EKKO_Project
SliceView Module

User's Guide

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Table of Contents

1 Introduction

Ground Penetrating Radar (GPR) data is often presented as two-dimensional cross-sections of the subsurface. Interpreting data from GPR line cross-sectional images can be confusing and labor intensive.

In areas where GPR data has been collected over an area, either by collecting the data in an organized XY grid or by walking back and forth and covering the area in a semi-random path, processing and displaying the data as a series of map images, called depth slices, is a very intuitive way of interpreting data.

The SliceView module generates depth slices that 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.

The SliceView module consists of two parts, SliceView-Grid and SliceView-Lines that process the GPR data depending on how it was collected.

Use SliceView-Grid to generate depth slices from GPR data collected in an XY grid. Here is a plot of grid data displayed in the MapView window of EKKO_Project:
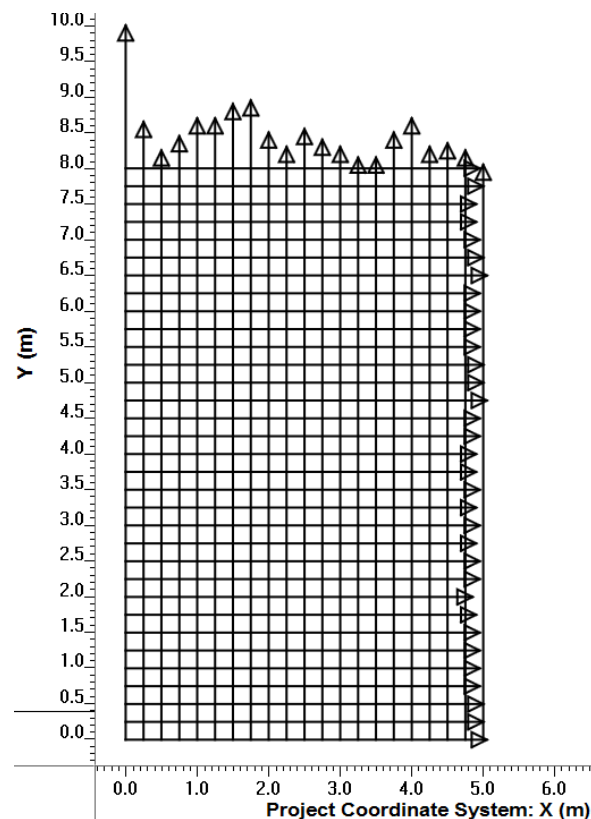
GPR data collected as an XY grid is processed using SliceView-Grid

Use SliceView-Lines to generate depth slices from GPR data collected in a semi-random path to cover the area. The data must have GPS or some other method to position the line(s) in 2D space. Here are two examples plotted in the MapView window in EKKO_Project:
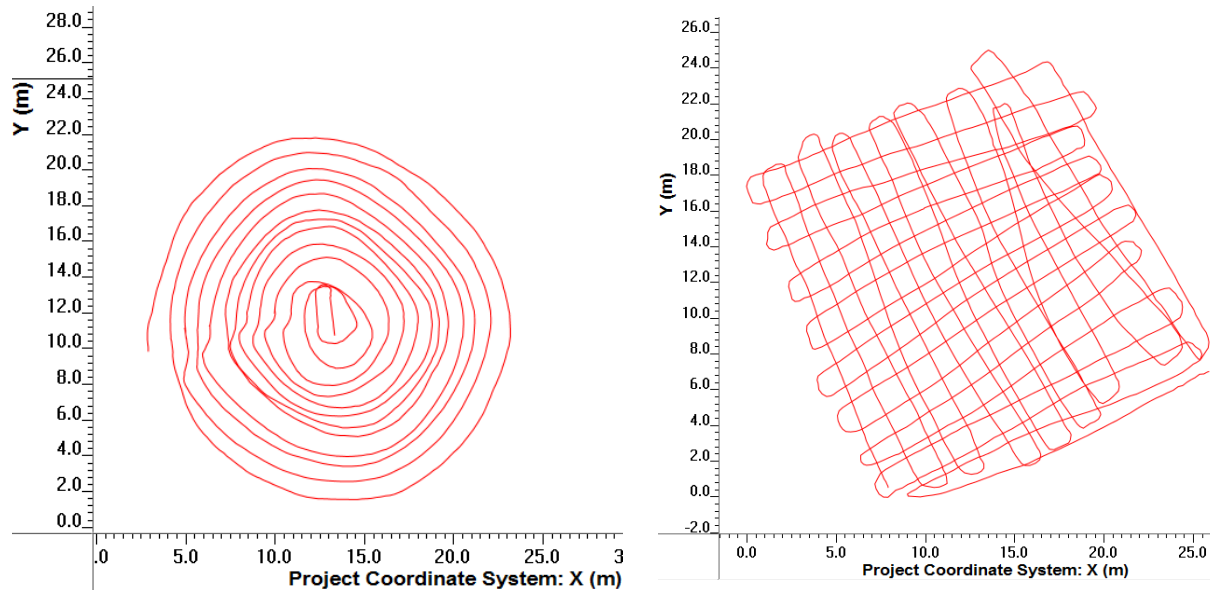
Data collected in a semi-random path to cover the area of interest is processed using SliceView-Lines

Use SliceView to:

- Analyze data by viewing depth slices at increasing depths
- Reprocess data using a different velocity
- Save data images to graphic image files to include in reports
- Extract the local project (XY) positions or global (GPS) positions of targets and write them to reports.

In addition, SliceView-Grids also:

- Displays grid data collected with GPS depth slices on Google Earth
- Exports grid data to 3D data files and 3D visualization software (available from Sensors & Software)

2 Opening SliceView-Grid

SliceView is an optional module of the EKKO_Project software. To access SliceView-Grid, you must first open EKKO_Project.

SliceView-Grid only works with project files containing grids.

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.

In the **Getting Started** dialog box, click ➜ Browse for Project File...

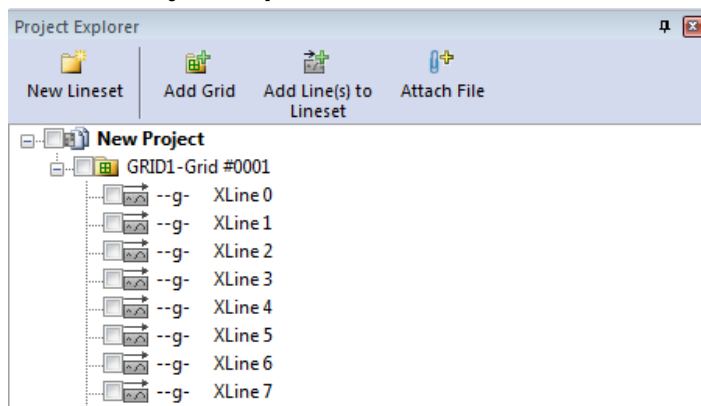Alternatively, click➜ Add Grid to create a new project with a grid or grids.
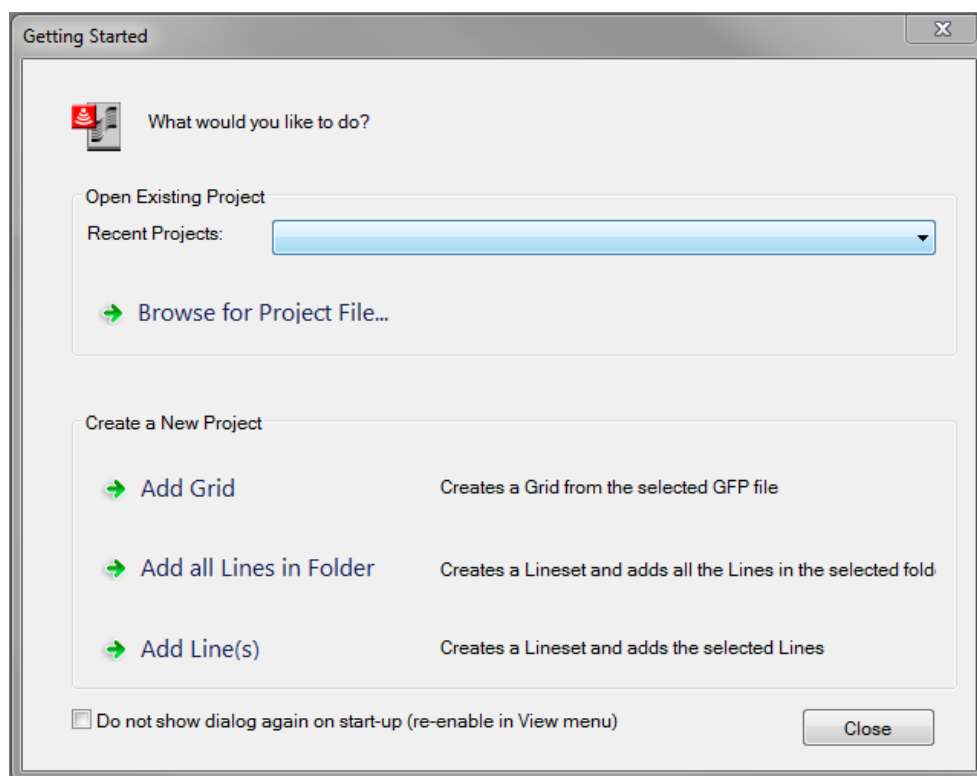
In the **Open** dialog box, navigate to and then select a grid or project file.

> **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.

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.

In **Project Explorer**, select a grid.

In the EKKO_Project menu bar, click **Tools > SliceView-Grid**.

Alternatively, right-click in the Project Explorer window and click SliceView-Grid.
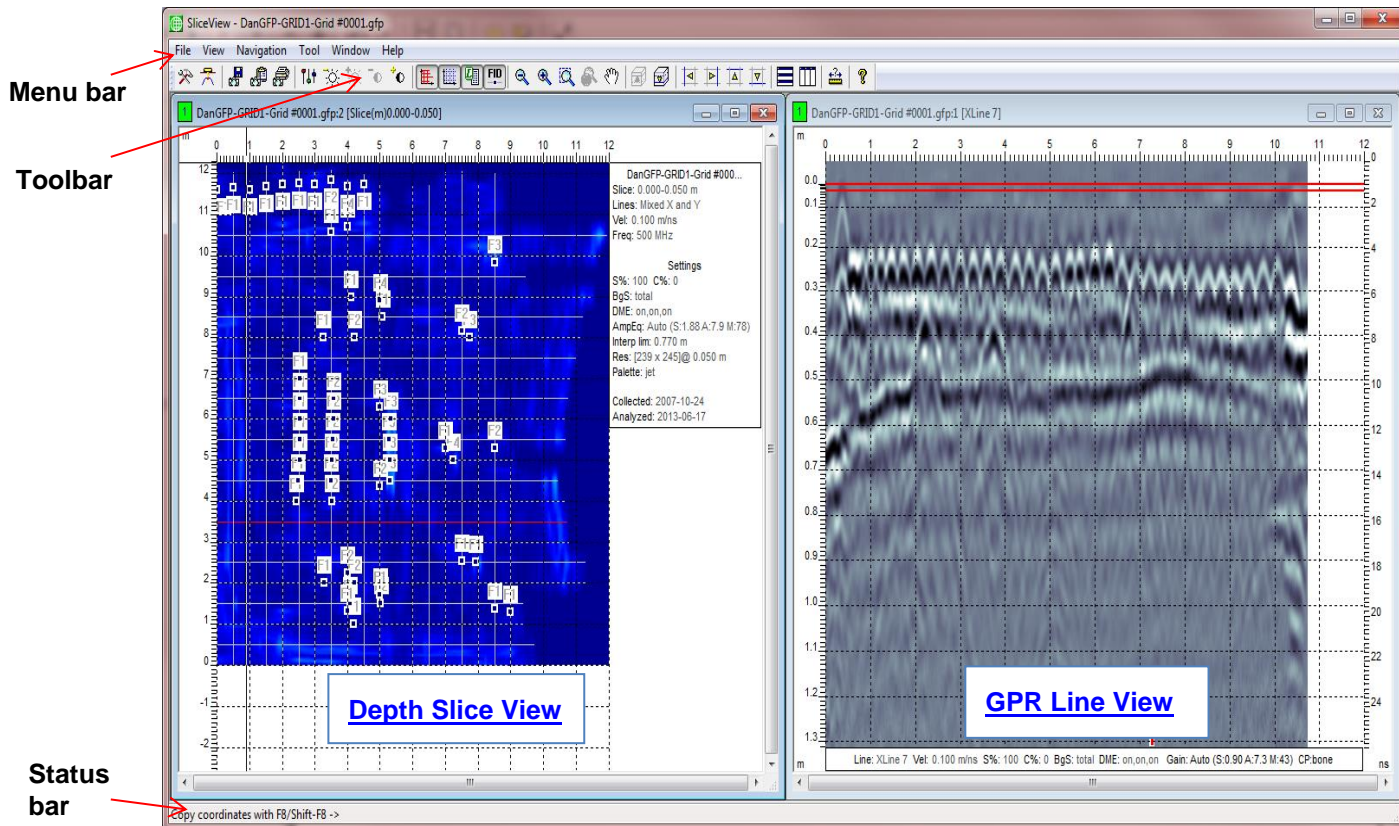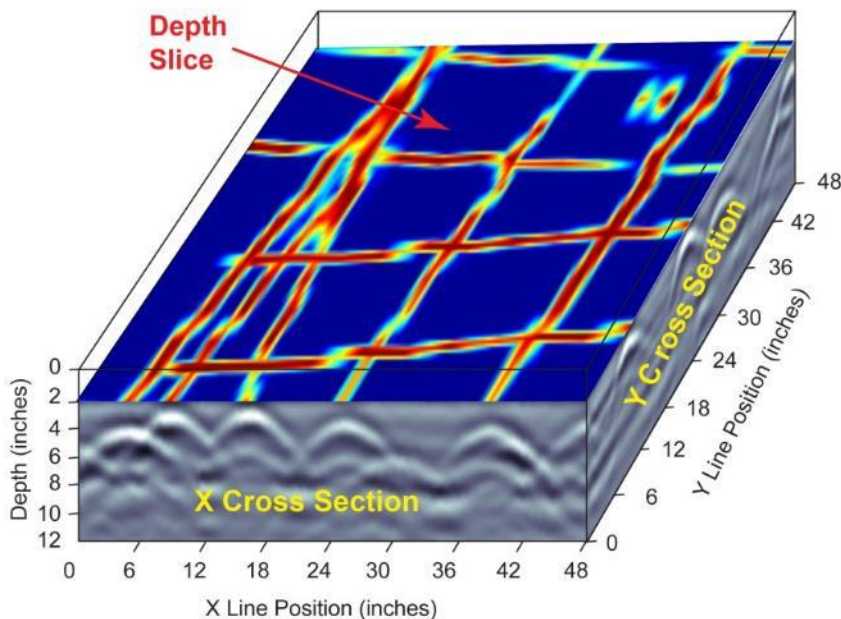
The SliceView-Grid window opens:

Figure 1: The SliceView-Grid window.

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

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.

Use the following table as a guide to working with the SliceView-Grid window:

Item	Description
Menu bar	Most SliceView-Grid operations can be performed through the menu bar. To learn more, see the menu bar.
Toolbar	Most SliceView-Grid 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-Grid 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

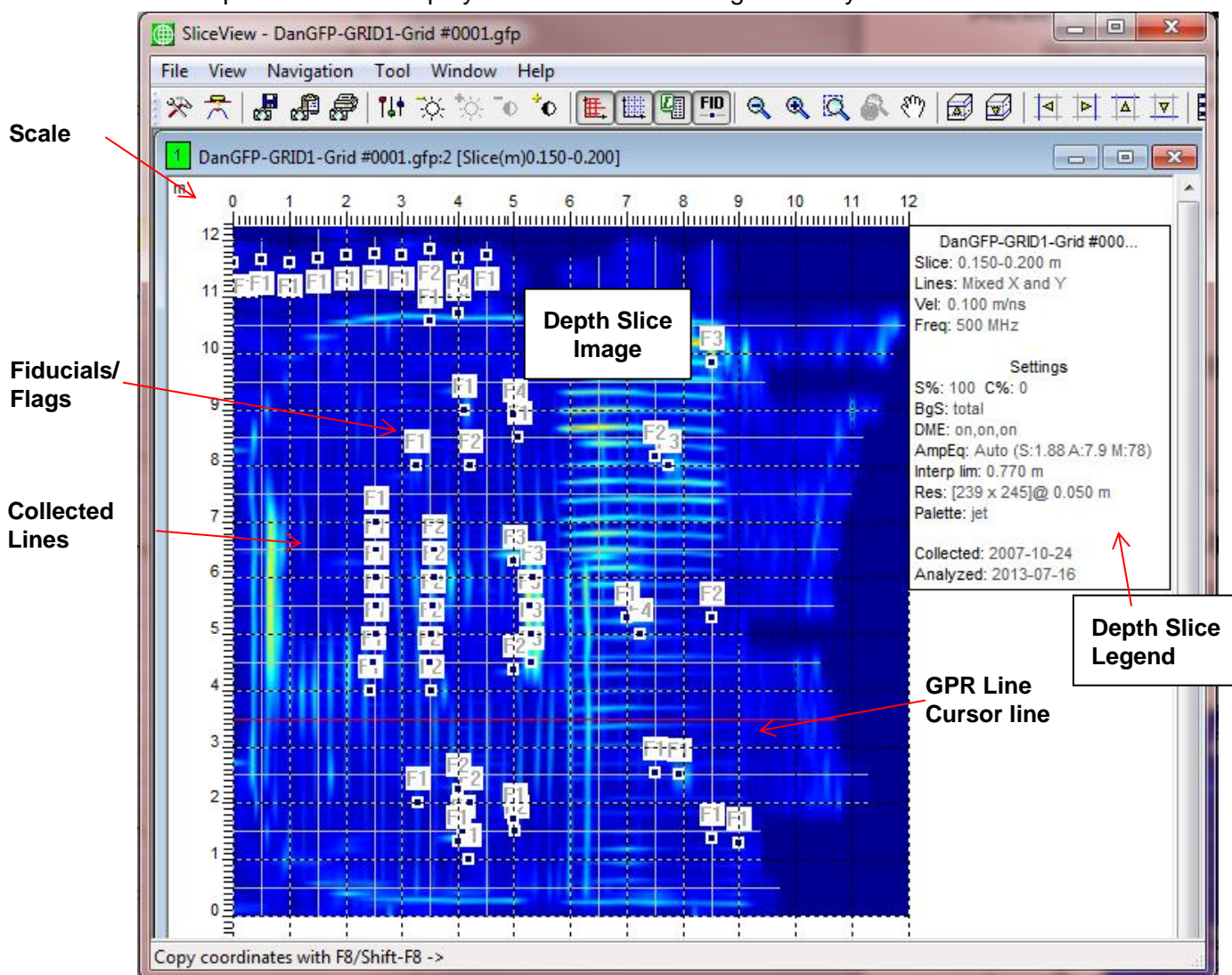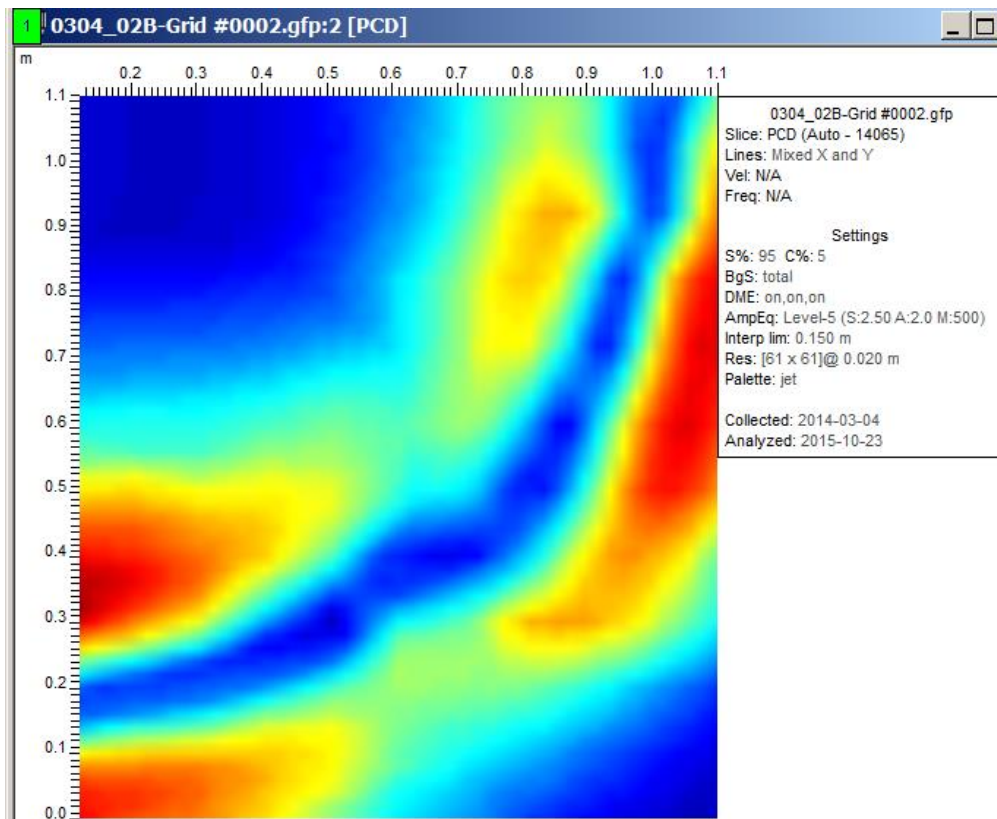The Depth Slice View displays slices of the current grid survey data.

