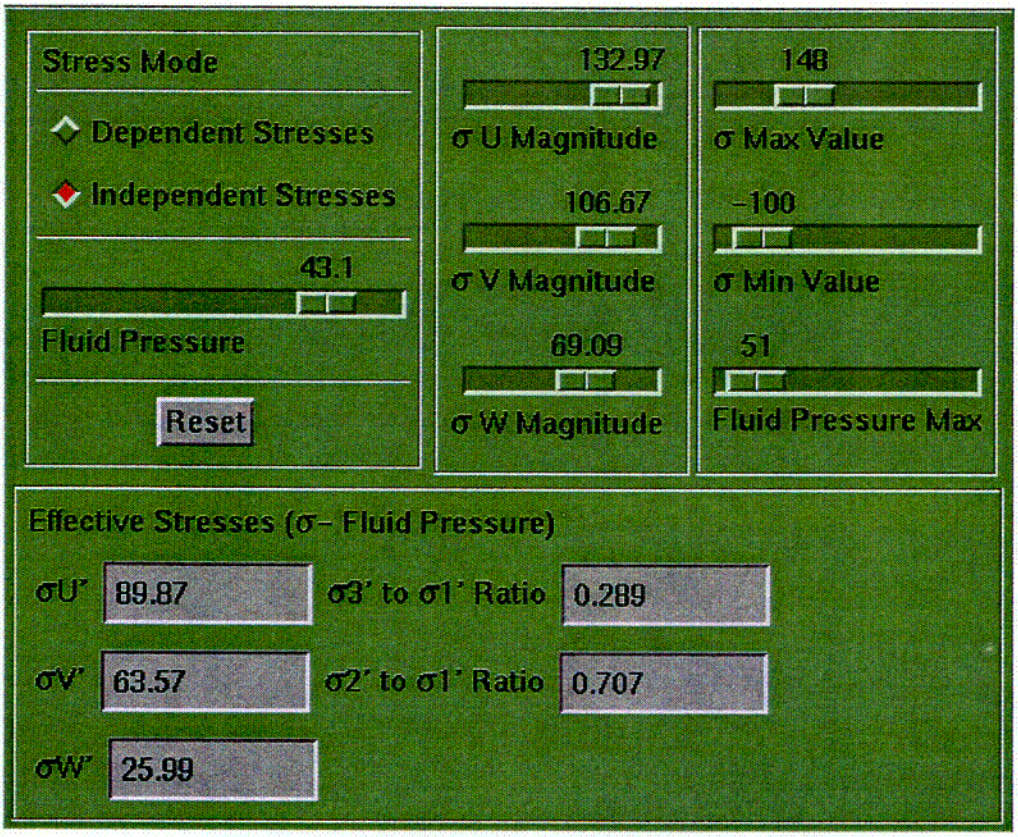
Example

Use the following example to determine if 3DStress is installed correctly and heighten your level of understanding of the 3DStress application suite.

Begin by opening the Mohr Graph Option window. Type 150 into the **Max Value** text box under the heading Sigma Range to increase the maximum allowable stress value. Now, change the magnitudes of σ_U, σ_V, and σ_W to 133, 108, and 68 respectively via the **Magnitude sliders** immediately to the left of the Sigma Range box. Change the **Fluid Pressure** (in the Sigma Range Box below the Max and Min Value text boxes) to 43. The options window should now look like this



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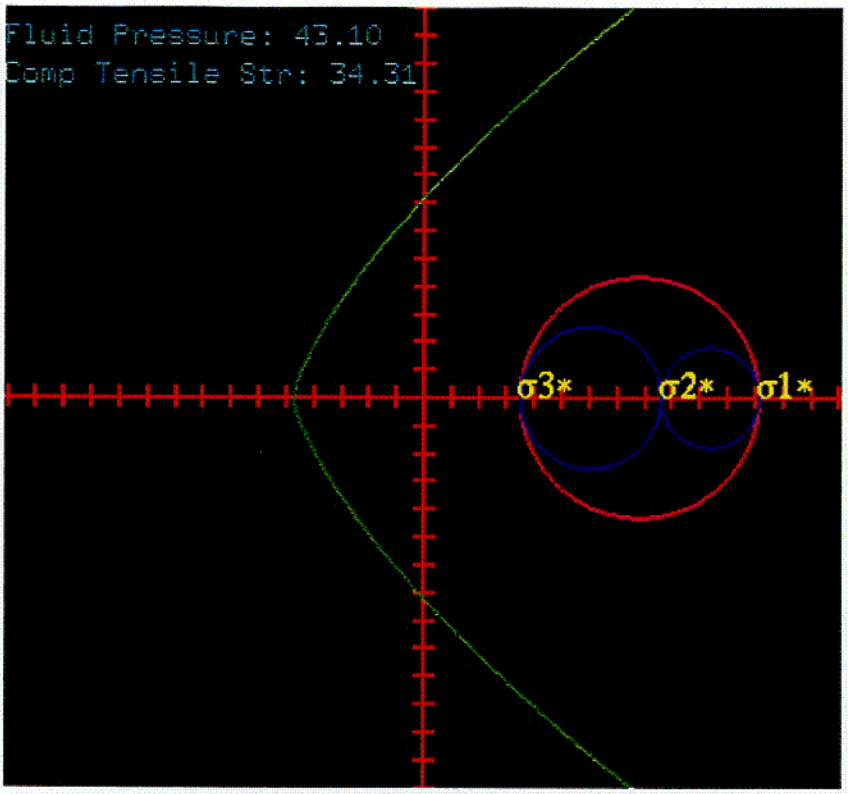
The Mohr Graph should look like this



