



EKKO_Project SliceView Module

User's Guide

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s u b s u r f a c e i m a g i n g s o l u t i o n s

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1 Introduction

Ground Penetrating Radar (GPR) data is often presented as two dimensional cross-sections of the subsurface. In areas where GPR data has been collected in a grid survey, interpreting data from GPR line cross-sectional images can be confusing and labor intensive.

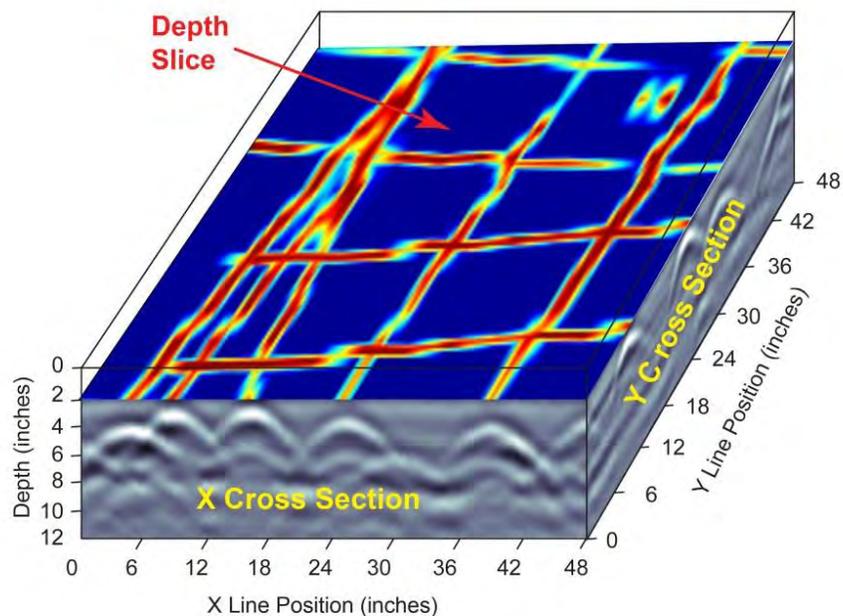
SliceView depth slices provide highly detailed subsurface information that can enhance GPR data interpretation and presentation. Displaying GPR responses as depth slices allows users to see the spatial correlation of targets, making interpretation easier as they can differentiate real targets from targets of no interest. For example, responses from utilities tend to produce linear targets while local targets, such as rocks, appear as point targets. This type of display can greatly enhance the interpretation of large data volumes.

SliceView is designed to process GPR grid data to enhance targets and create depth slices.

Use SliceView to

- Analyze grid data by viewing depth slices at increasing depths
- Reprocess grid data using a different velocity
- Save images to graphic image files
- Display data collected with GPS depth slices on Google Earth and extract the GPS target positions of targets write them to reports.
- Export grid data to 3D data files and 3D visualization software (available from [Sensors & Software](#))

The following conceptual grid image displays the relationship between depth slice images and X and Y GPR line images.



2 Opening SliceView

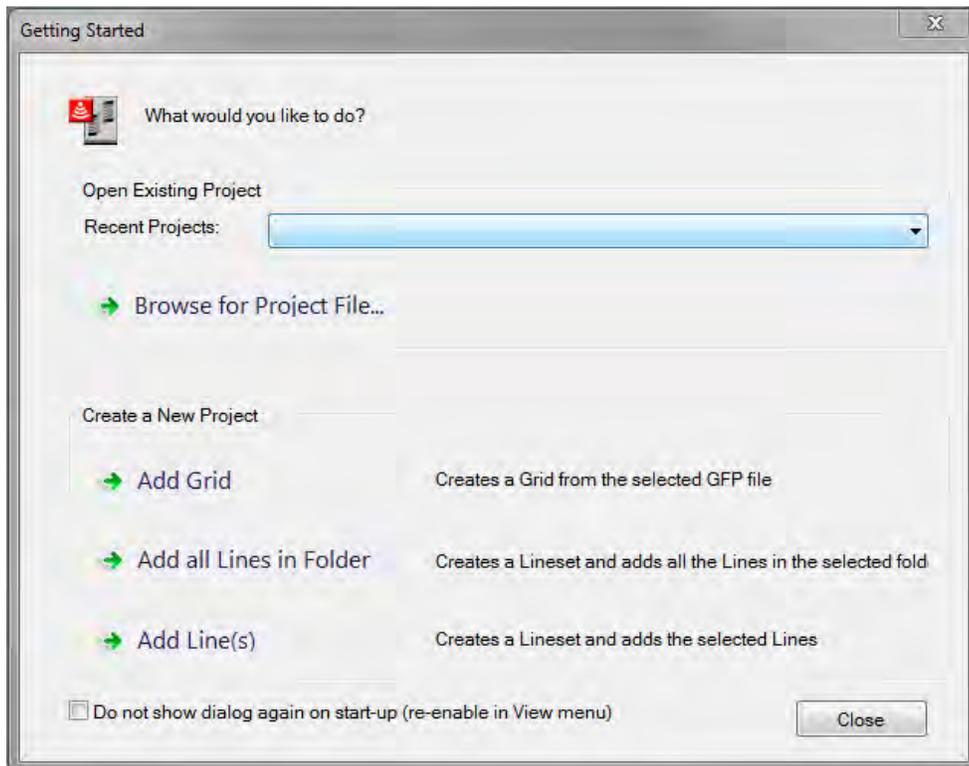
SliceView is a module of EKKO_Project. To access SliceView, you must first open EKKO_Project.

SliceView only works with project files containing grids.

1. To open EKKO_Project, click **Start > All Programs > Sensors & Software GPR > EKKO_Project**.

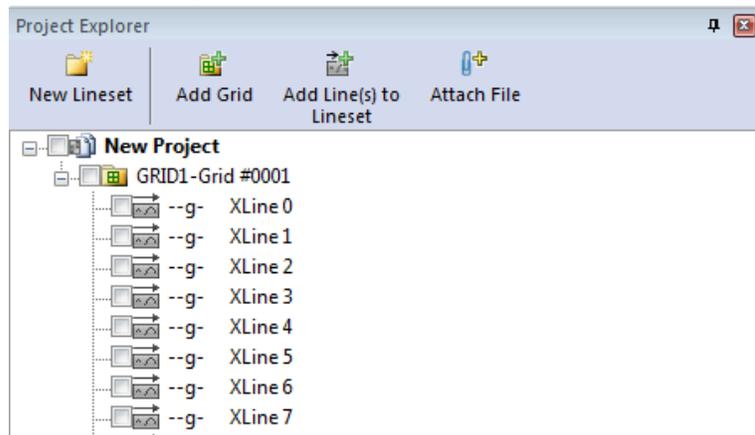
The **Getting Started** dialog box automatically opens to assist you to select a grid.

2. In the **Getting Started** dialog box, click → **Browse for Project File...**
Alternatively, click → **Add Grid** to create a new project with a grid or grids



3. In the **Open** dialog box, navigate to and then select a grid or project file.
Note: If you are opening a project only gpz files are listed, if you are adding a grid to a project file, only .gfp files are listed.
4. Click **Open**.

The grid is displayed in the **Project Explorer**:



Note: GFP files can contain more than one grid survey but SliceView can only process one grid from a GFP file. If the GFP file contains more than one grid, you must select one grid survey from the list.

5. In **Project Explorer**, select a grid.
 6. In the **EKKO_Project** menu bar, click **Tools > SliceView**.
Alternatively, right-click in the Project Explorer window and click SliceView.
- The SliceView window opens:

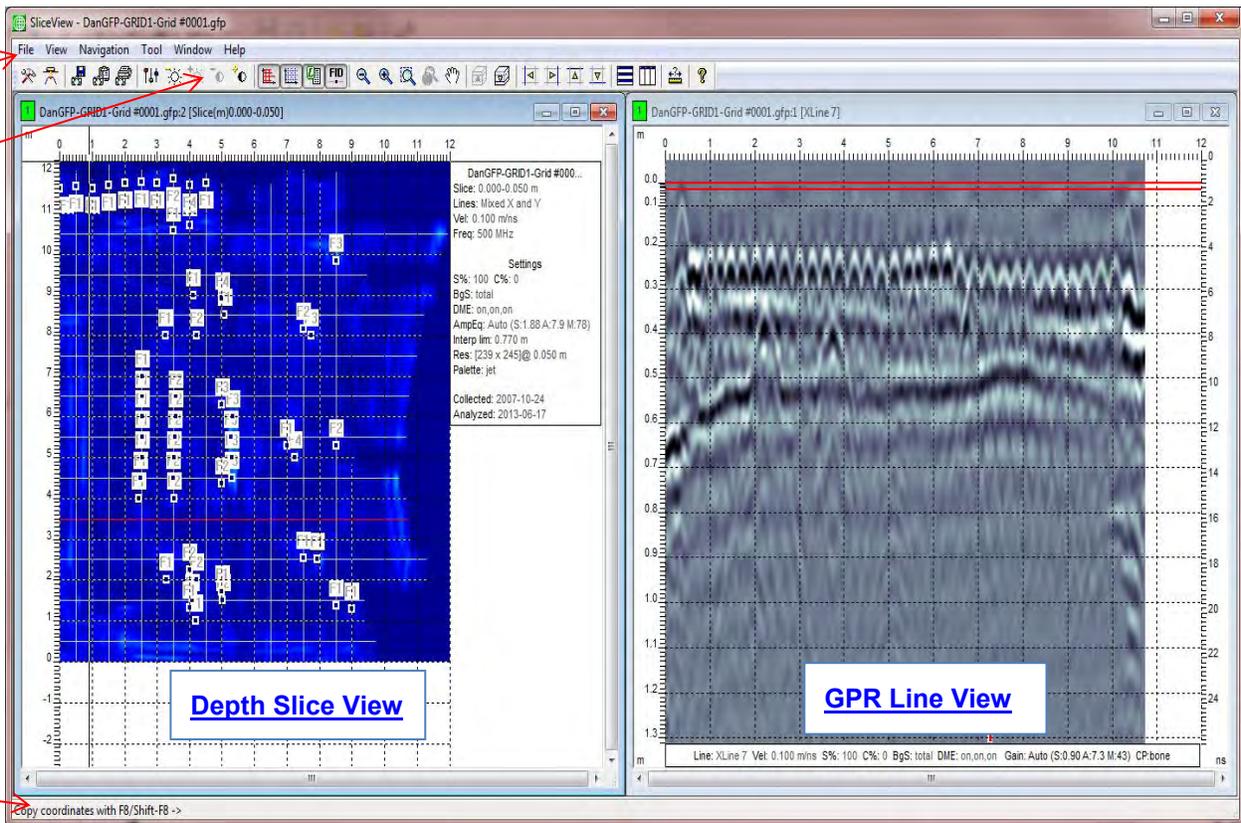


Figure 1: The SliceView window.

7. The first time SliceView opens a grid, it processes the grid data using default settings that are appropriate for most data sets. See [Data Processing](#) to see the settings and edit them if necessary.
8. Use the following table as a guide to working with the SliceView window:

| Item | Description |
|-------------------------|---|
| Menu bar | Most SliceView operations can be performed through the menu bar. To learn more, see the menu bar . |
| Toolbar | Most SliceView operations can be performed through the toolbar. To learn more, see the toolbar . |
| Depth Slice View | The Depth Slice window displays the current depth slice images. To learn more, see Depth Slice View . |
| GPR Line view | The GPR Line View displays the current GPR line image. To learn more, see GPR Line View . |

2.1 Active Window

SliceView typically displays two windows at a time; the Depth Slice and the GPR Line windows. Only one window can be active and accept changes at a time. The active window is the one that was last selected by clicking in it with the mouse cursor and is usually identified by its darker title banner and a red X in the top corner.

To make changes in a particular window, first ensure it is the active window. The active window is also checked in menu bar [window](#) list. Often, trying to edit a window immediately makes it the active window.

2.2 Depth Slice View

The Depth Slice View displays slices of the current grid survey data.

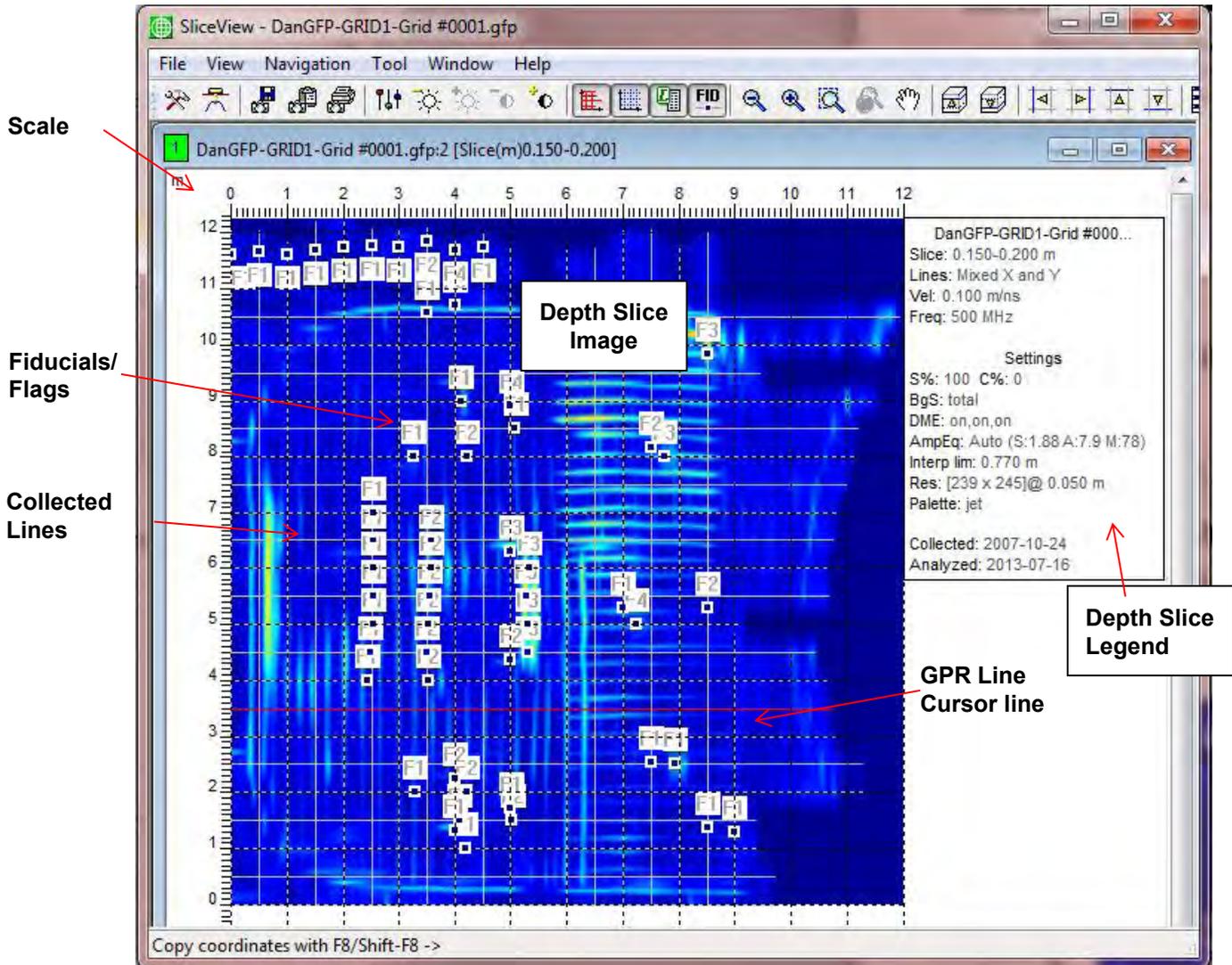
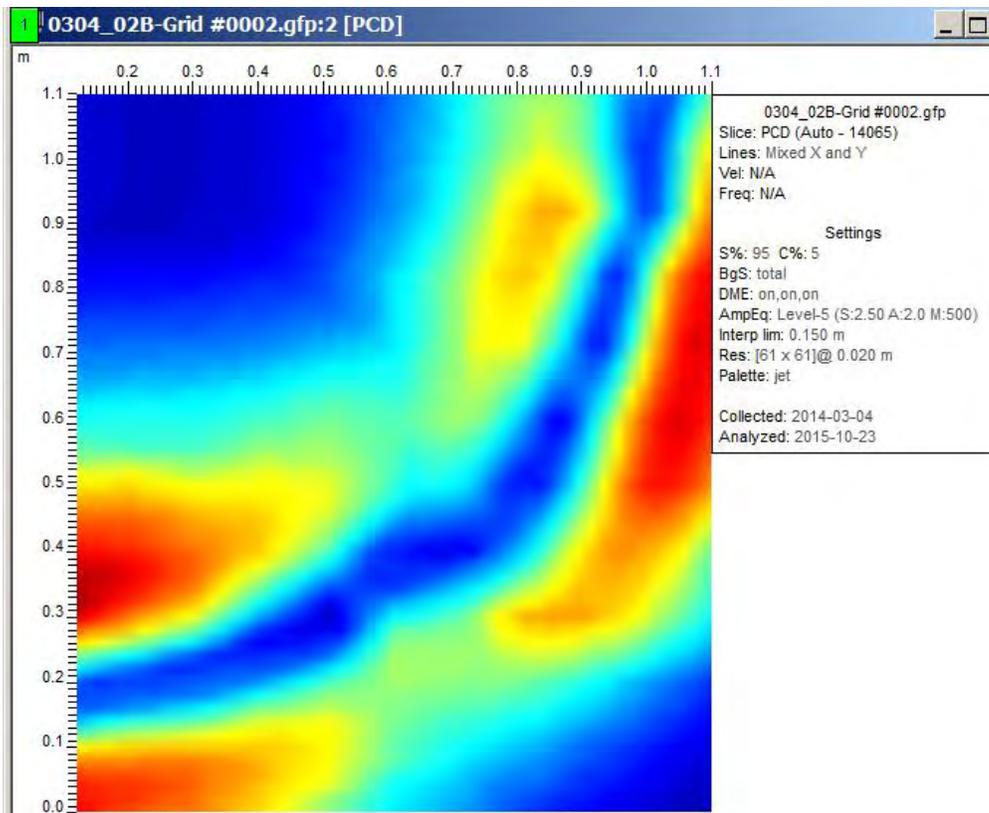


Figure 2: Depth SliceView

The slice images currently supported in SliceView are

- **Depth Slices:** images of the average GPR signal amplitudes in the specified depth range (or thickness). Depth slice images are dependent on the current [Signal Velocity](#) value.
- **Time Slices:** images of the average GPR signal amplitude in the specified time range. The Plan View window title banner lists the current depth or time range used to generate the slice image. The optional Depth Slice Legend on the upper right also lists the depth or time range of the current slice image as well as other information.
- **PCD Slice:** for Conquest grid data, the Power Cable Detector (PCD) slice can be displayed by selecting the  button on the Toolbar.



Axes scales corresponding to the X and Y positions appear on the left and top of the depth slice image respectively.

To learn more about working in Depth Slices, see the [Menu bar](#) or [Toolbar](#) sections.

2.3 GPR Line View

The GPR Line View displays the X or Y line indicated by the red colored grid line in the Depth Slice View.

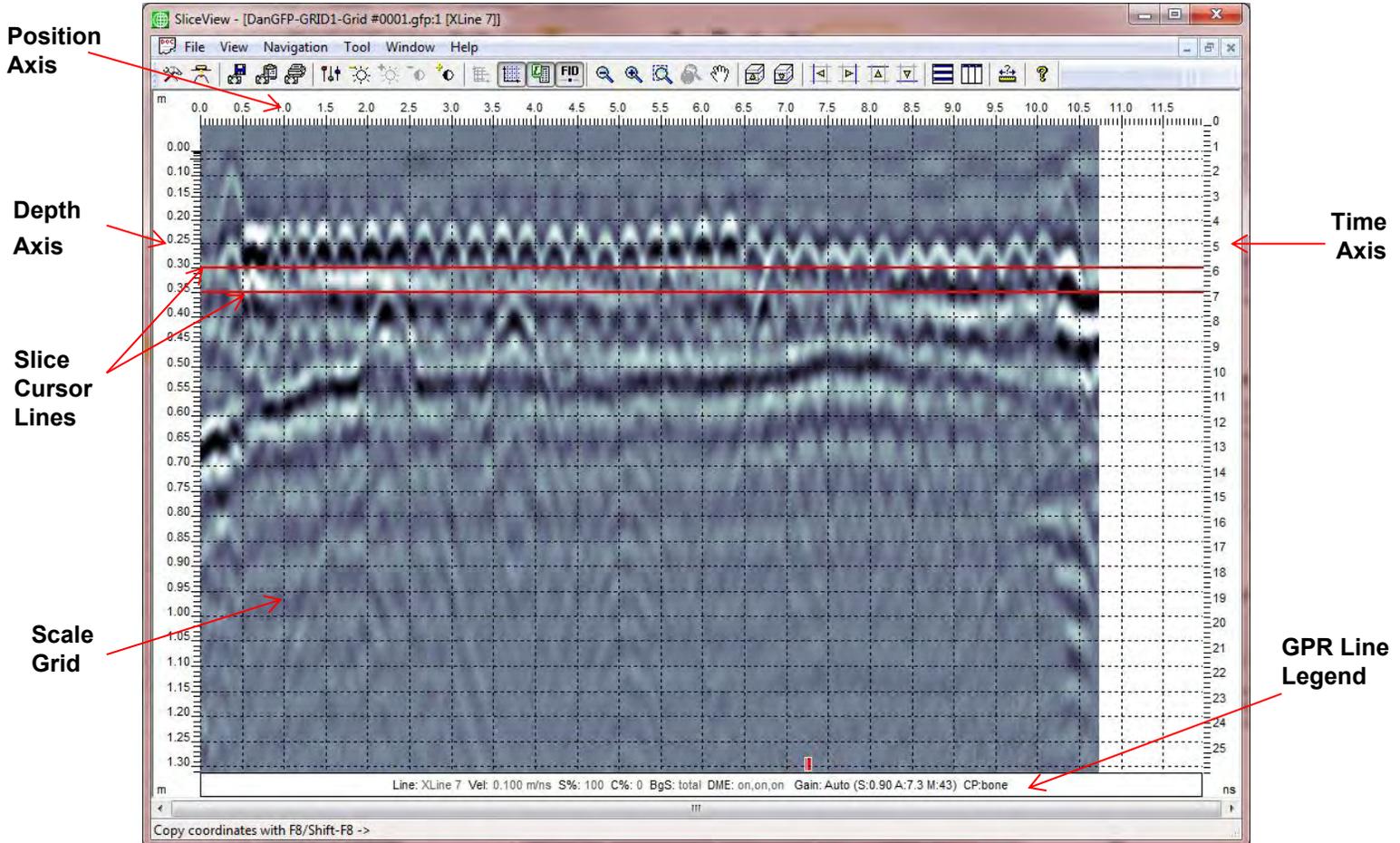
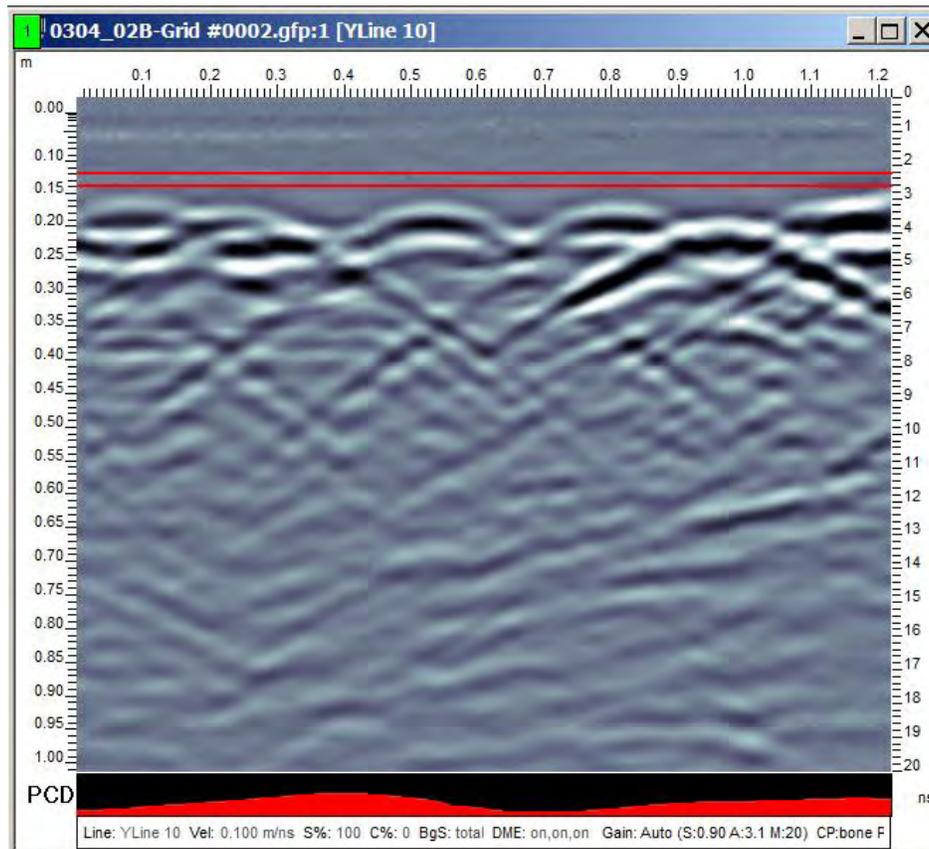


Figure 3: GPR Line View

For Conquest grid data, the Power Cable Detector (PCD) response is displayed below the grid line.



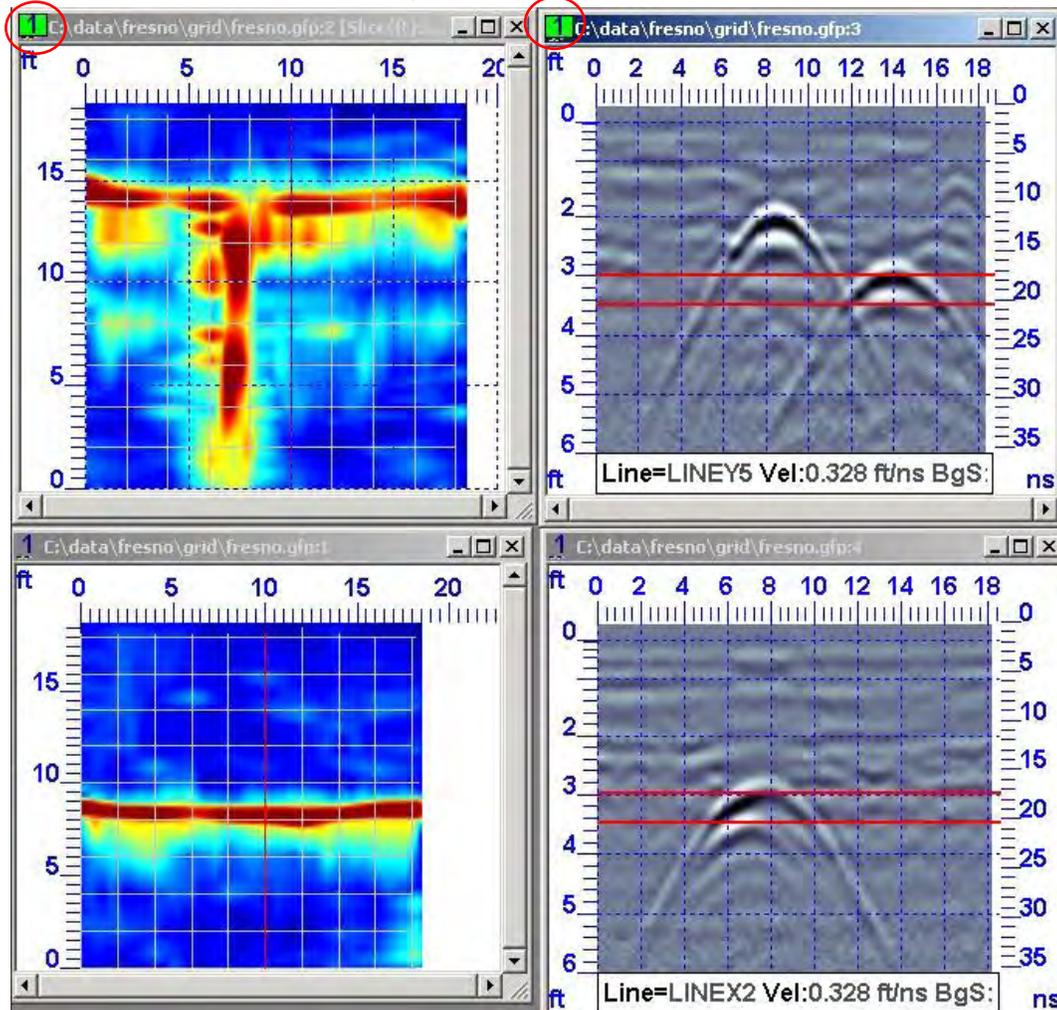
To learn more about working with the GPR Line images, see the [Menu bar](#) or [Toolbar](#) sections.

2.4 Opening a New Window

To open a new **Depth Slice View**, in the menu bar click **Window > New Depth Slice View Window**.

To open a new **GPR Line View**, in the menu bar click **Window > New GPR Line Window**.

When multiple windows are opened at once, only one GPR line window and one Depth Slice View window can be modified. These windows are indicated by the same bright green number in the upper left corner along the title banner.



3 Toolbar

Most SliceView operations can be performed through the toolbar. If the Toolbar is not visible, in the Menu Bar, click **View > Toolbar**.



To display a brief description of a toolbar button, hold your cursor over the button for at least one second.



A description is also displayed in the [Status Bar](#).