Figure 2: Depth SliceView

The slice images currently supported in SliceView-Grid 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.
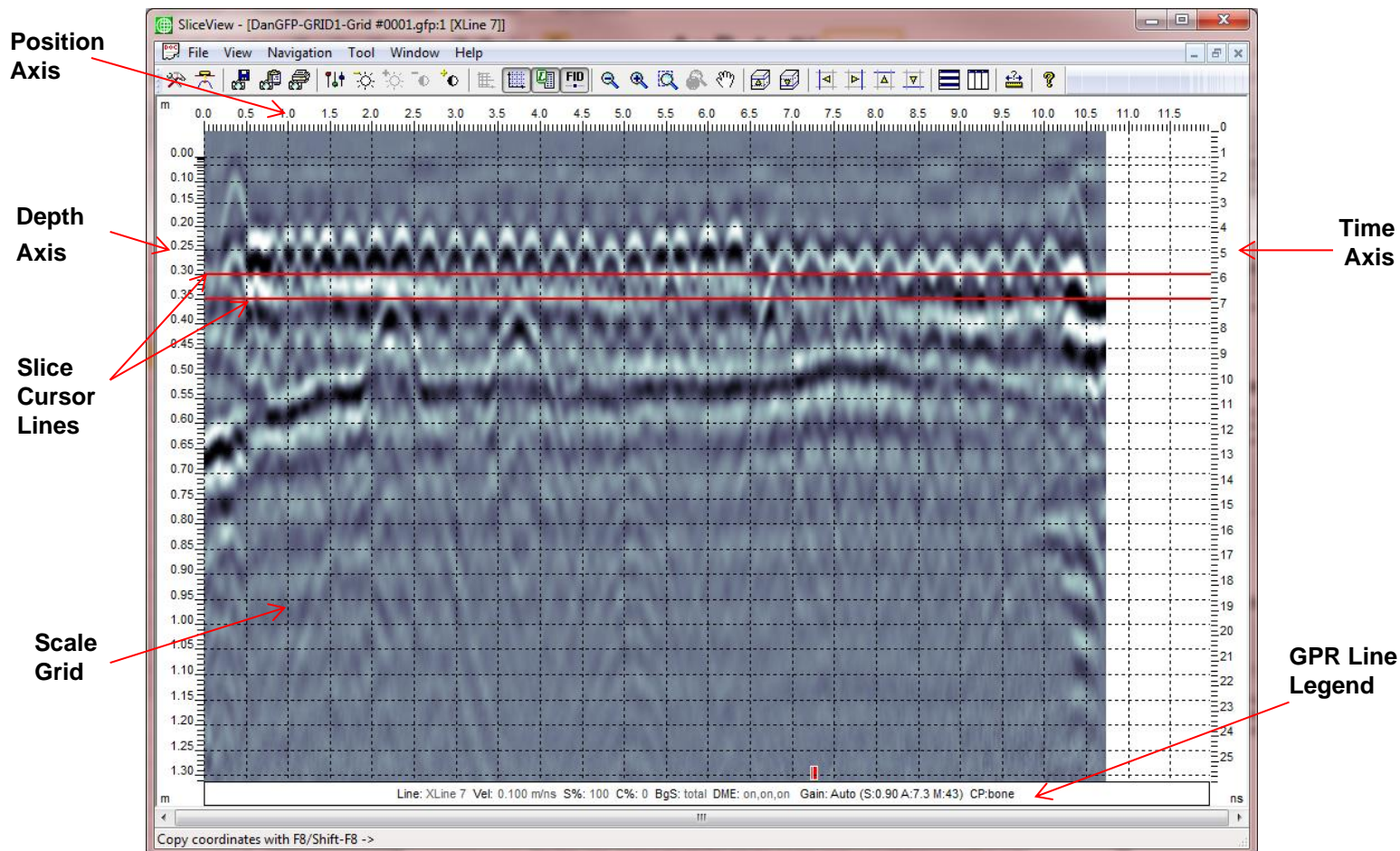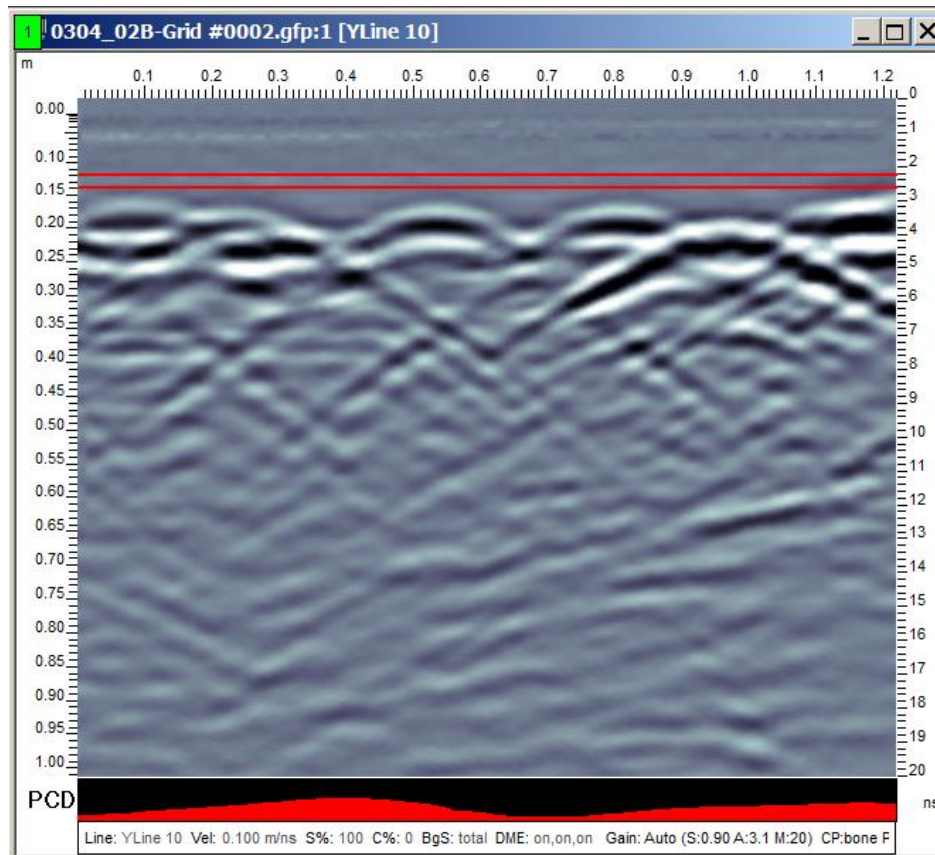

Figure 3: GPR Line View

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.
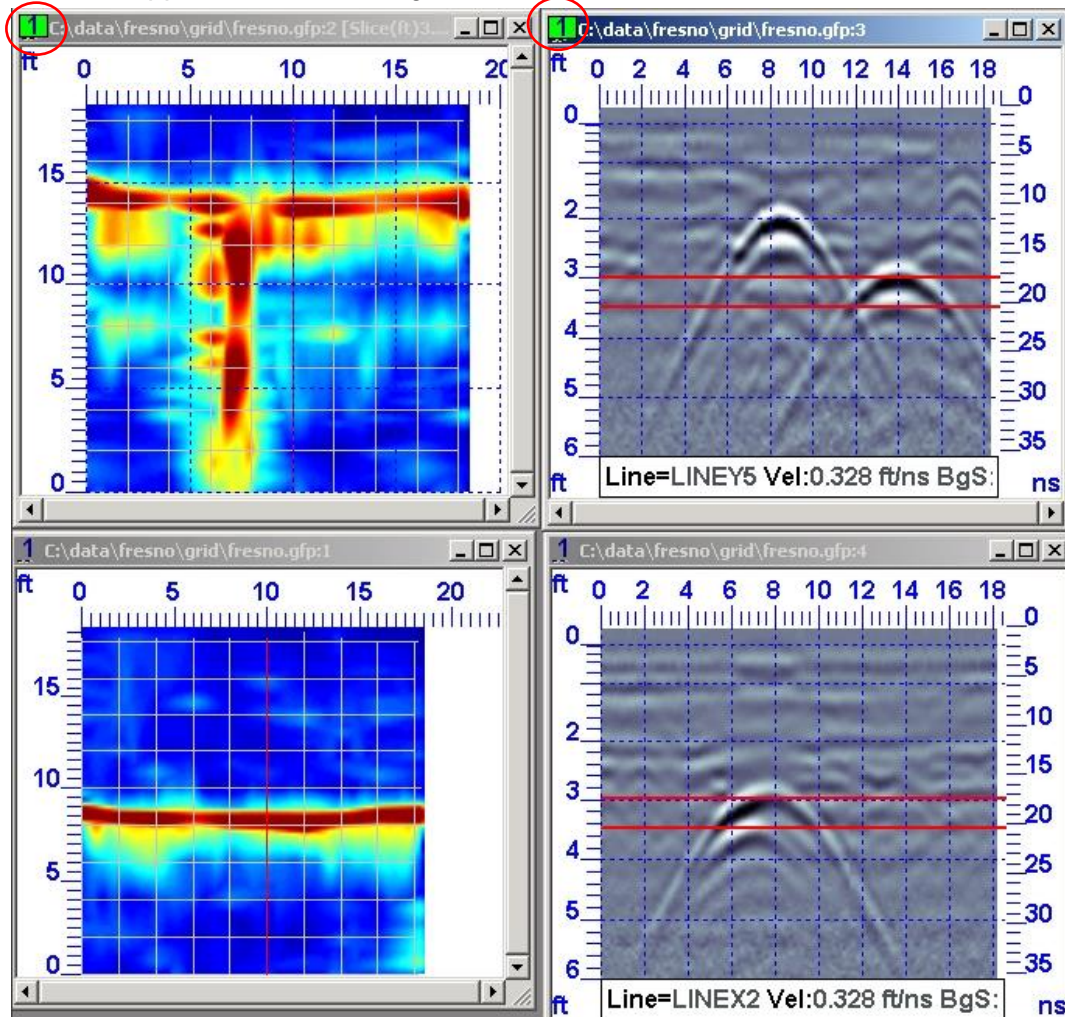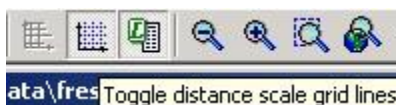
3 Toolbar

Most SliceView-Grid 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-Grid 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…	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
Decrease Sensitivity	1. To decrease how sensitive the image is to small signal variations, select the image you want to change. 2. 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). To learn more, see Sensitivity.
Increase Sensitivity	1. To increase how sensitive the image is to small signal variations, select the image you want to change. 2. 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). To learn more, see Sensitivity.
Decrease Contrast	1. To decrease contrast, select the image you want to change. 2. 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%. To learn more, see Contrast.
Increase Contrast	1. To increase contrast, select the image you want to change. 2. 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%. To learn more, see Contrast.
Decrease Gain	If the Gain value is a numbered level, this button is enabled: 1. To decrease gain, select the window (depth slice or GPR line) you want to change. 2. Click the **Decrease Gain icon**. The gain level value will decrease by 1, stopping at 1. To learn more about gaining the GPR Line, see Gain. To learn more about gaining depth slices, see Amplitude Equalization Gain.
Increase Gain	If the Gain value is a numbered level, this button is enabled: 1. To increase gain, select the window (depth slice or GPR line) you want to change. 2. Click the **Increase Gain icon**. The gain level value will increase by 1, stopping at 12. To learn more about gaining the GPR Line, see Gain. To learn more about gaining depth slices, see Amplitude Equalization Gain.
Gain Value	Use dropdown to select **Auto**, **User** or a Numbered Gain **Level** for the currently active window (either GPR line or Depth Slice window). 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.

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**. 1. Click the **Select Zoom Area** icon. 2. 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. 3. 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
Move Slice Down	To scroll down through the image one depth slice per click until you reach the lowest depth slice, click the **Move Slice Down** icon. If a GPR Line window is open, the slice cursor lines on the GPR line image move down 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.
Line Left	With a GPR Line pane open, click the **Line Left** icon to move left one Y GPR Line image at a time. To use this feature, Y-lines will have been collected and included to generate a depth slice image. To learn more, see Navigation.
Line Right	With a GPR Line pane open, click the **Line Right** icon to move right one Y GPR Line image at a time. To use this feature, Y-lines will have been collected and included to generate a depth slice image. To learn more, see Navigation.
Line Up	With a GPR Line pane open, click the **Line Up** icon to move up one X GPR Line image at a time. To use this feature, X-lines will have been collected and included to generate a depth slice image To learn more, see Navigation.
Line Down	With a GPR Line pane open, click the **Line Down** icon to move down one X GPR Line image at a time. To use this feature, X-lines will have been collected and included to generate a depth slice image. To learn more, see Navigation.
Horizontally Tile Windows	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. To learn more, see Tile Horizontally.
Vertically Tile Windows	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. To learn more, see Tile Vertically.
Measure Distance on Image	To measure the velocity from a hyperbola in the grid data set, click the Measure Distance on Image icon.
Help	Click the **Help** icon to open the SliceView-Grid Help file.

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

Cursor on the depth slice   **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-Grid 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-Grid, 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-Grid 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.

a. 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.

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

| File | View | Navigation | Tool | Window | Help |
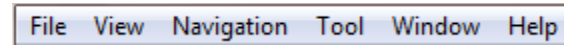
The following sections describe the SliceView-Grid Menu Bar features.

5.1 File

File

Export Data   ▶
Advanced File Options ▶

Exit
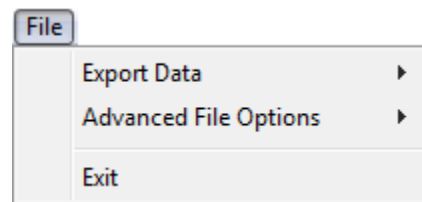
5.1.1   Export Data

SliceView-Grid 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).
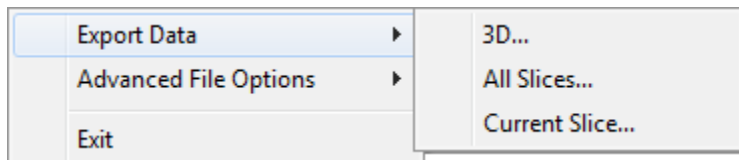
The following image shows 3D GPR data in Voxler:
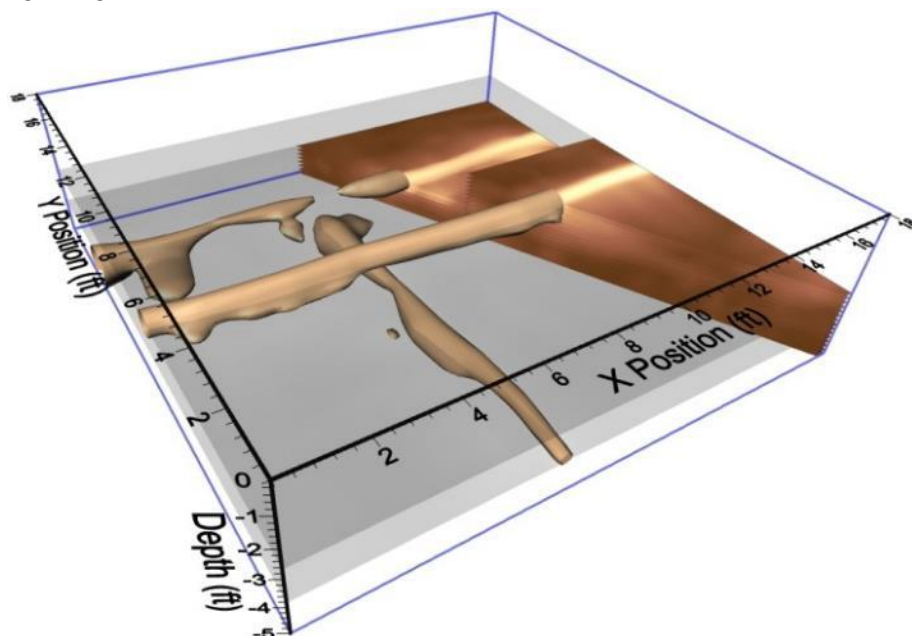
Data is exported as the 3D location of each point within the grid (X, Y, Z) and the average signal strength at that point (amplitude). The X and Y voxel dimensions are controlled by the Slice Resolution value, while the Z voxel dimension is controlled by the Thickness value.

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-Grid without Migration or Envelope processing:
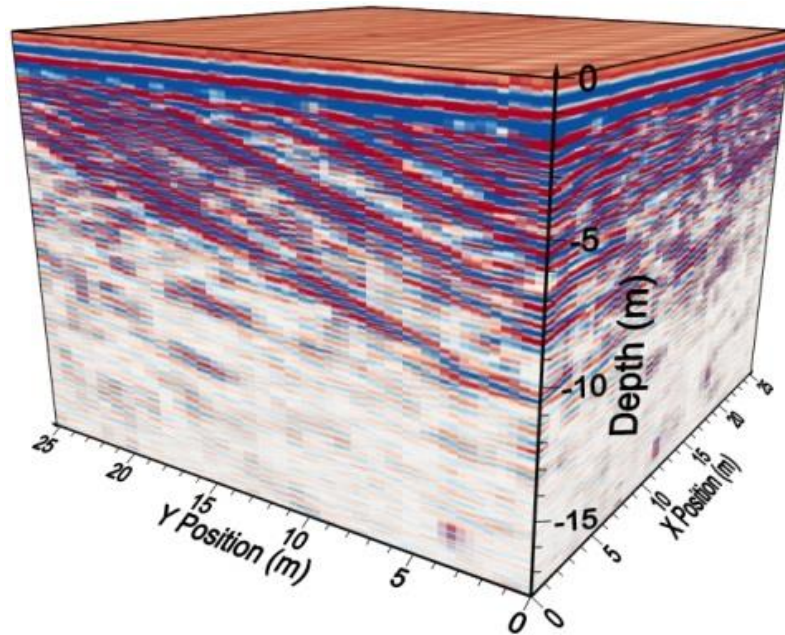
Geological data that has not received envelope processing is best displayed when slice thickness is set finer than the default thickness, ideally the same as the temporal sampling interval. This is typically about 1/5 of the default slice thickness value.