Click the **Apply Button** at the bottom of the Mohr Graph's Option window to transfer the stress relationships, the fluid pressure, and the automatically computed tensile strength to the rest of the application suite.

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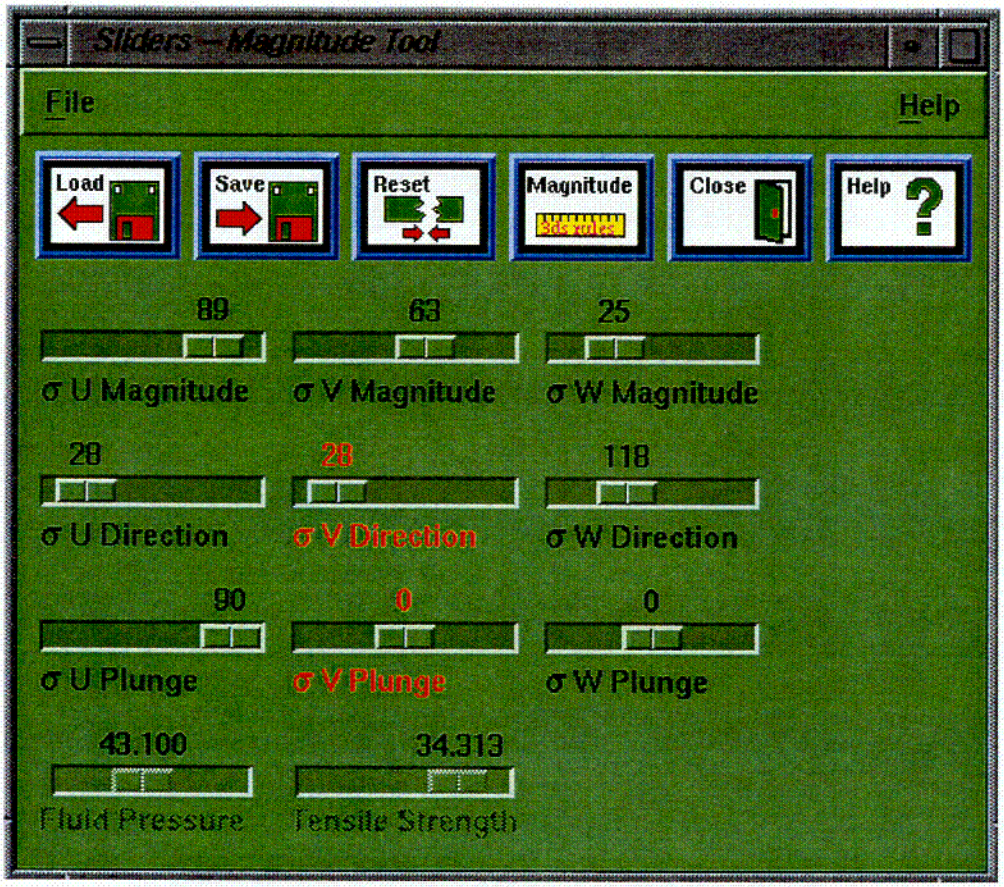
C24

Open the Magnitude Tool window and change the **V Direction** slider to 28. The Magnitude Tool window should now look like this



Note that the effective stresses from the Mohr Graph have been normalized to produce the new U, V, and W.