Use the following table as a guide to working with the SliceView Toolbar:

| Item | Description |
|---|--|
|  Data Processing | To open the Data Processing dialog box, click the Data Processing icon. To learn more, see Data Processing . |
|  Hyperbola Velocity Calibration | To calculate a velocity value using hyperbola fitting, click the Hyperbola Velocity Calibration icon. To learn more, see Hyperbola Velocity Calibration . |
|  Save Image As... | <ol style="list-style-type: none"> 1. Click the Save Image As icon to save the image in the Active Window to a graphics image file. 2. Open the Save File dialog box. 3. Select the folder to save the image to. 4. Enter the File name. 5. Select the Save as type option (jpg, bmp, gif, png, tiff), 6. Click Save. |
|  Save View | To save the image in the Active Window and attach it to the project file. When the GPR Summary Report is selected in EKKO_Project, the user can select from the images attached to project to appear in the report. To learn more, see GPR Summary Report in the EKKO_Project manual. |
|  Copy current image to clipboard | To save the image in the Active Window to the clipboard, click the Copy current image to clipboard icon. |
|  Print | Click the Print icon to print the image in the Active Window . |
|  Display Settings | To open the Settings dialog box, click the Display Settings icon. To learn more, see Slice Settings or GPR Line Settings . |

| Item | Description |
|--|--|
|  <p>Decrease Sensitivity</p> | <ol style="list-style-type: none"> To decrease how sensitive the image is to small signal variations, select the image you want to change. Click the Decrease Sensitivity icon. Sensitivity decreases by 5% each time you click the icon. The sensitivity range is 0 to 100%. The default is 100% (most sensitive). <p>To learn more, see Sensitivity.</p> |
|  <p>Increase Sensitivity</p> | <ol style="list-style-type: none"> To increase how sensitive the image is to small signal variations, select the image you want to change. Click the Increase Sensitivity icon. Sensitivity increases by 5% each time you click the icon. The sensitivity range is 0 to 100%. The default is 100% (most sensitive). <p>To learn more, see Sensitivity.</p> |
|  <p>Decrease Contrast</p> | <ol style="list-style-type: none"> To decrease contrast, select the image you want to change. Click the Decrease Contrast icon. Contrast decreases by 5% each time you click the icon. The contrast range is 0 to 100%. The default is 100%. <p>To learn more, see Contrast.</p> |
|  <p>Increase Contrast</p> | <ol style="list-style-type: none"> To increase contrast, select the image you want to change. Click the Increase Contrast icon. Contrast increases by 5% each time you click the icon. The contrast range is 0 to 100%. The default is 100%. <p>To learn more, see Contrast.</p> |
| <p>Decrease Gain</p> | <p>If the Gain value is a numbered level, this button is enabled:</p> <ol style="list-style-type: none"> To decrease gain, select the window (depth slice or GPR line) you want to change. Click the Decrease Gain icon. The gain level value will decrease by 1, stopping at 1. <p>To learn more about gaining the GPR Line, see Gain. To learn more about gaining depth slices, see Amplitude Equalization Gain.</p> |
| <p>Increase Gain</p> | <p>If the Gain value is a numbered level, this button is enabled:</p> <ol style="list-style-type: none"> To increase gain, select the window (depth slice or GPR line) you want to change. Click the Increase Gain icon. The gain level value will increase by 1, stopping at 12. <p>To learn more about gaining the GPR Line, see Gain. To learn more about gaining depth slices, see Amplitude Equalization Gain.</p> |
| <p>Gain Value</p> | <p>Use dropdown to select Auto, User or a Numbered Gain Level for the currently active window (either GPR line or Depth Slice window).</p> <p>To learn more, see Gain. To learn more about gaining the GPR Line, see Gain. To learn more about gaining depth slices, see Amplitude Equalization Gain.</p> |

| Item | Description |
|---|--|
|  PCD | To display the Power Cable Detector (PCD) image for Conquest data. |
|  Toggle Collected Lines | To display data lines in the depth slice view window that correspond to all the data lines collected during the grid survey, click the Toggle Collected Lines icon. |
|  Toggle Scale Grid Lines | To display grid lines that correspond to the major position labels in the depth slice view window, click the Toggle Scale Grid Lines icon. |
|  Toggle Legend Viewing | To display a legend in either the Depth Slice View or GPR Line View window, click the Toggle Legend Viewing icon. |
|  Display FID Text | Fiducial markers are added at significant positions during data collection. To display or hide fiducial markers, click the Display FID Text icon. To learn more, see Show Fiducials . |
|  Zoom Out | Click the Zoom Out icon to display more of the image, making it smaller and possibly less detailed. |
|  Zoom In | To display a more detailed view of a smaller area of the image, click the Zoom In icon. |
|  Select Zoom Area | To zoom in on a specific area of the selected window, Select Zoom Area . <ol style="list-style-type: none"> Click the Select Zoom Area icon. Click in the image and drag the cursor to the dimensions you want to magnify. A box will be superimposed on the image as you drag it. Release the mouse to zoom in on the selected area. |
|  Fit to Window | To return the grid to full size, click the Fit to Window icon. |
|  Pan View | To drag and drop data images around a zoomed-in image, click the Pan View icon. To learn more, see Pan . |
|  Move Slice Up | To scroll up through the image one depth slice per click until you reach the highest depth slice, click the Move Slice Up icon. If a GPR line window is open, the slice cursor lines (Figure 4) on GPR line image move up to match the slice image. Moving through slice images provides insight into the depth of various features in the 3D volume. To learn more, see Navigation . |

| Item | Description |
|---|---|
|  <p>Move Slice Down</p> | <p>To scroll down through the image one depth slice per click until you reach the lowest depth slice, click the Move Slice Down icon.</p> <p>If a GPR Line window is open, the slice cursor lines on the GPR line image move down to match the slice image.</p> <p>Moving through slice images provides insight into the depth of various features in the 3D volume.</p> <p>To learn more, see Navigation.</p> |
|  <p>Line Left</p> | <p>With a GPR Line pane open, click the Line Left icon to move left one Y GPR Line image at a time.</p> <p>To use this feature, Y-lines will have been collected and included to generate a depth slice image.</p> <p>To learn more, see Navigation.</p> |
|  <p>Line Right</p> | <p>With a GPR Line pane open, click the Line Right icon to move right one Y GPR Line image at a time.</p> <p>To use this feature, Y-lines will have been collected and included to generate a depth slice image.</p> <p>To learn more, see Navigation.</p> |
|  <p>Line Up</p> | <p>With a GPR Line pane open, click the Line Up icon to move up one X GPR Line image at a time.</p> <p>To use this feature, X-lines will have been collected and included to generate a depth slice image.</p> <p>To learn more, see Navigation.</p> |
|  <p>Line Down</p> | <p>With a GPR Line pane open, click the Line Down icon to move down one X GPR Line image at a time.</p> <p>To use this feature, X-lines will have been collected and included to generate a depth slice image.</p> <p>To learn more, see Navigation.</p> |
|  <p>Horizontally Tile Windows</p> | <p>To display all open windows so they are tiled horizontally, click the Horizontally Tile Windows icon. All panes are resized so they are all visible and accessible.</p> <p>To learn more, see Tile Horizontally.</p> |
|  <p>Vertically Tile Windows</p> | <p>To display all open windows so they are tiled vertically, click the Vertically Tile Windows icon. All panes are resized so they are all visible and accessible.</p> <p>To learn more, see Tile Vertically.</p> |
|  <p>Measure Distance on Image</p> | <p>To measure the velocity from a hyperbola in the grid data set, click the Measure Distance on Image icon.</p> |
|  <p>Help</p> | <p>Click the Help icon to open the SliceView Help file.</p> |

4 Status Bar

To display the status bar, on the bottom of the screen, click **View > Status Bar**.

Hold the mouse cursor over toolbar buttons to display screen tips on the status bar.

The right side of the status bar displays information about the position of the mouse cursor:

Slice(m): 0.300-0.400, X(m): 15.228, Y(m): 13.402

Cursor on the depth slice

Line:LINEX07, Depth(m): 1.308, Time(ns): 32.017, Pos(m): 14.045

Cursor on the GPR line images

4.1 GPS on the Status Bar

If GPS files are available or, if the Local – Global Coordinate relationship has been defined using GFP_Edit, moving the mouse cursor around the depth slice or GPR Line image displays GPS positions on the right side of the status bar.

Lat: 43.6324551 N, Long: 79.6388564 W, E: 609800.39, N: 4831951.80, Z: 17T

The GPS information format is defined by the [GPS Format](#); this could be Latitude-Longitude (in decimal degrees or degrees-minutes-seconds) or UTM (Universal Transverse Mercator) or both.

Note: there may be a difference between GPS positions on GPR Lines displayed in the SliceView and LineView software.

In LineView, which displays individual GPR lines, the GPS position is based by interpolating the GPS positions saved to the GPS file during data collection.

In SliceView, which displays multiple GPR lines combined into a grid, GPS positions are determined by using the defined Local-Global Coordinate Relationship and grid line positions.

Therefore, the GPS positions for any individual line in the grid displayed in SliceView will differ slightly from the GPS file collected with that line and used in LineView.

4.2 Exporting Status Bar Information

The Export Status Bar Information feature allows you to extract significant positions from the data image and copy them to other documents.

1. To copy the data information text from the status bar, position the mouse cursor in the position you want to record, and then press **F8**.

Press **Shift + F8** to save the column headings text.

2. Paste the text into another document, such as MS Word or Excel.

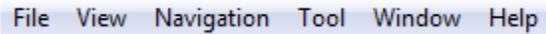
To create a file similar to the following example, press Shift + F8 and then paste the first line into the document.

Press F8 for all the subsequent lines.

| Slice(m) | X(m) | Y(m) | Latitude | Longitude | Easting | Northing | UTM Zone |
|-------------|-------|-------|--------------|-------------|-----------|------------|----------|
| 0.400-0.450 | 9.933 | 1.507 | 53.2792728 N | 9.0571937 W | 496186.51 | 5903339.58 | 29U |
| 0.400-0.450 | 9.532 | 2.019 | 53.2792786 N | 9.0571949 W | 496186.43 | 5903340.22 | 29U |
| 0.400-0.450 | 8.522 | 3.015 | 53.2792909 N | 9.0572003 W | 496186.08 | 5903341.6 | 29U |
| 0.350-0.400 | 7.996 | 3.513 | 53.2792972 N | 9.0572032 W | 496185.88 | 5903342.29 | 29U |
| 0.350-0.400 | 7.526 | 4.01 | 53.2793032 N | 9.0572055 W | 496185.73 | 5903342.96 | 29U |
| 0.350-0.400 | 7.028 | 4.55 | 53.2793097 N | 9.0572077 W | 496185.58 | 5903343.68 | 29U |
| 0.350-0.400 | 6.53 | 4.992 | 53.2793154 N | 9.0572107 W | 496185.38 | 5903344.32 | 29U |

5 Menu Bar

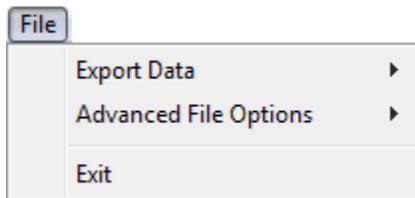
The SliceView menu bar contains links to a number of features that help you to navigate through, and work with, SliceView.



File View Navigation Tool Window Help

The following sections describe the SliceView Menu Bar features.

5.1 File



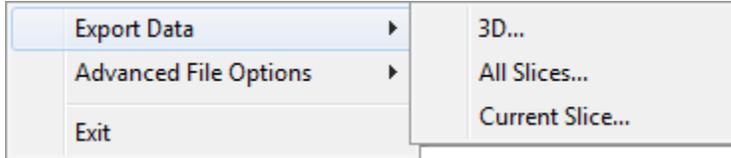
5.1.1 Export Data

SliceView data can be exported as a 3D file or depth slices to various formats:

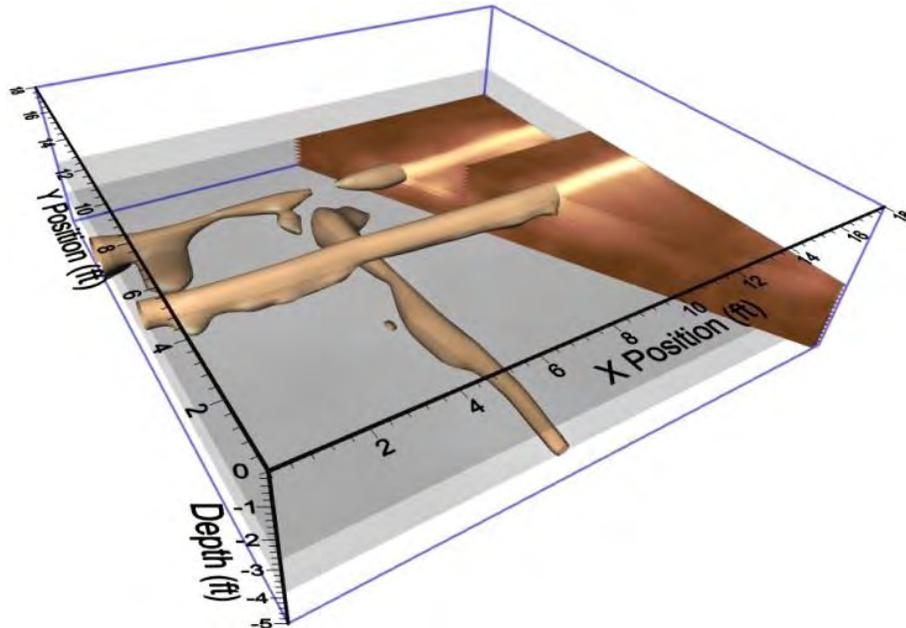
- [3D](#) files can be exported in HDF (Hierarchical Data Format) or CSV (Comma Separated Values) files.
- Depth Slices can be exported to Google Earth KMZ, Surfer ASCII GRD, or CSV (Comma Separated Values) files.

5.1.1.1 3D

Click **File > Export Data > 3D** to export grid survey data to an HDF or CSV file for processing and visualization with third-party software such as Golden Software's Voxler (available from Sensors & Software).



The following image shows 3D GPR data in Voxler:



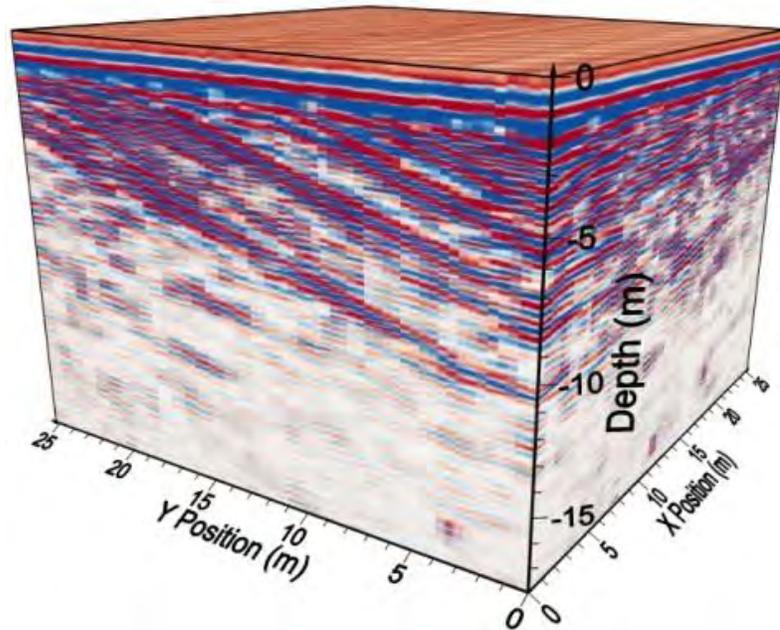
Data is exported as the 3D location of each point within the grid (X, Y, Z) and the average signal strength at that point (amplitude). The X and Y voxel dimensions are controlled by the [Slice Resolution](#) value, while the Z voxel dimension is controlled by the [Thickness](#) value.

Increasing slice resolution and reducing depth slice thickness before generating the 3D file may produce better 3D image resolution.

The default processing for depth slices and 3D files reveal linear targets such as utilities, rebar, foundations, and point targets (archaeological artefacts and human remains). With some types of data, default processing may not be appropriate for the 3D data display. For example, to display geological data in 3D, turn off the migration and enveloping processes ([DME Processing](#)).

To preserve flat-lying layers in the data, turn off [Background Subtraction](#).

The following image displays 3D geological data in Voxler that was processed in SliceView without Migration or Envelope processing:



Geological data that has not received envelope processing is best displayed when slice thickness is set finer than the default thickness; ideally the same as the temporal sampling interval. This is typically about 1/5 of the default slice thickness value.

5.1.1.2 3D HDF

HDF files are a binary format that can be viewed in software such as Voxler (available from [Sensors & Software](#)).

1. To export 3D data to HDF, in the menu bar click **File > Export Data > 3D**.
2. In the **Save As** dialog box, in the **Save as type** drop-down list click **Voxler HDF file**.
3. Select the folder you want to save this data to.
4. Click **Save**.

When a grid survey is exported to HDF, the HDF file is named the same as the GFP file, with the grid name appended to the name, for example GPRData-Grid.HDF.

5.1.1.3 3D CSV

CSV files can be imported into many programs; Microsoft Excel for example.

1. To export 3D data to a CSV file, in the menu bar click **File > Export Data > 3D**.
2. In the **Save As** dialog box, in the **Save as type** drop-down list click **XYZ-Amplitude Pairs**.
3. Select the folder you want to save this data to.
4. Click **Save**.

The header line indicates the X, Y, Z and depth columns with the half-width of the voxel (or cell) in that direction. The header line also lists the total number of samples in the CSV file.

The CSV file lists depth or time depending on the [Slice Units](#) setting.

5.1.1.3.1 Depth

The CSV file format is X Y Z depth amplitude where amplitude values represent the average signal strength in the thickness of the depth slice.

The Z values (column three) represent elevation values with the surface at elevation zero (0.0) and the values are negative. The depth values (column four) are the same as the Z values, but positive.

| X ± 0.0250m | Y ± 0.0250m | Z ± 0.00250m | Depth ± 0.0025m | Amplitude A/D |
|-------------|-------------|--------------|-----------------|---------------|
| 0.025 | 0.025 | -0.003 | 0.003 | 2801 |
| 0.025 | 0.075 | -0.003 | 0.003 | 4432 |
| 0.025 | 0.125 | -0.003 | 0.003 | 4195 |
| 0.025 | 0.175 | -0.003 | 0.003 | 3826 |
| 0.025 | 0.225 | -0.003 | 0.003 | 3315 |
| 0.025 | 0.275 | -0.003 | 0.003 | 2465 |
| 0.025 | 0.325 | -0.003 | 0.003 | 2698 |

5.1.1.3.2 Time

The CSV file Time format is X Y Z Time Amplitude.

The Z values (column three) are time values with the surface at time zero (0.0) so the values are negative; Time values (column four) are the same, but the values are positive.

| X ± 0.0250m | Y ± 0.0250m | Z ± 0.0500m | Time ± 0.0500ns | Amplitude A/D |
|-------------|-------------|-------------|-----------------|---------------|
| 0.025 | 0.025 | -0.05 | 0.05 | 384 |
| 0.025 | 0.075 | -0.05 | 0.05 | 633 |
| 0.025 | 0.125 | -0.05 | 0.05 | 495 |
| 0.025 | 0.175 | -0.05 | 0.05 | 581 |
| 0.025 | 0.225 | -0.05 | 0.05 | 476 |
| 0.025 | 0.275 | -0.05 | 0.05 | 342 |

5.1.1.4 Current Slice

5.1.1.4.1 Exporting Slice(s) to Google Earth

SliceView will not export to Google Earth unless there is a relationship between project coordinates and gps coordinates.

EKKO_Project automatically creates a relationship if you have .gps files.

If you do not have gps data, or want to change the relationship, use the GFP_Edit program. To learn more, see the [Editing Grids in GFP Edit](#).

- To export the current slice to a Google Earth KMZ file, in the menu bar click **File > Export Data > Current Slice**.
To export all slices to a Google Earth KMZ file, in the menu bar click **File > Export Data > All Slices**.

- In the **Export slice** dialog box, in the **Save as type** drop-down list click **Google Earth KMZ**. The file defaults to the file and current folder name, but you can rename the file before saving it.

5.1.1.4.2 Viewing Slices in Google Earth

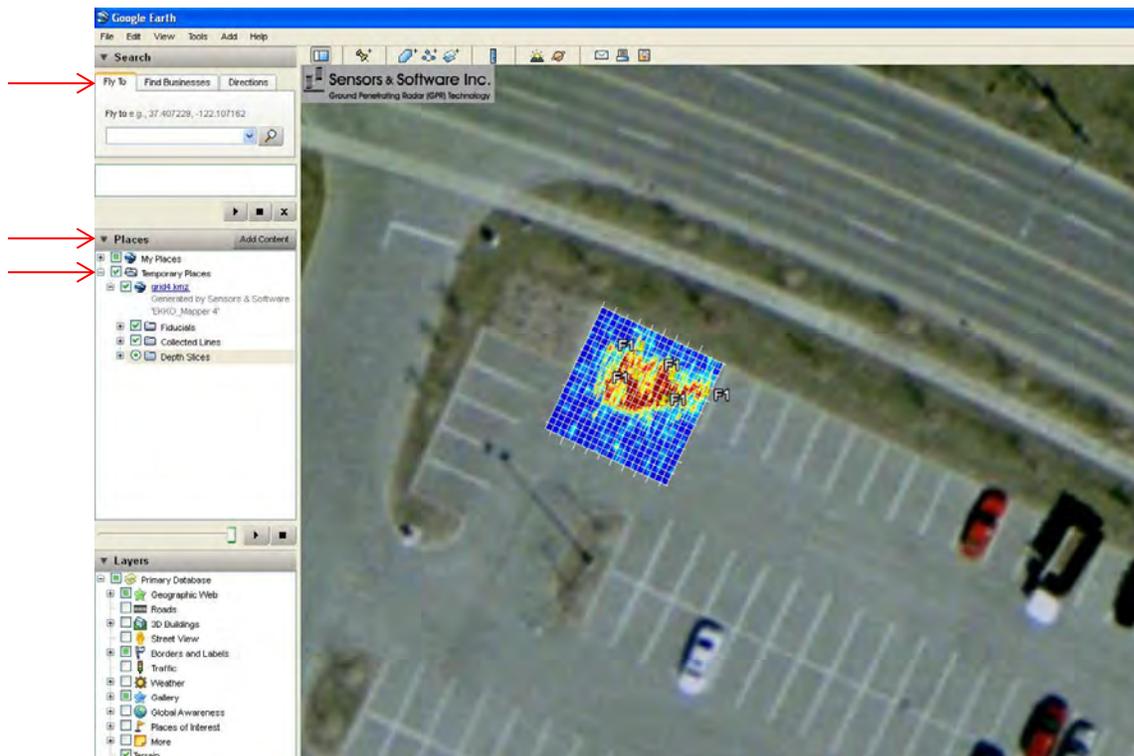
To display Google Earth (.kmz) files, Google Earth must be installed and the computer must have internet access.

Open .kmz files using one of the following methods:

- After saving a .kmz file, Google Earth automatically launches displaying the kmz file.
- From Windows Explorer, navigate to the kmz and double-click the file.
- Open Google Earth. Click **File > Open**, navigate to the kmz file, and then open it.

When a kmz file opens, Google Earth displays the GPR slice location and superimposes it over the ground image.

The following images displays a GPR slice plotted in Google Earth:



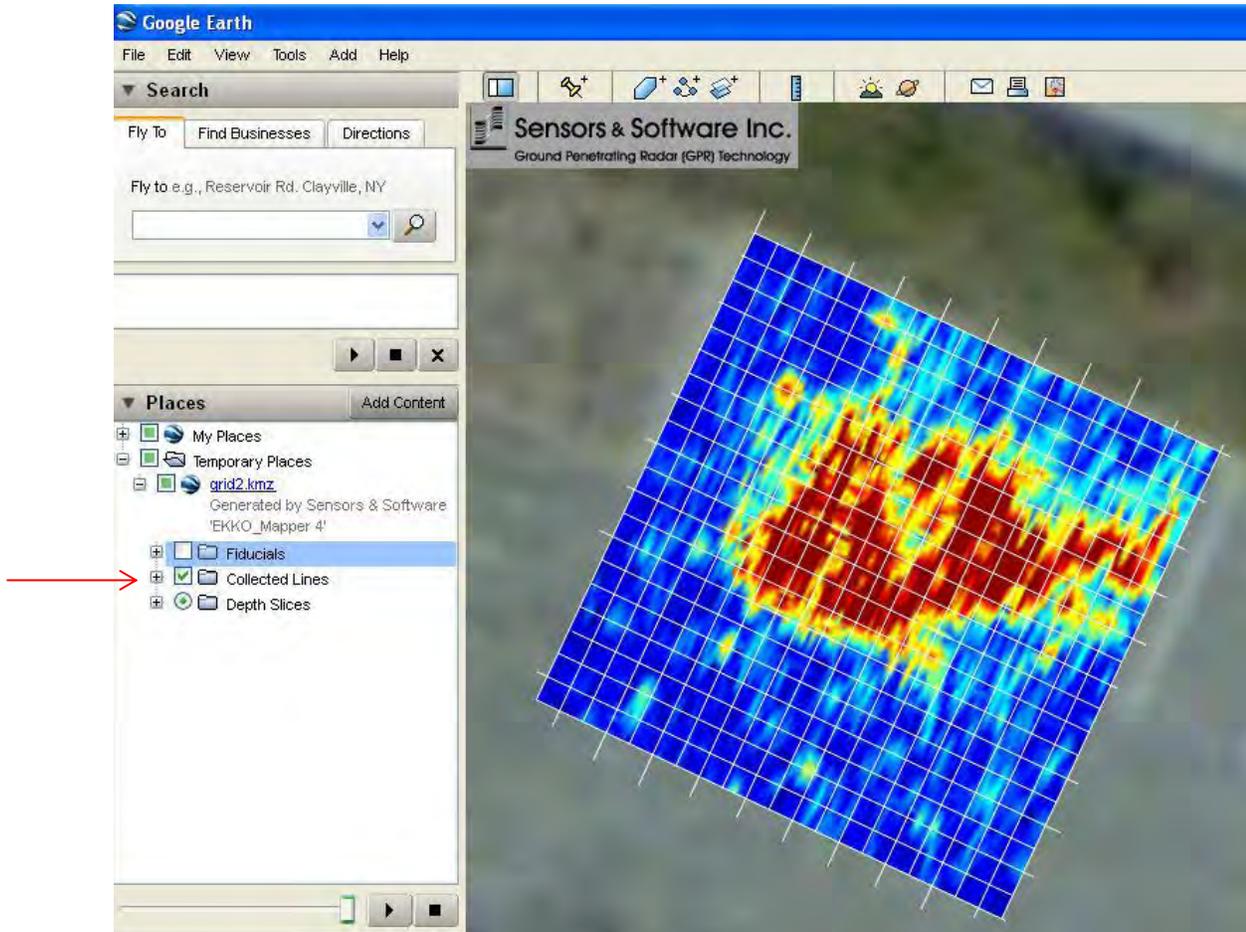
The Places pane enables slice display, line collection, and fiducial markers.

The .kmz file is listed in the **Fly to** tab **Places** pane, **Temporary Places** file. When exiting, Google Earth prompts you to save the .kmz file to **My Places**.

The Google Earth default view displays Collected Lines and Fiducial Markers on the data image.

Collected Lines

Collected Lines are listed in the **Places** pane, **Temporary Places** file. To enable or disable this feature, select or deselect the **Collected Lines** checkbox.

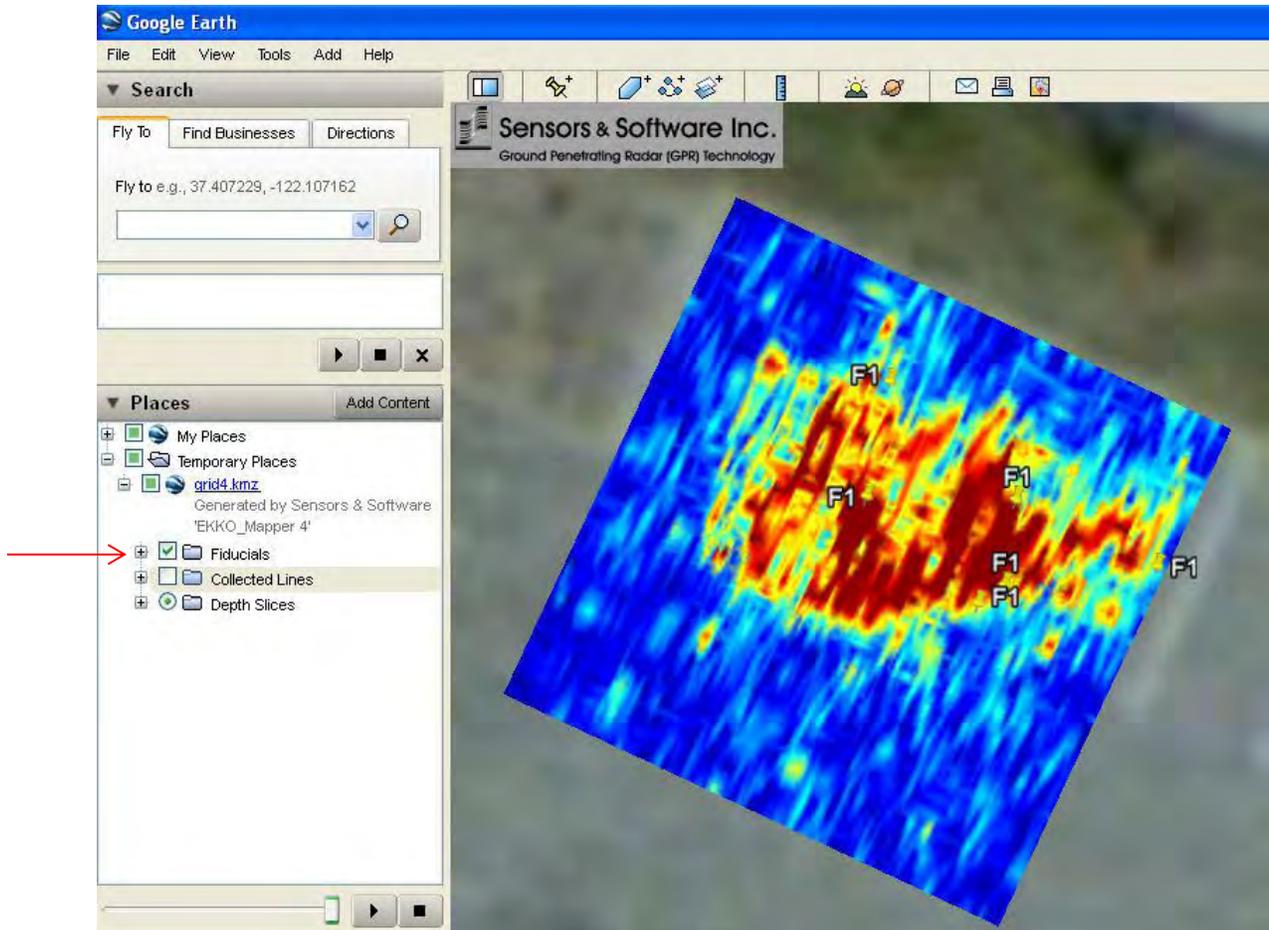


Fiducial Markers

Fiducial Markers are listed in the **Places** pane, **Temporary Places** file.