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).

a. To export 3D data to HDF, in the menu **File > Export Data > 3D**.

b. In the **Save As** dialog box, in the **Save as type** drop-down list click **Voxler HDF file**.

c. Select the folder you want to save this data to.

d. 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.

e. If Voxler is installed on the computer, Voxler launches automatically generates 3D images with pre-set parameters for the following types of 3D displays.

   1) Volume Render (Volrender) displays the whole cube of data and allows the user to modify the transparency to highlight GPR reflections of certain signal strength. For example, it is common to make weak GPR reflectors transparent and only display the strongest reflections in the data.

   2) ClipPlanes slice through the cube of data, like depth slices but with the advantage of slicing at any angle through the data cube.

   3) Isosurfaces show all the points of a single, user defined GPR amplitude value in the cube with all other data transparent; great for showing the strongest reflectors in the data.
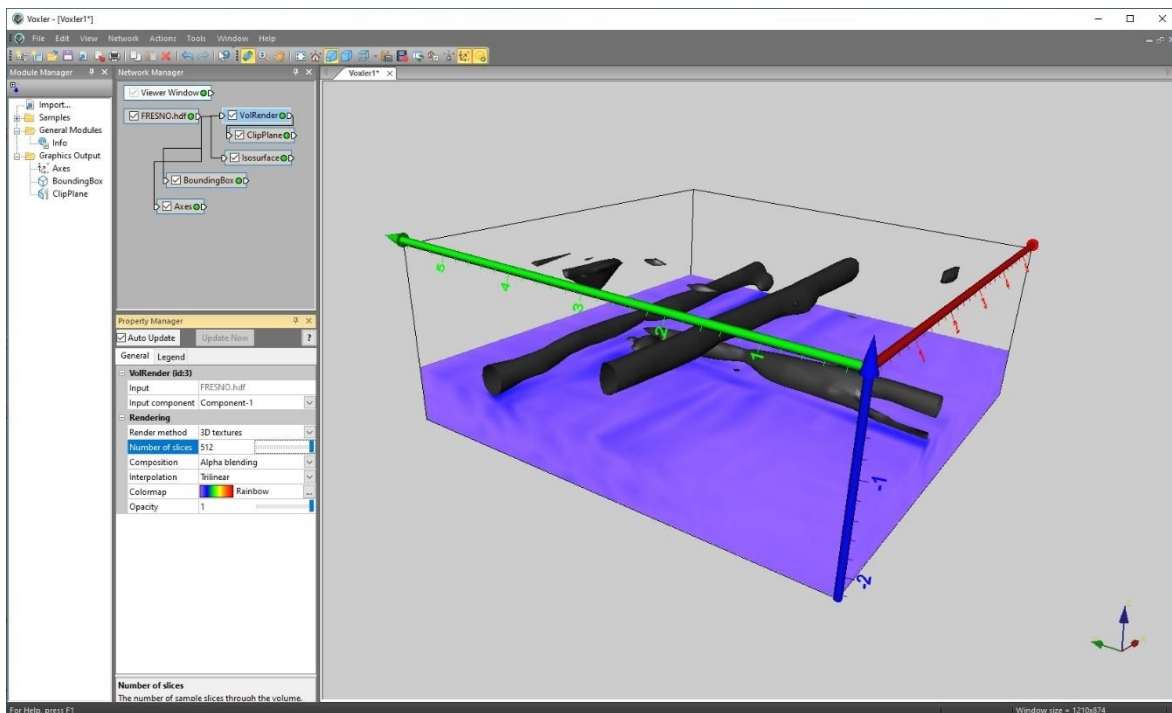
In the example above, GPR grid data is displayed in 3D in Voxler as a volume render (purple cube), a clip plane (top of purple cube) and an isosurface (grey, linear objects).

To edit the view, select the display, for example, Volrender, in the Network Manager window and modify the properties in the Property Manager window.

For each type of data display, there are many properties to adjust, but some of the more important ones when viewing GPR data are described below.

Volrender Properties
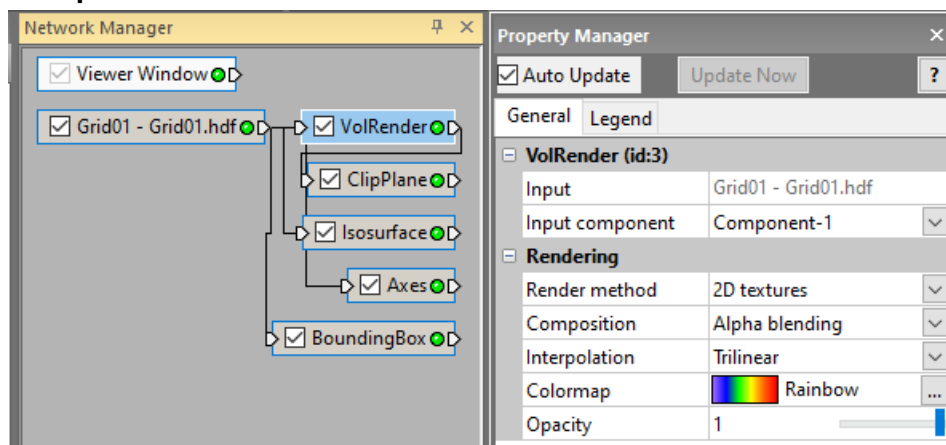
Change the **Render method** to **3D textures** to provide a smoother image.

If desired, change the **Colormap** by clicking on the colormap and selecting a new colormap.

Open the **Colormap Editor** by clicking on the ⌐···⌐

In the **Colormap Editor** change the **Opacity Mapping** to **Middle Ramp** and modify the opacity of the data by moving the opacity line:
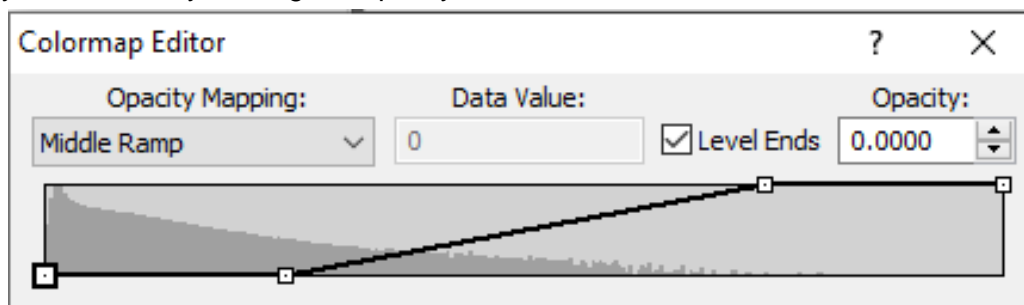
This allows the user to make weak reflections in the data cube translucent or invisible and the stronger reflections visible.

ClipPlane Properties
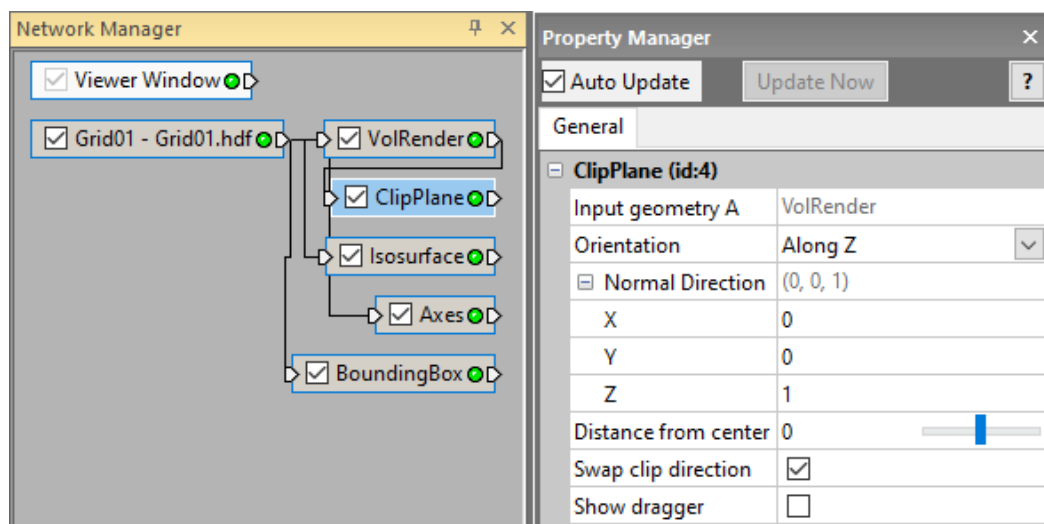
Modify the **Normal direction** by changing the X, Y and Z values. Z = -1 to slice from top to bottom in a GPR cube. You can adjust these values to slice through the cube on an angle, for example X = 1, Y =1 and Z =1.

Slide the **Distance from Center** slider to change the position of the slice.

Isosurface Properties
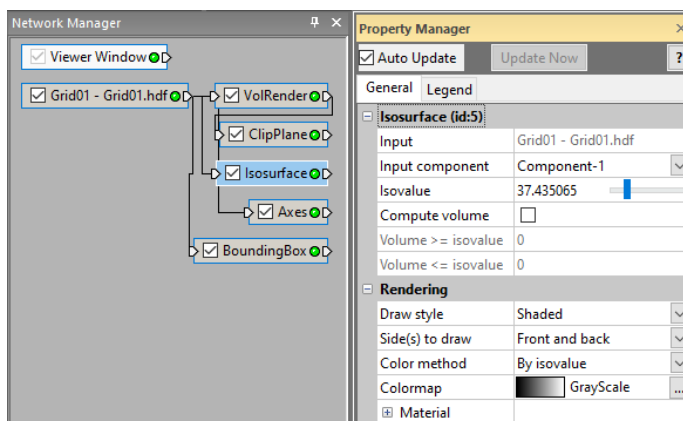
Change the **Colormap** by clicking on the colormap and selecting a new colormap.

Slide the **Isovalue** slider to change the amplitude value to display.

5.1.1.3   3D CSV

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

a.   To export 3D data to a CSV file, in the menu bar click **File > Export Data > 3D.**
In the **Save As** dialog box, in the **Save as type** drop-down list click **XYZ-Amplitude Pairs**.
Select the folder you want to save this data to.
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-Grid will not export to Google Earth unless a there is 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.

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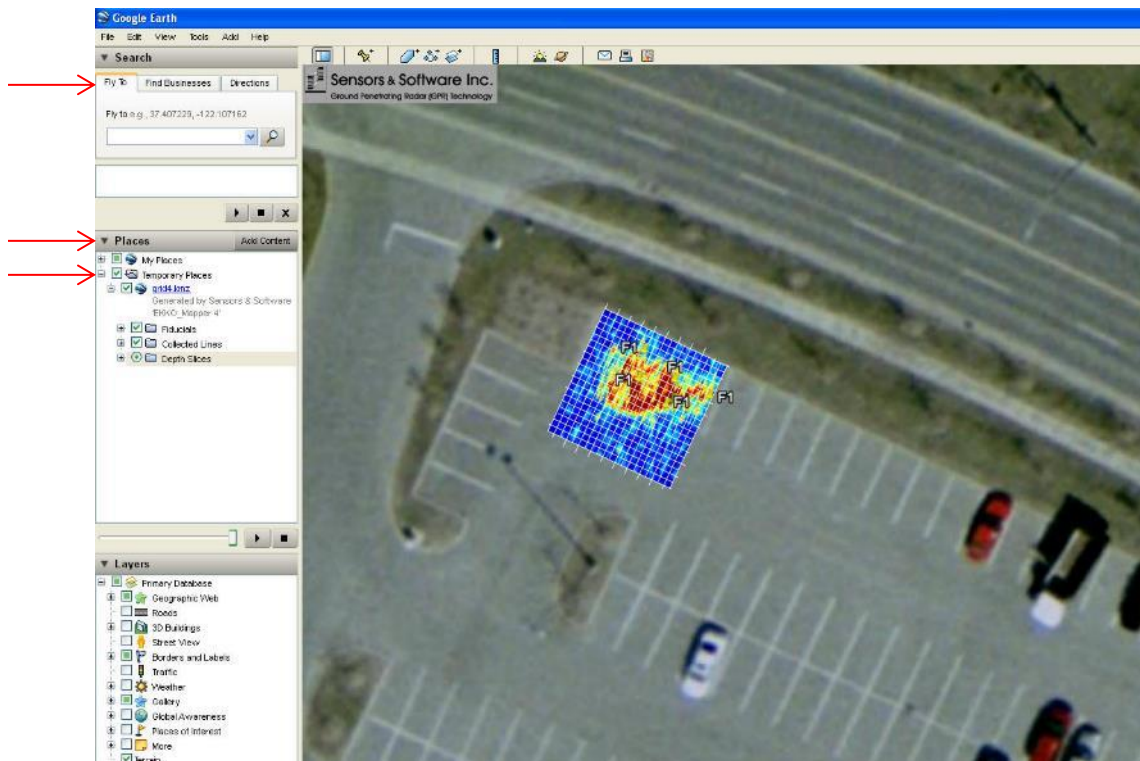
The Places pane enables slice display, line collection, and fiducial markers.

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.
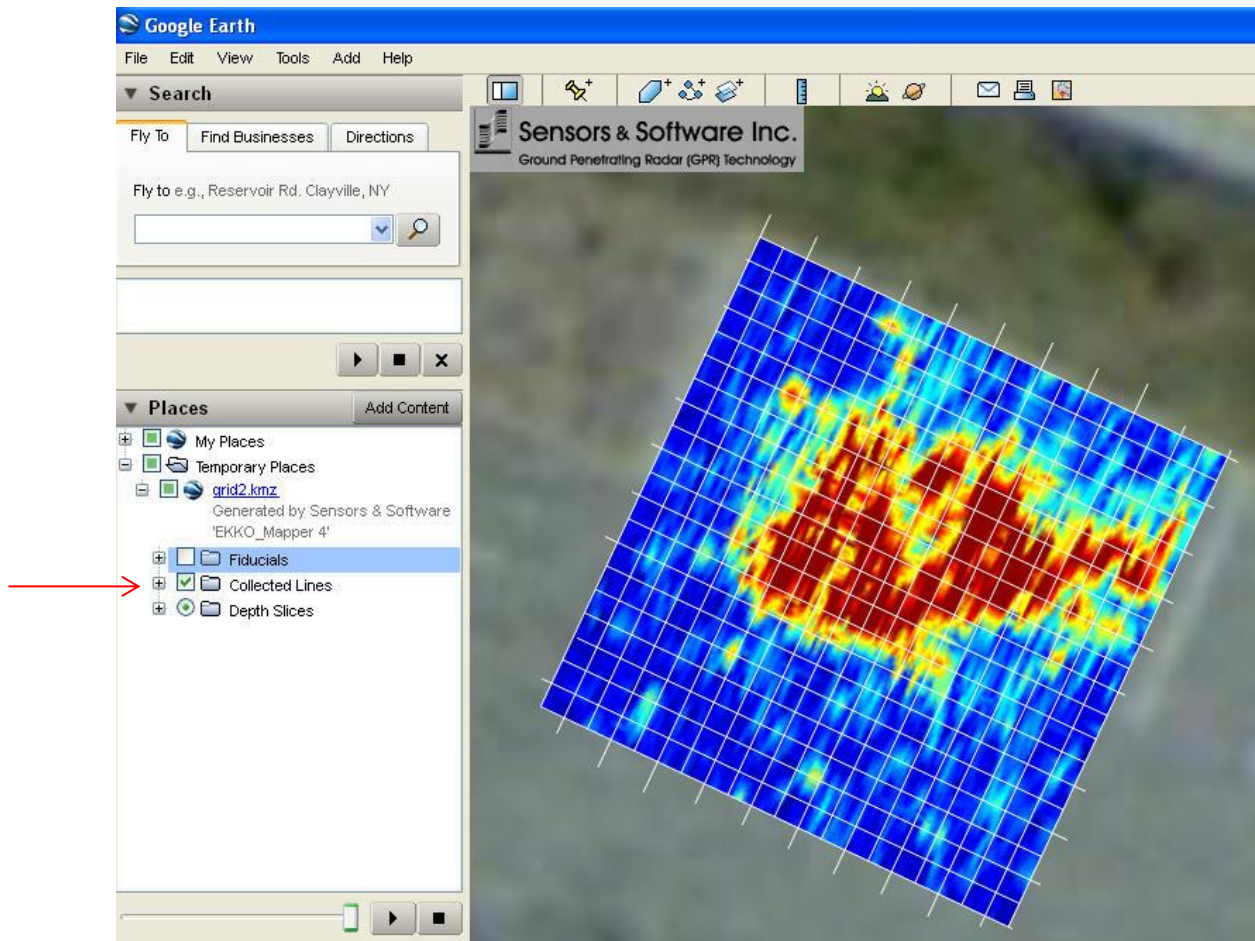
Fiducial Markers

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.
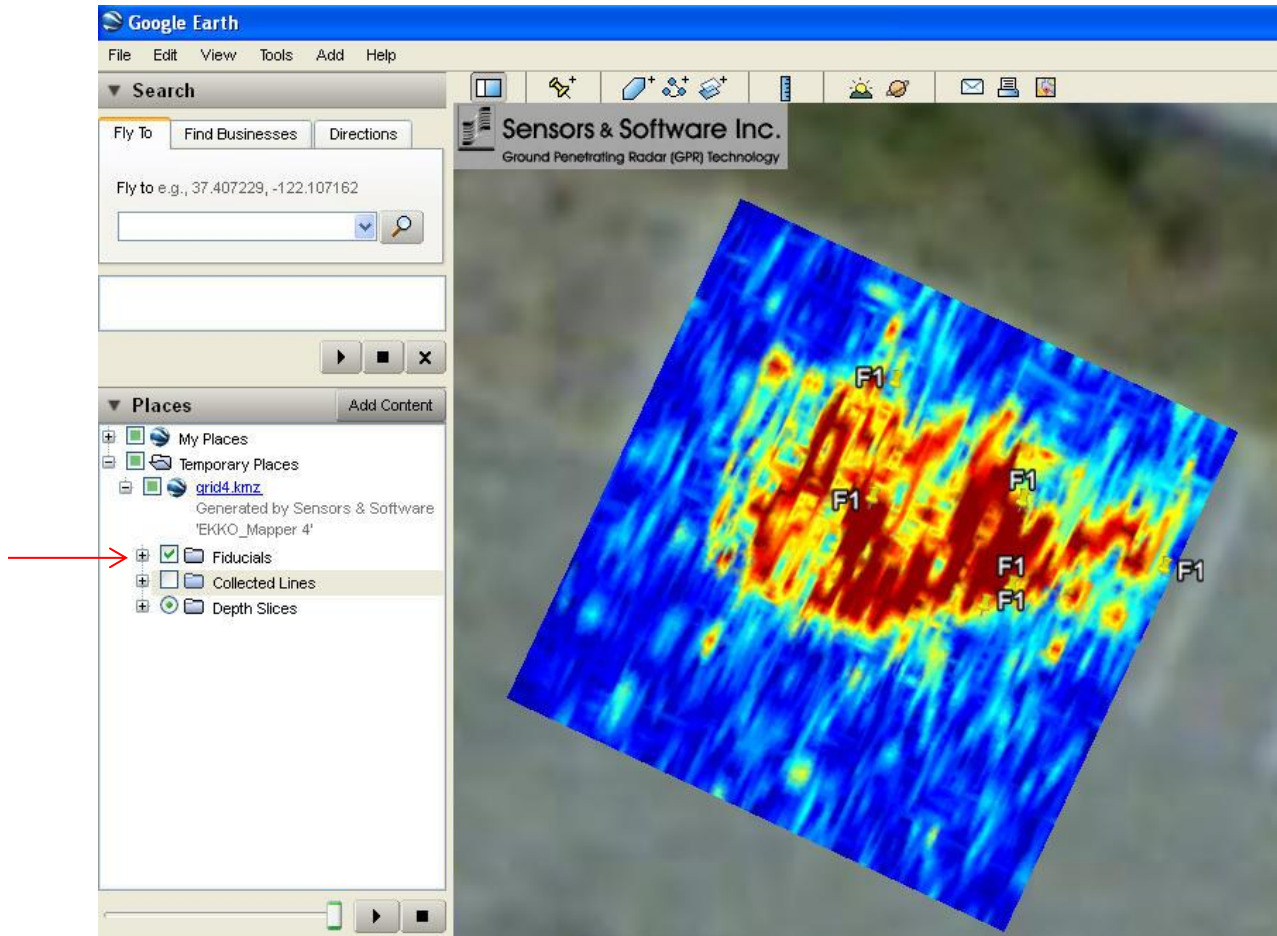
Depth Slices