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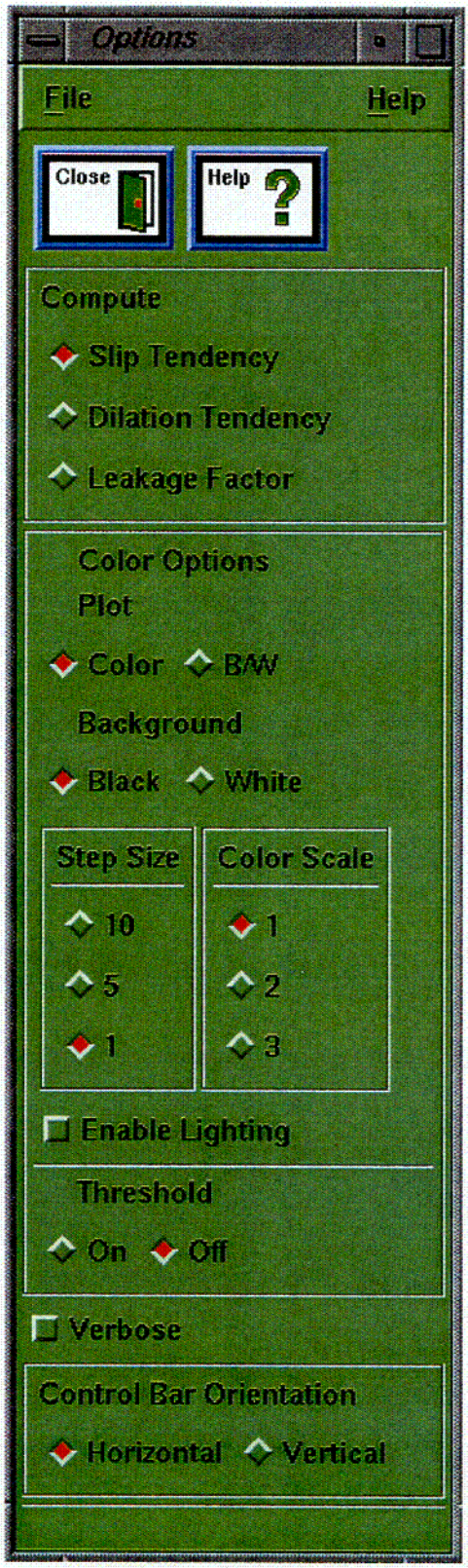
C25

Before loading any files, open the Options window and change the **Step Size** to 1. The Options window should look like this



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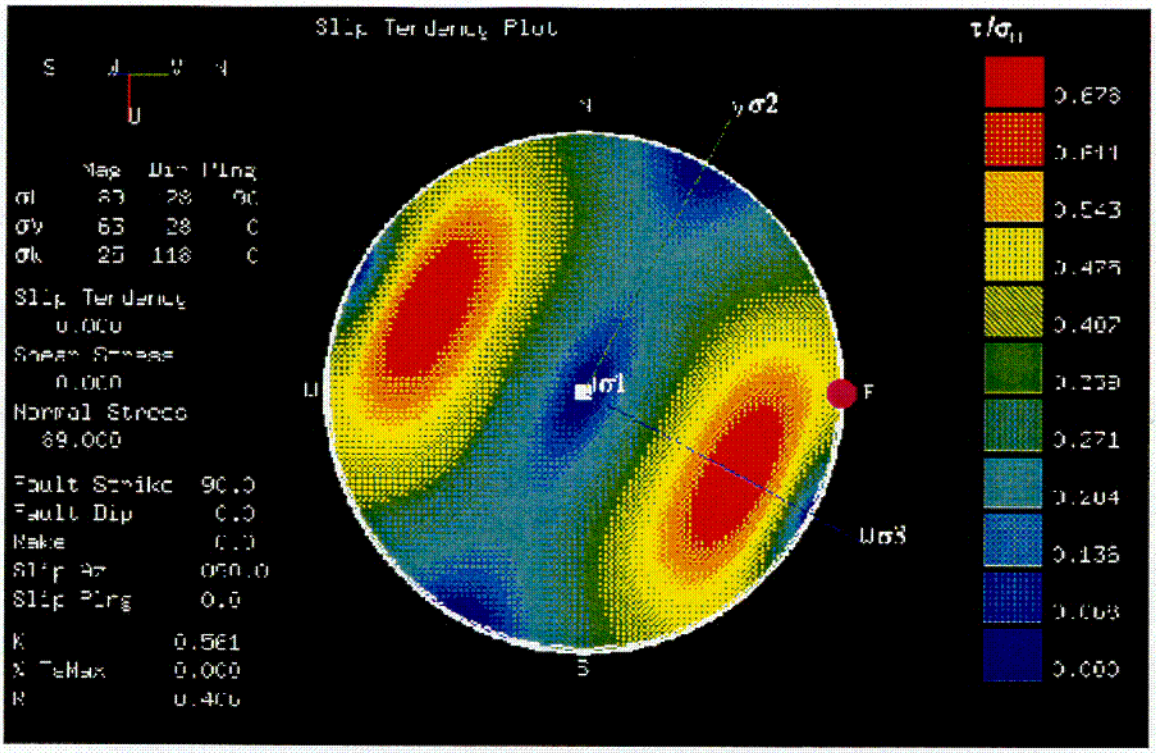
C26