To enable or disable this feature, select or deselect the Fiducials checkbox.

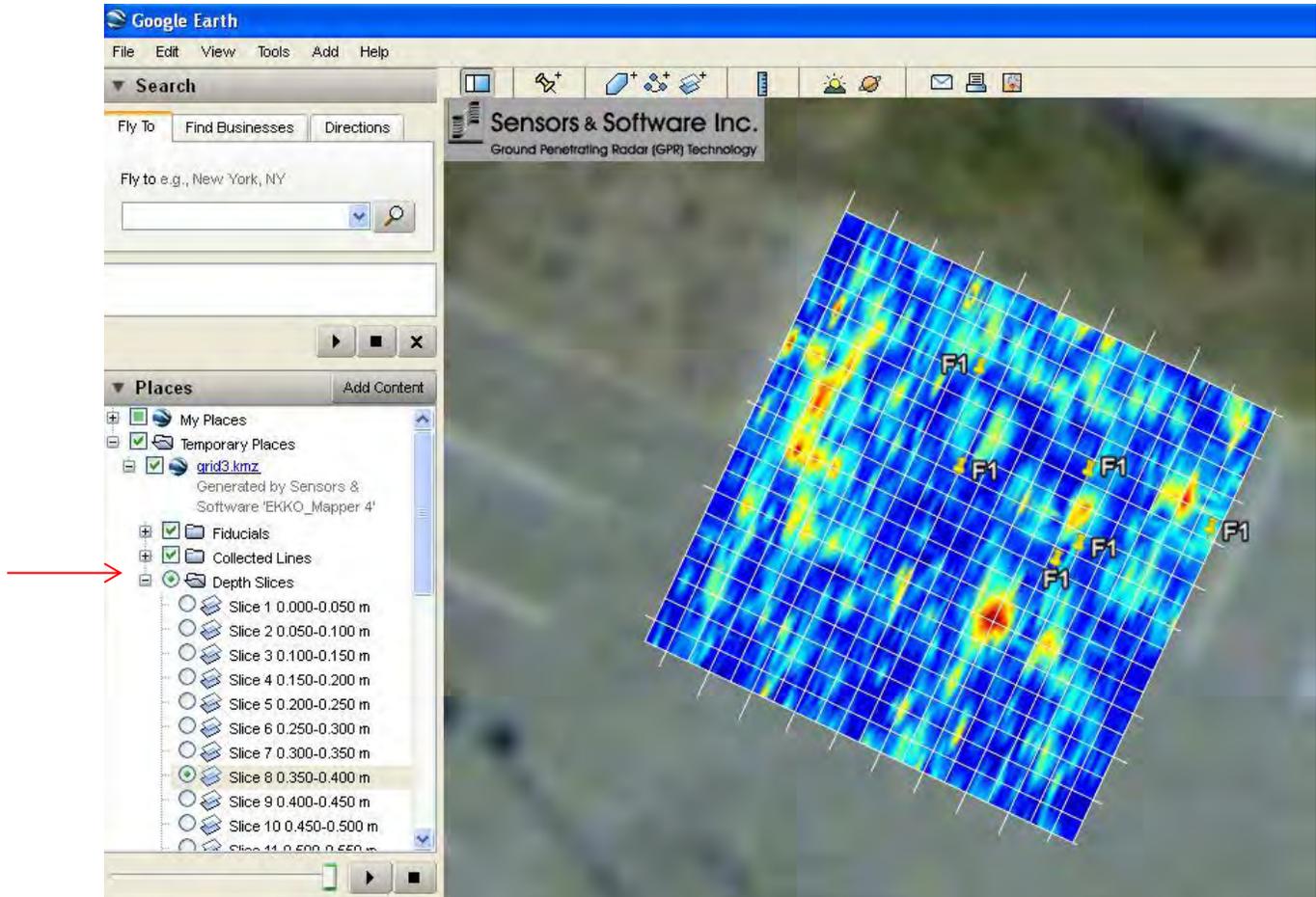
To display individual Fiducial Markers, click the plus sign (+) beside the Fiducial option.



Depth Slices

Depth Slices are listed in the **Places** pane, **Temporary Places** file.

- To display the list of slices, click the plus sign (+) beside the kmz file name.
- To select a different depth slice image, in the **Depth Slice** list, click a slice.



Google Earth Accuracy

Google Earth images may not always align with the actual GPS location. Google Earth may also place Depth slice images at high latitudes incorrectly.

The grid position can be adjusted using GFP_Edit. To learn more, see [Exporting Grids to GFP Edit](#).

5.1.1.4.3 Surfer ASCII Grid Files

Surfer is third-party processing and visualization software developed by Golden Software for plotting two-dimensional data such as GPR depth slices.

1. To export the current slice to a Surfer ASCII Grid (.grd) file, select **File > Export Data > Current Slice**.
To export the all slices to Surfer ASCII Grid files, select **File > Export Data > All Slices**.
2. In the **Export slice** dialog box, in the **Save as type** drop-down list click **Surfer ASCII grid (grd)**.

The file name defaults to the file and current folder name, but you can rename the file before saving it.

The following table displays an example of .GRD file:

```

DSAA
213  227
-0.3 10.35
-0.7 10.65
0    5911
0    0    0    0    0    0    50    110    189    118    63    200    123    164    205    30
0    0    0    0    0    0    100   221   378   236   127   400   202   148   242   61
0    0    0    0    0    0    150   331   567   355   190   600   366   488   610   91
0    0    0    0    0    0    201   442   757   473   254   800   404   316   485   12
0    0    0    0    0    0    251   552   946   592   317   1000  505   396   606   15
0    0    0    0    0    0    301   663   1135  710   381   1200  606   429   727   18
30   60   90   120  150  180  352   774   1325  829   445   1400  708   501   849   21
45   90   135  181  226  271  418   741   1224  787   485   1310  704   544   937   19
66   133  199  266  332  399  485   709   1124  745   525   1221  701   587   1025  18
49   99   149  198  248  298  551   677   1024  703   565   1132  697   630   1114  16
71   143  215  287  359  431  618   645   924   662   605   1042  694   673   1202  15
90   180  309  360  450  540  684   620   824   620   645   953   691   716   1290  13
91   183  464  495  458  550  751   604   724   578   685   864   687   760   1379  12
65   131  618  660  420  662  818   549   624   537   725   774   684   803   1467  11
46   92   773  825  525  827  884   517   524   495   765   685   680   846   1556  95
32   65   928  990  630  993  951   485   424   453   805   596   677   889   1644  80
45   91   1083 1156 736  1159 1018 453  384  417  845  507  674  933  1733  66
100  201  947  1011 644  1014 1106 675  646  692  995  558  666  932  1737  89
79   159  812  867  552  869  1194 651  765  972  1146 583  658  932  1742  11

```

5.1.1.4.4 CSV File

CSV (Comma Separated Values) files can be imported into many programs similar to Microsoft Excel.

- To export the current slice to a .csv file, click **File > Export Data > Current Slice**.
To export the all slices to a .csv files, click **File > Export Data > All Slices**.
- In the **Export slice** dialog box, in the **Save as type** drop-down list, click **Comma Separated Values (.csv)**.

The file name defaults to the file and current folder name, but you can rename the file before saving it.

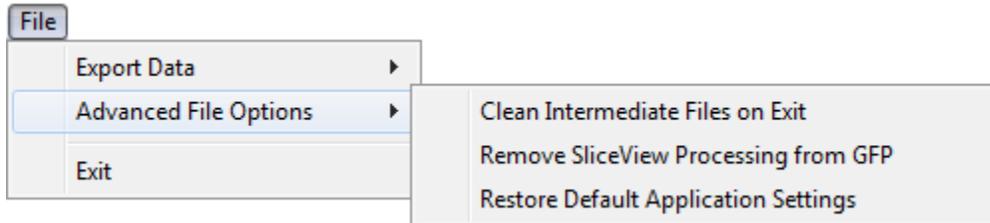
The header line indicates the X, Y, Z and depth columns with the half-width of the voxel (or cell) in that direction. The header line also lists the total number of samples in the CSV file.

The CSV file(s) list X, Y, and depth columns with the half-width of the voxel (or cell) in that direction. The header line also lists the total number of samples in the CSV file.

The CSV file list [Depth](#) or [Time](#) depending on the [Slice Units](#) setting.

5.1.2 Advanced File Options

Use the Advanced File Options menu to perform more advanced SliceView operations such as clean up intermediate files, remove all processing from the current GFP file, or restore the Default Application Settings.



Note: Processing is not lost, just recalculated.

5.1.2.1 Clean Intermediate Files on Exit

Intermediate files are stored in your project GPZ file to enable images to be displayed quickly. After opening a file and processing GPR data files, SliceView generates intermediate files that display depth slices and GPR line images.

To automatically delete intermediate files when you exit SliceView, click **Clean Intermediate Files on Exit**.

If hard disk space is not an issue, leave this option unchecked so data images can display more quickly by not reprocessing data every time a file opens.

For small grids, data can be reprocessed and displayed quickly, but large grids may still take many minutes to process.

5.1.2.2 Remove SliceView Processing from GFP

SliceView files save data file names, grid geometry, and selected data processing for GPR data files.

To delete data processing settings from the file, click **Remove SliceView Processing**.

Note: Only use this option when you are trying to recover from a data processing error.

5.1.2.3 Restore Default Application Settings

To reset file settings to the default value, click **Restore Default Application Settings**.

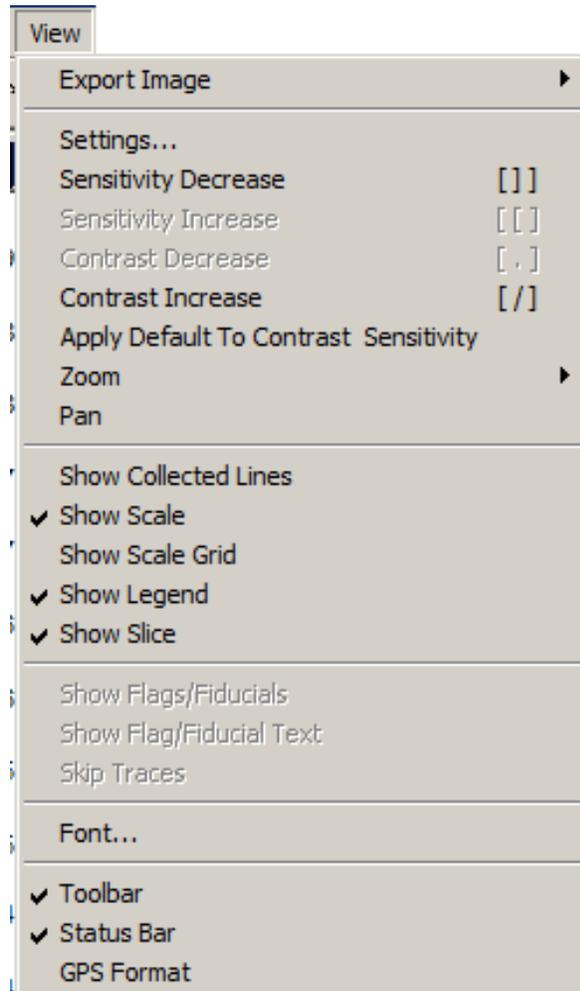
Note: Only use this option when a severe error has occurred and recovery using other means has not solved the problem.

5.1.3 Exit

Click **Exit** to close SliceView and return to EKKO_Project.

5.2 View

To open the View menu, in the [menu bar](#) click **View**.



Use the following table as a guide to working with the **View** menu:

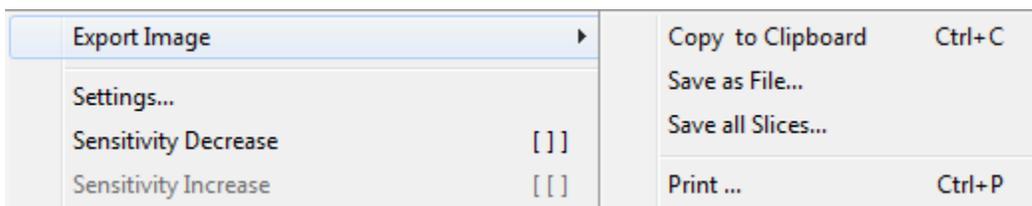
| Item | Description |
|-----------------------------|--|
| Export Image | Click Export Image to send a depth slice or GPR line view to the clipboard, save it as a graphics image file, or send it to a printer. To learn more, see Export Image . |
| Settings | Click Settings to adjust the GPR line and slice image color palette, line, scale and cursor colors, contrast, and sensitivity values. To learn more, see Slice Settings or GPR Line Settings . |
| Sensitivity Increase | Click Sensitivity Increase to make the image more sensitive by five percent increments. To learn more, see Sensitivity . |

| Item | Description |
|-----------------------------|---|
| Sensitivity Decrease | <p>To make the image less sensitive by five percent increments, click Sensitivity Decrease.</p> <p>To learn more, see Sensitivity.</p> |
| Contrast Increase | <p>To increase contrast by five percent increments, click Contrast Increase.</p> <p>To learn more, see Contrast.</p> |
| Contrast Decrease | <p>To decrease contrast by five percent increments, click Contrast Decrease.</p> <p>To learn more, see Contrast.</p> |
| Zoom | <p>To increase or decrease the size of the depth slice or GPR line image, click Zoom.</p> <p>To learn more, see Zoom.</p> |
| Pan | <p>To move images within a zoomed-in display, click Pan.</p> <p>To learn more, see Pan.</p> |
| Show Collected Lines | <p>To superimpose lines onto the Depth Slice image to display where a grid's data lines were collected, click Show Collected Lines.</p> <p>Use this feature when a partial grid or partial lines were collected in a survey to avoid having to interpret a target in an area where no data was collected.</p> <p>To learn more, see Show Collected Lines.</p> |
| Show Scale | <p>To display scales around the image, click View > Show Scale.</p> <p>For Depth Slice images, X and Y position scales are displayed across the top and left side of the image respectively.</p> <p>To view the Depth Slice scale, see the Depth Slice View image.</p> <p>For GPR Lines, a depth scale is displayed on the left side of the image. A time scale is displayed on the right side of the image and a position scale is displayed across the top of the image.</p> <p>To view the GPR Line scale, see the GPR Line View image.</p> |
| Show Scale Grid | <p>To superimpose a grid of dashed lines onto the depth slice or GPR line image, click View > Show Scale Grid.</p> <p>To learn more, see Show Scale Grid.</p> |
| Show Legend | <p>To display a legend with the depth slice (Figure 2) or GPR Line (Figure 3) image, click View > Show Legend.</p> <p>The Depth Slice Legend, displayed to the right of the slice image, contains depth slice information including the slice range, resolution, velocity, data collection date, data analysis date, and settings including data processing, color palette, sensitivity, and contrast. For Conquest grid data it also displays the maximum PCD level in the grid.</p> <p>To view the Depth Slice Legend, see the Depth Slice View image.</p> <p>The GPR Line Legend, displayed below the GPR line image, contains GPR line information including the line name, velocity, data processing, gain, color palette, contrast, and sensitivity. For Conquest grid data it displays the maximum PCD level in the Conquest grid line.</p> <p>To view the GPR Line Legend, see the GPR Line View image.</p> |

| Item | Description |
|--------------------------------|---|
| Show Slice | To display the depth slice image, click View > Show Slice . Show Slice displays only the position of collected lines without the slice image. This option defaults to on. |
| Show Flags/Fiducials | To display flags/fiducials (Figure 2), click View > Show Flags/Fiducials . Flags/Fiducials are markers and/or comments added during data acquisition at specific trace positions along the line. To learn more, see Show Flags/Fiducials . |
| Show Flag/Fiducial Text | To display text associated with the fiducials, click View > Show Flag/Fiducial Text . If the grid survey data does not contain any fiducials, this option is greyed out. |
| Skip Traces | If the data file contains positions where traces were skipped during data collection, display this information on the GPR Line image by clicking View > Show/Hide > Skipped Traces . Skipped traces appear as colored rectangles on the bottom of the GPR line. |
| Font | Use the Font option to define the font you want to use for the position, depth and time axes, and the text in the legends. Changing font type and size can increase the available screen area to display data images on and improve the readability of printed images or graphics image files. |
| Toolbar | To display the toolbar below the menu bar, click View > Toolbar (Figure 1). |
| Status Bar | To display the status bar along the bottom of the SliceView window, click View > Status Bar (Figure 1). |
| GPS Format | To open the Configure GPS Format dialog box, click View > GPS Format . To learn more, see GPS Format . |

5.2.1 Export Image

To export any depth slice or GPR line view to the clipboard, save it as a graphics image file, or send it to a printer, click **Export Image**.



Use the following table as a guide to working with the **Export Image** menu:

| Item | Description |
|--------------------------|--|
| Copy to Clipboard | Click Copy to Clipboard to copy the depth slice or GPR Line image in the active window to the clipboard for pasting into other documents. |

| Item | Description |
|------------------------|--|
| Save as File | To save an electronic copy of the image in the active window: <ol style="list-style-type: none">1. Click Save as File.2. In the Save File dialog box, navigate to the folder you want to save the image in.3. In the File name field, enter a name for the file.4. In the Save as type drop-down list, select the graphics format file type.5. Click Save. |
| Save all Slices | To save an electronic copy of all depth slice images in the active window: <ol style="list-style-type: none">1. Click Save All.2. In the Save File dialog box, navigate to the folder you want to save the image in.3. In the File name field, enter a name for the file.4. In the Save as type drop-down list, select the graphics format file type.5. Click Save. |
| Print | To print a hard copy of the image click Print . |

5.2.2 Settings

The Settings option allows you to change how GPR line and depth slice images are displayed through color palettes, line, scale and cursor colors, contrast, and sensitivity values.

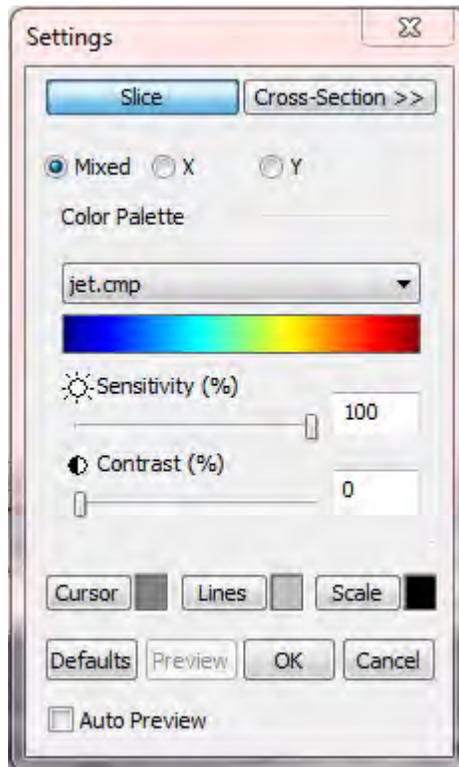
You can access the Settings option from the [menu bar](#) or the [toolbar](#).

5.2.2.1 Slice Settings

1. In the menu bar, click **View > Settings** to adjust the slice image color palette, line, scale and cursor colors, contrast, and sensitivity values of GPR line and slice images.

Alternatively, in the toolbar click .

The **Slice Settings** dialog box opens:



2. Use the following table as a guide to working with the **Slice Settings** dialog box:

| Item | Description |
|----------------------|--|
| Slice | Click Slice to open the Depth Slice Settings dialog box. |
| GPR Line | To open the GPR Line Settings dialog box, click GPR Line . To learn more, see GPR Line Settings . |
| Mixed, X, Y | Select Mixed , X , or Y as a grid data collection method option. To learn more, see Lines in Depth Image Slice . |
| Color Palette | To change the depth slice image color, click the Color Palette drop-down list. To learn more, see Slice Color Palette . |

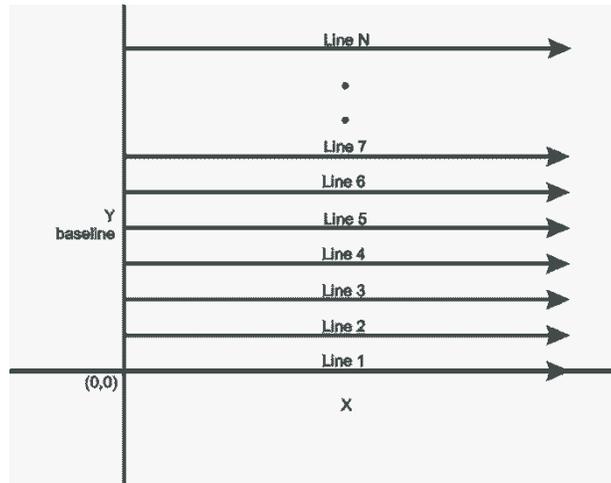
| Item | Description |
|---------------------|---|
| Sensitivity | Move the Sensitivity slider to increase or decrease the sensitivity of the image to small signal variations. Alternatively, enter a percentage number into the Sensitivity text box. To learn more, see Sensitivity . |
| Contrast | Move the Contrast slider to increase or decrease the contrast of the image to small signal variations. Alternatively, enter a percentage number into the Contrast text box. To learn more, see Contrast . |
| Cursor | To change the color of the grid line indicating the position, within the grid, of the current GPR Line displayed in the GPR Line window, click Cursor . To learn more, see Cursor Color . |
| Lines | To change the color of lines corresponding to the GPR lines collected during the grid survey, click Lines . To learn more, see Lines Color . |
| Scale | To change the color of the scale grid lines, click Scale . To learn more, see Scale Color . |
| Defaults | Click Defaults to revert the settings to their default values. |
| Preview | To display the effects of the slice setting change before applying them, click Preview . |
| OK | Click OK to apply your changes. |
| Cancel | Click Cancel to close the Settings dialog box; all changes will be lost. |
| Auto Preview | Select Auto Preview to see the effect of changes made to the settings, including Sensitivity, Contrast and the Color Palette. |

5.2.2.1.1 Generating Depth Slices with GPR Lines

In the [Slice Settings](#) dialog box, select the GPR Lines used to generate the depth slices; the options are: X lines only, Y lines only, or Mixed (X and Y lines).

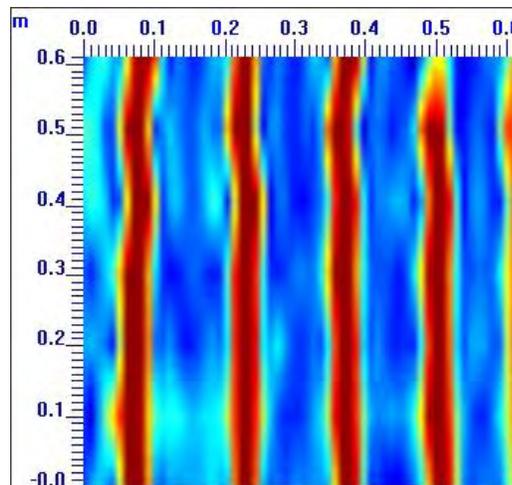
X Grids

X-grids are areas covered by a series of parallel lines in the X direction:



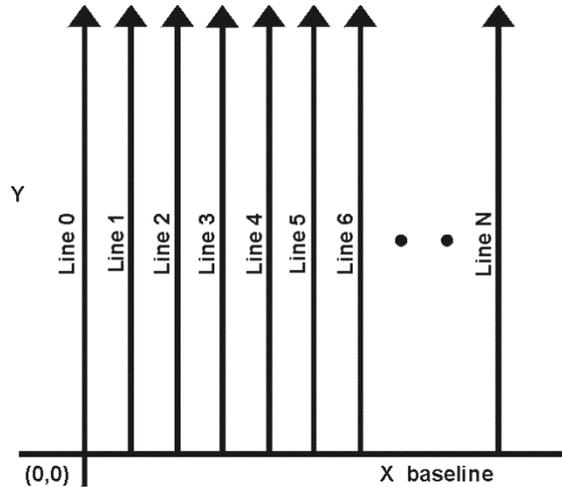
In the [Slice Settings](#) dialog box, click the **X** option to generate a depth slice using only X data lines in the grid.

The GPR Line view display only X-direction lines:



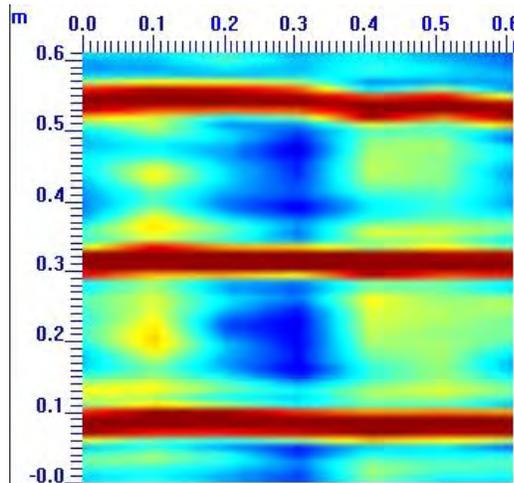
Y Grids

Y-grids are areas covered by a series of parallel lines in the Y direction:



In the [Slice Settings](#) dialog box, click the **Y** option to generate a depth slice image using only Y data lines in the grid. The GPR Line view displays only Y data lines.

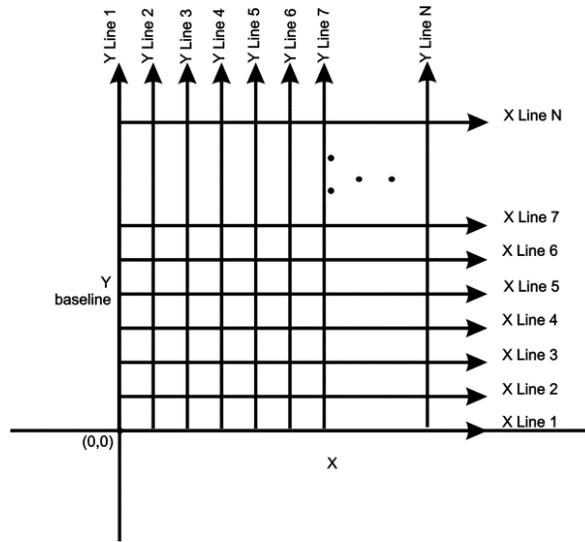
Click the **X or Y lines** option to emphasize targets perpendicular to the line direction. In the following image, rebar are running in two directions, but the rebar parallel to the X lines have been eliminated:



Click the **Y lines only** option to display rebar perpendicular to the Y lines and eliminate the parallel rebar parallel.

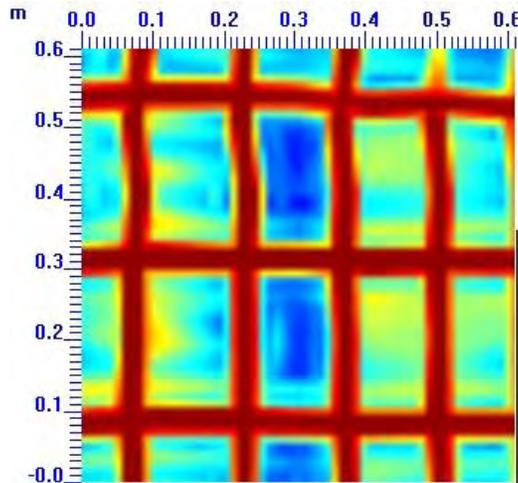
Mixed Grids

Mixed grid areas are covered by lines in both the X and Y directions



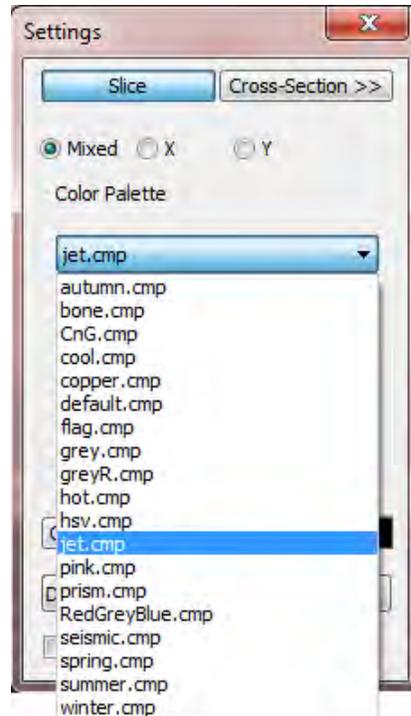
In the [Slice Settings](#) dialog box, click **Mixed** to generate depth slice images based on both X and Y lines.

The GPR Line view displays an X line or a Y line



5.2.2.1.2 Slice Color Palette

In the Settings dialog box, click the **Slice Color Palette** drop-down to select depth slice image colors from a predefined color palette. Experiment with the palette to determine the best colors for the selected grid scan data set. The default color palette for slices is jet.

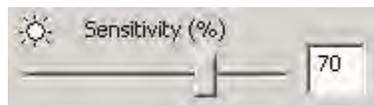


5.2.2.1.3 Sensitivity

The Sensitivity settings control how sensitive an image is to small signal variations. Sensitivity values range from 0 to 100%, least sensitive to most sensitive (default 100%).

Before changing a sensitivity value, make sure that the depth slice image you want to change is in the active window.

To adjust sensitivity move the slide left to decrease sensitivity and right to increase sensitivity:



You can also adjust sensitivity from the menu bar and toolbar:

Increase Sensitivity

- To increase sensitivity by 5% increments, in the [Menu bar](#), click **View > Sensitivity Increase**.
- To increase sensitivity by 5% increments, in the [Toolbar](#), click the sensitivity increase  icon.
- To increase sensitivity by 10% increments, press **Shift** while clicking the menu or toolbar.
- To increase sensitivity by 10% increments, press **Ctrl** while clicking the menu or toolbar.