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.
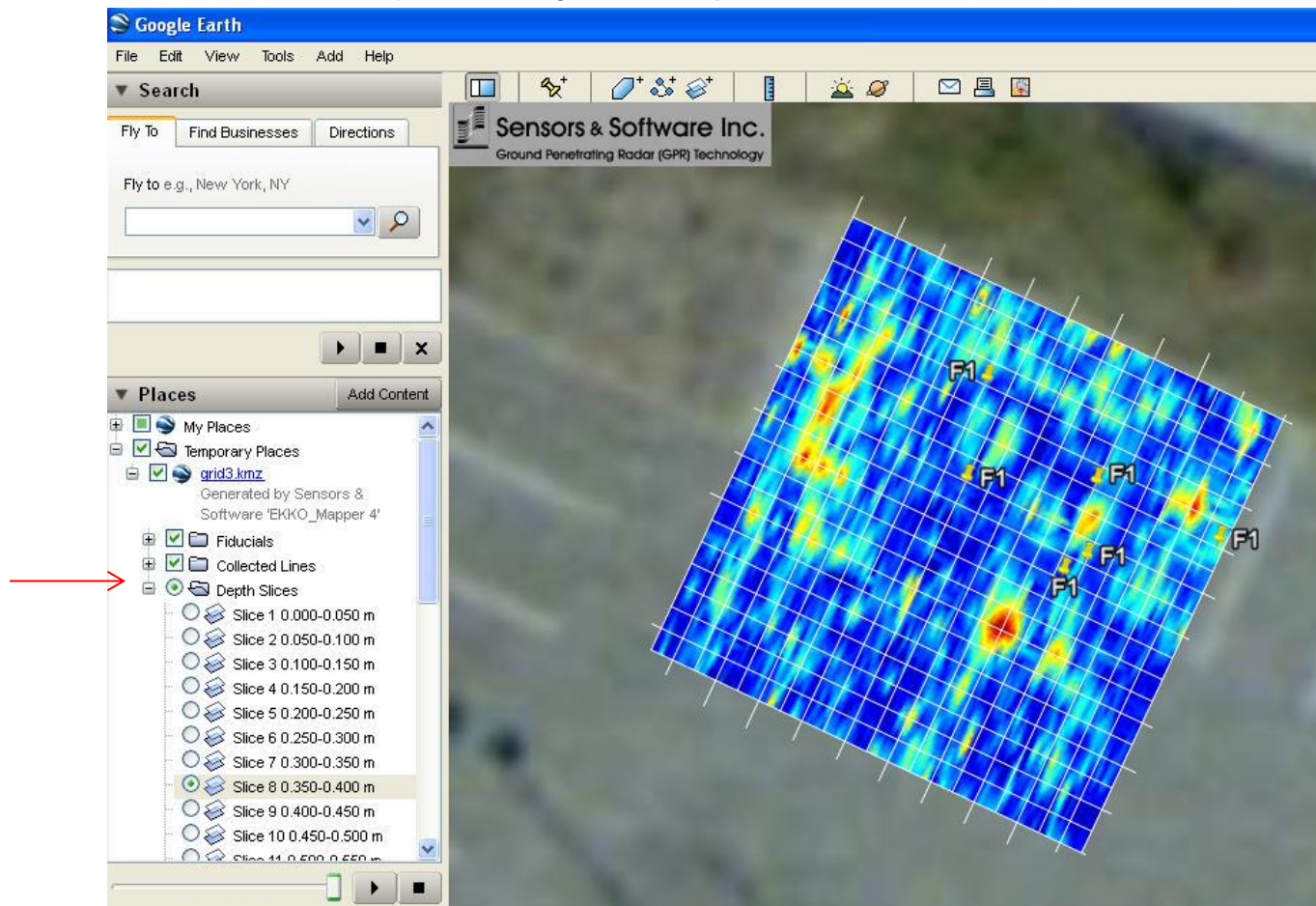
Google Earth Accuracy

Google Earth images may be 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.

a. 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.**

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.

a.   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-Grid operations such as clean up intermediate files, remove all processing from the current GFP file, or restore the Default Application Settings.
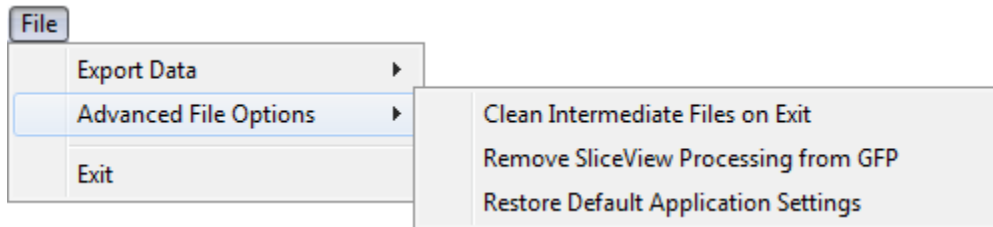
> **Note**: Processing is not lost, just recalculated.

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-Grid generates intermediate files that display depth slices and GPR line images.

To automatically delete intermediate files when you exit SliceView-Grid, 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–Grid Processing from GFP

SliceView-Grid files save data files 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-Grid and return to EKKO_Project.

5.2 View

To open the View menu, in the menu bar click **View**.
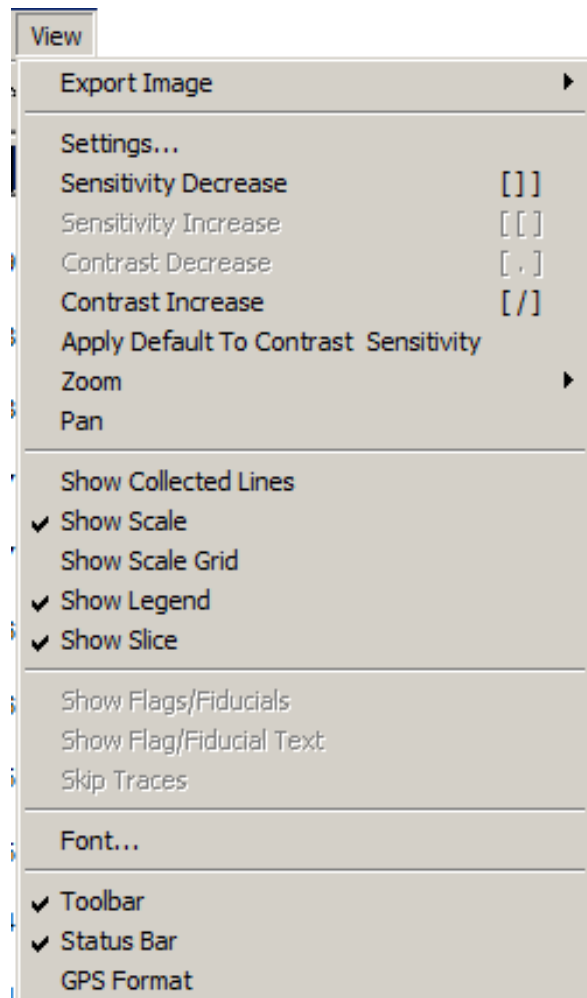
Use the following table as a guide to working with the **View** menu:

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	To make the image less sensitive by five percent increments, click **Sensitivity Decrease**. To learn more, see [Sensitivity](#).
Contrast Increase	To increase contrast by five percent increments, click **Contrast Increase**. To learn more, see [Contrast](#).
Contrast Decrease	To decrease contrast by five percent increments, click **Contrast Decrease**. To learn more, see [Contrast](#).
Zoom	To increase or decrease the size of the depth slice or GPR line image, click **Zoom**. To learn more, see [Zoom](#).
Pan	To move images within a zoomed-in display, click **Pan**. To learn more, see [Pan](#).
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. To learn more, see [Show Collected Lines](#).
Show Scale	To display scales around the image, click **View > Show Scale**. For **Depth Slice images**, X and Y position scales are displayed across the top and left side of the image respectively. To view the Depth Slice scale, see the [Depth Slice](#) View image. 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. To view the GPR Line scale, see the [GPR Line](#) View image.
Show Scale Grid	To superimpose a grid of dashed lines onto the depth slice or GPR line image, click **View > Show Scale Grid**. To learn more, see [Show Scale Grid](#).
Show Legend	To display a legend with the depth slice ([Figure 2](#)) or GPR Line (Figure 3) image, click **View > Show Legend**. 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. To view the **Depth Slice Legend**, see the [Depth Slice](#) View image. 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. To view the **GPR Line Legend**, see the [GPR Line](#) View image.

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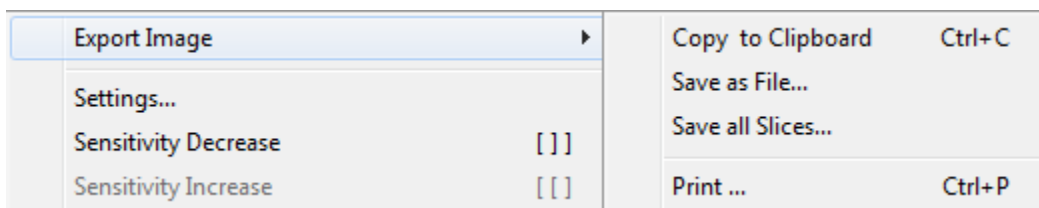
Use the following table as a guide to working with the **Export Image** menu:

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: 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: 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.
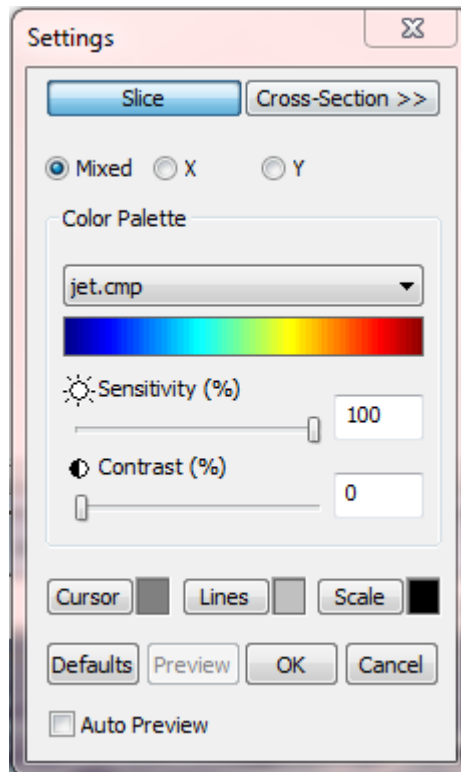
You can access the Settings option from the menu bar or the toolbar.

5.2.2.1   Slice Settings

a.   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:

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).
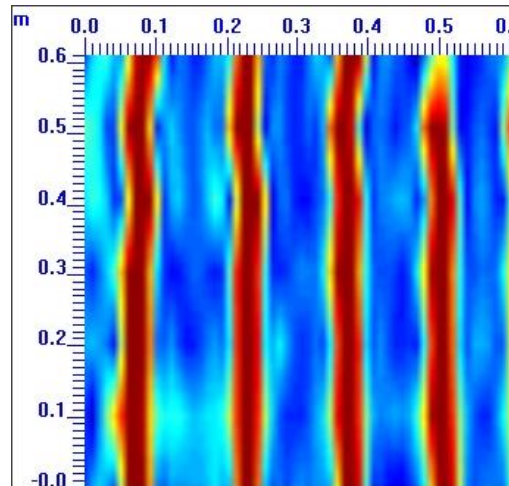
X Grids

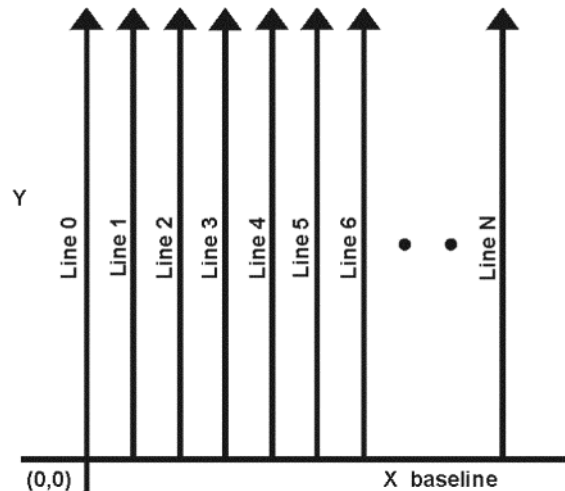X-grids are areas covered by a series of parallel lines in the X direction:
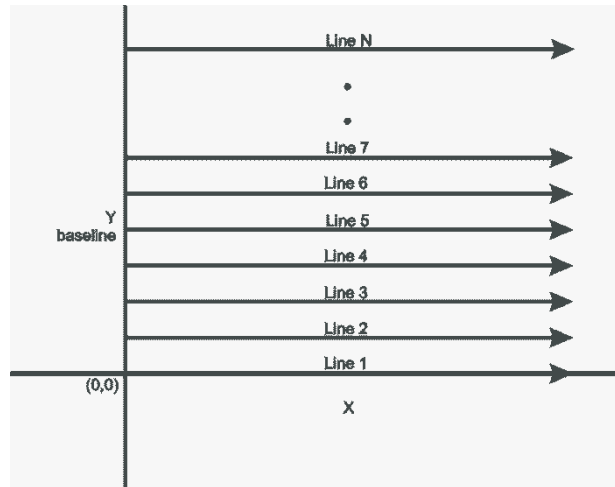
In the Slice Settings dialog box, click the **X** option to generate a depth slice using only X data lines in the grid.

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:
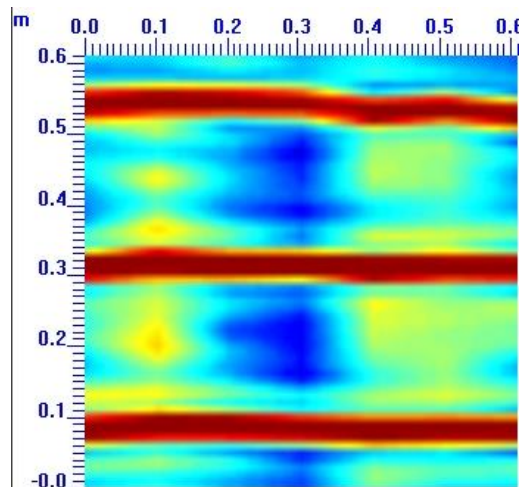
Click the Y lines only option to display rebar perpendicular to the Y lines and eliminate the parallel rebar parallel.
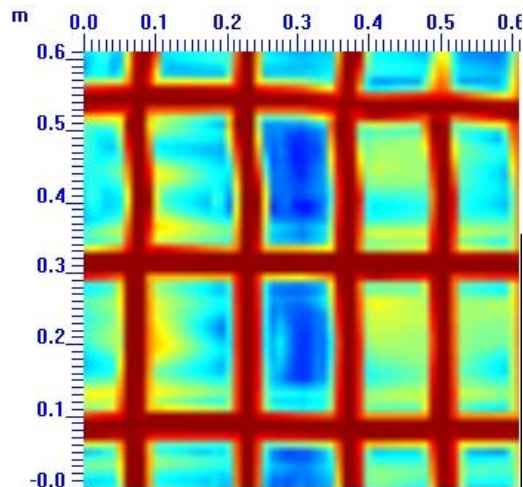
Mixed Grids

Mixed grid areas are covered by lines in both the X and Y directions
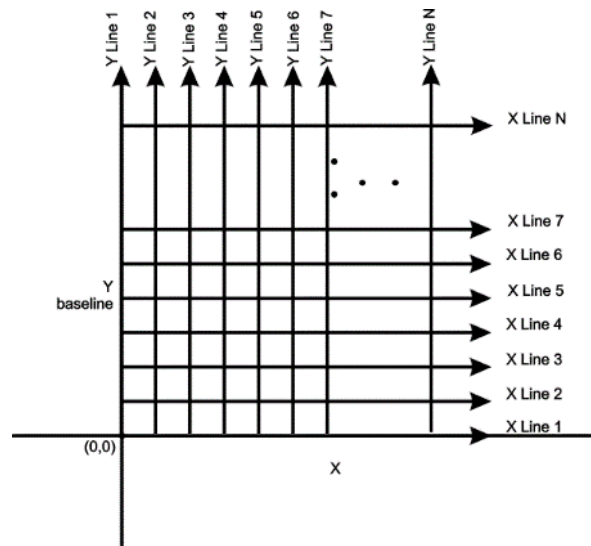
In the [Slice Settings] dialog box, click **Mixed** to generate depth slice images based on both X and Y lines.

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.
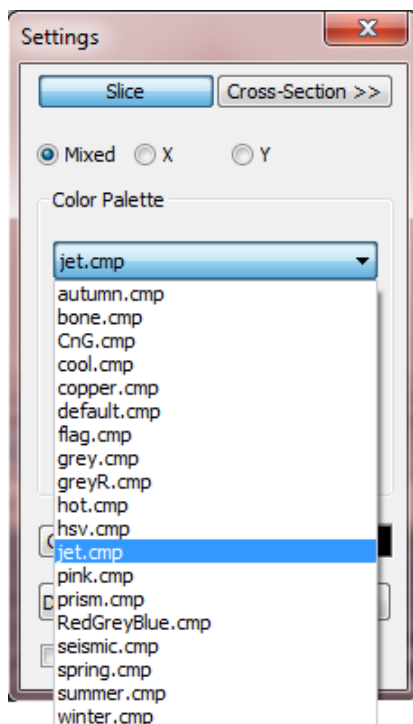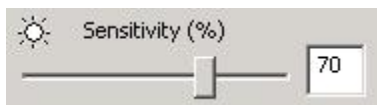

5.2.2.1.3 Sensitivity

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.
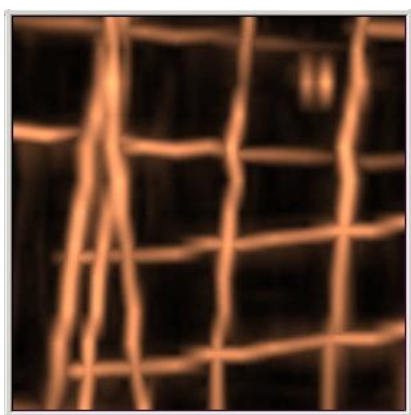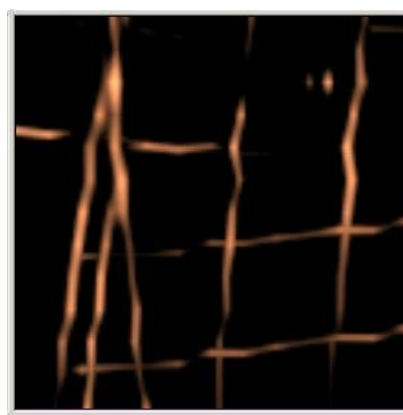
Sensitivity default 100%   **Sensitivity 50%**

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 <u>Menu bar</u>, click **View > Contrast Decrease**.