The Tendency Plot should now look like this



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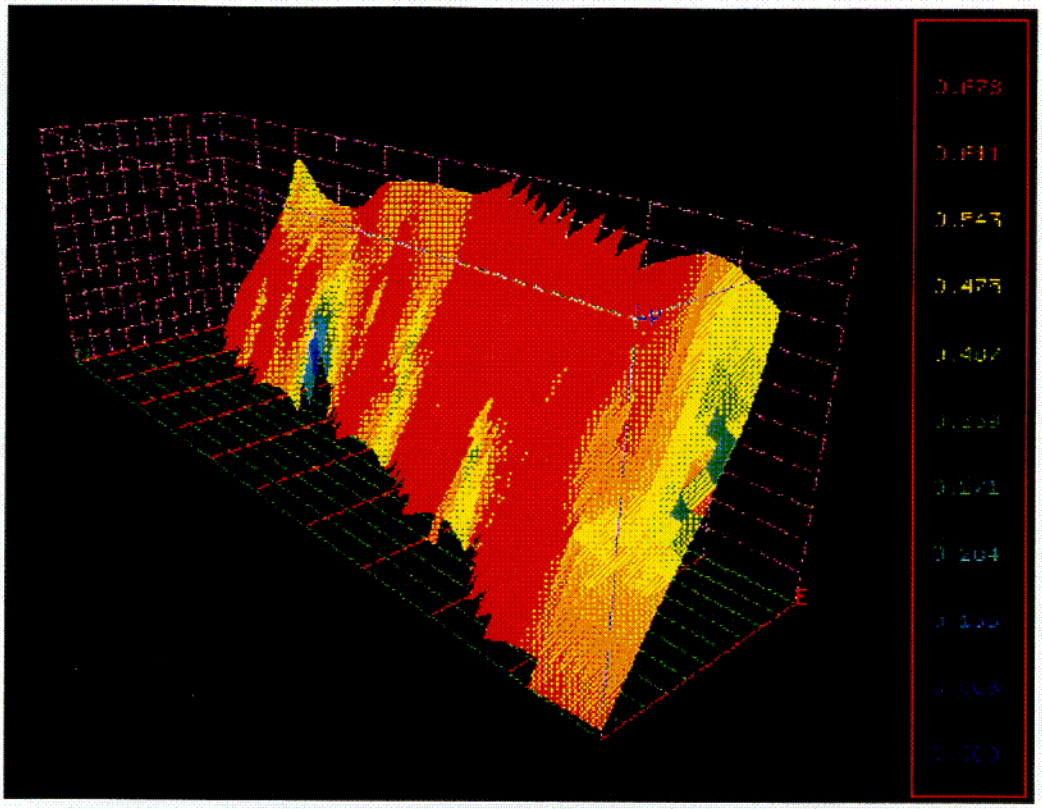
C27

Open the 3D Fault Viewer and load the file flt010_bowRidge020.flt (provided with the 3dstress version 1.3 release). The 3D Fault Viewer should look like this



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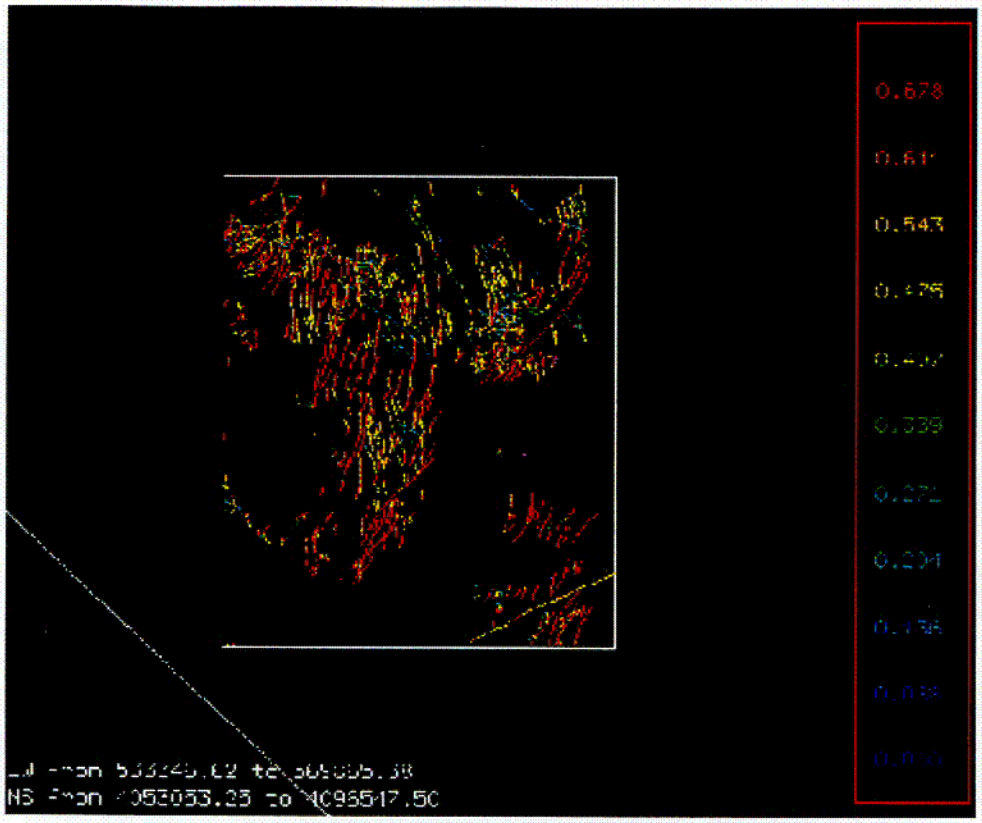
C28