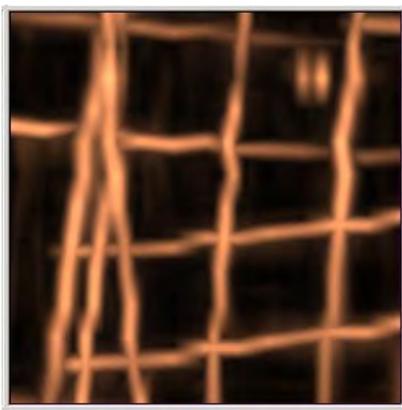
Decrease Sensitivity

Decreasing sensitivity widens the color palette around the zero signal level, removing weaker signals in the image so only the strongest signals are visible.

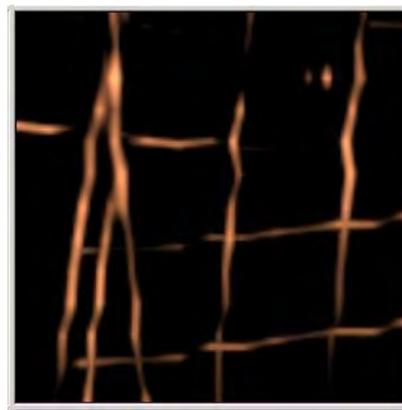
- To decrease sensitivity by 5% increments, in the [Menu bar](#), click **View > Sensitivity Decrease**.
- To decrease sensitivity by 5% increments, in the [Toolbar](#), click the sensitivity decrease  icon.
- To decrease sensitivity by 10% increments, press **Shift** while clicking the menu or toolbar.
- To decrease sensitivity by 10% increments, press **Ctrl** while clicking the menu or toolbar.

Depth Slice Images

Depth Slice signals vary from zero to extreme positive values. As sensitivity decreases, the color associated with the zero signal level on the left side of the color palette widens to the right resulting in the weaker signals being removed from the image.



Sensitivity default 100%



Sensitivity 50%

5.2.2.1.4 Contrast

The Contrast setting enables you to control how much of the image area is at the extremes of the color palette. Contrast ranges from 0 to 100%, less contrast to more contrast (default 0% - no added contrast).

Before changing contrast values, make sure the depth slice image you want to change is the active window.

Contrast Increase

- To increase contrast by 5% increments, in the [Menu bar](#), click **View > Contrast Increase**.
- To increase contrast by 5% increments, in the [Toolbar](#), click increase contrast  icon.
- To increase contrast by 10% increments, press **Shift** while clicking the menu or toolbar.
- To increase contrast by 10% increments, press **Ctrl** while clicking the menu or toolbar.

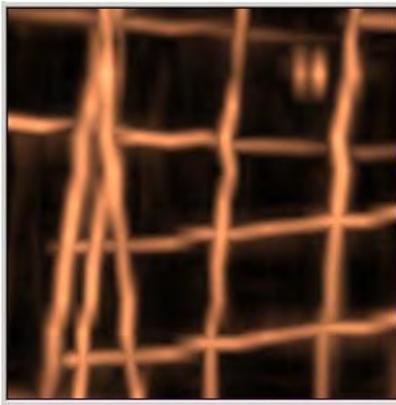
Contrast Decrease

- To decrease contrast by 5% increments, in the [Menu bar](#), click **View > Contrast Decrease**.
- To decrease contrast by 5% increments, in the [Toolbar](#), click the decrease contrast  icon.
- To decrease contrast by 10% increments, press **Shift** while clicking the menu or toolbar.
- To decrease contrast by 10% increments, press **Ctrl** while clicking the menu or toolbar.

As contrast increases, more data is displayed at the extreme value of the color palette. Contrast helps make weak targets more visible in the image.

Depth Slice Images

Depth Slice signals vary from zero to extreme positive values. As contrast increases, the color associated with the extreme positive signal level on the right side of the color palette widens to the left, resulting in the weaker signals appearing stronger in the image.



Contrast default 0



Contrast 50 %

5.2.2.1.5 Cursor Color

Cursor Lines are colored lines indicating

- The position of the GPR Line displayed in the GPR Lines view in the grid displayed in the Depth Slice view ([Figure 5](#)).
- The thickness range of a depth slice is indicated by two parallel lines superimposed on the GPR Line image ([Figure 4](#)).

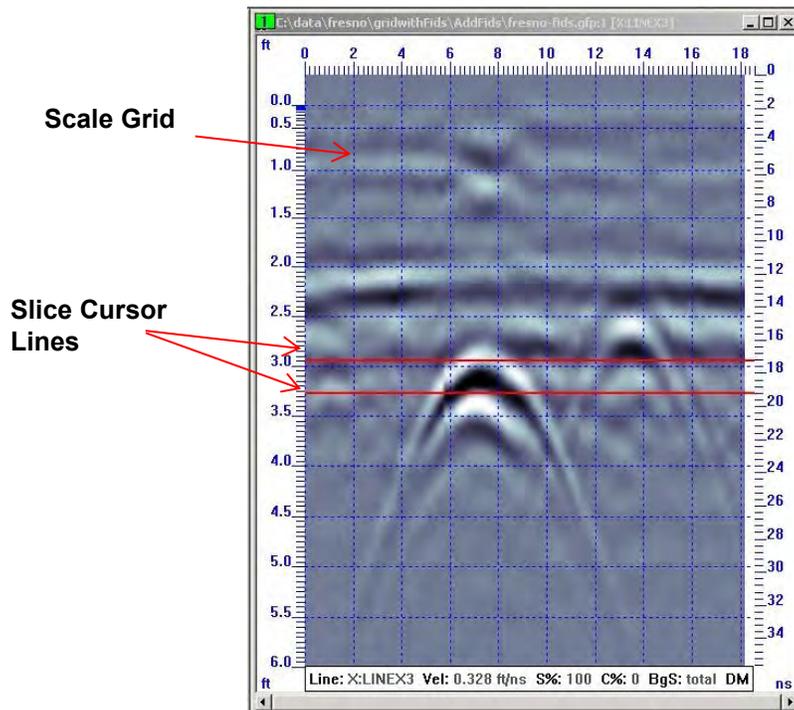


Figure 4: Slice Cursor line and Scale Grid

1. To change the line color, in the [Settings](#) dialog box, click **Cursor**.



2. In the **Color** dialog box, select a color that provides high cursor line visibility on the depth slices and GPR Lines.
3. Click **OK**.

The GPR Line Cursor Line in the depth slice view is not visible if the [Show Collected Lines](#) option has been turned off.

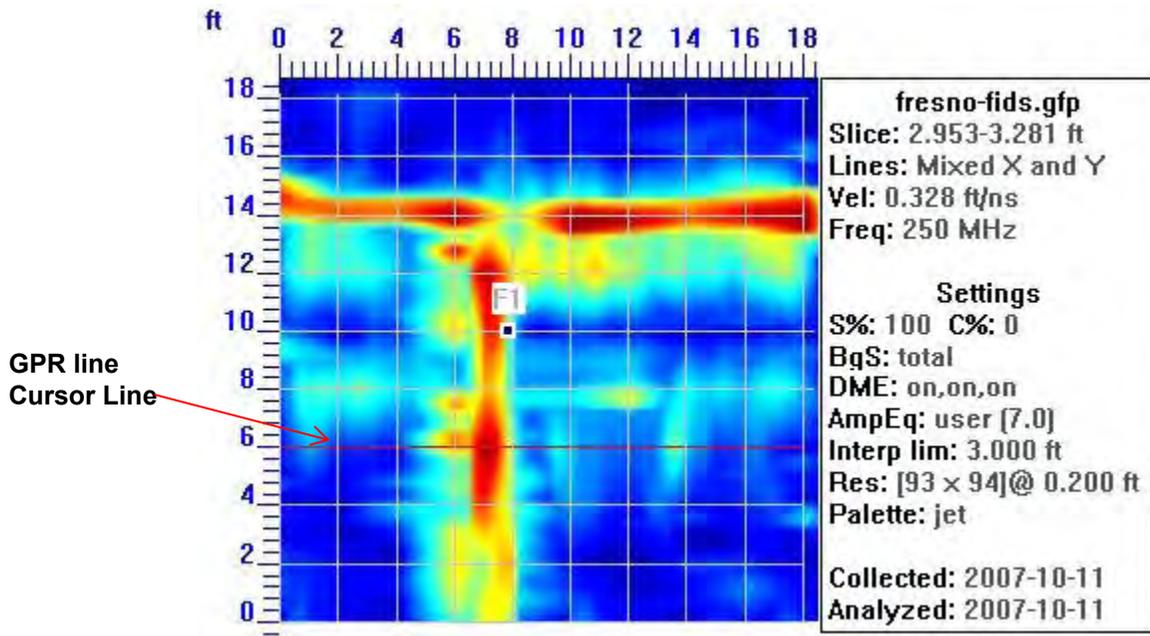


Figure 5: GPR line cursor line

5.2.2.1.6 Lines Color

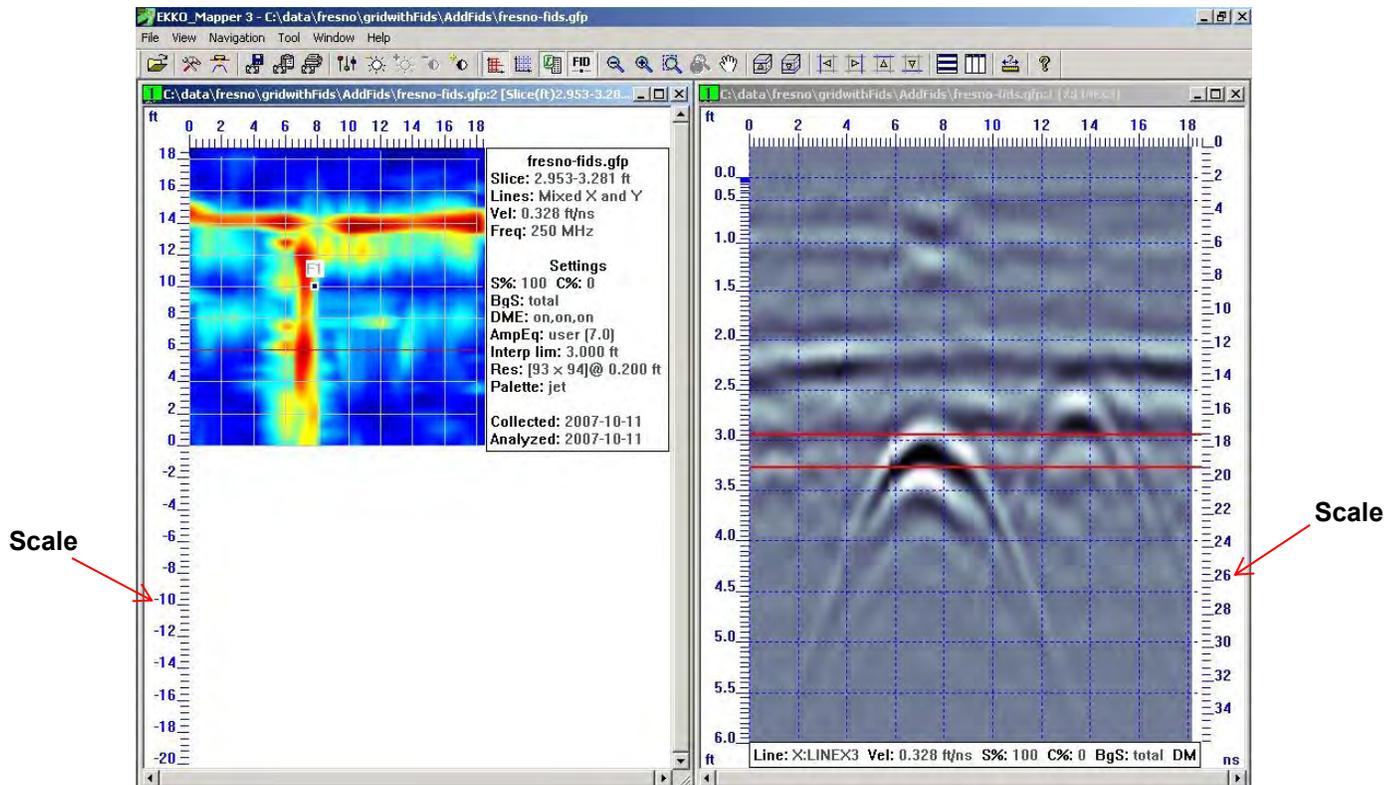
Lines corresponding to all the GPR lines collected during the grid survey can be displayed in the Depth Slice view.

This option is only available if the Depth Slice view is the active window.

1. To change **Line Color**, in the [Settings](#) dialog box, click **Lines**.
2. In the **Color** dialog box, select a line color that provides high line visibility on the depth slices.
3. Click **OK**.

5.2.2.1.7 Scale Color

Scale Grid Lines correspond to major position and depth labels can be superimposed on the depth slice and the GPR Lines.



The **Show Scale Grid** option only applies to the image in the active window.

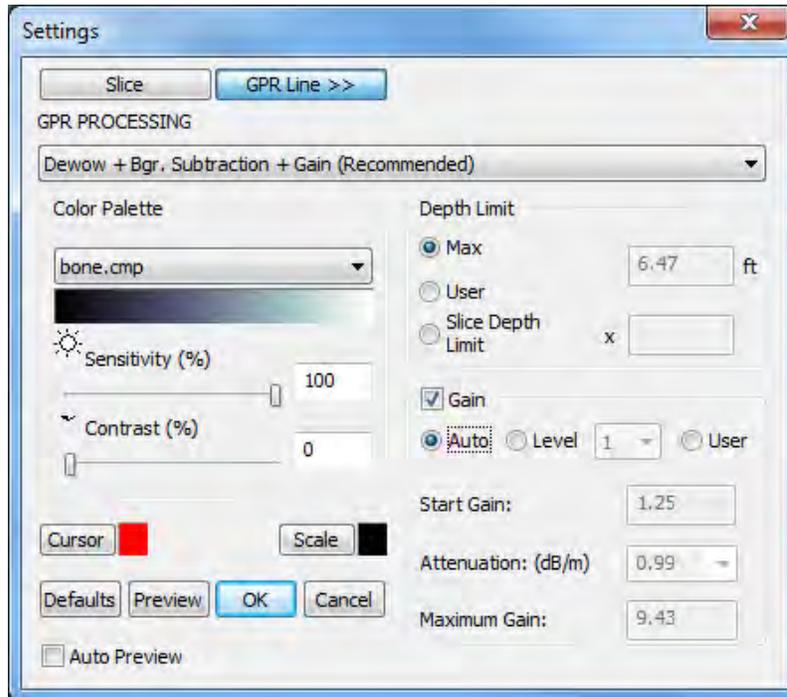
1. To change **Scale Color**, in the [Settings](#) dialog box, click **Scale**.
2. In the **Color** dialog box, select a line color that is visible on the image.
3. Click **OK**.

5.2.2.2 GPR Line Settings

1. Click **View > Settings** to adjust the GPR Line color palette, line, scale and cursor colors, contrast, and sensitivity values of GPR line and slice images.

Alternatively, in the toolbar click .

The **GPR Line Settings** dialog box opens:



2. Use the following table as a guide to working with the **GPR Line Settings** dialog box:

| Item | Description |
|-----------------------|---|
| GPR Processing | To select the type of processing to apply to the current active GPR line image, click the GPR Processing drop-down list. To learn more, see GPR Processing . |
| Color Palette | To change the GPR Line color, click the Color Palette drop-down. To learn more, see Color Palette . |
| Sensitivity | Move the Sensitivity slider to increase or decrease the sensitivity of the image to small signal variations. Alternatively, enter a percentage number into the Sensitivity text box. To learn more, see Sensitivity . |
| Contrast | Move the Contrast slider to increase or decrease the contrast of the image to small signal variations. Alternatively, enter a percentage number into the Contrast text box. To learn more, see Contrast . |

| Item | Description |
|--------------------|--|
| Cursor | To change the color of the depth lines superimposed on the GPR Line view indicating the depth range of the depth slice displayed in the Depth Slice view, click Cursor . To learn more, see Cursor Color . |
| Scale | Click Scale to change the color of the scale grid lines. To learn more, see Scale Color . |
| Depth Limit | Depth Limit enables you to change the maximum depth displayed on GPR line images. To learn more, see Depth Limit . |
| Gain | Gain "amplifies" the strength of the GPR data signals in the GPR line images. To learn more, see Gain . |
| Defaults | Click Defaults to revert the settings to their default values. |
| Preview | To display the effects of the slice setting change before applying them, click Preview . |
| OK | Click OK to apply your changes. |
| Cancel | Click Cancel to close the Settings dialog box; all changes will be lost. |
| AutoPreview | To see the effect of changes made to the settings, including Sensitivity, Contrast and the Color Palette, select Auto Preview . |

5.2.2.2.1 GPR Processing

Advanced users who understand GPR Processing routines, such as Dewow, background subtraction, migration, and enveloping can use this feature to apply processing to a GPR Lines.

- To access the **GPR Processing type**, in the [Settings](#) dialog box, click the **GPR Processing** drop-down list.
- Select a processing routine.



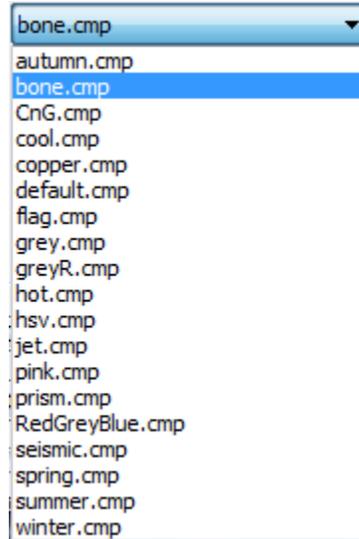
- The recommended and default GPR Processing option is **Dewow + Bgr. Subtraction + Gain**.
- To display the GPR Lines with the same processing as the depth slices, click **Depth Slice Processing**.

Contrast, Sensitivity and Gain are locked to the GPR Line settings dialog and cannot be changed in the Slice Settings dialog.

To learn more, see [Data Processing](#).

5.2.2.2.2 GPR Line Color Palette

Click the GPR Line **Color Palette** to select the color palette you want the GPR Lines to use. One color palette may best highlight the features in a data set, so experiment with the palettes to determine the best color palette for a particular data set.



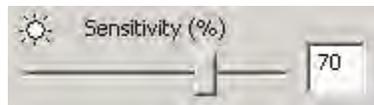
The default color palette for GPR line images is bone.

5.2.2.2.3 Sensitivity

The Sensitivity settings control how sensitive an image is to small signal variations. Sensitivity values range from 0 to 100%, least sensitive to most sensitive (default 100%).

Before changing a sensitivity value, make sure that the GPR line image you want to change is in the active window.

To adjust sensitivity move the slide left to decrease sensitivity and right to increase sensitivity:



You can also adjust sensitivity from the menu bar and toolbar:

Increase Sensitivity

- To increase sensitivity by 5% increments, in the [Menu bar](#), click **View > Sensitivity Increase**.
- To increase sensitivity by 5% increments, in the [Toolbar](#), click the sensitivity increase  icon.
- To increase sensitivity by 10% increments, press **Shift** while clicking the menu or toolbar.
- To increase sensitivity by 10% increments, press **Ctrl** while clicking the menu or toolbar.

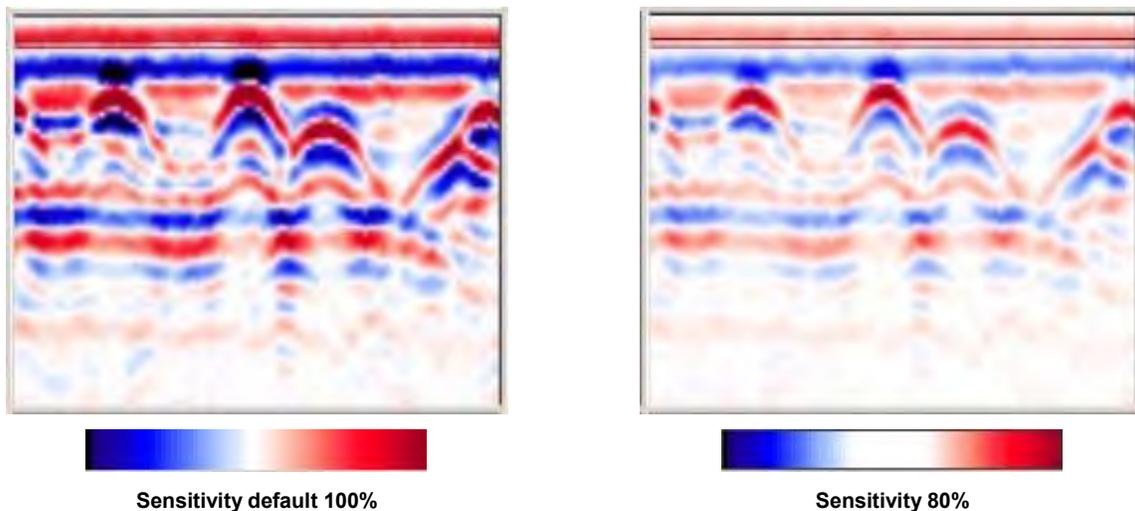
Decrease Sensitivity

Decreasing sensitivity widens the color palette around the zero signal level, removing weaker signals in the image so only the strongest signals are visible.

- To decrease sensitivity by 5% increments, in the [Menu bar](#), click **View > Sensitivity Decrease**.
- To decrease sensitivity by 5% increments, in the [Toolbar](#), click the sensitivity decrease  icon.
- To decrease sensitivity by 10% increments, press **Shift** while clicking the menu or toolbar.
- To decrease sensitivity by 10% increments, press **Ctrl** while clicking the menu or toolbar.

GPR line Images

GPR line signals vary from extreme negative values to extreme positive values with the zero signal in the middle. As sensitivity decreases, the color associated with the zero signal level widens resulting in the weaker signals being removed from the image.



5.2.2.2.4 Contrast

The Contrast setting enables you to control how much of the image area is at the extremes of the color palette. Contrast ranges from 0 to 100%, less contrast to more contrast (default 0% - no added contrast).

Before changing contrast values, make sure the GPR Line image you want to change is the active window.

Contrast Increase

- To increase contrast by 5% increments, in the [Menu bar](#), click **View > Contrast Increase**.
- To increase contrast by 5% increments, in the [toolbar](#), click increase contrast  icon.
- To increase contrast by 10% increments, press **Shift** while clicking the menu or toolbar.
- To increase contrast by 10% increments, press **Ctrl** while clicking the menu or toolbar.

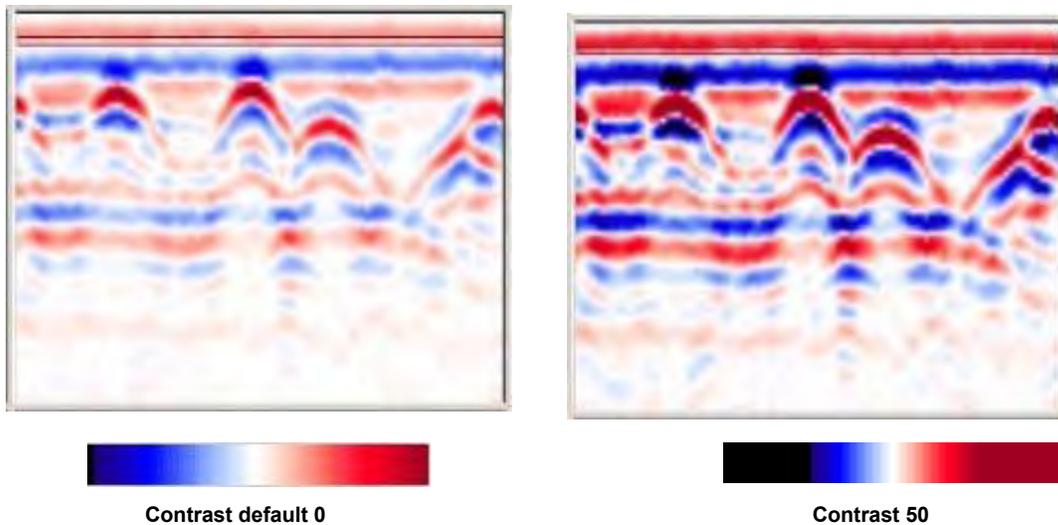
Contrast Decrease

- To decrease contrast by 5% increments, in the [Menu bar](#), click **View > Contrast Decrease**.
- To decrease contrast by 5% increments, in the [toolbar](#), click the decrease contrast  icon.
- To decrease contrast by 10% increments, press **Shift** while clicking the menu or toolbar.
- To decrease contrast by 10% increments, press **Ctrl** while clicking the menu or toolbar.

As contrast increases, more data is displayed at the extreme value of the color palette. Contrast helps make weak targets more visible in the image.

GPR Line Images

GPR line signals vary from extreme negative values to extreme positive values with zero in the middle. As contrast increases, the colors associated with the high positive and negative signal levels at the ends of the color palette widen resulting in the weaker signals appearing stronger in the image.



5.2.2.2.5 *Cursor Color*

Cursor Lines are colored lines indicating

- The position of the GPR Line displayed in the GPR Lines view in the grid displayed in the Depth Slice view ([Figure 5](#)).
- The thickness range of a depth slice is indicated by two parallel lines superimposed on the GPR Line image ([Figure 4](#)).

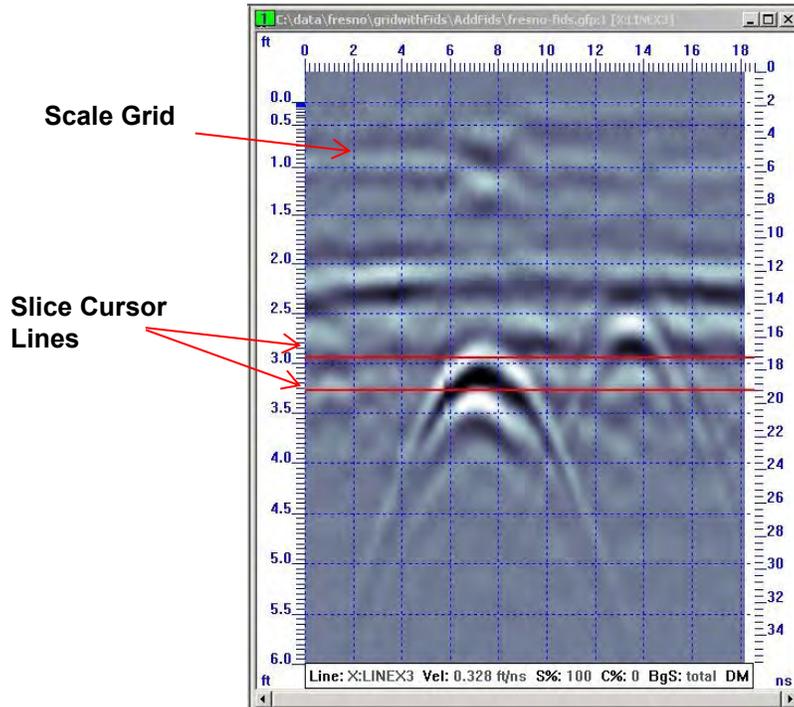


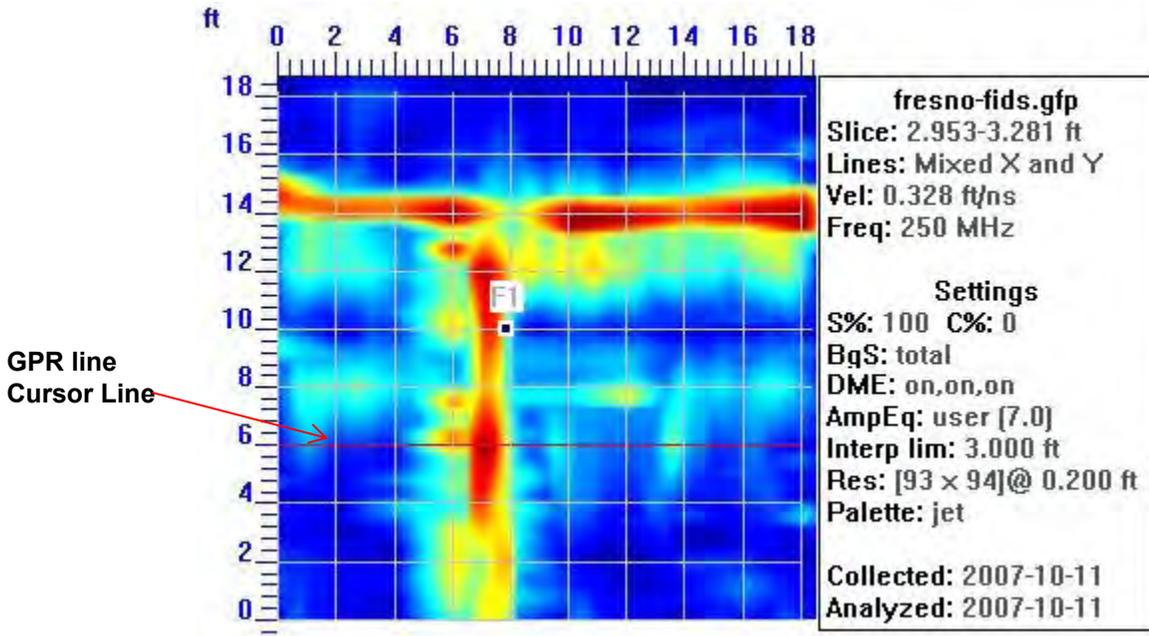
Figure 6: Slice Cursor line and Scale Grid

1. To change the line color, in the [Settings](#) dialog box, click **Cursor**.



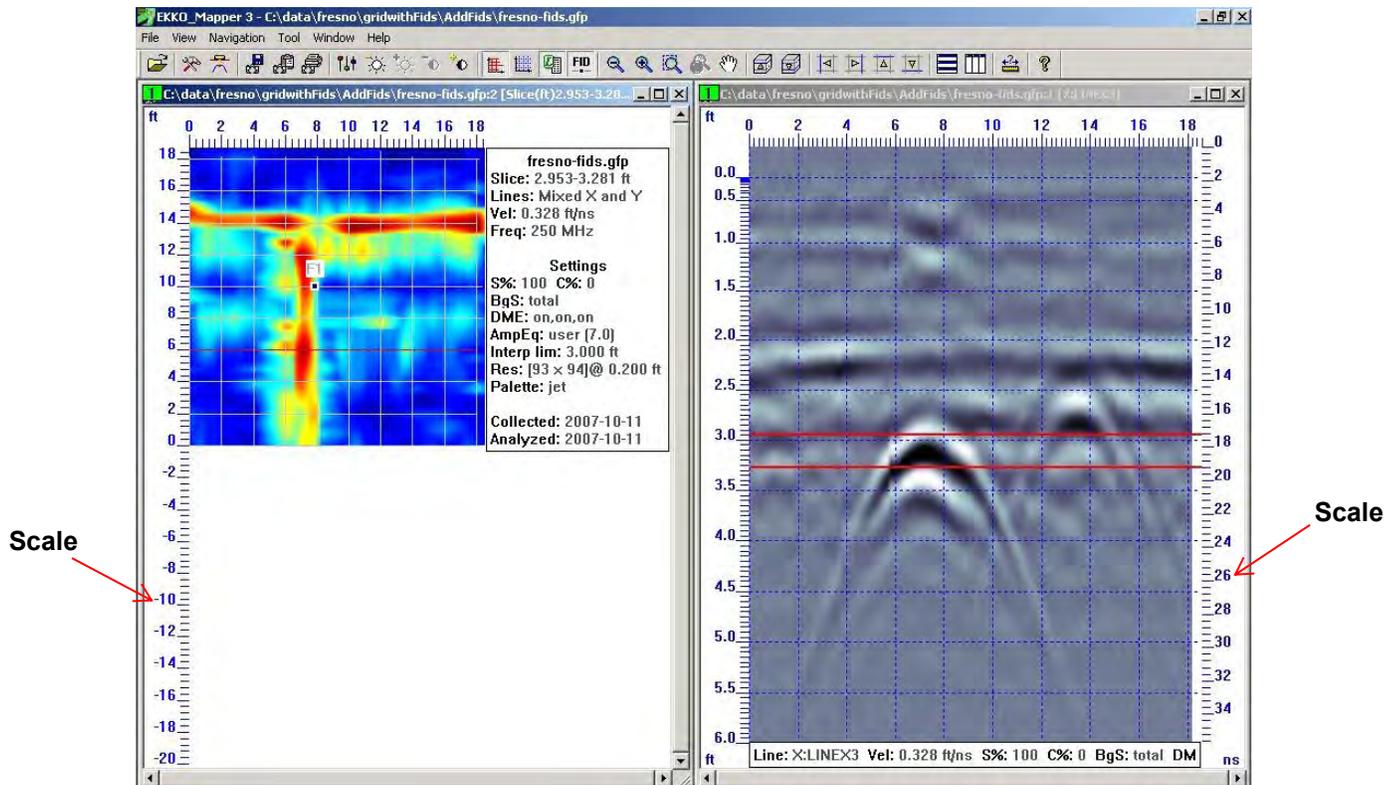
2. In the **Color** dialog box, select a color that provides high cursor line visibility on the depth slices and GPR Lines.
3. Click **OK**.