- To decrease contrast by 5% increments, in the <u>Toolbar</u>, 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.
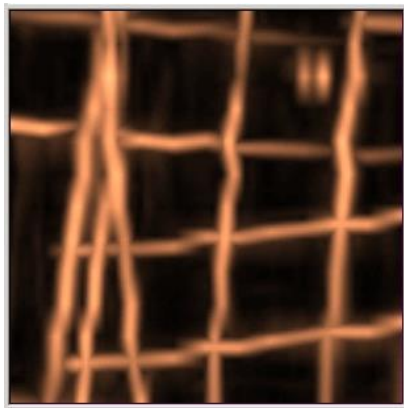
Contrast default 0   **Contrast 50 %**

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).
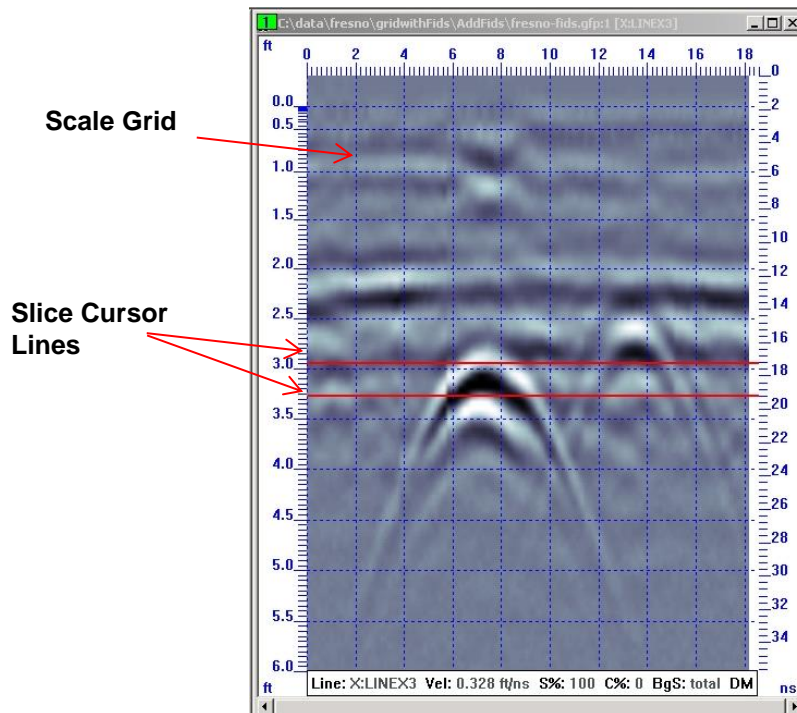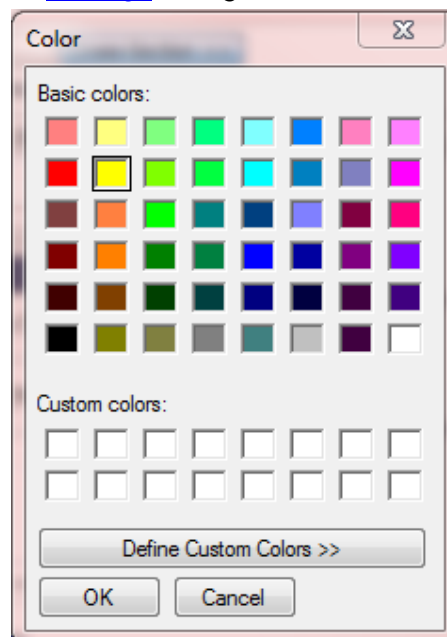

Figure 4: Slice Cursor line and Scale Grid

a. To change the line color, in the Settings dialog box, click **Cursor**.

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

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.

GPR line Cursor Line
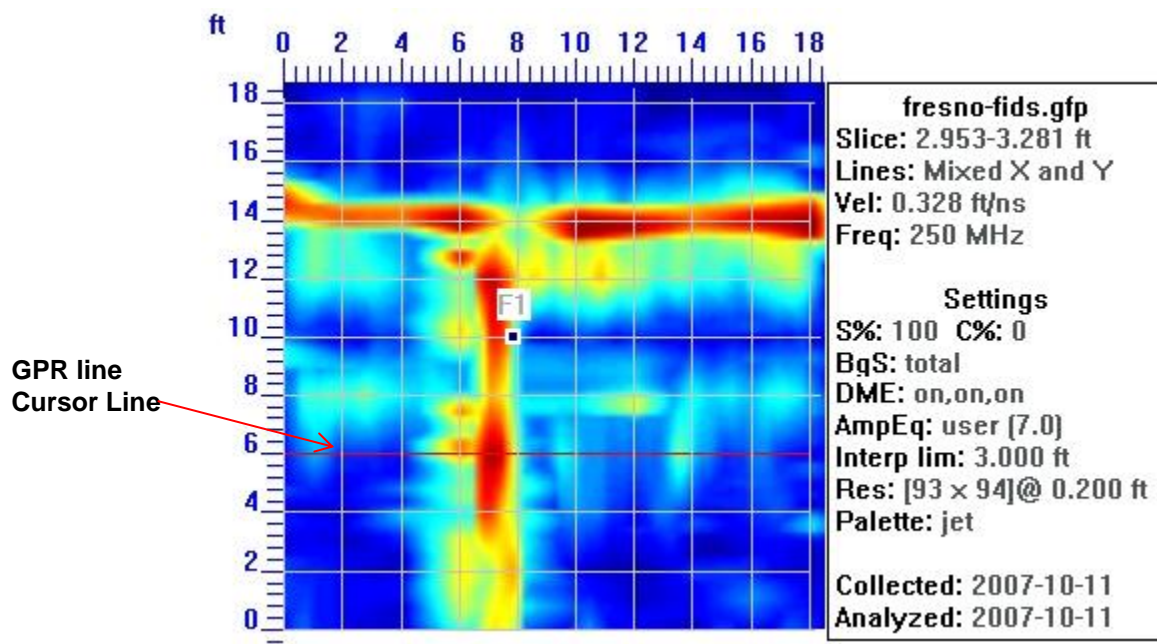
Figure 5: GPR line cursor line

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.

a.   To change **Line Color,** in the Settings dialog box, click **Lines**.

b.   In the **Color** dialog box, select a line color that provides high line visibility on the depth slices.

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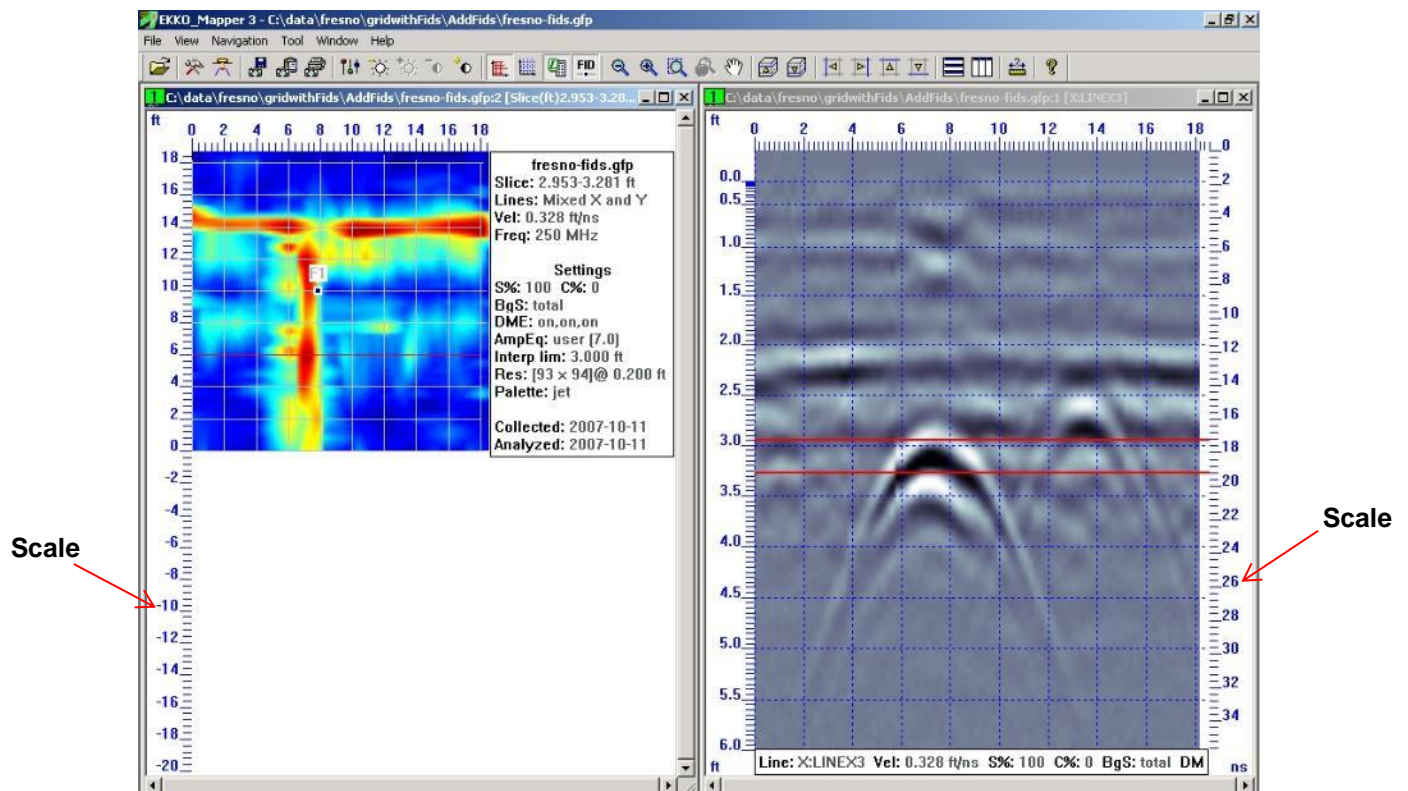
The **Show Scale Grid** option only applies to the image in the active window.

a.   To change **Scale Color**, in the Settings dialog box, click **Scale**.

b.   In the **Color** dialog box, select a line color that is visible on the image.

c.   Click **OK**.

5.2.2.2   GPR Line Settings

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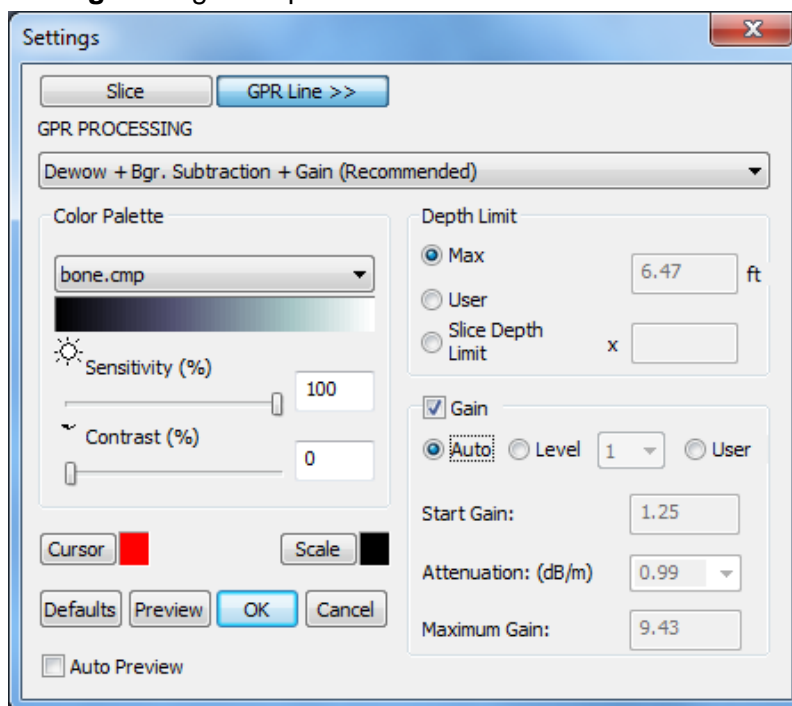
Use the following table as a guide to working with the **GPR Line Settings** dialog box:

| 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.

a. To access the **GPR Processing type**, in the Settings dialog box, click the **GPR Processing** drop-down list.

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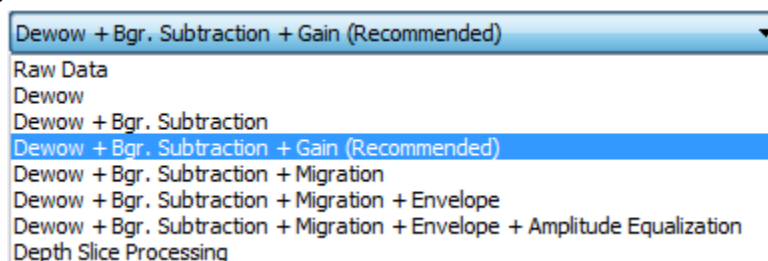
- The recommended and default GPR Processing option is **Dewow + Bgr. Subtraction + Gain**.
- To display the GPR Lines with the same processing as the depth slices, click **Depth Slice Processing**.

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.
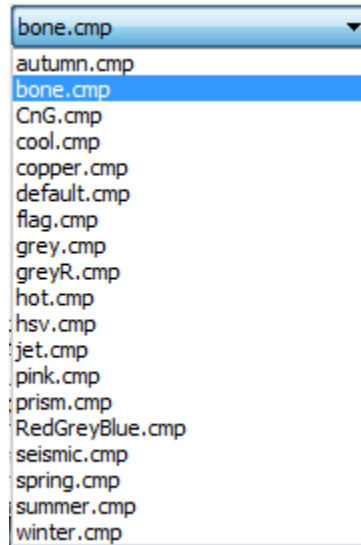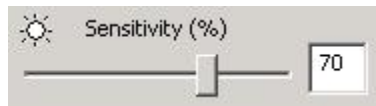

The default color palette for GPR line images is bone.

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.

Sensitivity default 100%   **Sensitivity 80%**
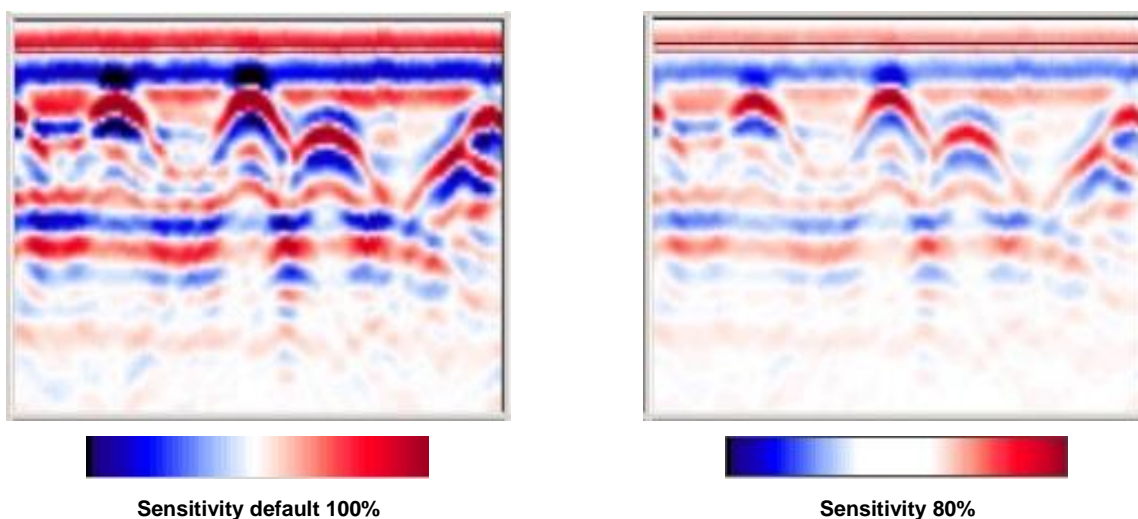
5.2.2.2.4 Contrast

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.

Contrast default 0   **Contrast 50**
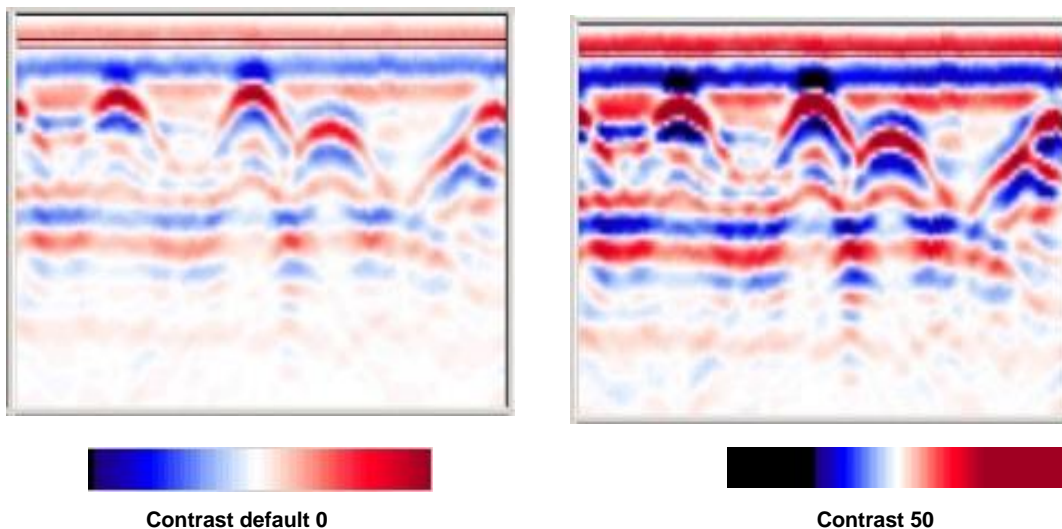
5.2.2.2.5   Cursor Color

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).

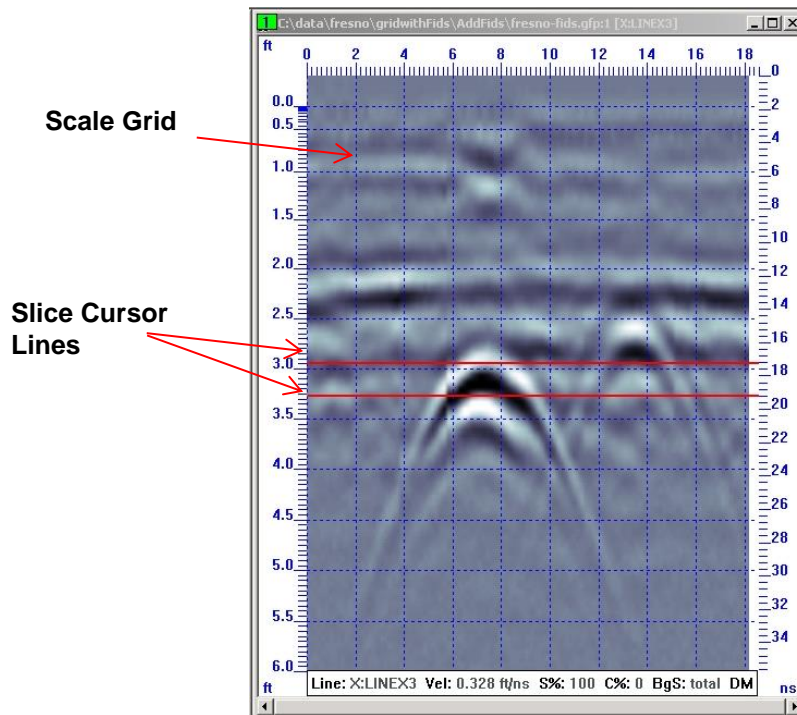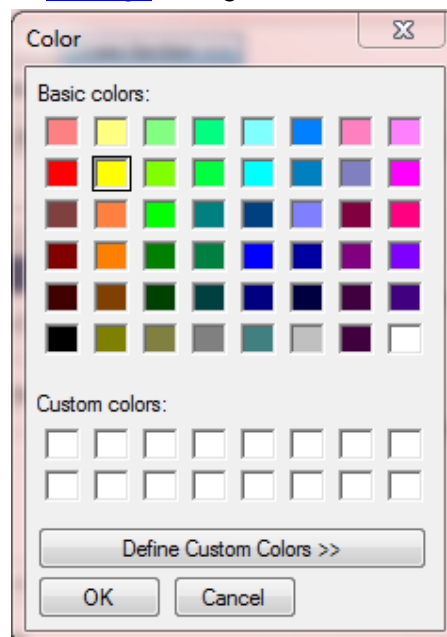**Figure 6: Slice Cursor line and Scale Grid**

a.   To change the line color, in the Settings dialog box, click **Cursor**.