Open the Map Viewer and load the fault file frizzell.lin and the coverage file worldutmz11.lin (both provided with the 3dstress version 1.3 release as well). The Map Viewer should look like this



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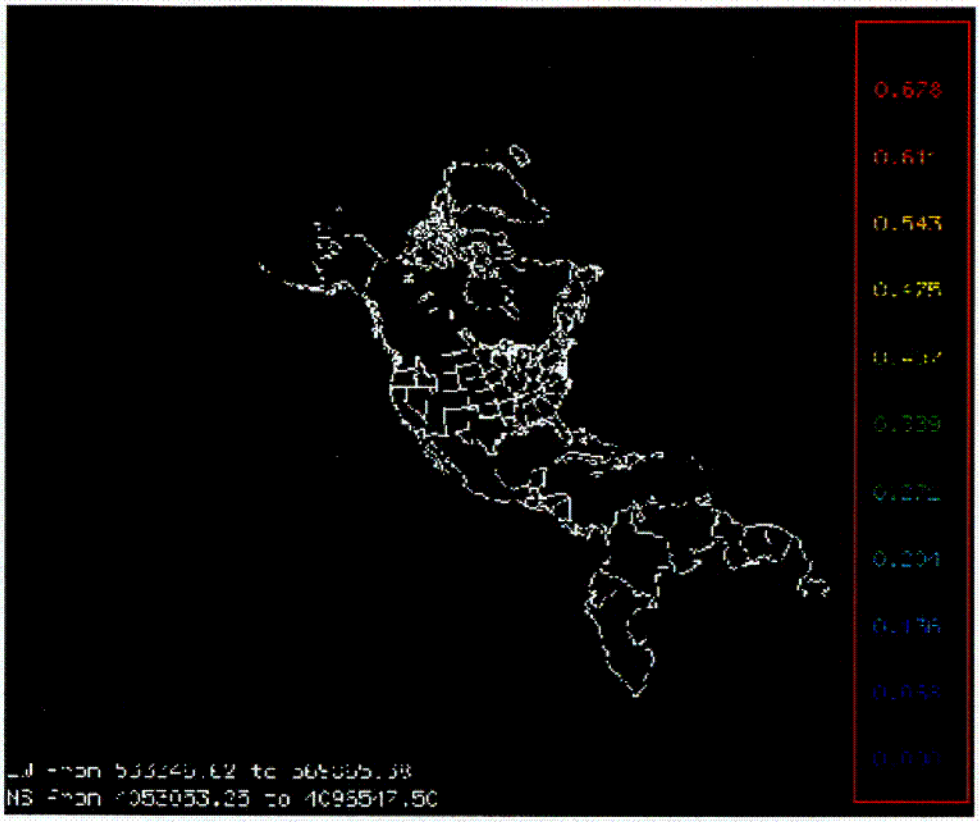
C29

Now, zoom out using the middle mouse button to view the whole coverage.