The GPR Line Cursor Line in the depth slice view is not visible if the [Show Collected Lines](#) option has been turned off.



5.2.2.2.6 Scale Color

Scale Grid Lines correspond to major position and depth labels can be superimposed on the depth slice and the GPR Lines.



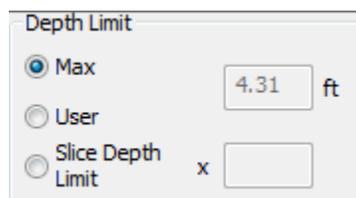
The **Show Scale Grid** option only applies to the image in the active window.

4. To change **Scale Color**, in the [Settings](#) dialog box, click **Scale**.
5. In the **Color** dialog box, select a line color that is visible on the image.
6. Click **OK**.

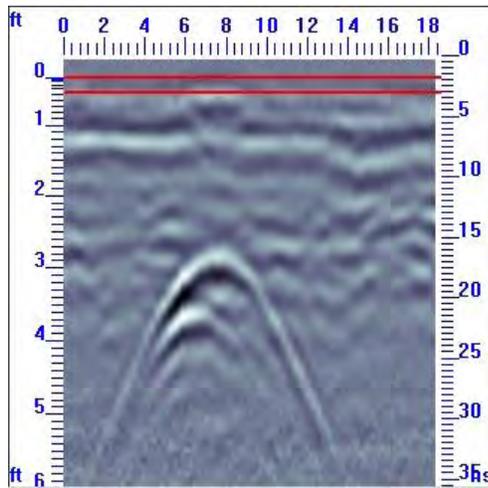
5.2.2.2.7 GPR Line Depth Limit

Use Depth Limit to change the maximum depth displayed on GPR line images.

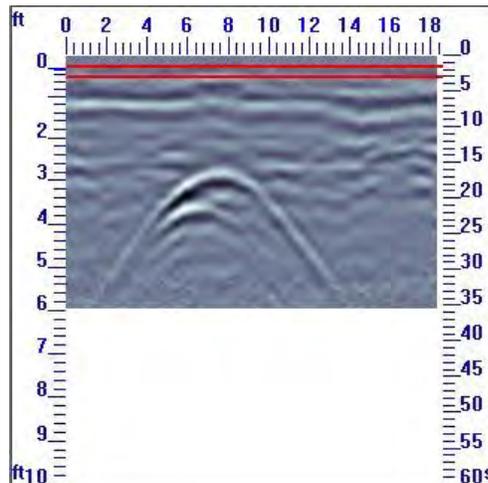
To access **Depth Limit**, in the [Settings](#) dialog box select a depth limit setting.



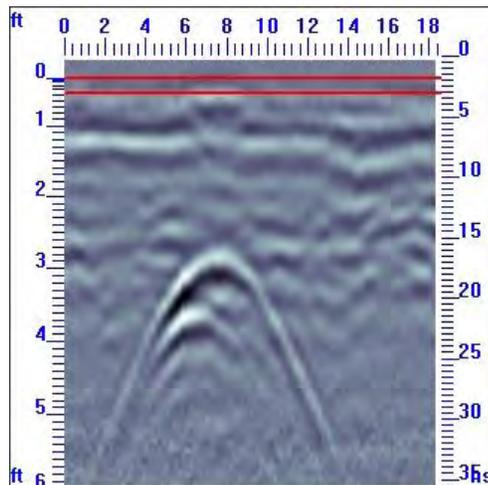
- **Max:** Displays the full depth range of GPR line data (default setting).



- **User:** Select **User** to enter the maximum depth value to display in the GPR line image in the **ft.** text box.



- **Slice Depth Limit:** Select **Slice Depth Image** to enter a multiplication factor for the [Slice Depth Limit](#).



For example, a multiplication factor of two sets the GPR Line depth limit to twice the current slice depth limit. A multiplication factor of 0.5 zooms the slice depth limit to only show the shallow data in the GPR Line view.

Setting the Depth Limit to a value larger than the maximum GPR line depth displays the full depth and time axes of the GPR line, but data below the maximum depth will be blank.

Note: Use Depth Limit only to display GPR Lines. If the depth limit setting is less than the maximum depth, it does not limit the GPR Line data used for generating depth slices.

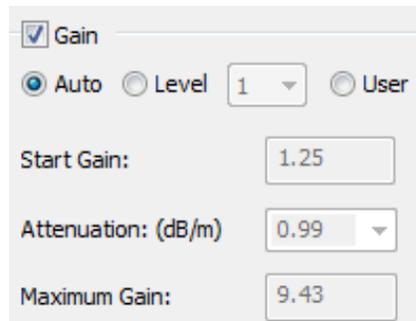
Depth slices deeper than the depth limit are still visible, but the [slice cursor lines](#) on the GPR line that define the thickness of the depth slice fall off the bottom of the GPR line as you scroll down through the depth slices.

To learn how to limit the maximum data depth to generate depth slices, see the [Slice Depth Limit](#).

5.2.2.2.8 Gain

Gain enables you amplify the strength of the GPR data signals in the GPR line images (similar to adjusting the volume knob on a radio). Gain is only applied to the GPR line image display; changing gain has no effect on depth slice images.

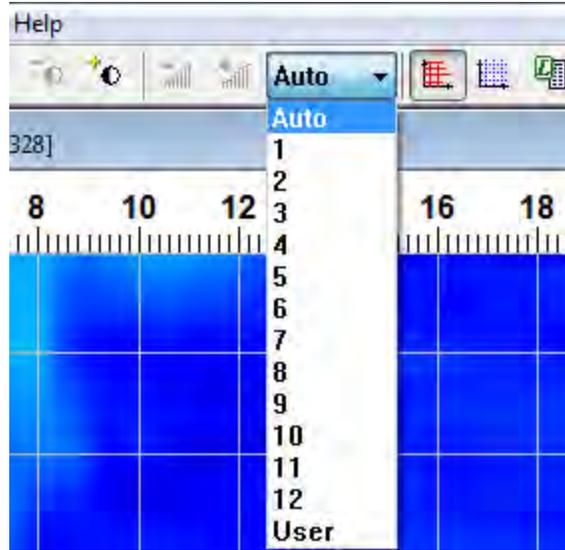
- To add **Gain** to GPR Processing, in the [Settings](#) dialog box, select the **Gain** checkbox.



- Select the **Auto**, **Level** or **User** option.
 - Auto** uses the average decay curve of the GPR signal strength over time to calculate an appropriate gain parameter values for attenuation, maximum gain and start gain. If the GPR line images are properly gained using the Auto gain setting, use it. If an Auto gain does not gain the GPR line properly, try using the gain Levels.

Level uses 12 pre-defined settings for **Start Gain**, **Attenuation** and **Maximum Gain** (see details below) that increase from a low gain at 1 to a high gain value at 12. Typically one of these 12 settings applies a suitable gain to the GPR line. If not, select a gain level that is close and then switch to a **User** and modify the gain parameters (see below) until the gain is the best.

The gain level is changed in this dialog but can also be changed using the Gain Level dropdown list and the Gain Level increase or decrease buttons on the Toolbar. Note that the gain is applied to the data in the currently selected window, either the GPR line or the Depth Slice window.



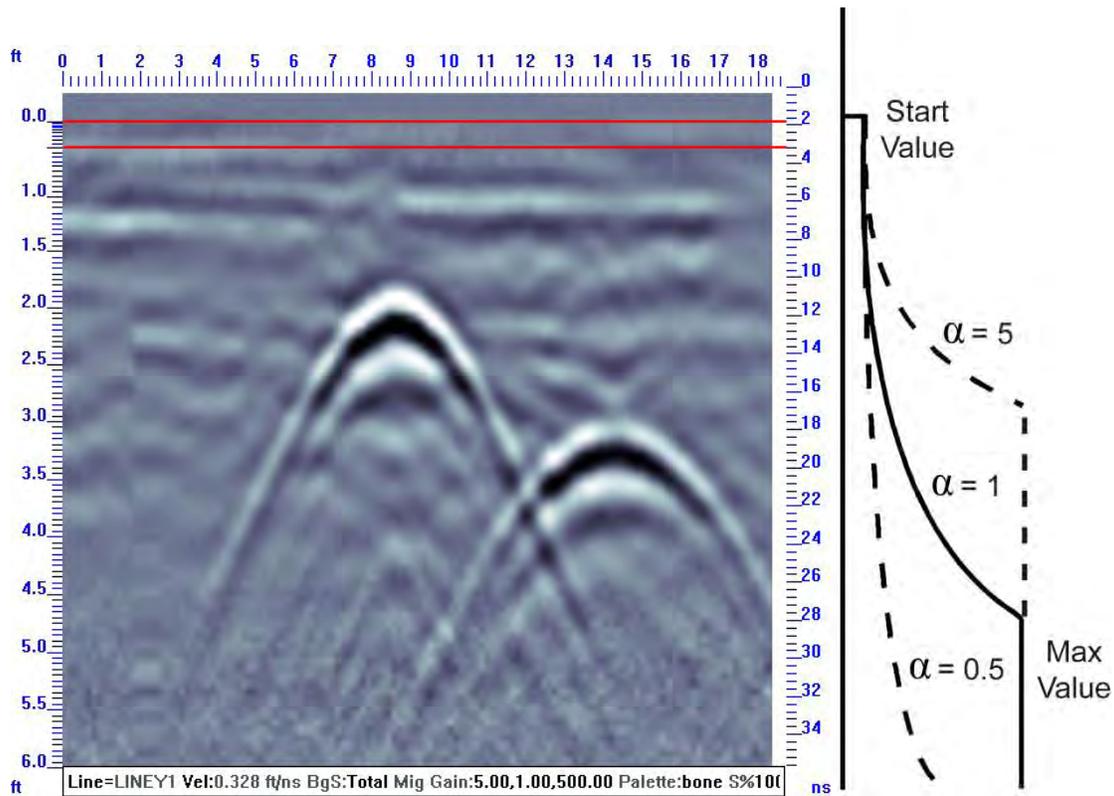
This makes it easy to quickly scroll through several pre-set gain levels and find one that makes the GPR line look the best.

- **User** allows the 3 gain parameters to be manually set:
 - **Start Gain:** In the **Start Gain** text box, enter the zero depth value at the top of the GPR line. Start Gain values are usually 1 to 3 (1 default).
 - **Attenuation:** To learn more, see [Attenuation](#).
 - **Maximum Gain:** In the Maximum Gain text box, enter a value between 20 and 1000 (500 default).
Maximum Gain is the highest multiplication factor that can be applied to GPR line data. Attenuation stops increasing once it reaches Maximum Gain.

Since the strongest GPR signals are returned from shallow targets at the top of the GPR line, the gain applied to the GPR lines increases with increasing depth.

Gain begins with the **Start Gain** value at the top of the GPR line, increases at a rate defined by the **Attenuation** value, and levels off to a constant multiplier when the **Maximum Gain** value is reached.

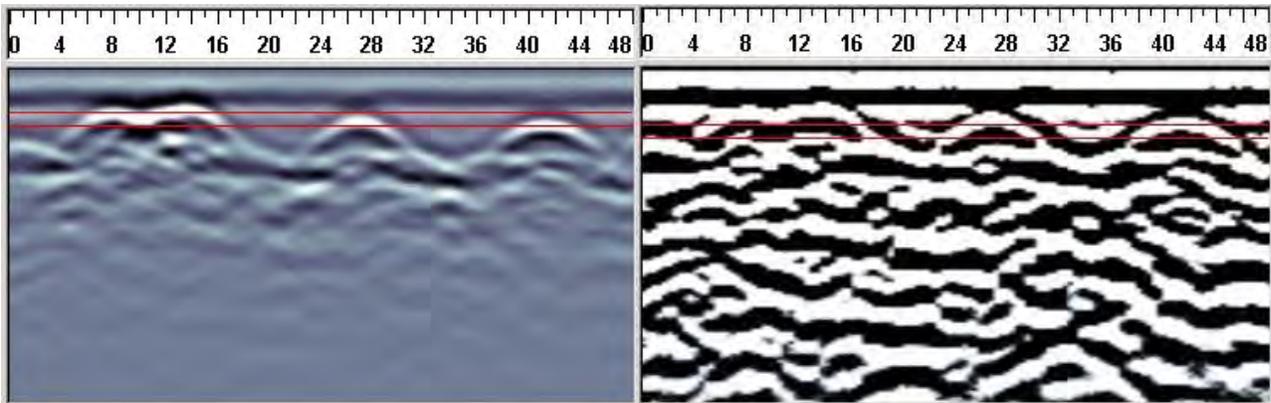
The following image displays a GPR line image with the gain function shape and parameters on the right.



In most cases, **Start Value** is 1 to 3, **Attenuation** (α), which controls steepness, is 0.5 to 50, and **Maximum Gain**, which cuts off the exponential rise, is 20 to 1000. To avoid over-gaining data, start with low attenuation and maximum gain values and increase as necessary.

Attenuation

Attenuation values define the steepness value of the gain. Lower values result in a more gradual slope, while higher values produce steeper slopes. The ramp rises from the Start Gain value up to the Maximum Gain value.



A low attenuation value produces a clear GPR line image

High attenuation values overgain data producing an unclear image

1. To select an attenuation value, in the [Gain](#) pane, click the **User** option.
2. In the **Attenuation** drop-down list, click a value between 0.0 and 50.0.
You can enter another value into the text box.

Attenuation values apply gain to the GPR lines in the same way that the Amplitude Equalization Gain value applies gain to the slices. When you find an attenuation value the produces clear GPR line images that are not over-gained, you can apply the same gain value to User Amplitude Equalization to produce quality depth slice images.

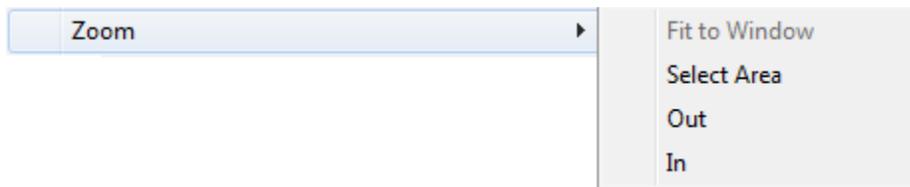
5.2.2.3 Apply Default to Contrast Sensitivity

To apply the default contrast and sensitivity values to the active window, in the [menu bar](#), click **View > Apply Default to Contrast Sensitivity**.

5.2.3 Zoom

Use Zoom to increase or decrease the size of the depth slice or GPR line image in the active window.

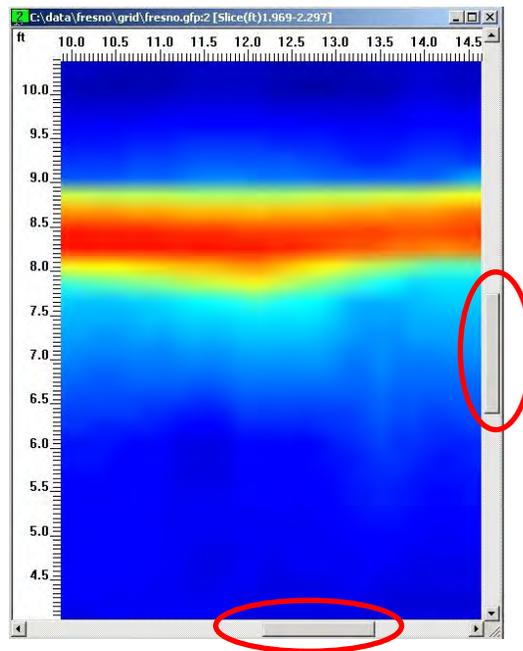
To access **Zoom**, in the [menu bar](#), click **View > Zoom**.



There are four Zoom options:

| Option | Description |
|----------------------|--|
| Fit to Window | To zoom to the full grid size, click View > Zoom > Fit to Window . |
| Select Area | <ol style="list-style-type: none"> 1. To zoom in to a specific area of the slice or GPR line, click View > Zoom > Select Area. 2. Draw a box around the area you want to zoom in on. 3. Click the magnifying glass () icon. |
| Out | To zoom out of the current image size, click View > Zoom > Out . |
| In | To zoom into the current image size, click View > Zoom > In . |

After zooming into an image, scroll bars appear on the bottom and right edge of the image.



Use the scroll bars to move around the image and view different areas. The scroll bar narrows each time the image is zoomed-in to indicate that a smaller percentage of the full image range is displayed.

A zoomed-in image still displays X and Y scales. The image may show more data than defined by the box because the additional data will be added to the right or bottom of the image so it always retains the correct aspect ratio.

5.2.4 Pan

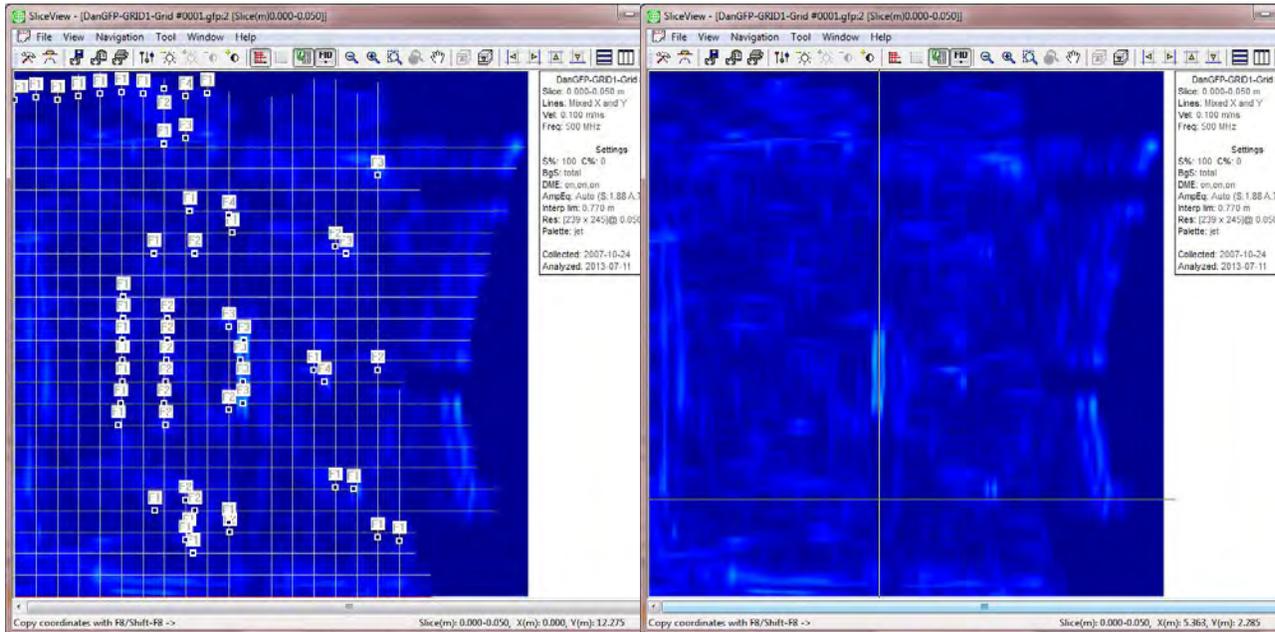
Click **Pan** to move images around a zoomed-in image; in Pan Mode the cursor displays a hand icon (👉). You can click and drag data images to a new location. As the image is dragged, a dashed box outlining the current viewed image is formed. The image will move to the location of this dashed box.

To exit Pan mode, click **View > Pan**.

5.2.5 Show Collected Lines

To superimpose lines onto the depth slice image to display where a grid's data lines were collected, click Show Collected Lines.

Use this feature when a partial grid or partial lines were collected in a survey to avoid having to interpret a target in an area where no data was collected.



Show Collected Lines

Disable Show Collected Lines

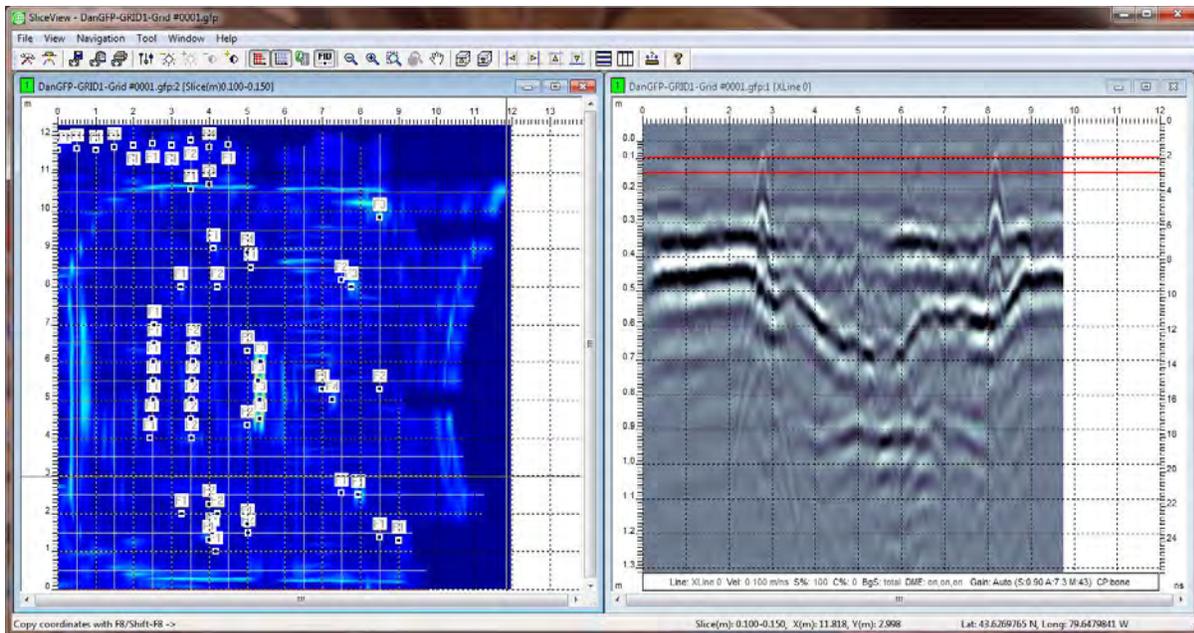
5.2.6 Show Scale Grid

To superimpose a grid of dashed lines onto the depth slice or GPR Line view, in the Menu bar click **View > Show Scale Grid**.

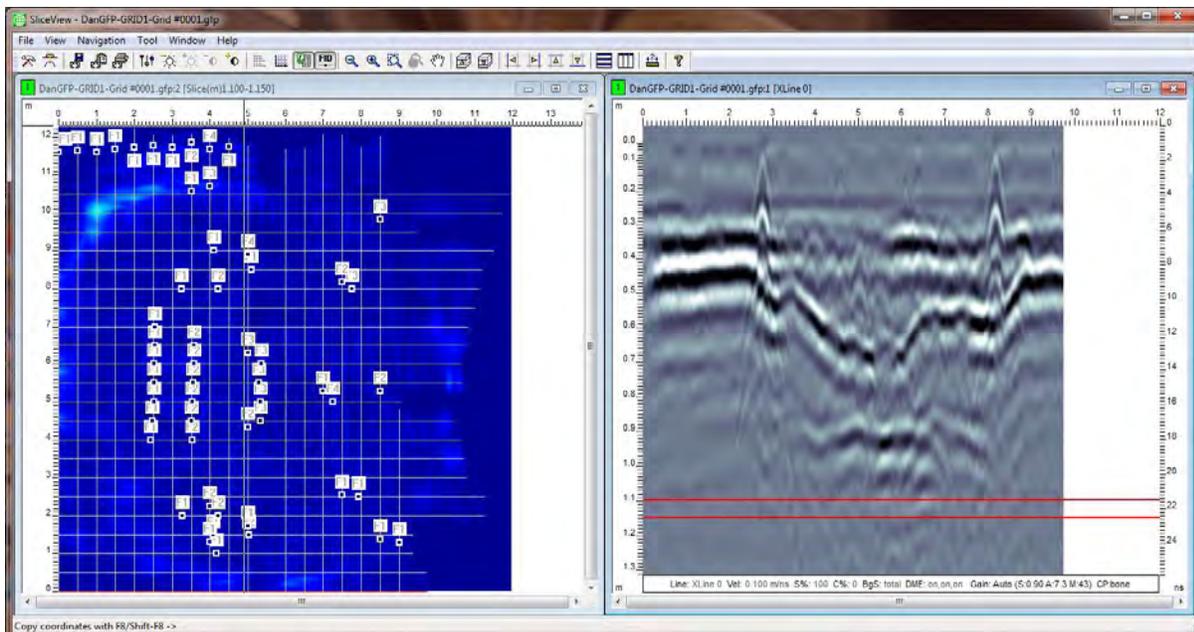
Horizontal and vertical grid lines appear at major positions and depths as indicated on the position and/or depth scales.

In normal operation the scale grid is turned off to remove clutter from the image. Turn the grid scale on to display more detailed positioning information to assist with the interpretation.

With Scale Grids:



Without Scale Grids:

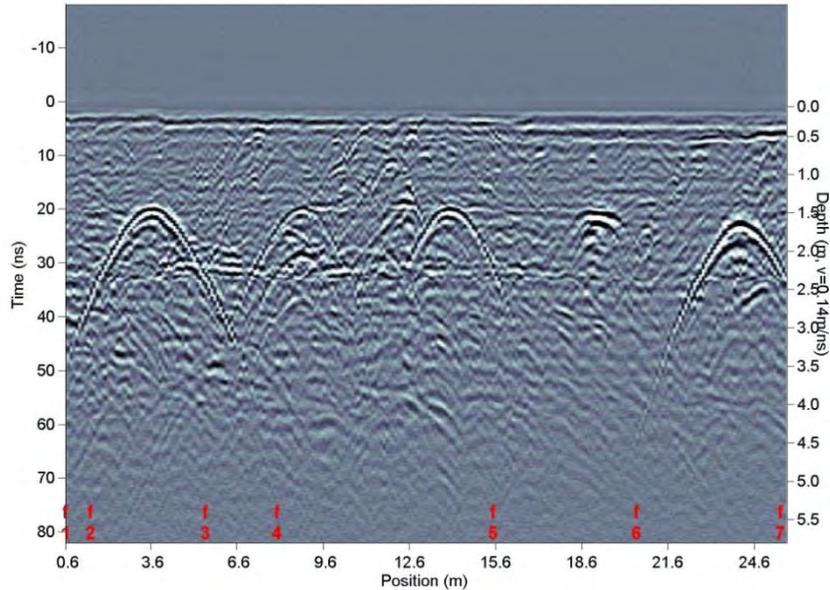


5.2.7 Show Flags/Fiducials

Flags/Fiducials are markers and/or comments added during data acquisition at specific trace positions along the line.

To enable Flags/ Fiducials, click **View > Display Flags/Fiducials**.

The following image displays a number of fiducial markers highlighted red:

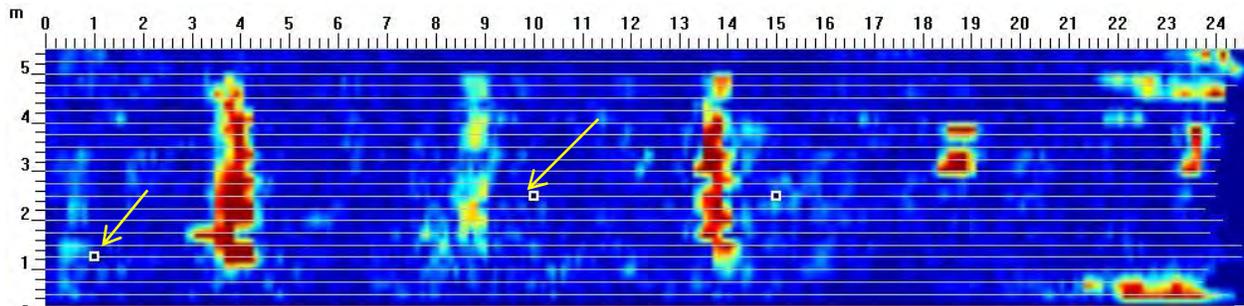


If your older GPR system does not write fiducials to the GFP file created during grid data collection, use the GFP_Edit utility program to import fiducials separately into the GFP file.