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

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.

GPR line Cursor Line
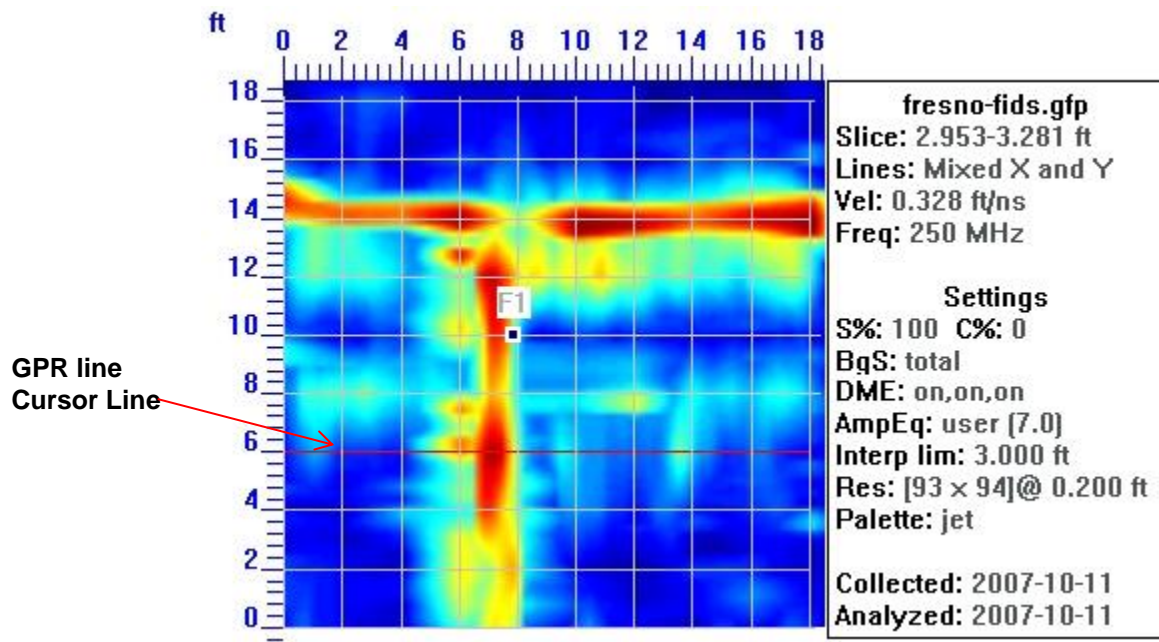
5.2.2.2.6   Scale Color

Scale Grid Lines correspond to major position and depth labels can be superimposed on the depth slice and the GPR Lines.
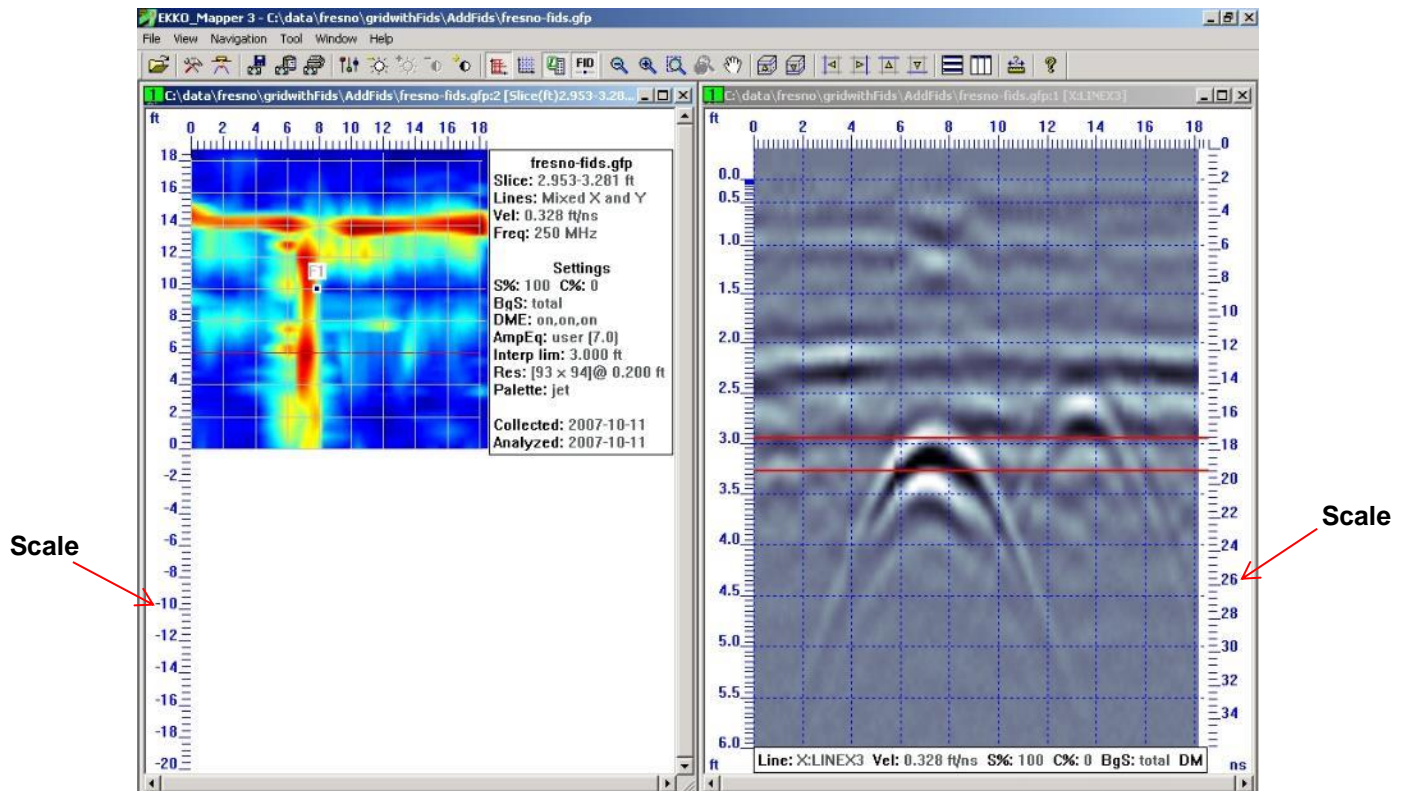
The **Show Scale Grid** option only applies to the image in the active window.

b. To change **Scale Color**, in the Settings dialog box, click **Scale**.
c. In the **Color** dialog box, select a line color that is visible on the image.
d. 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.
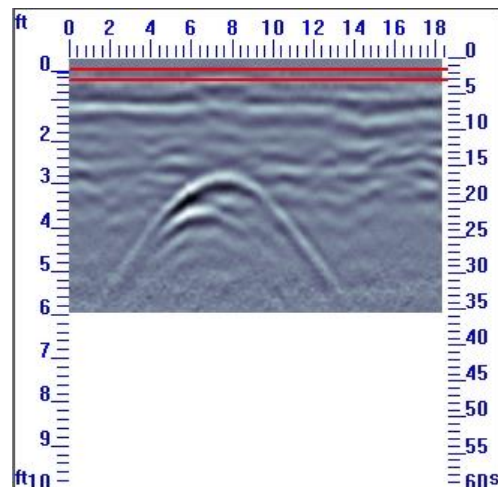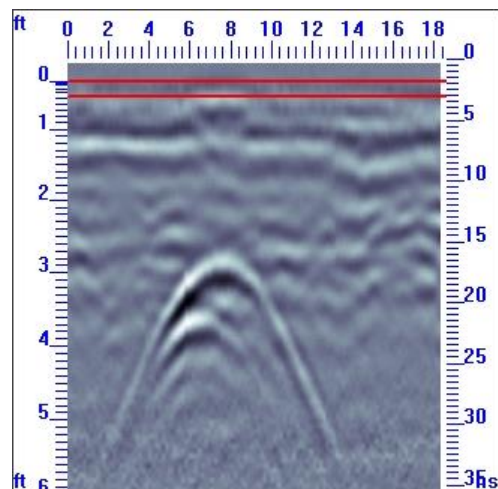
- **Max**: Displays the full depth range of GPR line data (default setting).
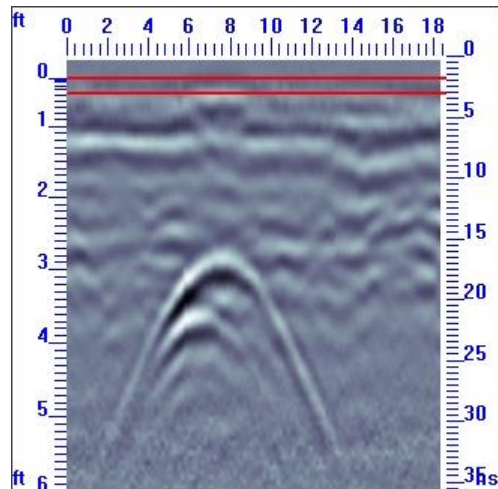
- **User**: Select **User** to enter the maximum depth value to display in the GPR line image in the **ft.** text box.

- **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.

a.   To add **Gain** to GPR Processing, in the Settings dialog box, select the **Gain** checkbox.
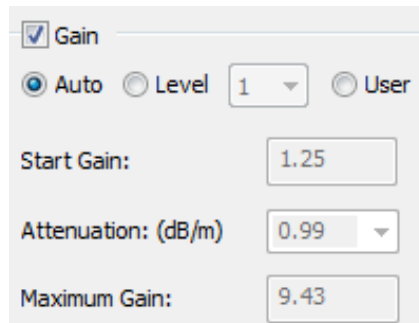
Select the **Auto, Level** or **User** option.

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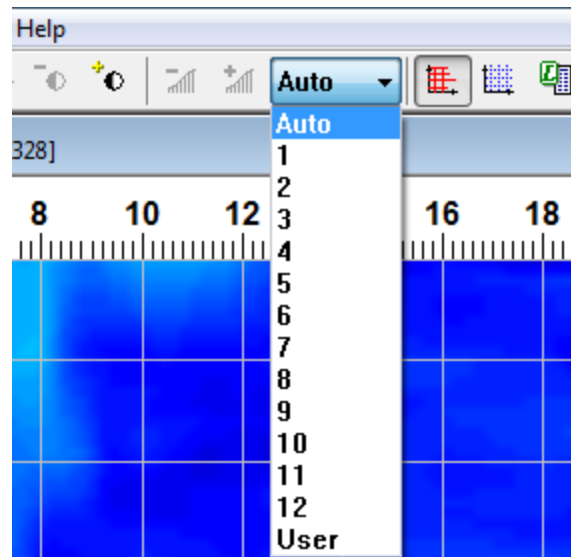
This makes it easy to quickly scroll through several pre-set gain levels and find one that makes the GPR line look the best.

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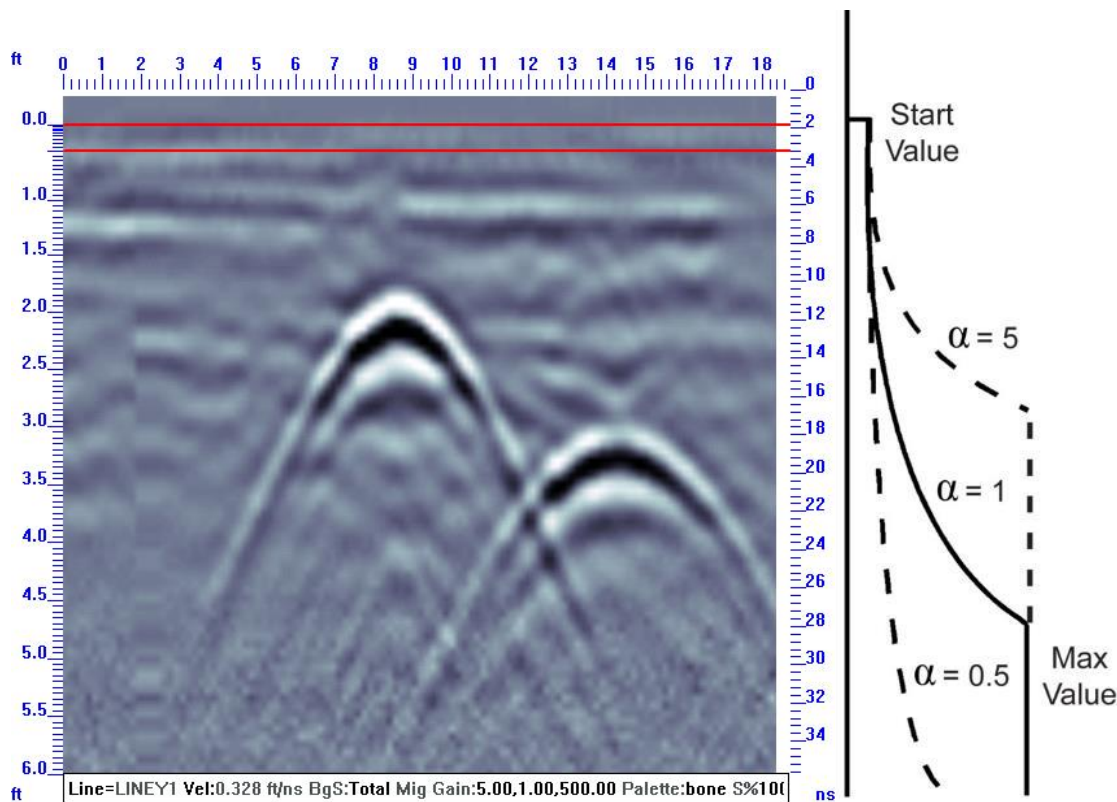
In most cases, **Start Value** is 1 to 3, **Attenuation** (a), which controls steepness, is 0.5 to 50, and **Maximum Gain**, which cuts off the exponential rise, is 20 to 1000. To avoid over-gaining data, start with low attenuation and maximum gain values and increase as necessary.

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.
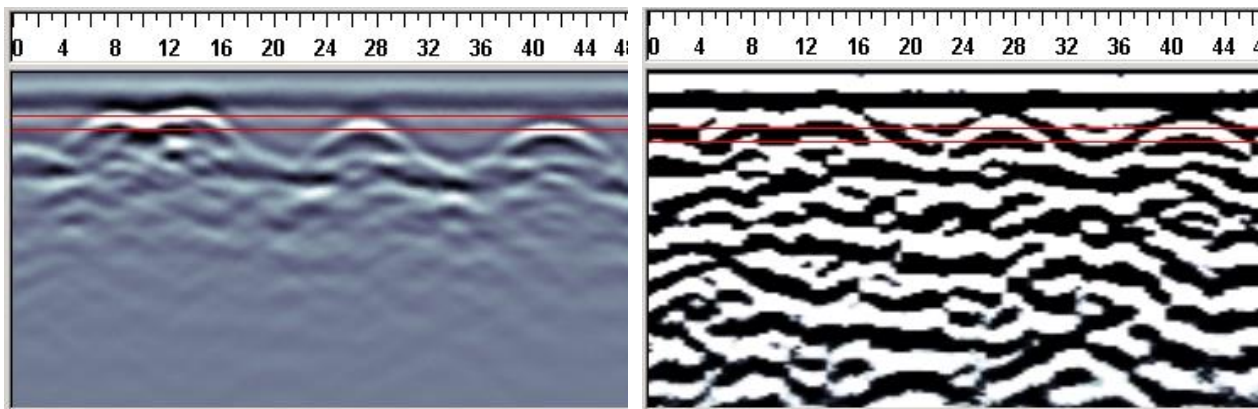
A low attenuation value produces a clear GPR line image   **High attenuation values overgain data producing an unclear image**

a.   To select an attenuation value, in the <u>Gain</u> pane, click the **User** option.

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 <u>menu bar,</u> **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 <u>menu bar</u>, click **View > Zoom**.

Zoom	▶	Fit to Window
		Select Area
		Out
		In
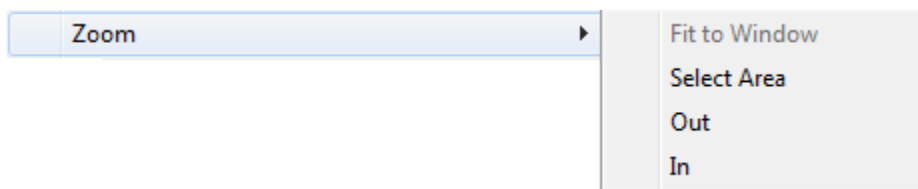
There are four Zoom options:

Option	Description
Fit to Window	To zoom to the full grid size, click **View > Zoom > Fit to Window**.
Select Area	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.
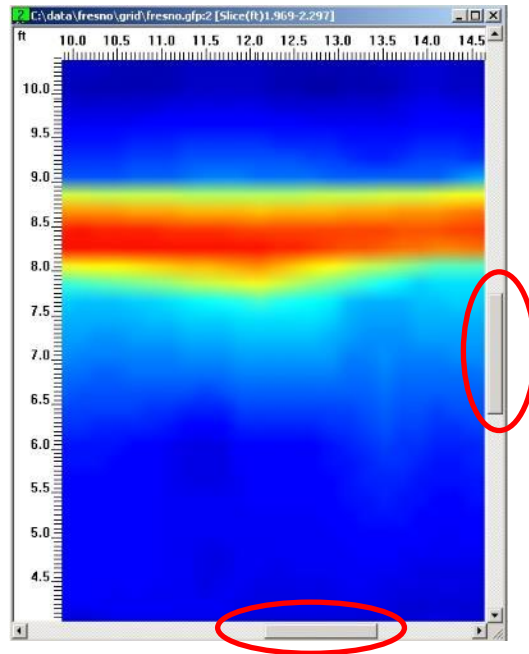
Use the scroll bars to move around the image and view different areas. The scroll bar narrows each time the image is zoomed-in to indicate that a smaller percentage of the full image range is displayed.