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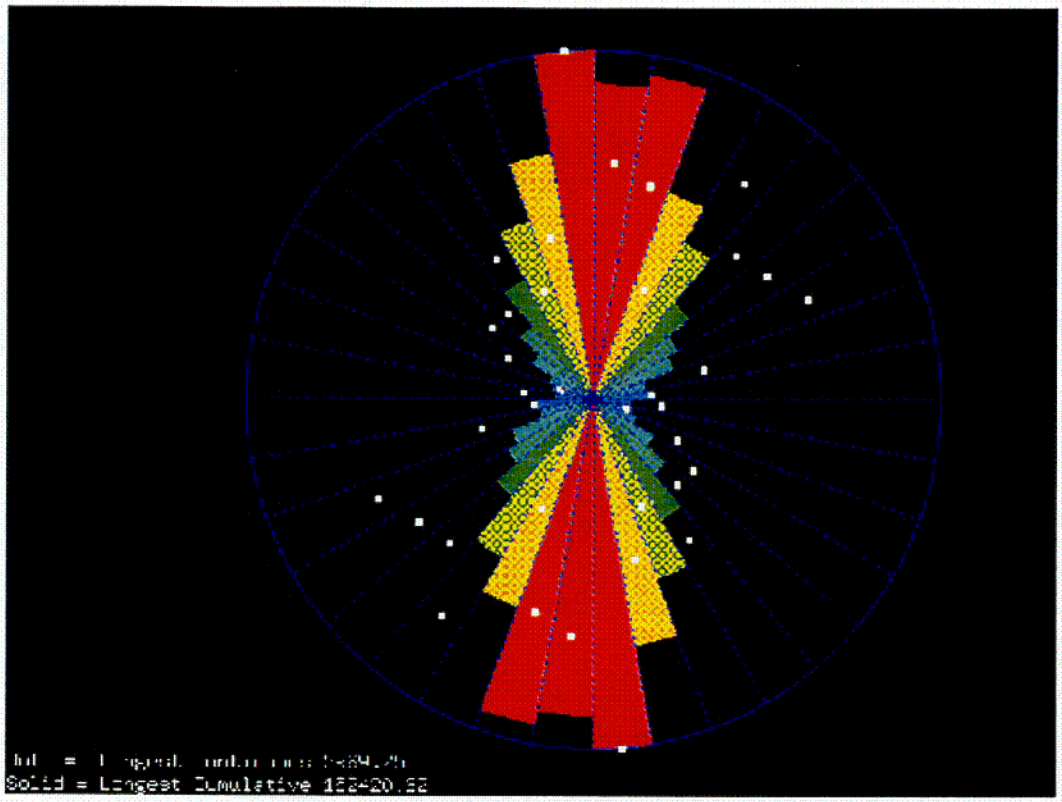
C30

The Rose Diagram should look like this



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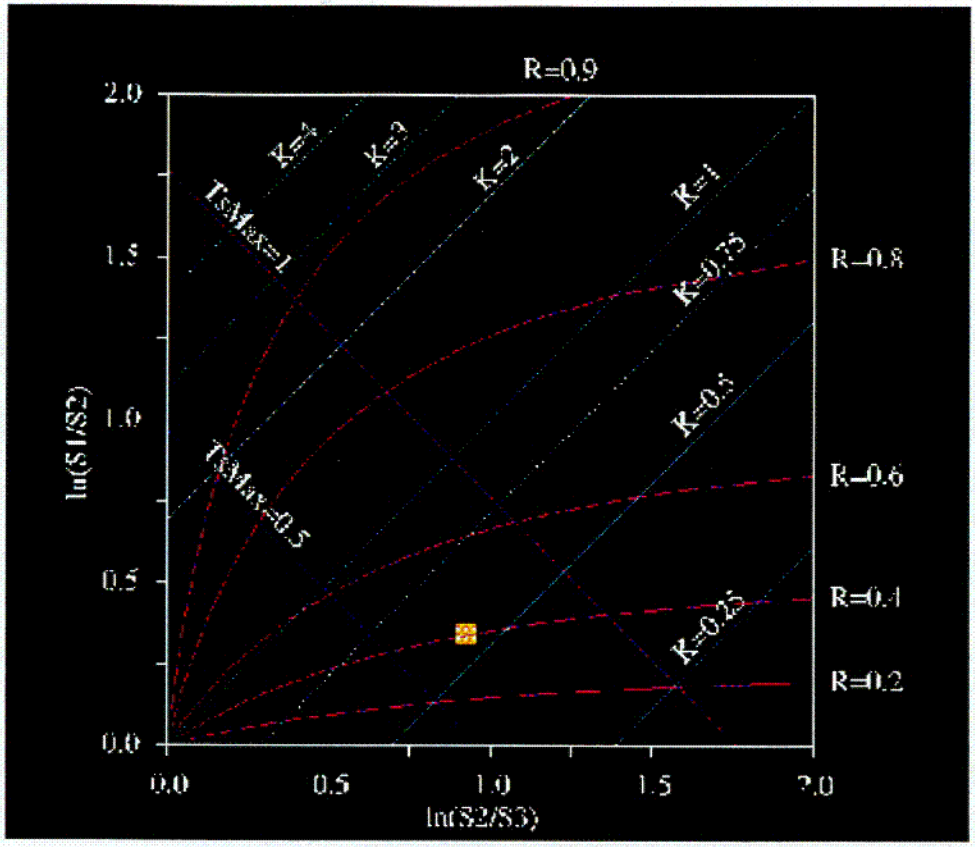
C31