If the grid contains Flags/Fiducials on any data lines, they are automatically displayed on the image in the Depth Slice View when [Show Collected Lines](#) is enabled. The flags/fiducials appear as small squares on the line.

To turn flags/fiducials on or off, click **View > Display Flags/Fiducials**.

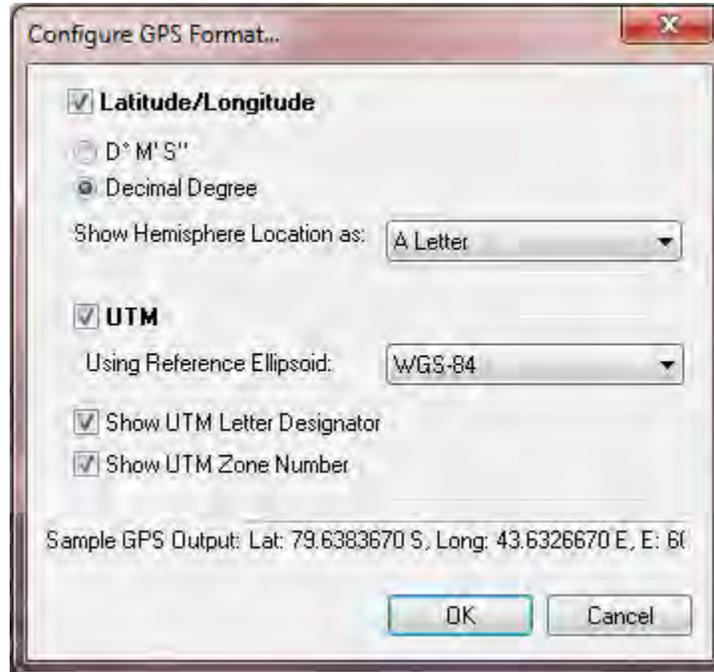
The following image displays flag/fiducial markers as little squares on the depth slice view image.



5.2.8 GPS Format

If the GPR data file contains GPS data, GPS information is displayed on the [Status Bar](#). The format of the GPS information displayed is controlled by the GPS the GPS Format dialog box.

1. To open the GPS Format dialog box click **View > GPS Format**.



5.2.8.1.1 Latitude/Longitude

2. Select the **Latitude/Longitude** checkbox to enable the Latitude/Longitude pane.
 - a. Select to display Latitude/Longitude in Degrees Minutes Seconds (**D° M' S"**) or **Decimal Degrees**.
 - b. In the **Show Hemisphere Location at** drop-down list, select one of the following options:
 - **Do not show**
 - **Positive/Negative**
Displayed as a plus (+) sign when latitude is in the Northern hemisphere or Longitude is in the Eastern Hemisphere.
Displayed as a minus (-) sign when latitude is in the Southern hemisphere or Longitude is in the Western Hemisphere.
 - **Letter**
For latitude, "N" for North or "S" for South. For Longitude, "E" for East or "W" for West.
 - **Word**
For latitude, "North" or "South". For Longitude, "East" or "West"
- The current GPS output is displayed in the **Sample GPS Output** field.

5.2.8.1.2 UTM

3. Select the **UTM** (Universal Transverse Mercator) checkbox to enable the UTM pane.

From the **Using Reference Ellipsoid** dropdown list, select an option. The default is WGS-84.

 - Click the **Show UTM Letter Designator** option to display the letter designator.
 - Click the **UTM Zone Number** option to display the zone number.

The current GPS output is displayed in the **Sample GPS Output** field.
4. Click **OK**.

5.3 Navigation



5.3.1 Slice Up or Slice Down

Stepping Up or Down through depth slices provides insight into the depth of various features in the three dimensional volume.

- Click **Slice Up** () to scroll up through the depth slice image by single depth slice increments.
- Click **Slice Down** () to scroll down through the depth slice image by single depth slice increments.

When the highest or lowest depth slice is reached, the depth slice image does not change.

If the GPR Line View is open, as you move through the slices in the depth slice view, the slice cursor lines on the GPR line image move up or down corresponding to the depth slice image.

5.3.2 Line Up or Line Down

If you collected X-lines to generate a depth slice image (see [Lines in Depth Slice Image](#)) and a GPR Line view is open, click **Line Up** () or **Line Down** () to move through the X-GPR line one image at a time.

If the **Show Collected Lines** option is enabled, a horizontal cursor line corresponding to the grid position of the current X-line is displayed on the slice image on the depth slice view.

As the X-line GPR line image changes, the grid cursor line on the depth slice image moves to a new position corresponding to the new X-line.

You can switch the GPR Line View from X lines to Y lines by clicking an option under Line Left and Line Right.

These buttons are active when selecting an X line for [Hyperbola Velocity Calibration](#).

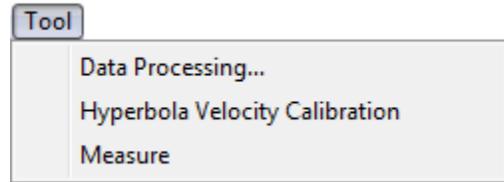
5.3.3 Line Left or Line Right

If you collected Y-lines to generate the depth slice image (see [Lines in Depth Slice Image](#)) and a GPR Line View is open, you can move through the Y-lines one at a time using the Left Arrow () and Right Arrow () buttons.

If the [Show Collected Lines](#) option is enabled, a vertical Cursor Line ([Figure 5](#)) corresponding to the grid position of the current Y line will be displayed on the depth slice image. As the Y line image changes, the cursor line on the depth slice image moves to a new position corresponding to the new Y line.

These buttons are active when selecting any Y line for [Hyperbola Velocity Calibration](#).

5.4 Tool

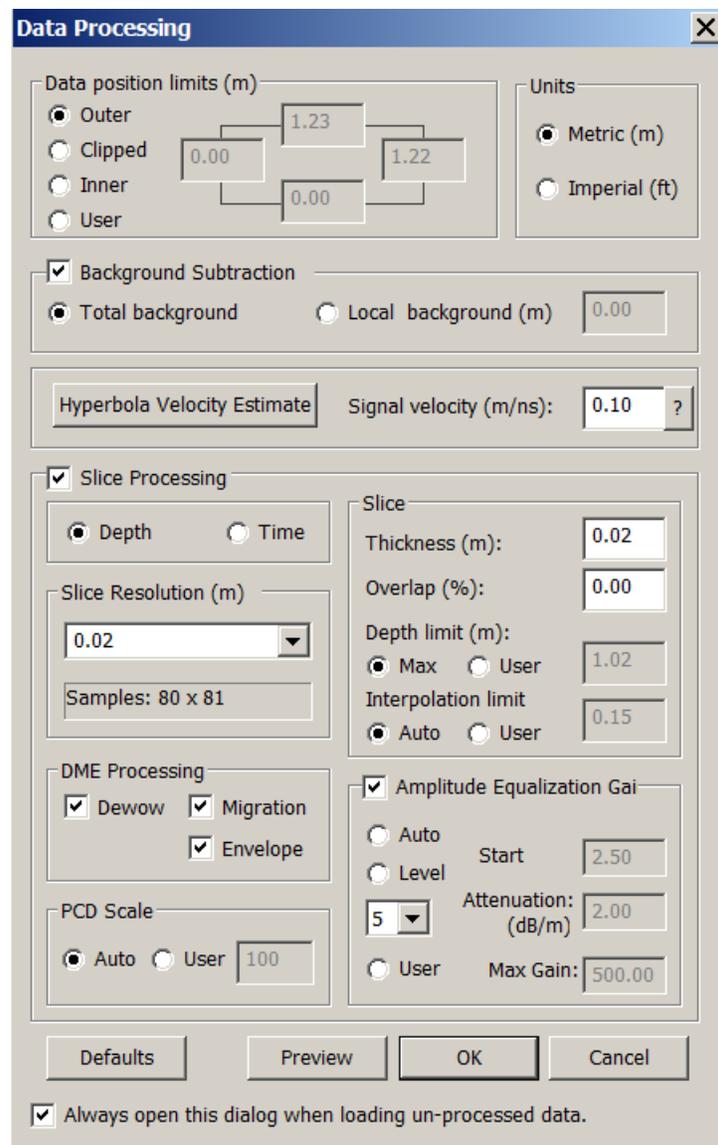


5.4.1 Data Processing

Use the Data Processing dialog box to set the parameters for the processing depth slice images.

To access Data Processing, in the menu bar click **Tool > Data Processing**.

Alternatively, from the toolbar, click :



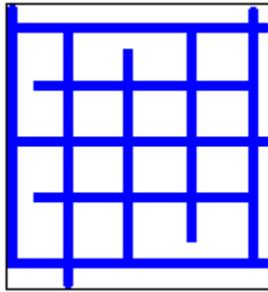
Slices produced in SliceView display GPR signal amplitude versus XY position. Amplitude value is the average amplitude value over the depth or time thickness. Data processing processes such as Dewow, Migration, Background Subtraction, and Envelope affect the original amplitude.

5.4.1.1 Data Position Limits

Data Position Limits define the positions at the edges of the depth slice image. This setting always defaults to the Outer positions so a depth slice is generated that includes all the available data. You can select other settings such as [Clipped](#), [Inner](#), or [User](#) to define other grid dimensions.

5.4.1.1.1 Outer

Select this option to apply **Outer** data position limits to a grid when you want the longest lines in the X and/or Y direction to define the size of the grid so the depth slice generated is the largest possible and uses all the available data in the grid.



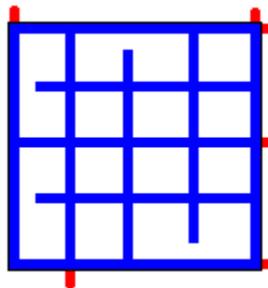
GPR lines that are shorter than the longest lines are padded with zero data so all lines are the same length.

For example, if all the lines are 10m long except one in the X direction that is 10.5m and another in the Y direction that is 10.2m long, the grid size plotted in the depth slice will be 10.5 x 10.2m.

5.4.1.1.2 Clipped

It is common to collect GPR lines that are longer than the grid dimensions; this allows operators to overshoot the end of the grid without having to try and stop the line exactly at the end position. Each GPR line is typically a slightly different length.

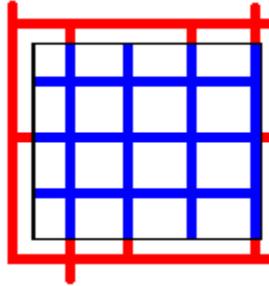
Select the **Clipped** data position limit to crop the grid using the first and last lines in X and Y directions; GPR lines that extend outside the defined grid are cut off.



Clipped data limit is not available if you have only X-lines or Y-lines, (no Y-lines to clip the X-lines and vice versa).

5.4.1.1.3 Inner

Select the **Inner** data position limit for the grid when the shortest lines in the X and/or Y direction define the size of the grid so the grid contains solid data with no zero data padding. Use this option when one or more GPR lines exceed the desired size of the grid and you want to truncate those lines and display a grid with no zero data padding.



For example, if all the lines are 10m long, except one in the X direction that is 10.5m long, and another in the Y direction that is 10.2m long, the grid size plotted in the depth slice will be 10 x 10m.

5.4.1.1.4 User

Select the **User** data position limit when you can define the minimum X, maximum X, minimum Y, and maximum Y positions for the grid. GPR lines are truncated and/or padded with zero data to fit the defined grid size.

5.4.1.2 Units

Distance and depth units displayed on the axes around the depth slice and GPR line images can be displayed in meters or feet.

Use this feature to convert and display the units default used during grid data collection from meters (m) to feet (ft.).

5.4.1.3 Background Subtraction

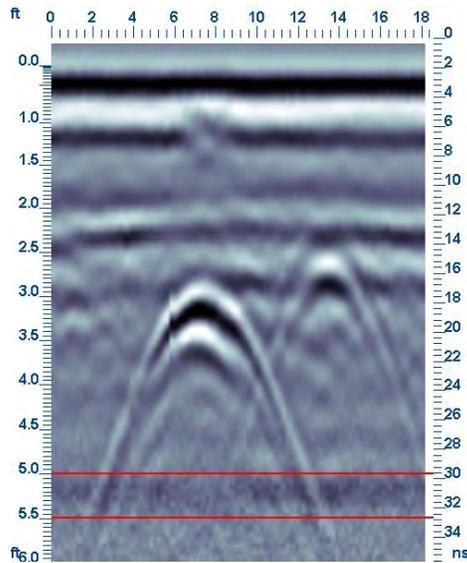
Horizontal events associated with direct air waves and the direct ground waves are displayed at the top of all GPR lines. These events are not reflections from within the ground and should be removed from the data before generating depth slice images.

Use background subtraction to remove these events and other horizontal reflectors in the GPR lines.

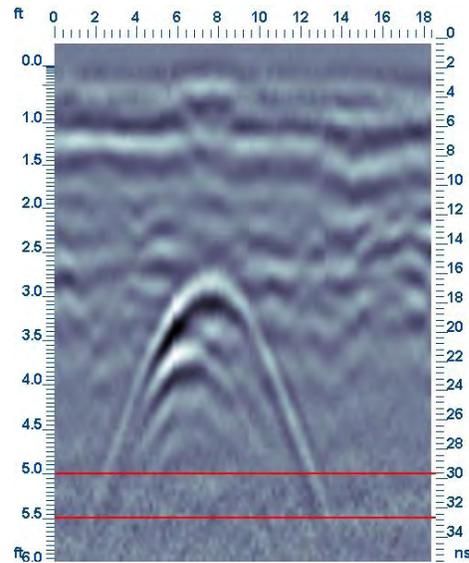
The background subtraction filter defaults to on, but can be turned off by unchecking this option. Turn off background subtraction when you are exporting geological data to 3D ([Export Data](#)).

5.4.1.3.1 Total Background

Use Total Background to calculate the average trace for the entire grid survey and then subtract it from every trace in the survey. This process removes the direct air and ground waves on the top of the data to improve the very shallow depth slice images.



Before Total Background Subtraction



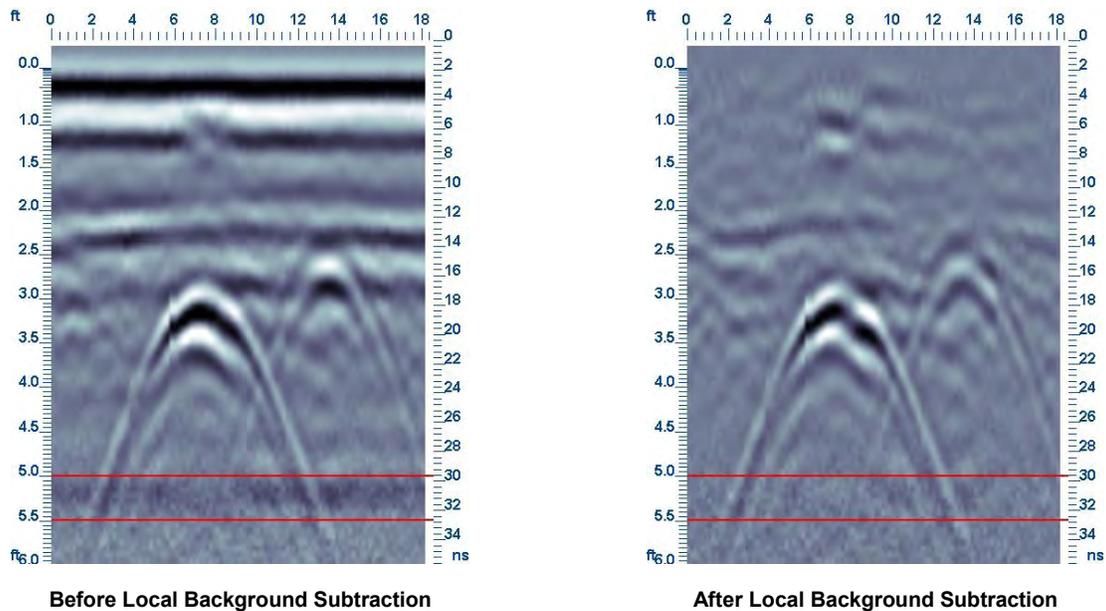
After Total Background Subtraction has been applied

This filter is most effective when the air wave and/or ground wave events are fairly constant throughout the grid of GPR lines. If the surface varies in composition or water content, the ground wave event will vary in amplitude and time; using total background subtraction may not remove the events satisfactorily on all GPR lines. In this case, using a Local Background Subtraction filter may be more effective.

5.4.1.3.2 Local Background

When using Local Background, an average trace in a user defined window width is calculated and subtracted from the trace in the center of the window. The window is then moved over one trace and the process is repeated. This type of filter is called a running average background subtraction filter.

This background subtraction filter is effective for removing local flat-lying events in the data such as, varying wave events or localized banding on one GPR line in the grid.



To determine an appropriate window width for the local background subtraction filter, scroll through the GPR lines in your grid and determine the length of the shortest flat-lying reflection that you want removed from the data. Start with a value of 1 meter (3 feet) and modify up or down as necessary to improve the depth slice images.

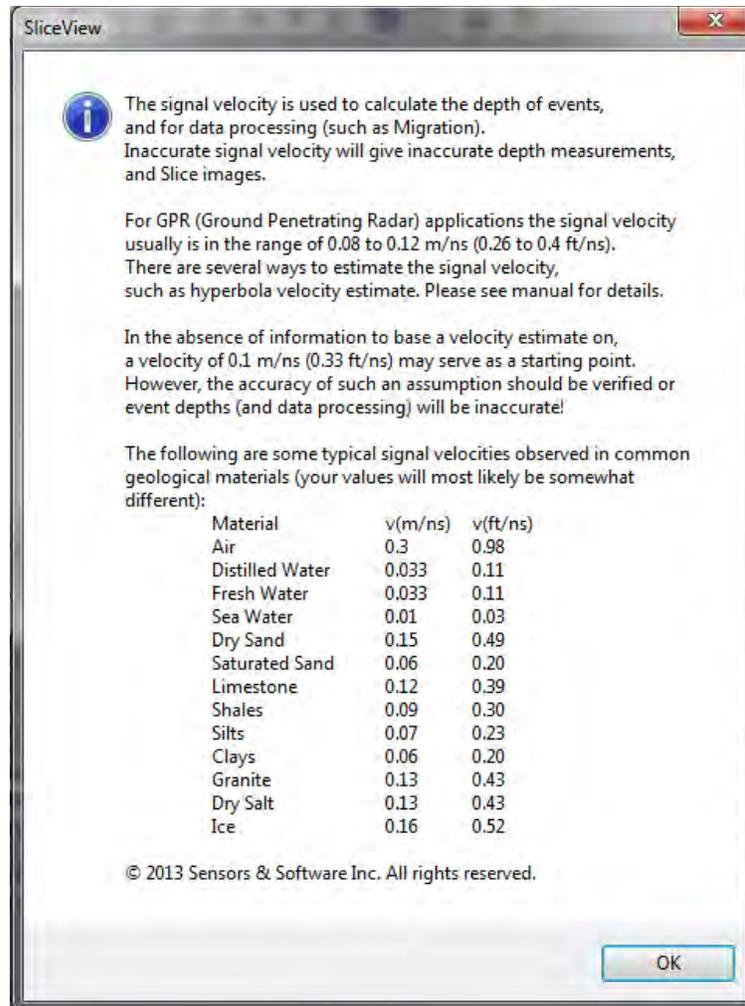
Caution: Be careful when using short distances for Local Background Subtraction as these can result in the removal of a significant amount of data.

5.4.1.4 Signal Velocity

An accurate signal velocity is necessary for creating good depth slice images. A poor velocity value may result in fuzzy images that are difficult to interpret and result in inaccurate depth estimates. Velocity defaults to a typical average velocity of 0.10 m/ns or 0.328 ft./ns.

You can enter a velocity into the Signal Velocity field in the units displayed (meters per nanosecond m/ns, or feet per nanosecond ft./ns).

- To display a list of typical signal velocities, in the [Data Processing](#) dialog box, beside **Signal Velocity**, click .



- Record the velocity for the material you are scanning.
- Click **OK**.
- In the [Data Processing](#) dialog box, in the **Signal Velocity** field enter the material velocity
- Click **OK**.

5.4.1.5 Slice Processing

Use Slice Processing to select the type of processing to apply to the current active slice before it is displayed.

Slice Processing defaults to on. If you do not want to perform slice processing, de-select the Slice processing checkbox. Turn this option off when you want to display GPE lines from a grid. For example, trying to determine the best slice processing options for a large grid when you know that slice processing will take a substantial period of time.

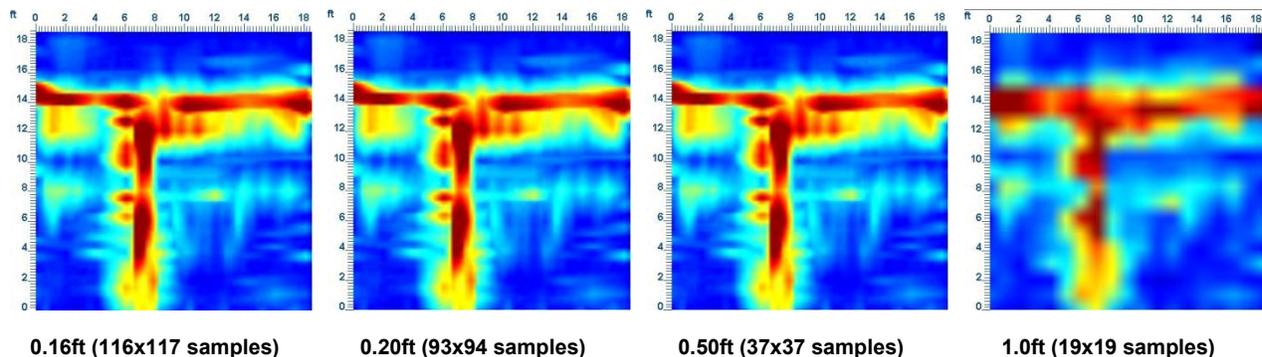
5.4.1.5.1 Slice Units

The Slice Units setting determines which units of measurement will be used for the slice thickness parameter: depth in meters or feet, or time in nanoseconds.

The Slice Units defaults to depth in the same units that the data were collected in, i.e. meters or feet, but these units can be changed (to learn more, see [Units](#)).

5.4.1.5.2 Slice Resolution

The smallest unit (box) of solid color in a depth slice image is called a pixel or a sample. Slice Resolution defines the physical size of the sample in a depth slice image. Decreasing the sample size increases the total number of samples and, as a result, the details of the images. However, Slice Resolution can also increase the time required to process and display the image. Increasing the sample size decreases the total number of samples and data processing time but results in increasingly fuzzier images.



Depth slices with a very small sample size are very detailed but take longer to process.

Slice Resolution defaults to an appropriate value based on the step size (the distance between traces during data collection) and the screen resolution. Slice resolution can be changed but not made finer (smaller) than the smallest step size in the data. A coarser (larger) resolution value results in faster data processing.

The [Depth Slice View Legend](#) displays the current slice resolution value and the total number of samples in the X and Y directions. To change the slice resolution value, enter a new value or use one of the four resolution values from the drop-down list (low, medium, high, and max).

Changes in slice resolution have the most effect on large grid data sets. It is a good practice to set slice resolution to a coarse value at first and then make sure that the depth slices generated are what you expect before proceeding with a finer sample size that takes longer to process.

5.4.1.5.3 DME Processing

DME (Dewow, Migration, and Enveloping) is a standard GPR data processing stream that is typically applied to the GPR lines before generating depth slice images. DME is generally for advanced users who understand these GPR data processing routines.

The default setting (recommended for novice users) is all processes checked so that they are performed before generating the depth slice images.

The processes selected in this option affect the number of processing streams available in the [GPR Processing](#) in the GPR Line Settings drop-down list. For example, if the Migration process is not selected, then the GPR processing streams listed will not include Migration.

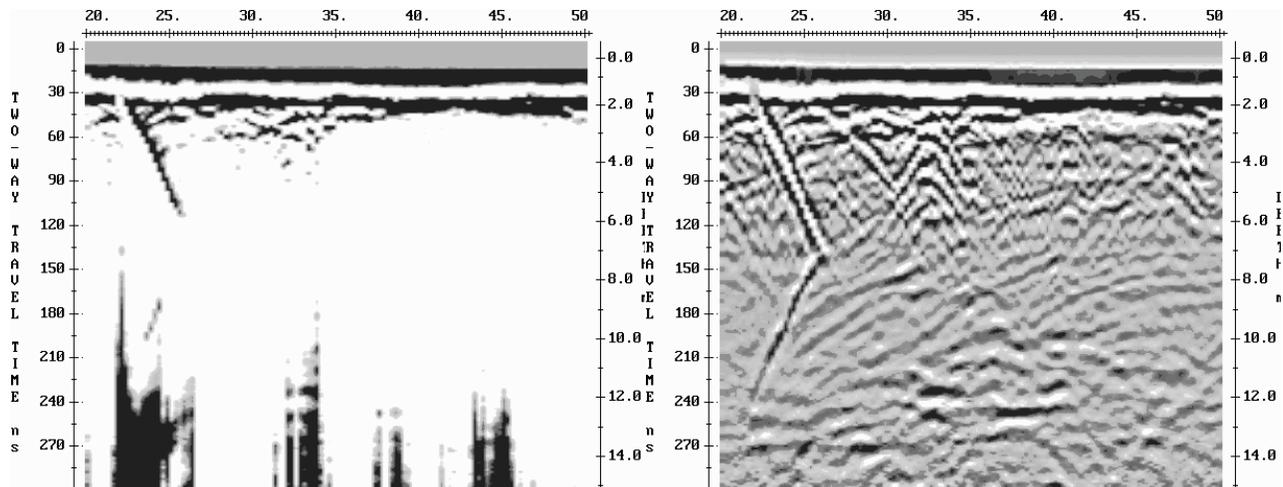
Turn off DME (uncheck) when you have processed grid data in some other program (such as EKKO_Project) and just want to use SliceView to display the data. In this case, Turn off [Background Subtraction](#) as well as. If grid data was gained you should also turn off [Amplitude Equalization Gain](#).

Review the DME settings when exporting geological data to 3D. It may look better in 3D without the Migration and Enveloping processes (see [Export Data](#)).

Dewow

Depending on the proximity of the transmitter and receiver, as well as the electrical properties of the ground, the transmit signal may induce a slowly decaying low frequency (wow) on the trace which is superimposed on the high frequency reflections.

The Dewow process (also called the Signal Saturation Correction) removes this unwanted low frequency while preserving the high frequency.



Raw data line containing the low frequency wow component - before dewow

The same data line after dewow removes the low frequency wow component

Wow is removed from the data by running a high pass average filter on each trace. A window with a width the same as that of one pulse width at the nominal frequency is set on the trace. The average value of all the points in this window is calculated and subtracted from the central point. The window is then moved along the trace by one point and the process is repeated.

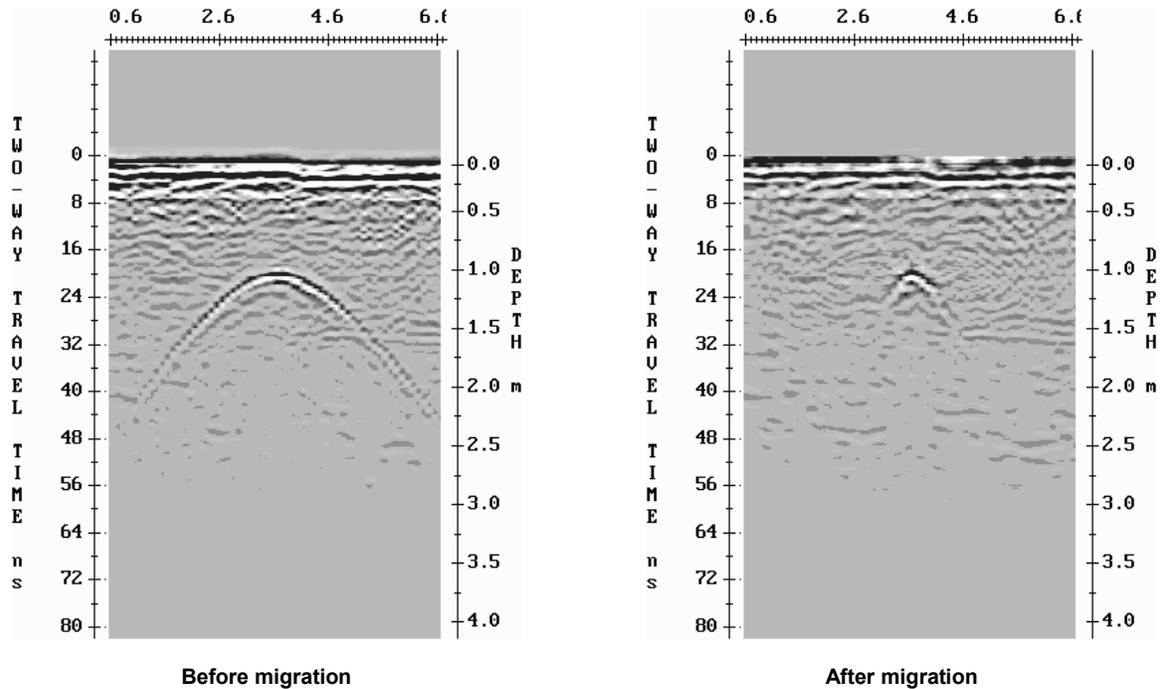
While any filter produces unwanted artifacts in the data to which it is applied, Dewow has been optimized after many experiments over many years to reach a satisfactory compromise filter.

The Dewow process is highly recommended when data processing GPR lines and depth slices.

Migration

Targets in the subsurface often generate hyperbolic responses on a GPR line. A hyperbola is the result of the wide beam-width inherent in most GPR systems.