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.
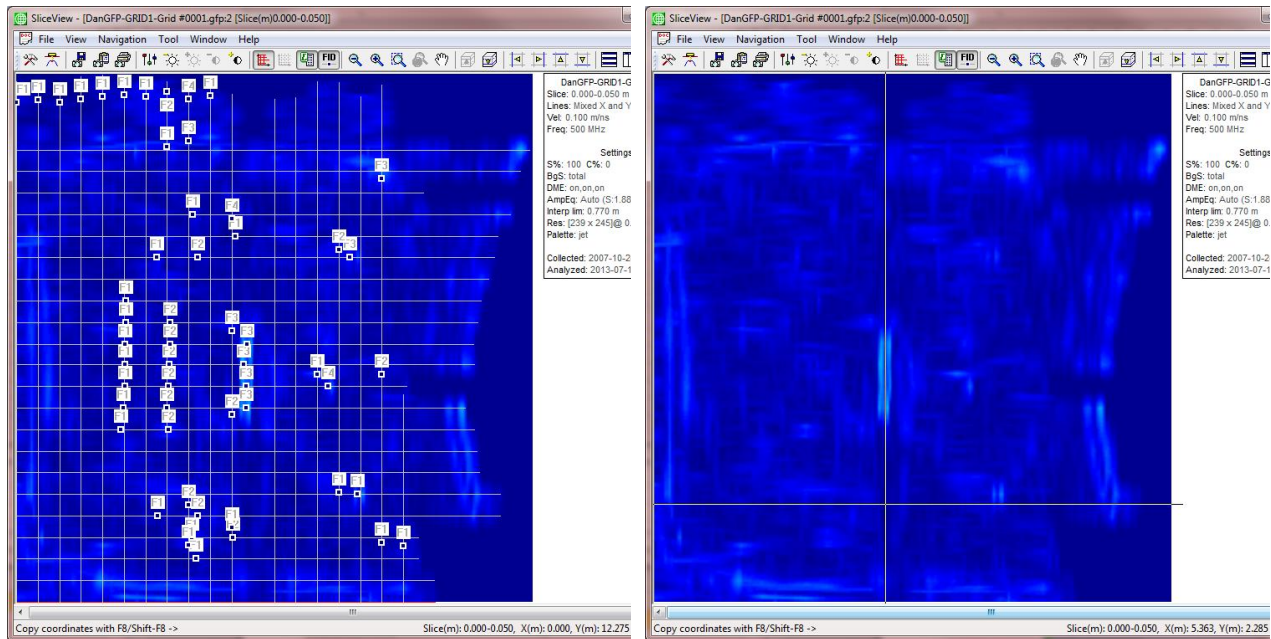
Show Collected Lines   **Disable Show Collected Lines**

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:
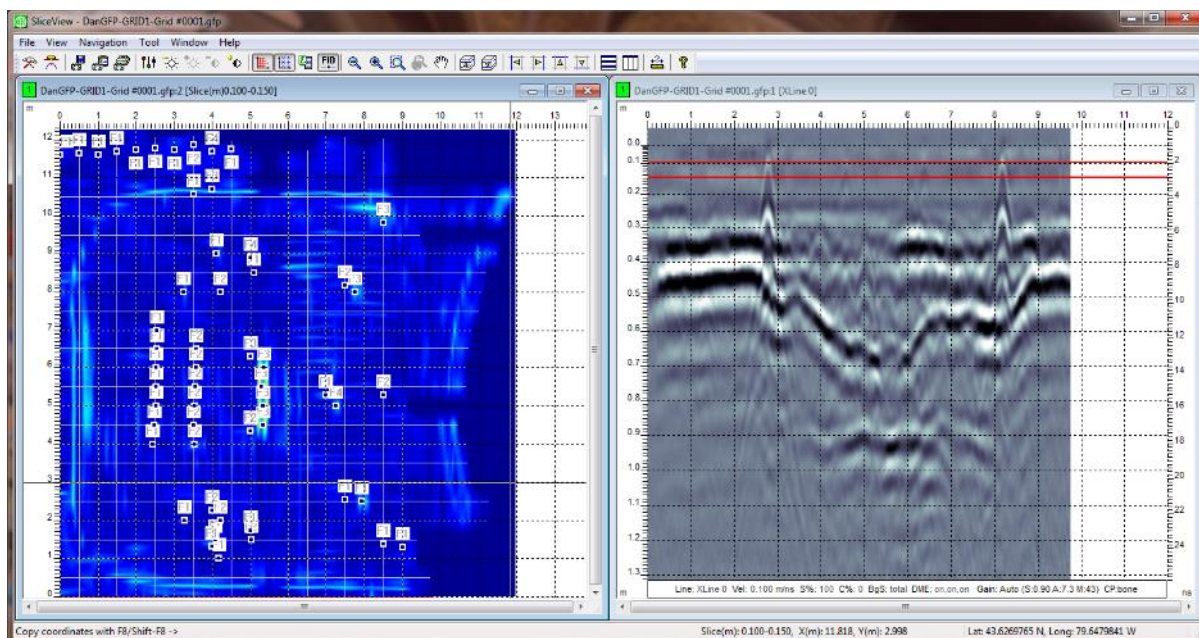
Without Scale Grids:

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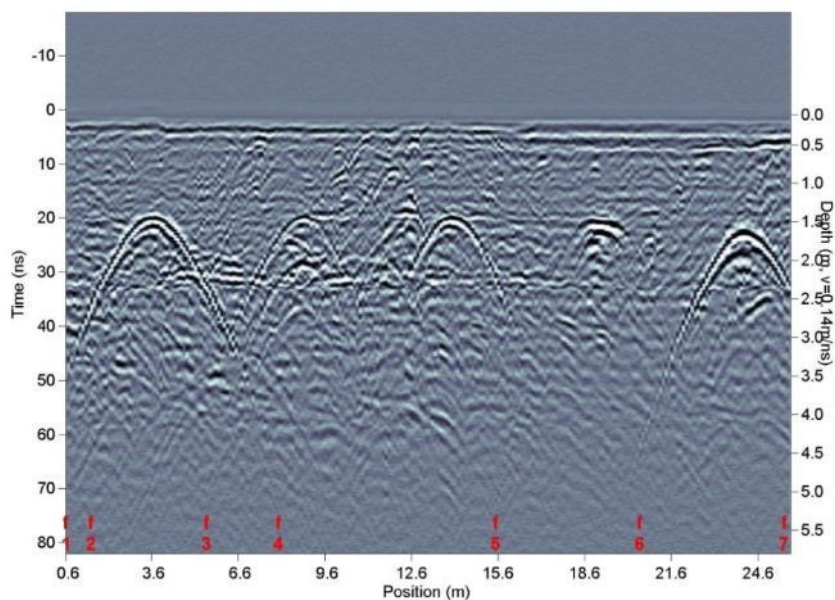
If your older GPR system does not write fiducials to the GFP file created during grid data collection, use the GFP_Edit utility program to import fiducials separately into the GFP file.

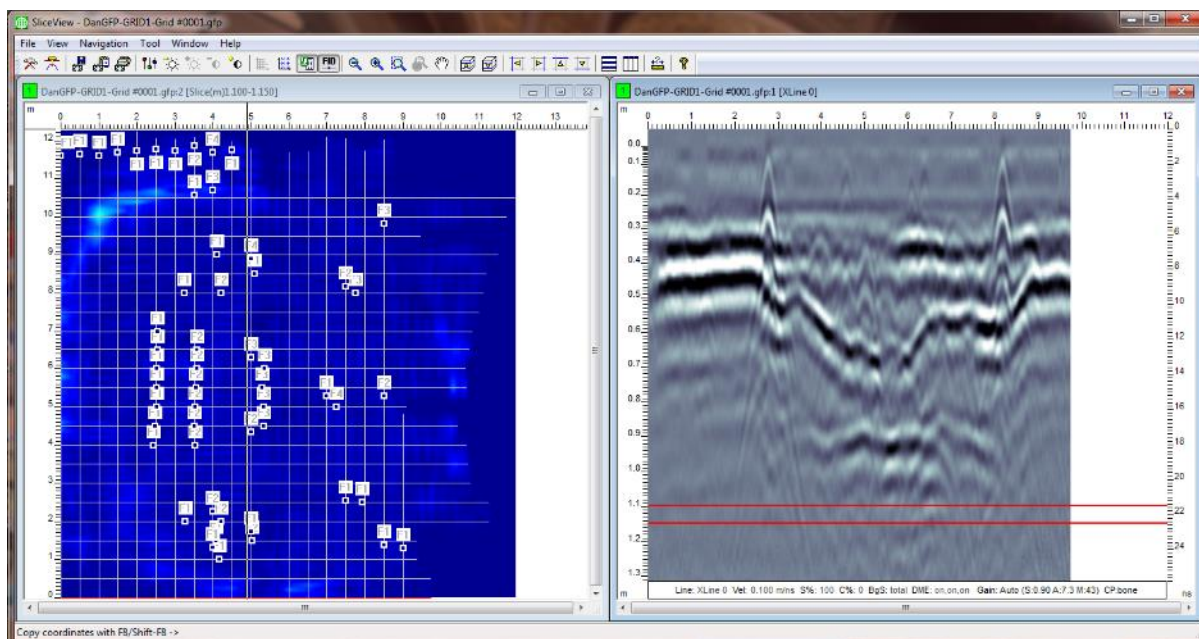If the grid contains Flags/Fiducials on any data lines, they are automatically displayed on the image in the Depth Slice View when Show Collected Lines is enabled. The flags/fiducials appear as small squares on the line.

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.
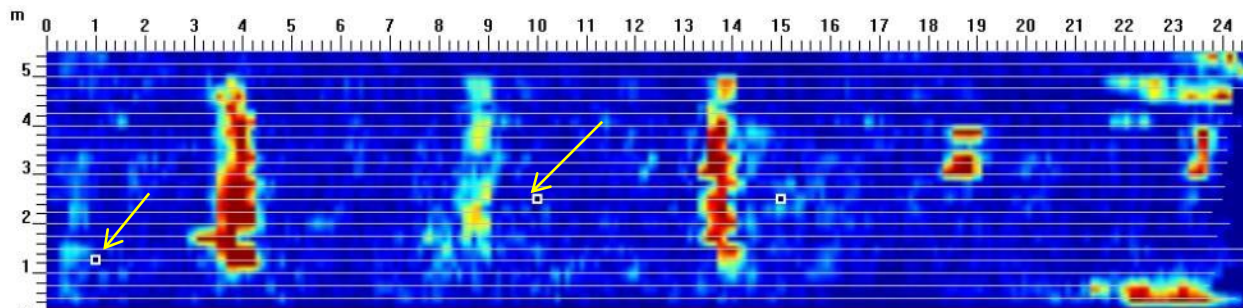
5.2.8   GPS Format

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.

a. To open the GPS Format dialog box click **View > GPS Format**.
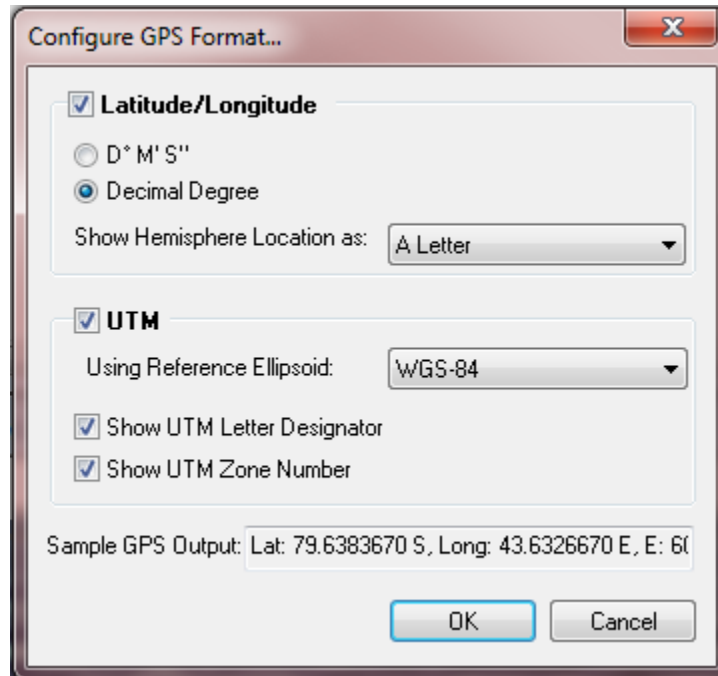
5.2.8.1.1 Latitude/Longitude

b. 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

c. 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.

Click **OK**.

5.3 Navigation
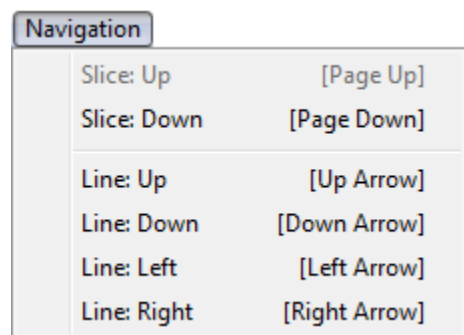
5.3.1   Slice Up or Slice Down

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 ().

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

Tool

Data Processing...
Hyperbola Velocity Calibration
Measure
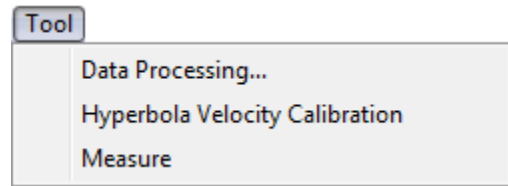
5.4.1   Data Processing

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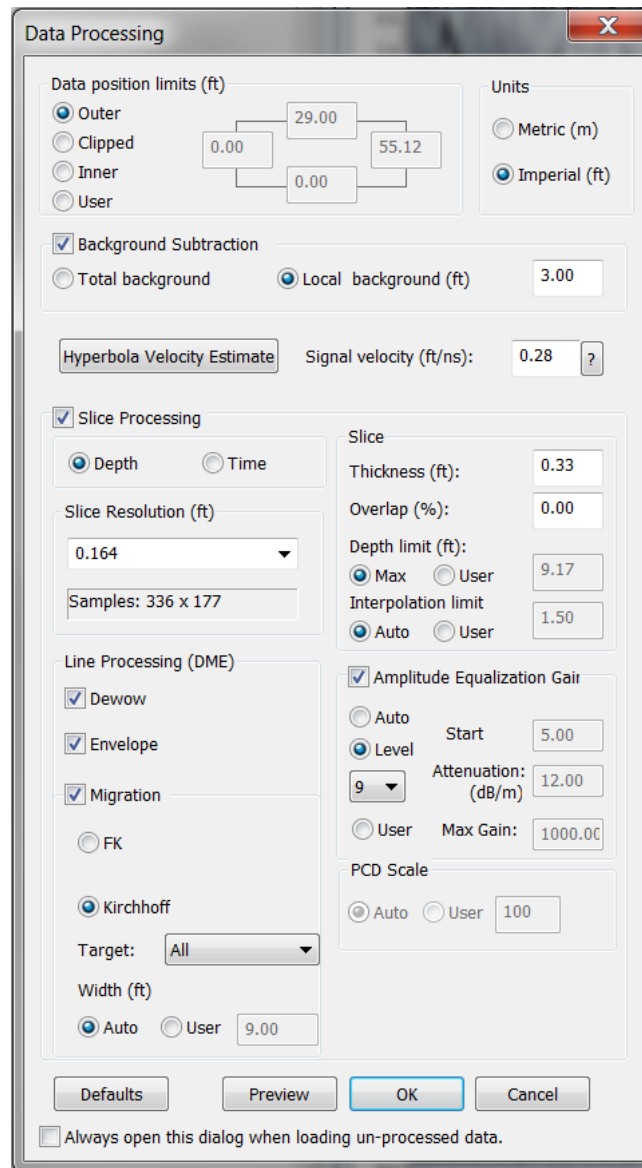
Slices produced in SliceView-Grid display GPR signal amplitude versus XY position. Amplitude value is the average amplitude value over the depth or time thickness. Data processing processes such as Dewow, Migration, Background Subtraction, and Envelope affect the original amplitude.

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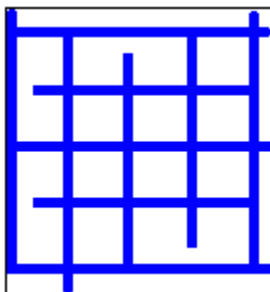
GPR lines that are shorter than the longest lines are padded with zero data so all lines are the same length.

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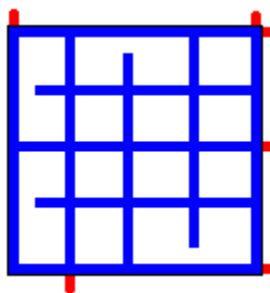
Clipped data limit is not available if you have only X-lines or Y-lines, (no Y-lines to clip the X-lines and vice versa).

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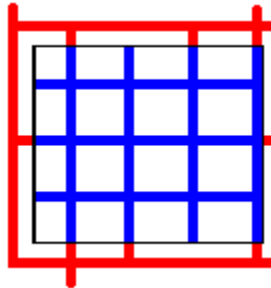
For example, if all the lines are 10m long, except one in the X direction that is 10.5m long, and another in the Y direction that is 10.2m long, the grid size plotted in the depth slice will be 10 x 10m.

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.
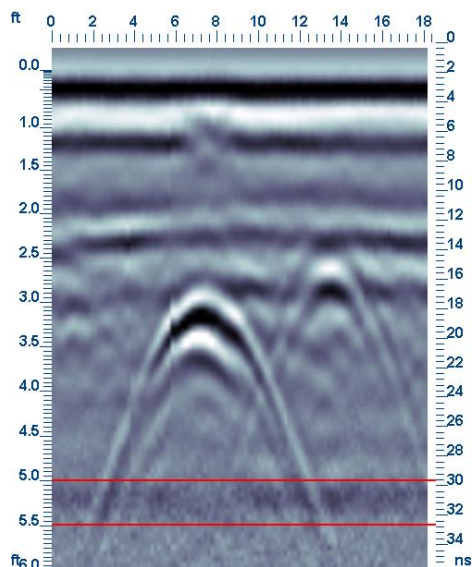
Before Total Background Subtraction   **After Total Background Subtraction has been applied**
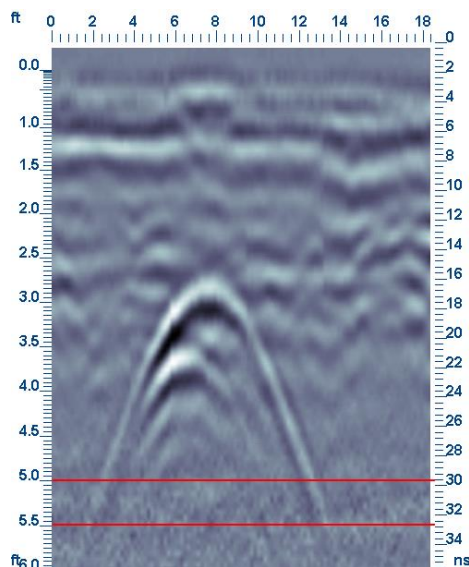
This filter is most effective when the air wave and/or ground wave events are fairly constant throughout the grid of GPR lines. If the surface varies in composition or water content, the ground wave event will vary in amplitude and time; using total background subtraction may not remove the events satisfactorily 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.
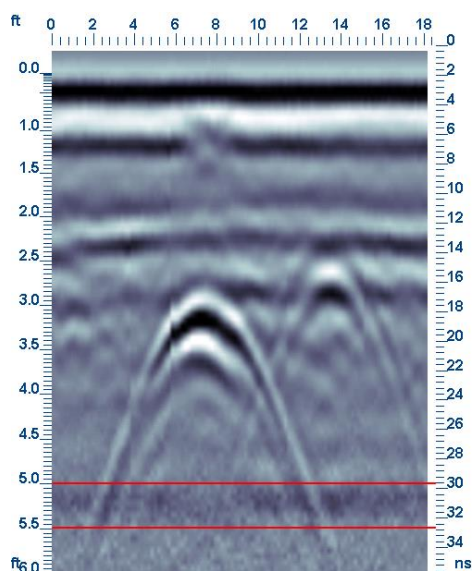
Before Local Background Subtraction   **After Local Background Subtraction**
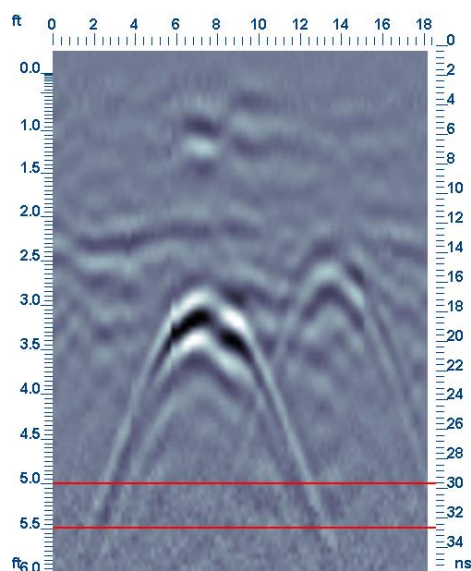
To determine an appropriate window width for the local background subtraction filter, scroll through the GPR lines in your grid and determine the length of the shortest flat-lying reflection that you want removed from the data. Start with a value of 1 meter (3 feet) and modify up or down as necessary 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).