The Stress Ratio Graph should look like this



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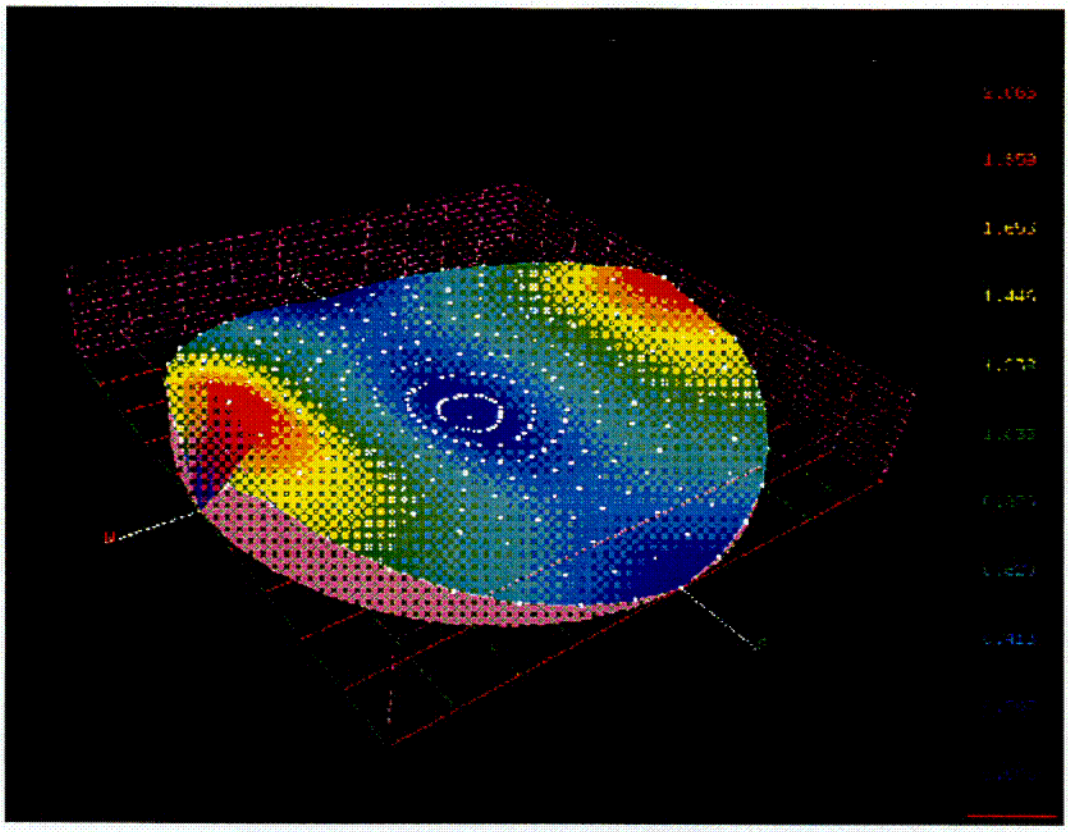
C32

Finally, Surface Viewer should look like this



This example is based on the following article:

Morris, A., D. A. Ferrill, and D. B. Henderson, 1996, "Slip-tendency analysis and fault reactivation," Geology, March 1996, 24(3): 275 278.

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C33

File Formats

Introduction and Requirements

This appendix describes procedures used to enter two-dimensional (2D) fault traces (e.g., from maps) and 3D fault surfaces into 3DStress. To enter data Arc/Info , EarthVision , or 3DMove must be available on the computer system.

Fault Import Procedures for 3DStress

The 3DStress application is capable of reading ASCII data files containing 2D fault trace data and 3D fault surfaces. The naming convention used by 3DStress developers is to suffix the 2D fault trace files with .lin and the 3D fault surface files described below with .flt, although 3DStress does not require consistent file suffixes. 3DStress also reads the 3D fault files (usually suffixed with .vbl) produced by 3DMove . The .lin and .flt fault file format is similar to the format produced by the Arc/Info UNGENERATE command. The file is divided into sections that describe individual fault traces or segments as shown below.

```
2D File Format

1
x1,     y1
x1,     y2
.
.
.
xN,     yN
END
2
x1,     y1
x2,     y2
.
.
.
xN,     yN
END
END
```

```
3D File Format

1
x1,     y1,     z1
x2,     y2,     z2
.
.
.
xN,     yN,     zN
END
2
x1,     y1,     z1
x2,     y2,     z2
.
.
.
xN,     yN,     zN
END
```

END

Generation of Fault Trace Files

CNWRA generates 2D fault trace files directly using Arc/Info. Line coverages are converted to the ASCII file format using the Arc/Info UNGENERATE command. The resulting fault trace files are input directly to the 3DStress application. Arc/Info line coverages can be generated using several techniques described in the Arc/Info user documentation.