The target is located at the apex, or top of, the hyperbola. Migration focuses the energy spread over the hyperbolic shape back to the apex of the hyperbola—the actual location of the object. This is an essential and highly recommended part of the data processing when generating depth slices. Migration allows linear targets viewed on depth slice images to appear as linear objects rather than hyperbolic shapes that make interpretation difficult.



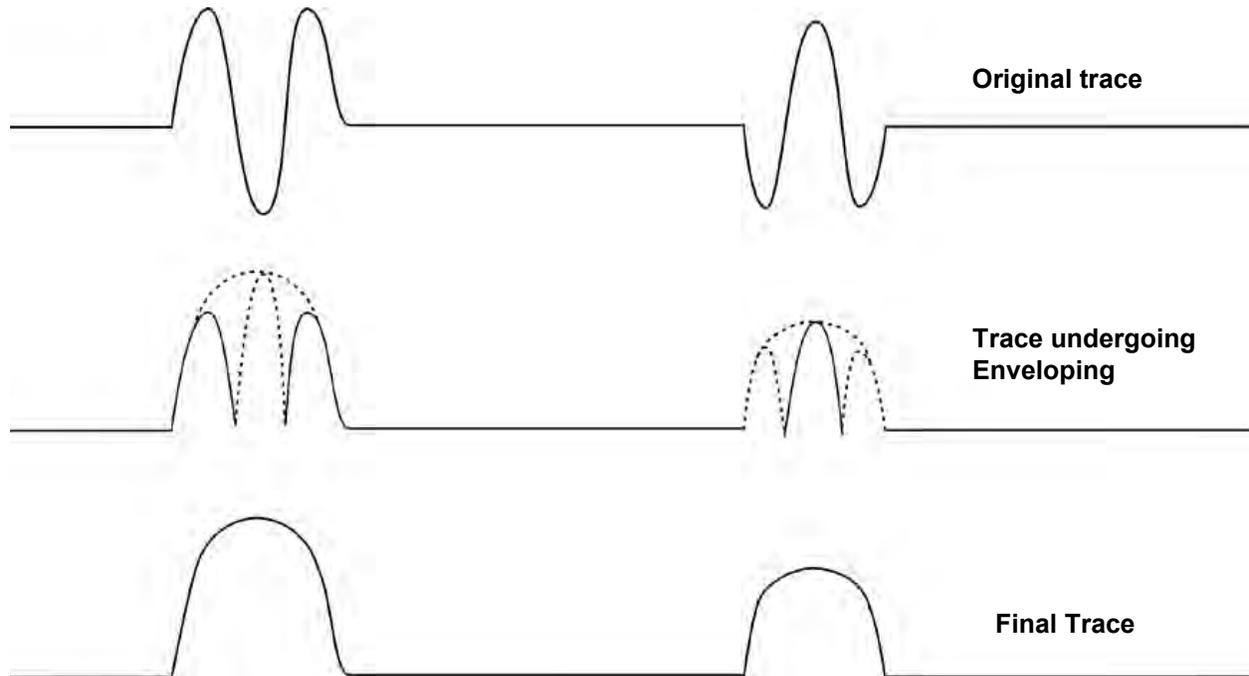
Migration requires an accurate Signal Velocity value. If the velocity value is too low or too high, hyperbolic reflectors will not be focussed back to a point and the target will have fuzzy edges in the depth slice.

Migration defaults to on and is highly recommended for most grid data sets but the user can turn the migration process off by unchecking the checkbox.

Envelope

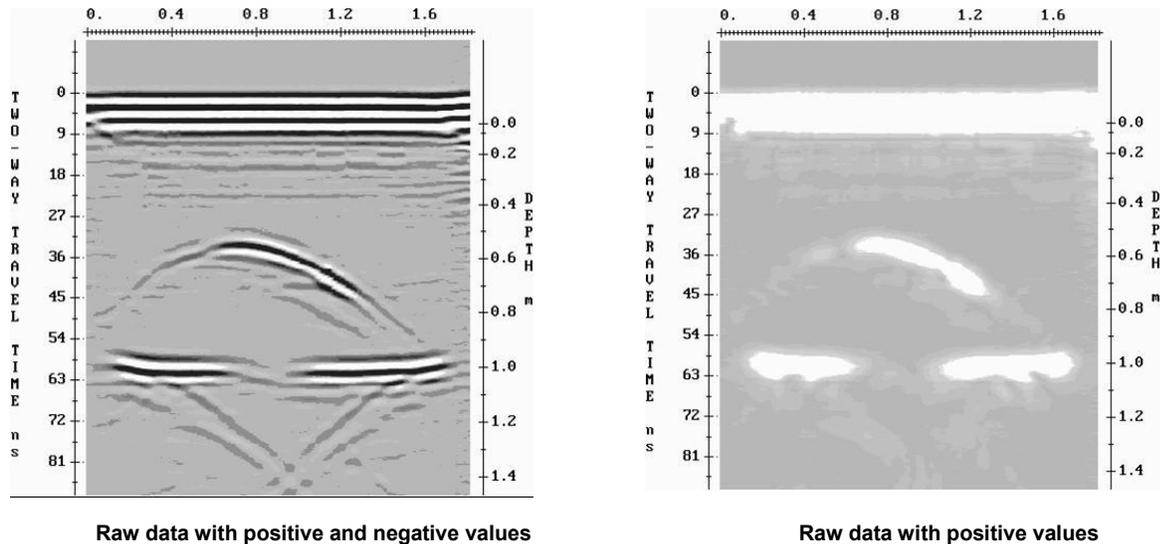
Enveloping a trace converts it from a signal with both positive and negative components to a signal with all positives. The process removes the oscillatory nature of the radar wavelet and shows the data in its true resolution.

In the following graphic, the top image shows the original trace made up of positive and negative components. The middle image show enveloping process turning negative components into positive. The bottom image shows a smooth wavelet outline.



At a single time or depth value, the amplitude value will be similar to the raw amplitude value but is always positive. Average enveloped amplitude is calculated by averaging the amplitude values over a depth or time thickness.

The following graphic shows how the enveloping process replaces the negative signal amplitudes in the raw data with positive values



Enveloping is highly recommended when displaying depth slices. Depth slices are generated by averaging all amplitude values in the thickness range. If enveloping is not done, the positive and negative amplitudes would cancel each other out, resulting in slice images with values close to zero.

If enveloping is turned off, the data retains the negative amplitude values and the color palette becomes bipolar, which means that the colors display positive, negative, or zero amplitude data values.

5.4.1.5.4 PCD Scale

PCD Scale is the setting for the maximum value on the Power Cable Detection (PCD) scale for the PCD slice image. This option is only accessible for Conquest grid data.

Auto automatically sets the PCD scale to the maximum value found in the Conquest grid data. This value is displayed in the Slice Legend (see table in [View](#)).

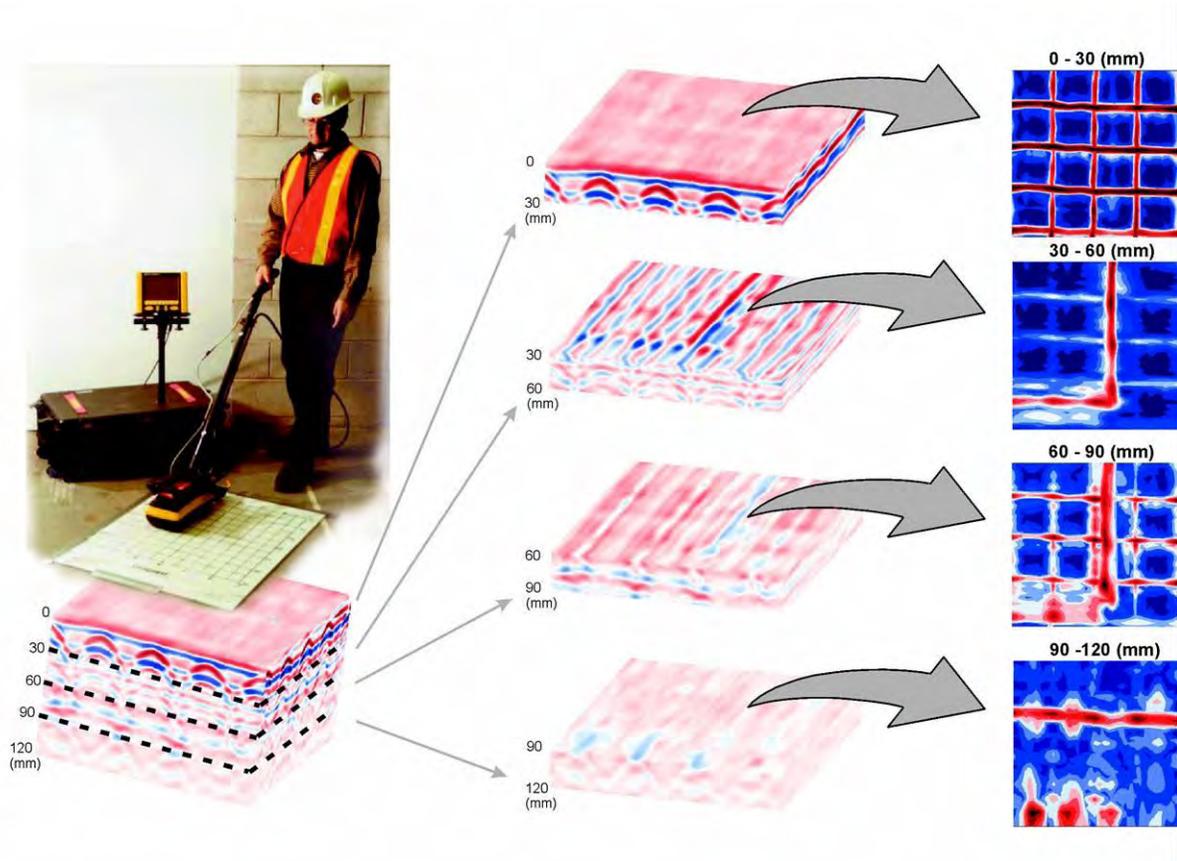
User allows the user to manually set the maximum PCD scale value. This is useful for increasing or decreasing the strength of the response in the PCD slice. This option is also useful to set a single maximum value when displaying PCD slices from multiple Conquest grids in MapView.

5.4.1.5.5 Slice - Thickness

Slice Thickness defines the thickness of the depth slices and is indicated by the slice cursor lines on the slice image (Figure 4) in the GPR Line View.

Depth slices plot the average signal amplitude between two depths or two times. For example, a depth slice with a thickness of 0.5 feet uses the signal amplitudes in 0.5 foot thick 3D slabs and averages those into 2D plan images.

Conceptually, SliceView divides the data volume into slabs of equal thickness and then displays depth slice images of the average amplitude in each slab:



The default thickness value is based on the antenna frequency used for the grid survey. In general, as antenna frequency decreases and wavelength increases, the default depth slice thickness is increased.

The default value in feet is $(1000/\text{frequency}) / 12$.

The default value in meters is $(1000/\text{frequency}) * 0.025$.

Frequency is in MHz For example, the default thickness for 250 MHz data is 0.33 feet or 0.10 meters.

Events with a large depth extent will be seen over several depth slices. In this case it may be possible to increase the thickness of the depth slice and still see the target. Be careful not to make the slice thickness too large, as the averaging process will reduce the amplitude of even very strong reflectors if they are averaged over too large a thickness interval.

5.4.1.5.6 *Slice - Overlap*

Overlap defines the percentage of overlap between depth slices. For example, an overlap of 50% means that each depth slice will overlap the depth slices above and below it by 50%. If the depth slice thickness is one foot, depth slice depth ranges would be 0.0-1.0, 0.5-1.5, 1.0-2.0, and so on.

The default setting is 0% which means there is no overlap between depth slices.

Overlap is useful for seeing a feature gradually appear and disappear as you step through several depth slices.

5.4.1.5.7 *Slice Depth Limit*

Depth Limit specifies the maximum depth of the data used to generate depth slice images. The depth slice depth limit is automatically set to Auto and defaults to the maximum depth in the GPR line data.

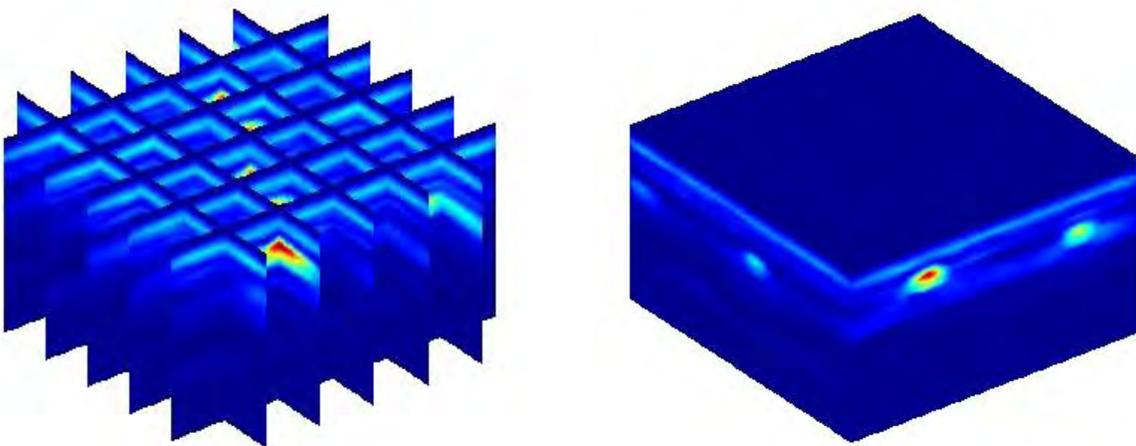
1. To change depth limit, select the **User** option.
2. In the text box, enter a new value that is less than or equal to the maximum depth value.
If you set depth limit higher than the maximum depth, the system ignores it and uses the maximum depth value.

Reducing the depth limit decreases the number of depth slice images. This is useful when the GPR signal depth is significantly less than the maximum depth of the GPR line data. You can set depth limit to the depth of penetration so the depth slice images of the background noise signals toward the bottom of the GPR lines are not generated and displayed.

5.4.1.5.8 *Slice - Interpolation Limit*

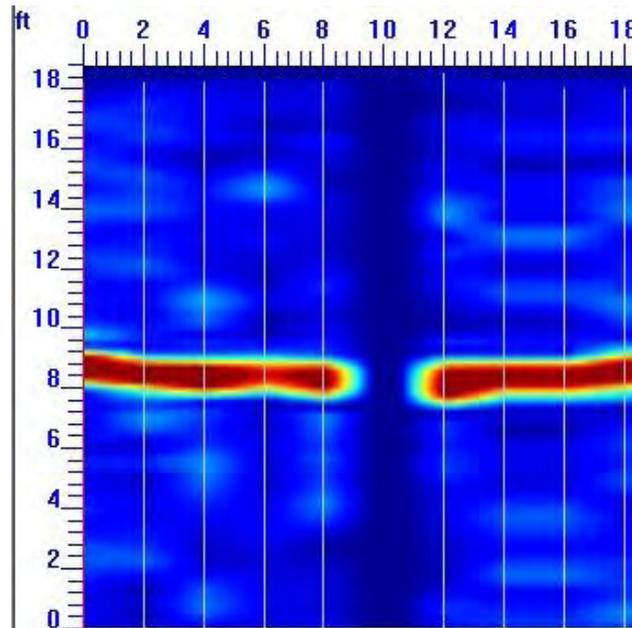
SliceView generates depth slice images by interpolating data into the gaps between GPR lines. As line separation or the distance between GPR lines increases, interpolating data into the gap is less desirable as artifacts may be created in the depth slice.

The following image displays how SliceView interpolates data between GPR lines to generate a solid data set that is then displayed as depth slices.



The Interpolation Limit defines the maximum distance (in meters or feet) that data will be interpolated. If the distance between two GPR lines exceeds this limit, a gap of zero data will be

left between them. The following image displays a depth slice image from a Y line data grid showing a gap with zero data where the line separation exceeded the Interpolation Limit.



This value defaults according to the data set and can usually be left as Auto. The default setting is 1.5 times the average survey line separation.

The User setting allows you to define the interpolation distance.

5.4.1.5.9 Amplitude Equalization Gain

Amplitude Equalization Gain applies a gain to depth slice data to compensate for weaker signals at depth. Use this feature to compare the relative signal strengths of targets in different depth slices.

To add **Gain** to GPR Processing, in the [Settings](#) dialog box, ensure the **Amplitude Equalization Gain** checkbox is checked.

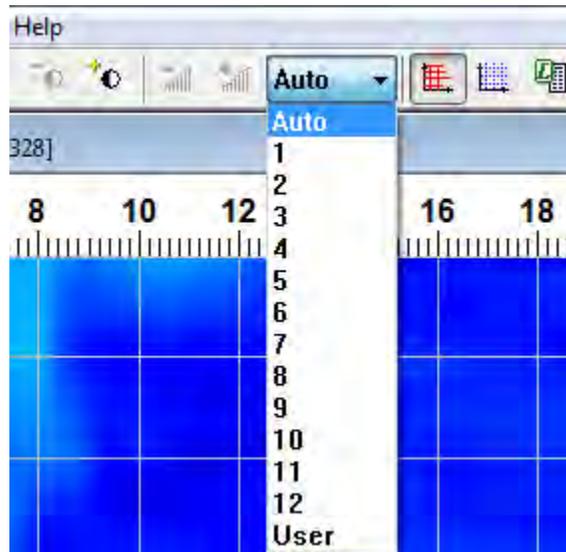
Select the **Auto**, **Level** or **User** option.

Auto uses the average decay curve of the GPR signal strength over time to calculate an appropriate gain parameter values for attenuation, maximum gain and start gain. If the GPR depth slice images are properly gained using the Auto gain setting, use it.

If an **Auto** gain does not gain the GPR line properly, try using the gain **Levels**.

Level uses 12 pre-defined settings for **Start Gain**, **Attenuation** and **Maximum Gain** (see details below) that increase from a low gain at 1 to a high gain value at 12. Typically one of these 12 settings applies a suitable gain to the GPR line. If not, select a gain level that is close and then switch to a **User** and modify the gain parameters (see below) until the gain is the best.

The gain level is changed in this dialog but can also be changed using the Gain Level dropdown list and the Gain Level increase or decrease buttons on the Toolbar.



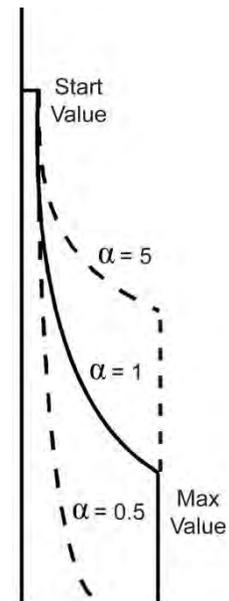
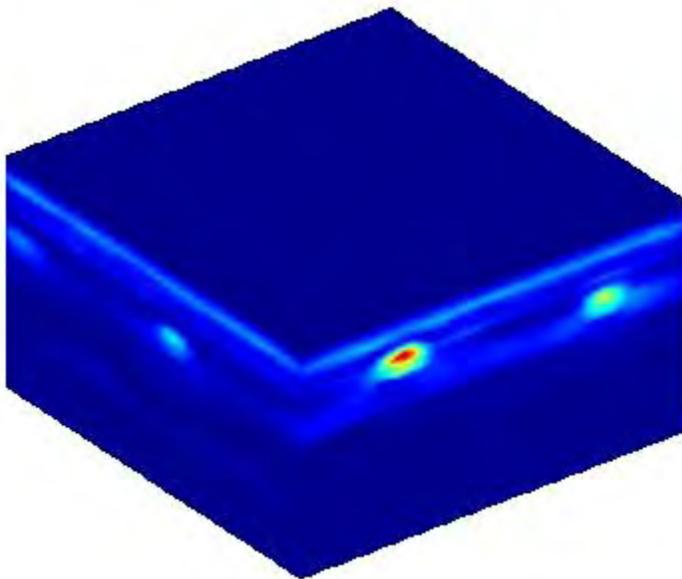
This makes it easy to quickly scroll through several pre-set gain levels and find one that makes the GPR depth slices look the best.

The **User** Amplitude Equalization Gain requires three parameters: [Attenuation](#), [Start Gain](#), and [Maximum Gain](#).

The strongest GPR signals come from shallow targets while deeper targets have weaker signal strength.

The gain applied to GPR data increases with increasing depth.

The following images display applying Amplitude Equalization Gain to grid data. The gain at the shallowest depth slice is set by the Start Gain. The gain increases for deeper slices set by attenuation. If the attenuation value is low, the gain increases slowly with depth. If the attenuation value is high, the gain increases quickly with depth. Gain increases until it reaches the max gain value which is the highest gain applied to the deepest slices.



The Amplitude Equalization Gain setting is only applied to the depth slice image display. Changing the gain setting has no effect on GPR line images.

The current Amplitude Equalization Gain value is displayed in the SliceView Legend.

To turn off Amplitude Equalization Gain, de-select the Amplitude Equalization Gain checkbox. Turning off Amplitude Equalization Gain generates slice images using the raw data amplitudes with no gain applied. It is not advisable to compare the signal amplitudes of targets in different slices.

To set the Amplitude Equalization Gain parameters manually, select the User option.

To set the Amplitude Equalization Gain parameters automatically, select Auto. Auto mode uses the average decay curve of the GPR signal strength over time to calculate appropriate gain parameter values for Attenuation, Maximum Gain, and Start Gain. If the resulting depth slices are not over-gained or under-gained, using Auto Amplitude Equalization Gain is acceptable.

However, Auto does not always gain data properly, especially if the data has strong, high amplitude signals deep in the section. This may result in the attenuation value being too high, resulting in over-gained data and depth slices with too many high amplitude signals which can be confusing for data interpretation. When this occurs with your data, use Auto to set the initial

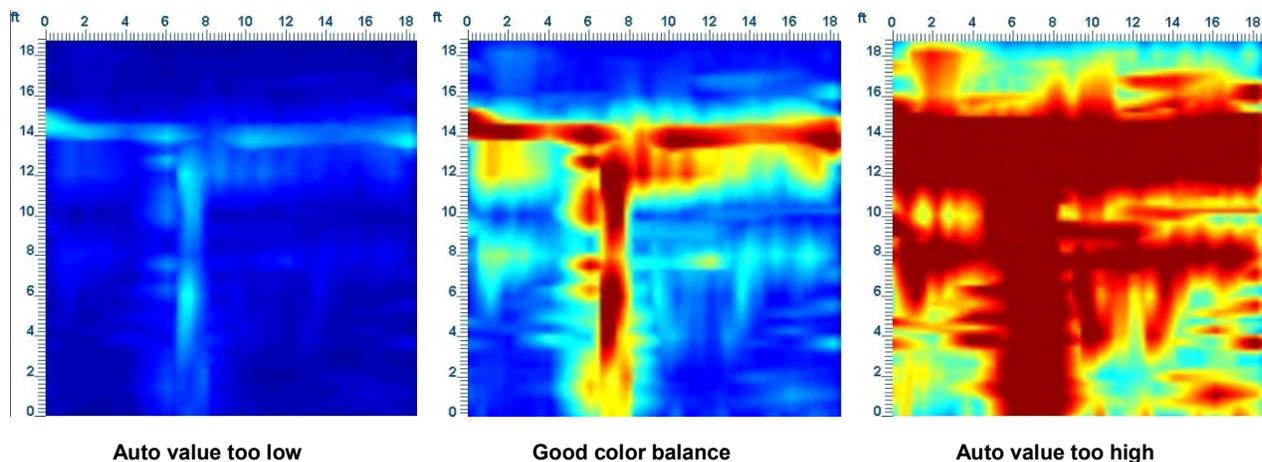
values for the gain parameters and then switch the gain to User and experiment using different values.

Attenuation

The Attenuation value defines the steepness of the gain function. Lower values result in a more gradual slope, while higher values produce steeper slopes. The value slope begins at the [Start Gain](#) value and increases up to the [Maximum Gain](#) value.

Low attenuation values are typically used, but higher values may improve the imaging of deeper targets. Use the lowest value possible because data can be over-gained making it more difficult to understand.

The following images show how Amplitude Equalization applies a gain to the weaker signals at depth. If the Auto value is too low or too high, select the User option and experiment with different values that generate images with a good balance of colors.



Typical attenuation values fall between 0.0 and 20.0, but you can enter any values by selecting the User option and then entering the value into the text box.

The Amplitude Equalization Gain value applies gain to slices in the same way that Attenuation applies gain to GPR lines. Once you find an attenuation value that produces clear GPR line images that aren't over-gained, you can use it as the attenuation value to produce quality depth slice images.

Start Gain

Start Gain is the gain value at zero depth at the top of the GPR line. Typical Start Gain values are 0 or 1; 1 is the default value.

Maximum Gain

Maximum Gain is the highest multiplication factor for the GPR line data. The slope defined by the attenuation stops increasing once it has reached the maximum gain value. Typically values for the Maximum Gain are between 20 and 1000 with 500 being the default value.

5.4.1.6 Defaults

Click **Defaults** to return the Data Processing settings to their default values.

5.4.1.7 Preview

Click **Preview** to display the effect of changes made to the Data Processing Settings before implementing those changes.

5.4.1.8 OK

Click **OK** to close the dialog box and implement any changes made to the Data Processing settings processing the grid survey data and generating slice images. Depending on the changes, processing time may change.

5.4.1.9 Cancel

Click **Cancel** to close the Data Processing dialog box ignoring any changes.

5.4.1.10 Un-processed Data

Select the **Always open this dialog when loading un-processed data** checkbox to automatically open a dialog box so you can confirm that all the data processing settings, especially velocity and the slice thickness, are correct before processing the data.

5.4.2 Hyperbola Velocity Calibration

An accurate target velocity is necessary for generating the clearest depth slice images and accurately determining the depth of an object from the GPR line images.

Hyperbola Velocity Calibration allows you to calculate a velocity value using hyperbola fitting. In hyperbola fitting you fit a typical response curve (hyperbola) to the raw data to in order to extract velocity.

It is important that you only perform hyperbola fitting on target responses where the GPR system has crossed the target perpendicularly. Hyperbola-fitting on a target that was crossed at an angle produces poor velocity values, fuzzy depth slice images, and inaccurate depth measurements.

To access velocity calibration, in the menu bar click **Tool > Hyperbola Velocity Calibration**.

Alternatively, in the toolbar click .

Note: this feature toggles the Hyperbola Velocity Calibration window on and off so it must be clicked again after calibration is completed. If the velocity value has changed, a Yes/No message box appears to confirm that you want to change the velocity value.

5.4.2.1 Velocity Calibration Window

Selecting Hyperbola Velocity Calibration prompts a hyperbola to appear on the GPR line image. If no PR line window is opened, a new one is automatically opened.

The window first displays the current GPR line.

Press [Line Up](#) and [Line Down](#) and [Line Left](#) and [Line Right](#) to move through the GPR lines and display one with a good hyperbola for the velocity calibration.



If necessary, you can change the value to make the hyperbola more visible.

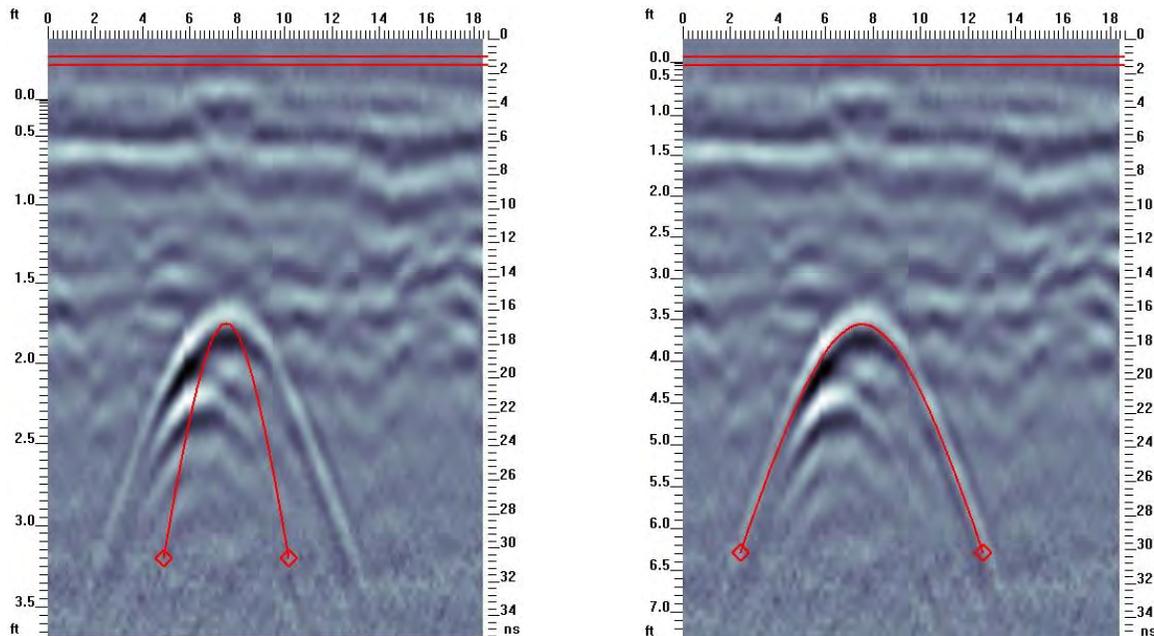
5.4.2.2 Hyperbola Fitting

The objective for hyperbola fitting is to superimpose the hyperbola over the data on top of a hyperbola in the GPR line image and then match the shape by dragging the handles on the end of the hyperbola tails.

To determine velocity, the superimposed hyperbola does not need to be placed at the very top of hyperbola in the image.

1. Select the colored band on the most visible hyperbola that has the longest tails.
2. To move the superimposed hyperbola, click the position on the GPR line image where you want to set the apex (top) of the hyperbola.

The hyperbola automatically jumps to the new position.



3. After the hyperbola has been positioned at the apex of the hyperbola in the GPR line image, match the shape of the hyperbola.
To change the shape of the hyperbola, click the diamond shaped handle on the ends of the hyperbola tails and then drag it to the position that best matches the shape of the image hyperbola.
4. Once the hyperbolas are matched, click **Hyperbola Velocity Calibration** again to exit velocity calibration mode.
5. If the velocity value has changed, in the message box click **Yes** to accept the new velocity value, or **No** to discard the changes.