Generation of Fault Surface Files

CNWRA generates 3D fault surface files by post processing EarthVision fault grid files into the format described above. The steps required for this procedure are as follows. 1) Create a 2D fault surface grid file with EarthVision . Grid the surface file using the exact data range, no z limits, and no extrapolation. High resolution grids generally give better results than low resolution grids. 2) Convert the 2D grid file to ASCII format using the script file run2grdToFlt generated by CNWRA. The run2grdToFlt script requires for successful execution that the Dynamic Graphics "ev_export" program and license be located on the local system. The contents of the run2grdToFlt script file are listed below:

```
#!/bin/sh

if [ $#  lt 1 ]
then
  echo "\nUsage $0  [zmin zmax]"
  echo "$# of 1\n"
  exit
fi

gridfile=$1
datfile='echo $gridfile   nawk  F"." '{print $1}''.goofy.dat
tmp1file='echo $gridfile   nawk  F"." '{print $1}''.tmp1
tmp2file='echo $gridfile   nawk  F"." '{print $1}''.tmp2
tmp3file='echo $gridfile   nawk  F"." '{print $1}''.tmp3
tmp4file='echo $gridfile   nawk  F"." '{print $1}''.tmp4
linfile='echo $gridfile   nawk  F "." ' {print $1}''.flt


echo "\nExport 2grd file to dat file \n"
ev_export  n  o $datfile $gridfile

head  31 $datfile

echo "\nConvert dat file to tmp1 file \n"
nawk '{
     if (substr($0,1,1) != "#") {
        x = $1 + 0.0
        y = $2 + 0.0
        z = $3 + 0.0
        printf "% 14.6f %14.6f % 14.6f\n", x,y,z
     }
     }' $datfile > $tmp1file

head  10 $tmp 1 file

cp $tmp 1 file $tmp2file

if [ $#  eq 3]
then
   echo "\nFilter tmp1 file for z ranges \n"
```

```
   nawk '{
        x = $1 + 0.0
        y = $2 + 0.0
        z = $3 + 0.0
        if ((z >= zmin) && (z <= zmax)) {
           printf "% 14.6f % 14.6f %14.6f\n", x,y,z
        }
     }' zmin=$2 zmax=$3 $tmp 1 file > $tmp2file
   head  10 $tmp2file
fi


echo "\nConvert dat file to flt file \n"

nawk 'BEGIN {
         cnt = 1
         xcntset = 0
     }
     {
         x[cnt] = $1 + 0.0
         y[cnt] = $2 + 0.0
         z[cnt] = $3

         if (cnt > 1) {
     if (!xcntset) {
        if (y[cnt] ! = y[cnt 1]) {
           xCnt = cnt 1
           xcntset = 1
           # print "Xcnt = ", xCnt
        }
     }
         }

         Cnt++
     }

      END {

         yCnt = (cnt 1)/xCnt
         # print "Ycnt = ", yCnt

         for (yi = 0; yi < yCnt 1; yi++) {
      vcnt = 0
      for (xi = 1; xi < xCnt; xi++) {
         ind = xi + (yi*xCnt)
         ind2 = ind + xCnt
         if ((z[ind] != "NZRNG") && (z[ind2] != "NZRNG")) {
            v[vcnt] = ind
            vcnt++
            v[vcnt] = ind2
            vcnt++
         }
      }

      if (vcnt > 2) {
         printf "%4d\n", yi
            for (vi = 0; vi < vcnt; vi++) {
       ind = v[vi]
       printf "%14.6f % 14.6f %s\n", x[ind], y[ind], z[ind]
            }
         printf "END\n"
      }
         }
         printf "END\n"
```

```
      }' zmin=$2 zmax=$3 $tmp2file > $tmp3file

echo "\nStrip null Z coordinates \n"

nawk '{
        if (NF == 3) {
      if ($3 != 0) {
         x = $1 + 0.0
         y = $2 + 0.0
         z = $3 + 0.0
         printf "% 14.6f %14.6f % 14.6f\n", x,y,z
      }
        } else {
          printf "%s\n", $1
        }
       }'$tmp3file > $tmp4file

head  10 $tmp4file

echo "\nStrip segments with less than 3 coordinates \n"

nawk 'BEGIN {
   segStr=""
   lineCount=0
}
{
   if (segStr !="") {
     segStr=segStr"\n"$0
   } else {
     segStr=segStr$0
   }
   if (NF = 3) {
      lineCount += 1
   }
}
/END/ {
   if (lineCount >3) {
      print segStr
   }
   lineCount =0
   segStr=""
}
END {
   print "END"
}'$tmp4file > $linfile

head  10 $linfile

rm $datfile $tmp1file $tmp2file $tmp3file $tmp4file

echo "\nFinished, created $linfile\n"
```