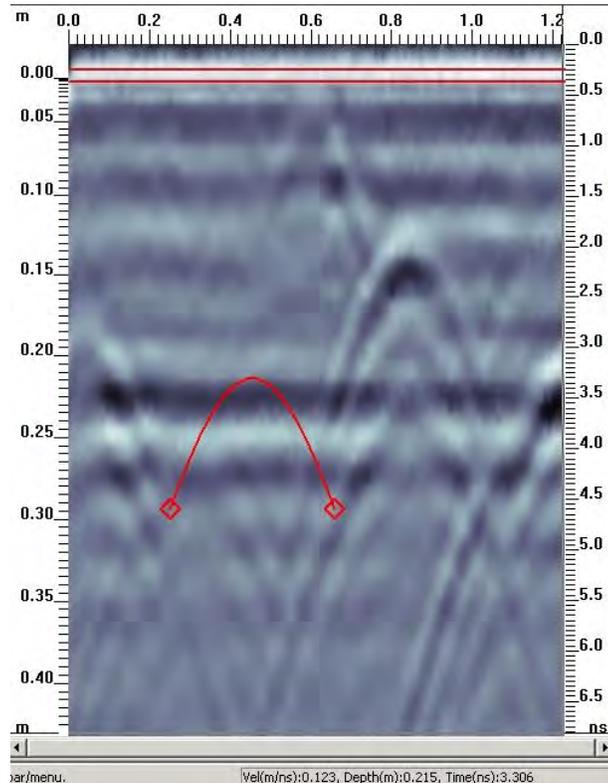
When you accept a new velocity, the grid data is automatically processed using the new velocity. The depth slice images and depth axis in the GPR line window will automatically update.

During the hyperbola velocity calibration, the **Status Bar** along the bottom of the SliceView window displays information including the velocity, depth, and time of the hyperbola. As the hyperbola shape changes, the velocity and depth also change. The depth value is always for the apex (top) of the superimposed hyperbola.

5.4.2.2.1 Target of Known Depth

You can also use Hyperbola Velocity Calibration to determine velocity using a target at a known depth.

1. For a target at a known depth, such as the one in the following image, the known thickness of a concrete slab, place the apex of the hyperbola on the reflection of the target.
2. Adjust the velocity by dragging the hyperbola handles until the depth value listed at the bottom of the screen matches the known depth.

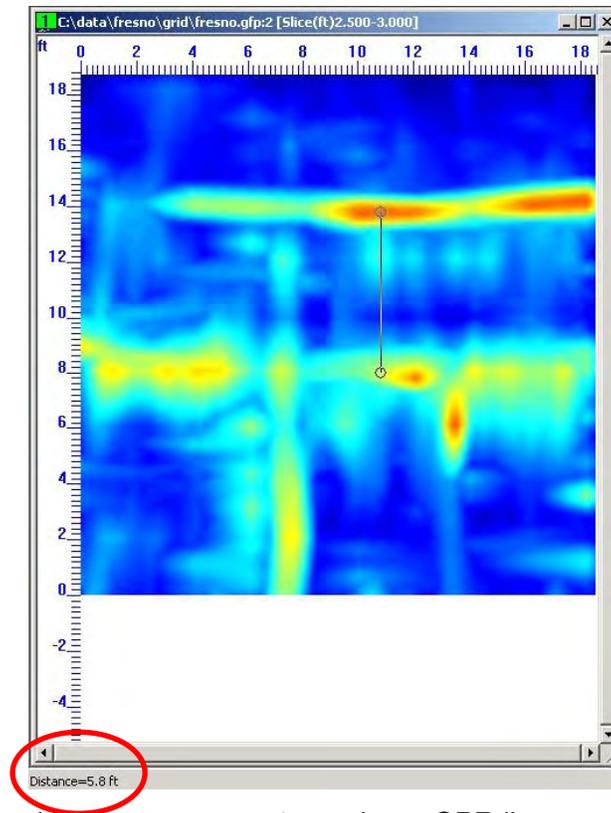


For example, if the reflection from the bottom of concrete is visible in the GPR line image, and the depth of the concrete is known, the apex of the hyperbola can be positioned on that reflection and the velocity changed until the depth value displayed on the bottom of the window matches the known depth.

5.4.2.3 Measure

Use the measure tool to measure the straight-line distance between any two points on a depth slice or GPR line image.

1. To access the Measure tool, in the menu bar, click **Tool > Measure**.
2. To measure the distance between two points, click the start position.
3. Drag and drop the cursor at the end position.
The distance between the two points (in the current units) is displayed on the Status Bar at the bottom of the screen.



It is important to understand that measurements made on GPR lines are based on the velocity so an accurate velocity is critical for an accurate measurement.

To exit from the Measure tool, click Toggle Measure Tool.

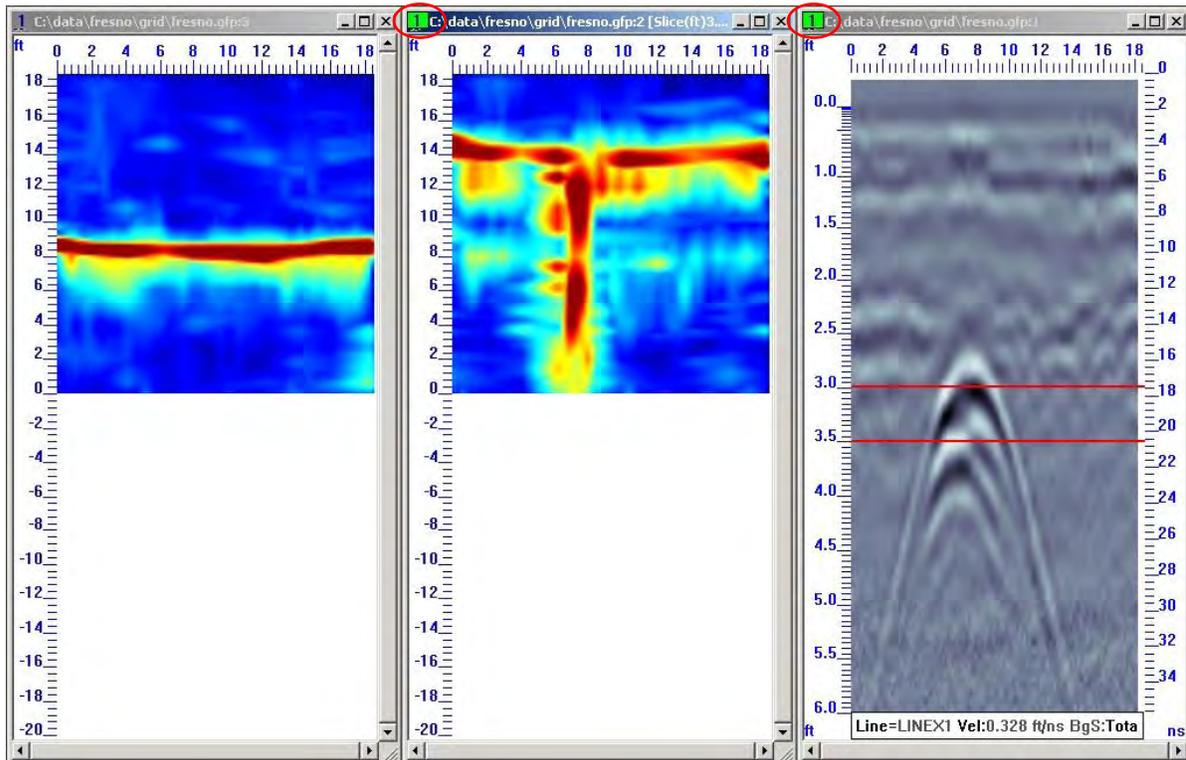
5.5 Window

5.5.1 New Plan View Window

In the menu bar, click **Window > New Window** to open another instance (window) of the current Depth Slice View window.

This is useful when looking at different slice views at the same time.

Windows display a green number on the left side of the title banner to indicate which data set they belong to. For example, all the windows associated with the first GFP file opened will have a number 1 in the banner, and all windows associated with the second GFP file opened will have a number 2 in the banner, and so on.



When multiple plan view windows open, only one can be active at one time. However, changing some variables, such as data processing parameters, velocity, slice thickness, and color palette, change the value for all plan view window instances. Other variables, such as Show Collected Lines, Show Scale, Show Scale Grid, Show Legend, and Show Slice only apply to the active window.

5.5.2 New GPR Line Window

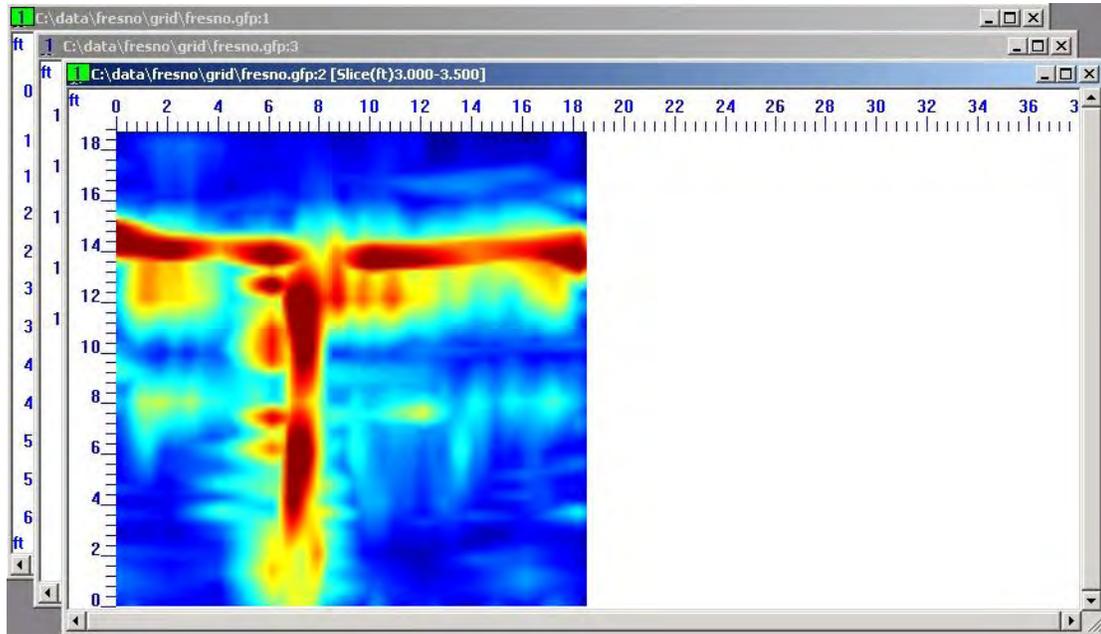
Use this feature when you are looking to display different GPR line images at the same time.

Click **Window > New GPR line Window** to open a GPR line window for the current grid survey.

Windows display a green number on the left side of the title banner to indicate which data set they belong to.

5.5.3 Cascade

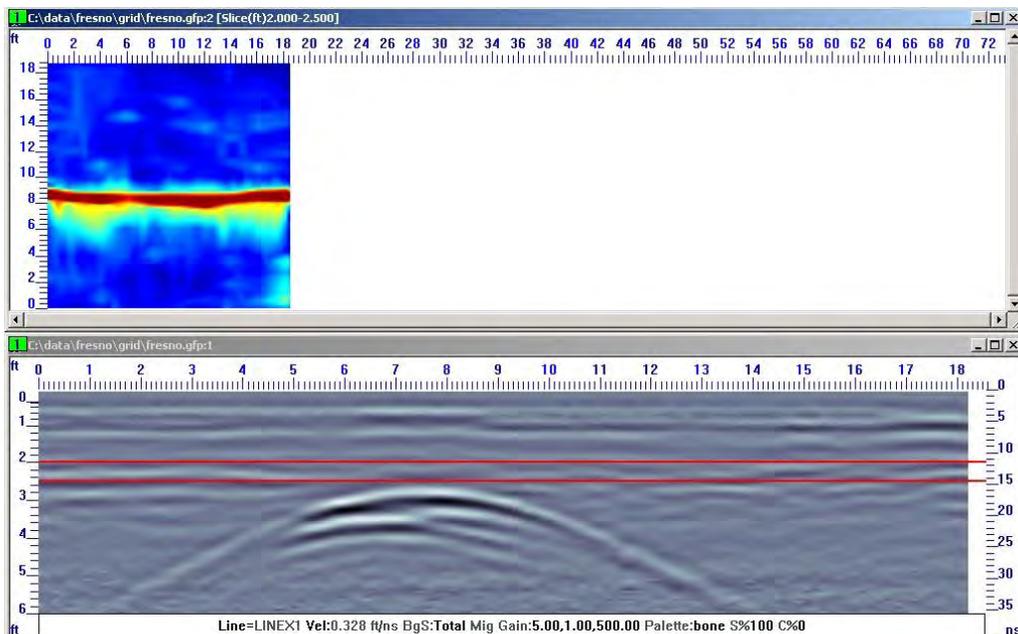
Click **Window > Cascade** to open windows to cascade on the screen, that is, the front section is completely visible and the title lines from the other sections are visible and accessible.



5.5.4 Tile Horizontally

In the menu bar click **Window > Tile Horizontally** to display all open windows so they are tiled horizontally.

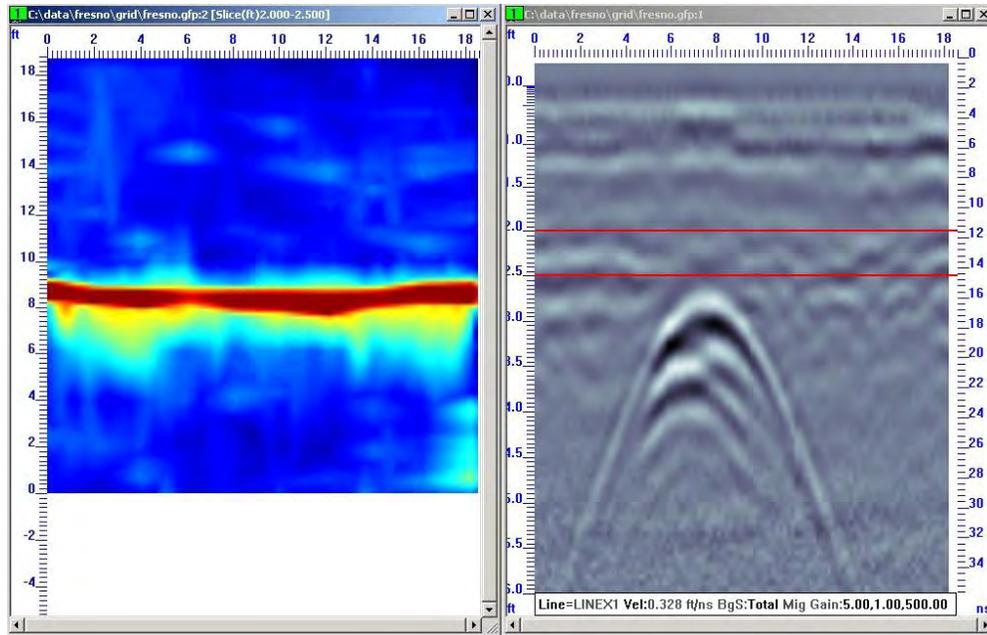
Alternatively, in the [toolbar](#) click .



5.5.5 Tile Vertically

In the menu bar, click **Window > Tile** to display all open windows so they are tiled vertically.

Alternatively, in the [toolbar](#) click .



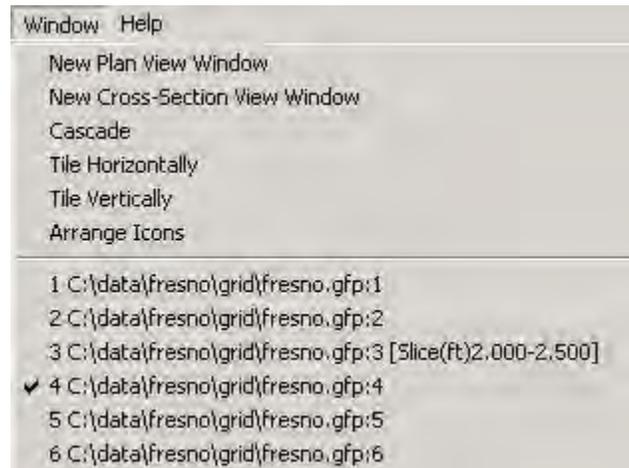
5.5.6 Arrange Icons

Click **Window > Arrange Icons** to change the order of all icons (minimized windows).



5.5.7 Selecting an Open Window

Click **Window** to display a list of all the currently open windows



A checkmarks indicates the active window. To change the active window, in the list, click another window.

5.6 Help

5.6.1 Contents

Click **Help > Contents** to open the SliceView User's Guide.

5.6.2 Sensors & Software Contact Information

Displays contact information for Sensors & Software including mailing address, email addresses, phone, and fax numbers.

5.6.3 About SliceView

This option displays a description, version number, and product number of SliceView.

Appendix A GFP_Edit

Use GFP_Edit to edit a grid or change the relationship between project and global coordinates. To edit a grid, export it from EKKO_Project, and then edit it with GFP_Edit. Once editing is complete, import the edited grid back into the project.

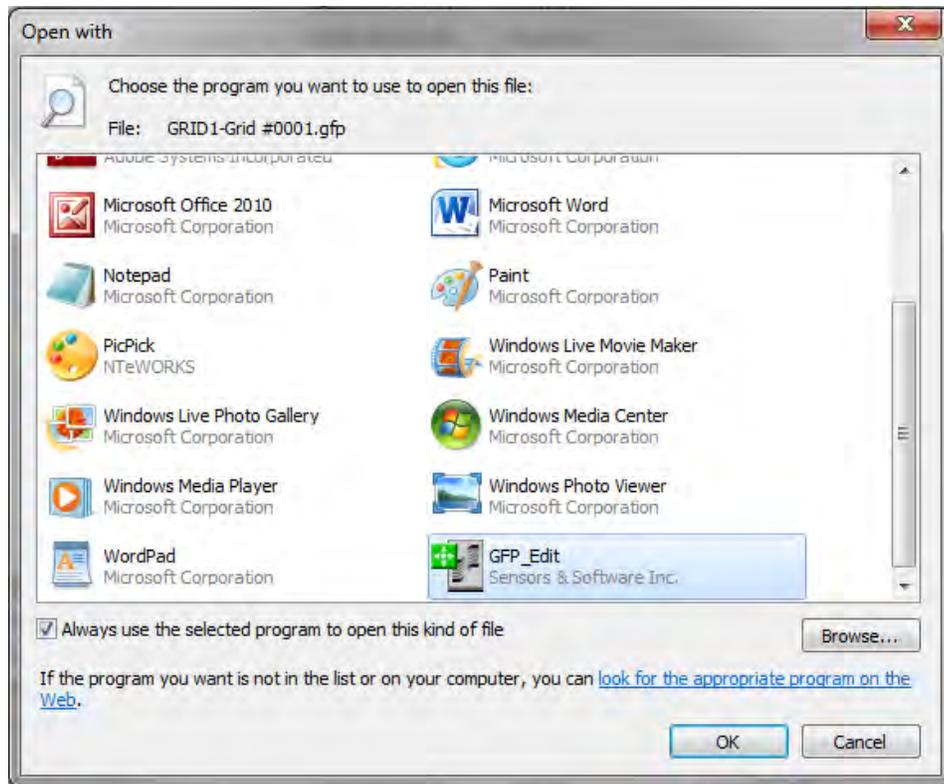
Before you can edit a grid, install GFP_Edit on your computer.

Exporting Grids to GFP_Edit

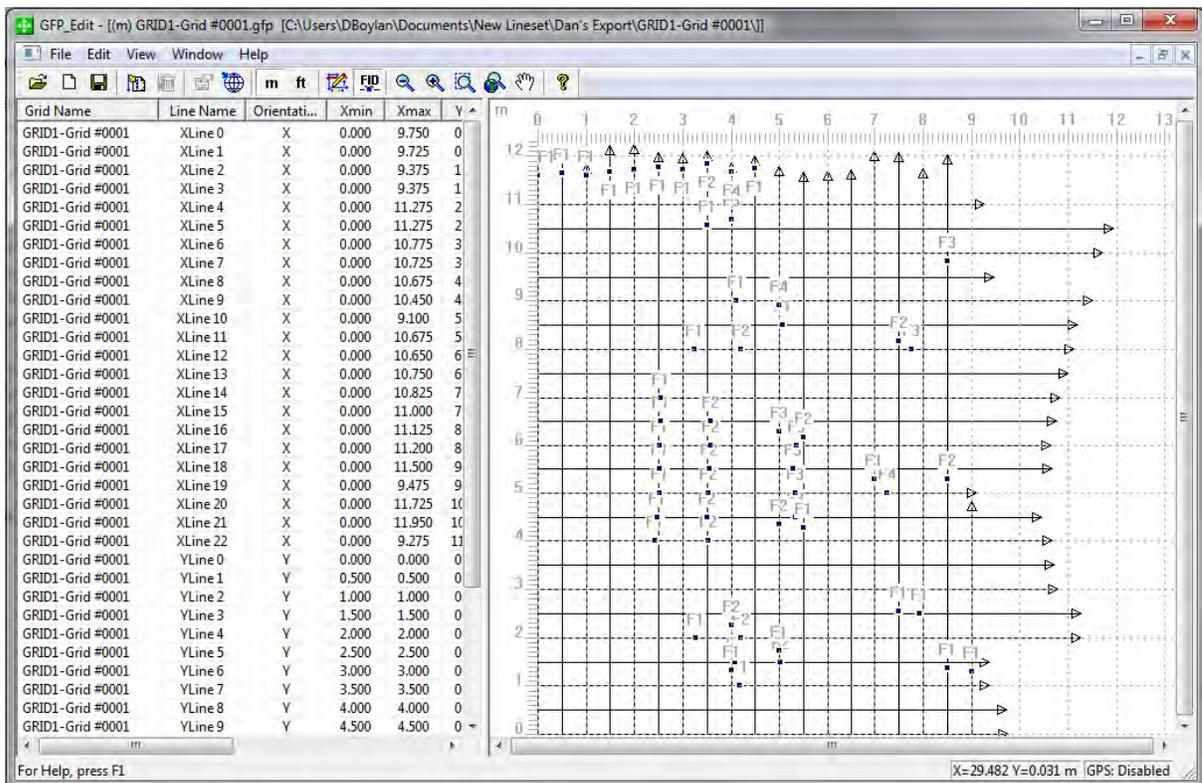
1. In the Project Explorer, select the grid you want to export.
2. In the menu bar, click **File > Export Line(s) > Line Data**.
3. In the **Select folder to export to** dialog box, navigate to the folder you want to export to.
 - a. To create an export folder, right-click in the display pane and create a new folder.
 - b. Select the folder
 - c. Click **Select Folder**.

Editing Grids in GFP_Edit

1. In Windows Explorer, click the exported grid.
2. In the folder, right-click the .gfp file  GRID1-Grid #0001.gfp
3. In the drop-down list, click **Open with**.
4. In the open with dialog box, click **GFP_Edit**.
 - a. If GFP_Edit is not listed, click **Browse**.
 - b. In the **Open with** dialog box, navigate to Sensors & Software folder.
 - c. Click  GFP_Edit V4 R1.1
 - d. Click  GFP_Edit V4 R1.1
 - e. Click  GFP_Edit 4.exe



- Click **OK**.
Edit the grid in GFP_Edit.



- Save your GFP file.

7. To Import the gfp file as a new grid to EKKO_Project, in EKKO_Project, click **Add Grid**.
8. In the **Open** dialog box, select the edited gfp file.
9. Click **Open**.
The new grid is displayed in Project Explorer
10. Right-click the new grid.
11. In the drop-down list click SliceView.
The new grid is displayed in SliceView.

Appendix B Glossary

| Term or Phrase | Definition |
|---|---|
| 3D View | Displaying depth or time slices and selected cross sections through a volume. Enables 3D visualization of grid survey data. |
| Amplitude Depth / Time Equalization | Equalizing the average amplitudes in all depth/time slices so that equivalent features in slices from different depths/times appear to have the similar amplitude in the generated image. |
| Attribute | Characteristic derived from original data. For example, the average amplitude of the dominant frequency between two times or depths. |
| Color Palette | The color palette or color table that converts a data attribute like amplitude into color in the creation of depth or time slice images and section views. |
| GPR line Image | When profiling data is displayed as a computer generated image, showing signal amplitude varying in time or depth versus position along the line. Often shortened to GPR line or section. |
| Cross Section Maximum Slice Depth Multiplier | Multiplication factor used to set the maximum depth displayed on the GPR line view. Maximum depth displayed is this factor multiplied by the Max Depth Limit specified in the slice processing. Shortened to Max Slice Depth Multiplier, |
| Depth Gain | Depth Gain: is a display gain applied that varies with depth along a trace. |
| Depth or Depth-Section Image: | Profiling data is displayed as a GPR line with the vertical depth scale. Often shortened to depth-section or section. |
| Depth Slice | Describes a data attribute derived from data between two depths - top of depth slice and bottom of depth slice. Most often a grid survey has the depth range from 0 to the maximum depth subdivided into a number of depth slices of equal thicknesses. |
| Depth Slice Image | Describes a depth slice when the slice attribute is displayed as a computer generated image. Normally be shortened to depth slice. |
| Gain | When displaying cross sections formed from traces, a display control is often needed to allow strong responses from shallow targets to be viewed at the same time as weaker responses from deep targets. Gain is applied to weak signals to make them larger. |
| GFP File | An XML format computer file which provides information on multiple files of data and enables a Sensors & Software program to automatically read and process the data to final form. |
| Grid | Describes a square or rectilinear set of straight lines covering an area. Acquiring data on a grid means acquiring data along each line forming the grid. Acquiring data on a grid is a pre-requisite for creating depth or time slice images. Conventional notation is to use a Cartesian coordinate system with X and Y axes. |
| Grid Resolution | Describes the XY spatial resolution attained in a grid and is controlled by the largest line or trace spacing. |
| Grid Size | Describes the real extent of a grid (e.g. 5m x 10m, 20ft x 50ft.). |

| Term or Phrase | Definition |
|---------------------------------------|--|
| Grid Survey | Describes the process of acquiring data on a grid over an area with the goal of creating depth or time slice images. |
| Hyperbolic Fitting | Fitting a hyperbolic shape to a local GPR response in the space-time domain. The fitting process yields a velocity above target and a depth estimate. |
| Hyperbolic Velocity Estimate | A point source GPR reflection appears as a hyperbola in the GPR line Image. Hyperbolic fitting enables the media velocity and target depth to be estimated. |
| Image Contrast | How much of image is at extremes of Color Palette. Effectively the Color Palette increases the area of extremes of data signal. Given as 0-100%, with default of 0% (no added contrast). |
| Image Sensitivity | How sensitive the image is to small signal variations. Effectively the Color Palette widens around the zero signal level. Given as 0-100%, with default being 100% (most sensitive) |
| Interpolation Limit | The maximum separation between lines when interpolating Slice data. Parallel Lines separated by more than the limit will result in an area on the Slice between the Lines with no GPR signal.(zero amplitude). |
| Line | Identifies the location of data acquisition. A line is normally straight and data are recorded from the start to the end of the line. |
| Line Name/Number | The identifier for a line of data saved when surveying along a line. (e.g. XL0010.DT1) |
| Line Profiling | Describes collecting data along one or more lines for immediate site assessment using PR line images. A series of lines can be used to help define site conditions prior to a grid survey. |
| Line Spacing Conversion Factor | Importing X or Y Lines, the position of the line on the grid area is determined using the Conversion Factor. If the Line name has a number N, the position is N* Factor. If the Line name does not have a number, a Line Spacing of Factor is used. I.e. XLine010, with a factor of 0.5 m, would be placed 10*0.5=2 meters from origin along Y axis. |
| Maximum Depth | Describes the maximum depth selected for viewing, processing, or data acquisition along a line. |
| Maximum Time | Describes the maximum time selected for viewing, processing or data acquisition along a line. |
| MultiSlice or MultiSlice View | Term used when displaying a number of contiguous depth or time slice images which, when viewed together, enable the user to view a complete volume described by the grid area and the maximum depth or maximum time. |
| Plan View | Window that displays a plan view of the surveyed area. The depth/time slices, line location map, and surface images (future development) are all displayed as layers, possibly overlaid, (e.g. line locations over depth slice image) within this window. |
| Slice Image Resolution | The spacing (m or ft.) between the regularized grid data points in the XY plane for the processed and interpolated slice attribute data. This is the parameter that determines the spatial resolution in the depth/time slice images. |
| Slice Overlap | Overlap (% of slice thickness) between the adjacent depth/time slices. |
| Slice Thickness | Thickness (m or ft.) of the time/depth slice. |

| Term or Phrase | Definition |
|-----------------------------------|--|
| Time Slice | Describes the data acquired between two times - top of time slice and bottom of time slice. Most often a grid survey has the maximum time subdivided into a number of time slices of equal thicknesses. |
| Time Slice Image | Describes a time slice when the slice attribute is displayed as a computer generated image. This term will normally be shortened to time slice. |
| Time or Time-Section Image | Term used when line profiling data are displayed as GPR line with the vertical time scale. Quite often the term is shortened to time-section or section. |
| Time Window | same as Maximum Time |
| Velocity | Term used to characterize the speed at which GPR signals travel. Velocity is a critical parameter when creating depth slice images and estimating depths of targets since velocity is used to convert travel-time to depth. |
| X Line | A line oriented in the X direction. (Y = constant while X position varies). |
| X Line Spacing | Refers to the spacing between X lines when a grid is covered by equi-spaced X lines. |
| X Slice | Time or depth slice image created from X lines in a grid. |
| X Y Axes | X and Y are the names given to the two orthogonal directions of a grid. When positioned at the specific corner of the grid which is selected to be the origin of the coordinate system and facing diagonally across the grid, the positive X direction runs to the right along the edge of the grid and the positive Y direction runs off to the left. |
| X Y Slice | Time or depth slice image created from combining both X and Y lines in a grid. |
| Y Line | A line oriented in the Y direction. (X = constant while Y position varies). |
| Y Line Spacing | Refers to the spacing between Y lines when a grid is covered by equi-spaced Y lines. |
| Y Slice | Time or depth slice image created from Y lines in a grid. |