a.   To display a list of typical signal velocities, in the Data Processing dialog box, beside **Signal Velocity**, click [?] .
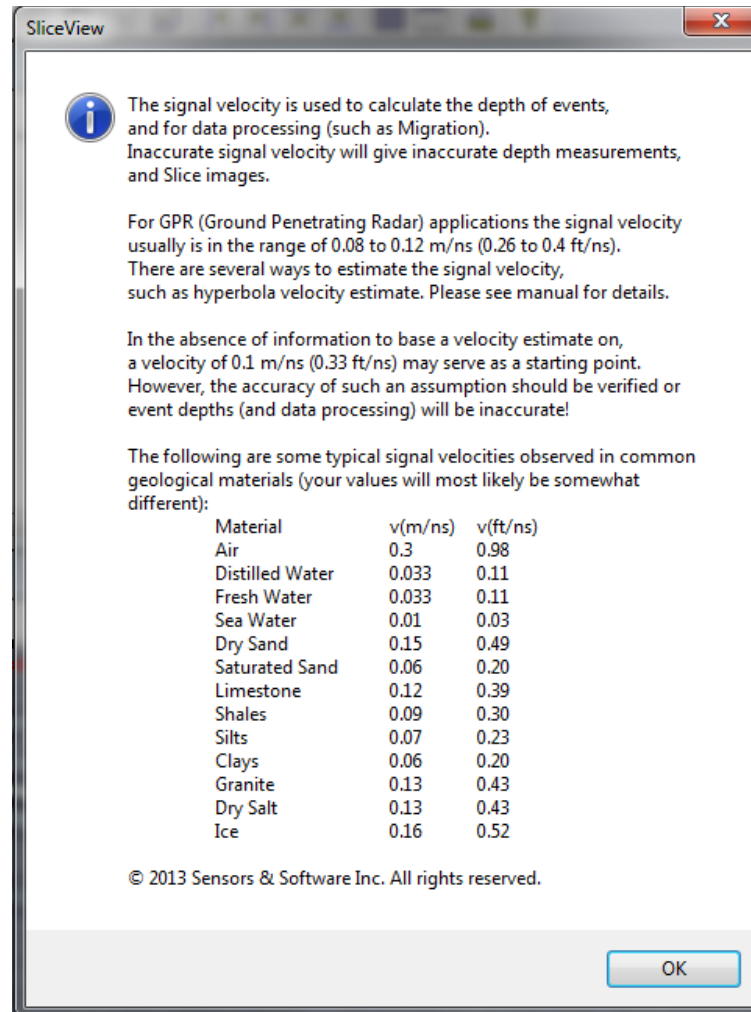
Record the velocity for the material you are scanning.
Click **OK**.
In the Data Processing dialog box, in the **Signal Velocity** field enter the material velocity
Click **OK**.

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.

| 0.16ft (116x117 samples) | 0.20ft (93x94 samples) | 0.50ft (37x37 samples) | 1.0ft (19x19 samples) |
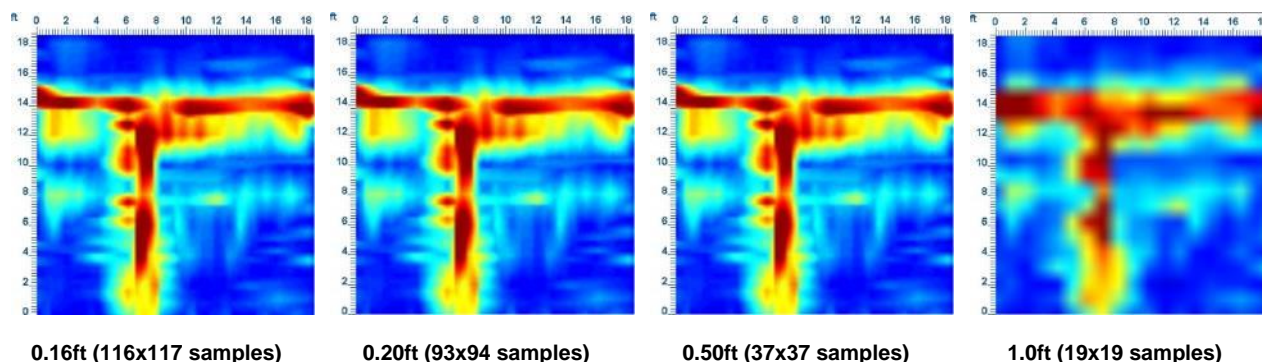
Depth slices with a very small sample size are very detailed but take longer to process.

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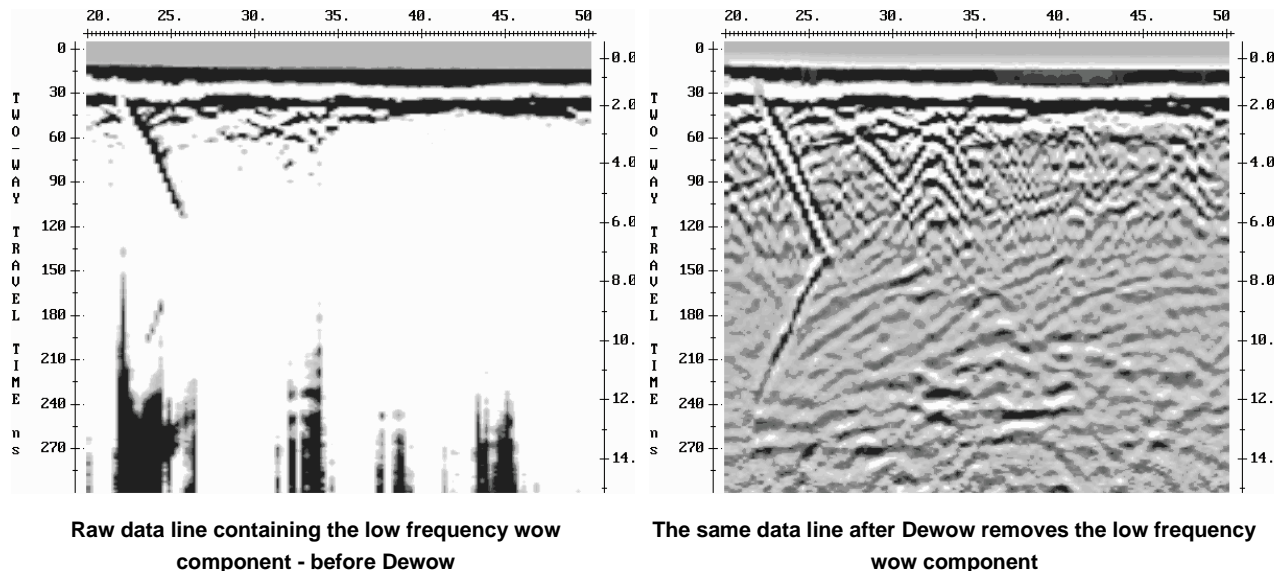
Wow is removed from the data by running a high pass average filter on each trace. A window with a width the same as that of one pulse width at the nominal frequency is set on the trace. The average value of all the points in this window is calculated and subtracted from the central point. The window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

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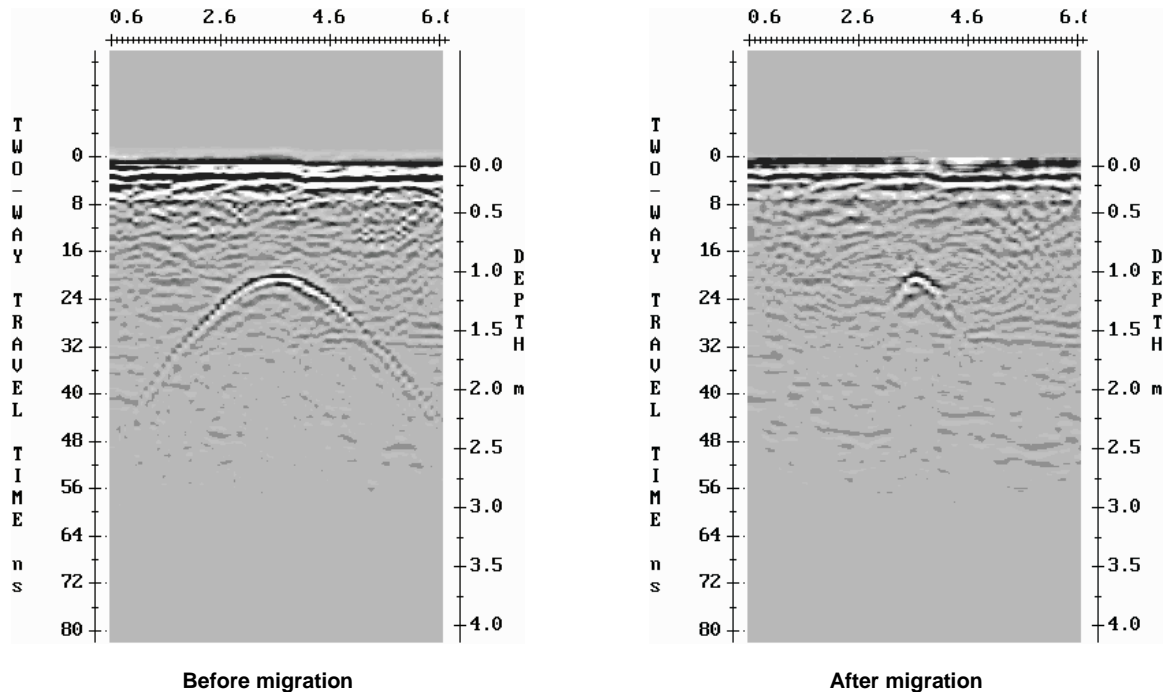
Migration requires an accurate Signal Velocity value. If the velocity value is too low or too high, hyperbolic reflectors will not be focussed back to a point and the target will have fuzzy edges in the depth slice.

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.

There are two types of migration available in SliceView: F-K Migration and Kirchhoff Migration.

The **F–K migration** applies a synthetic aperture image reconstruction process to the GPR line. The GPR data are Fourier-transformed into plane waves at a monochromatic frequency. The waves are then processed individually to superimpose the energy at source point. This transformation was devise by R.H. Stolt (Geophysics, Vol 43 1978, p 23-48) and is often called Stolt migration.

The **Kirchhoff migration** processes the data in its original space and travel time form and is more intuitive. The Kirchhoff migration sums along a hyperbolic trajectory for a given velocity and places that energy at the apex of the hyperbola. This concept is readily understood from examining GPR records with localized point targets. The point target response results in energy lying on hyperbolic trajectory in space-time cross sections. The Kirchhoff summation approach

essentially takes all the energy along a given hyperbola, sums it up and places it at the apex of the hyperbola which is the location of the source.

There are two parameters available for the Kirchhoff Migration:

Width: Window width used for summing along the hyperbolic trajectory. Default value is calculated based on the GPR line parameters and used during the migration processing.

If not using the default, the value is in feet or meters, depending on the units the GPR line was collected in.

Target Type: Type of target being imaged to optimize the gain for amplitude normalization. The options are: 0=All Targets, 1=Point Targets, 2=Rod/Cylinder-targets, and 3=Planar Targets. The default is 0=All Targets.

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 shows enveloping process turning negative components into positive. The bottom image shows a smooth wavelet outline.

Original trace

Trace undergoing Enveloping

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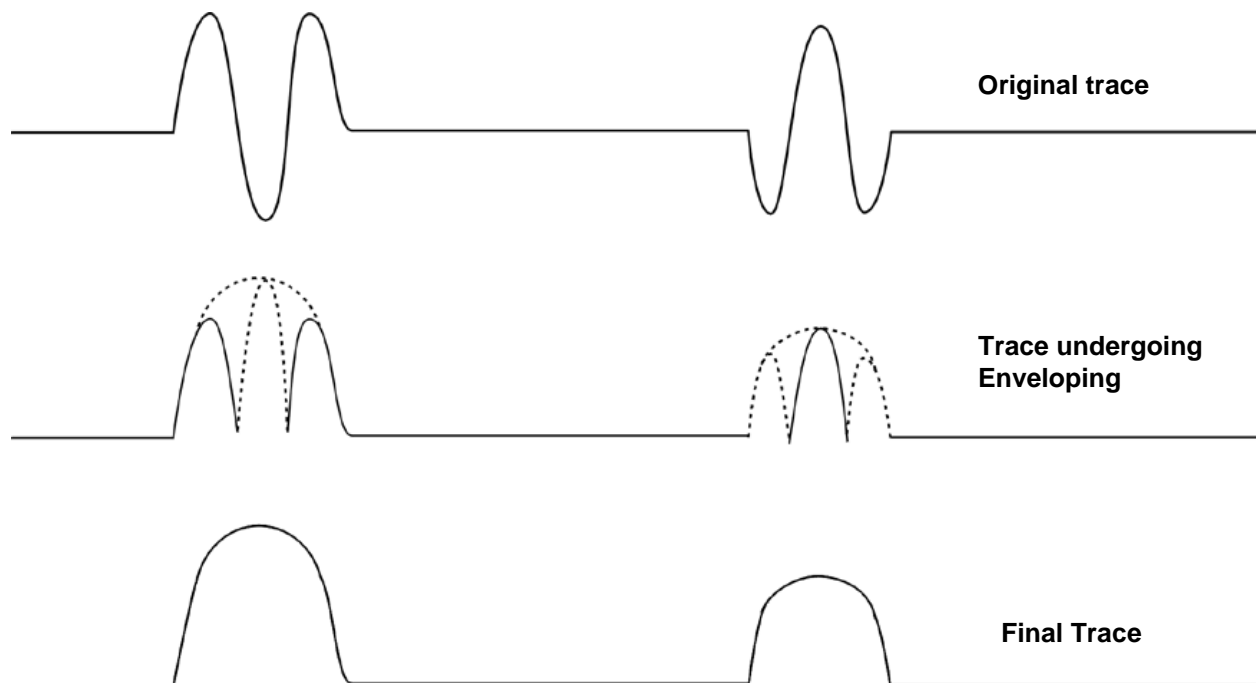
At a single time or depth value, the amplitude value will be similar to the raw amplitude value but is always positive. Average enveloped amplitude is calculated by averaging the amplitude values over a depth or time thickness.

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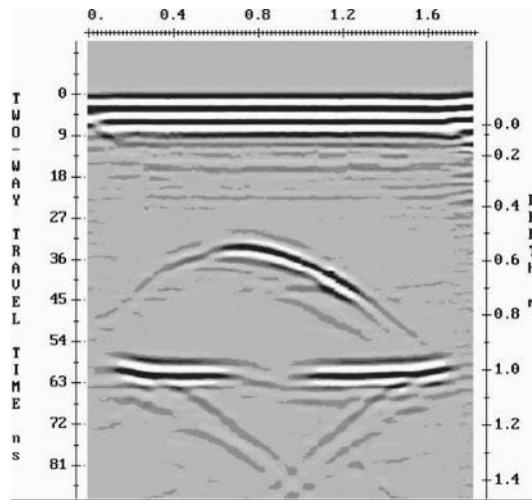
Raw data with positive and negative values   **Raw data with positive values**

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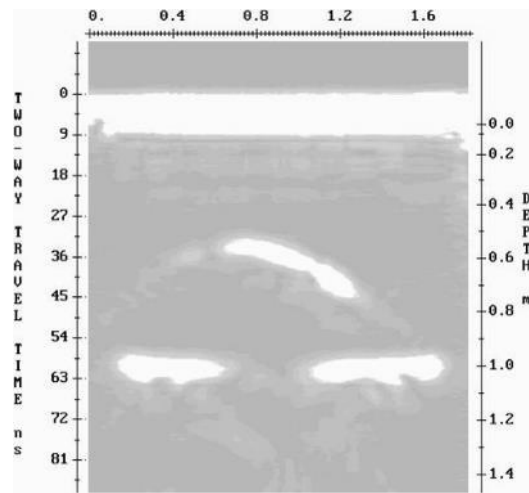
If enveloping is turned off, the data retains the negative amplitude values and the color palette becomes bipolar, which means that the colors display positive, negative, or zero amplitude data values.

5.4.1.5.4 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-Grid divides the data volume into slabs of equal thickness and then displays depth slice images of the average amplitude in each slab:
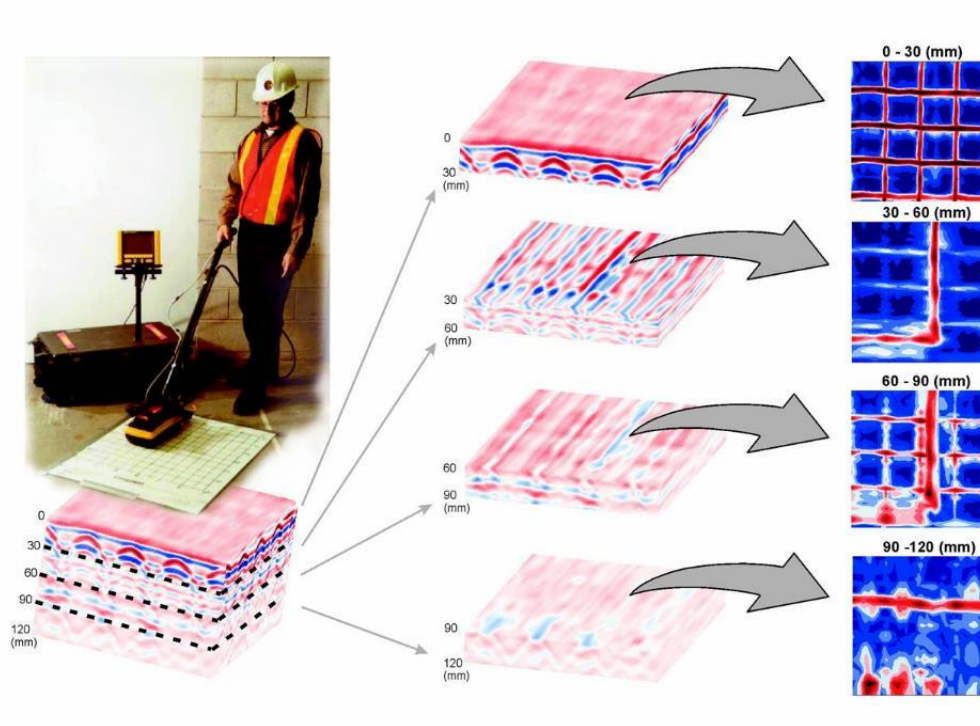
The default thickness value is based on the antenna frequency used for the grid survey. In general, as antenna frequency decreases and wavelength increases, the default depth slice thickness is increased.

The default value in feet is (1000/frequency) / 12.

The default value in meters is (1000/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.

5.4.1.5.5 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.

5.4.1.5.6 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.

a. To change depth limit, select the **User** option.

b. 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.

5.4.1.5.7   Slice - Interpolation Limit

SliceView-Grid generates depth slice images by interpolating data into the gaps between GPR linens. 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-Grid interpolates data between GPR lines to generate a solid data set that is then displayed as depth slices.
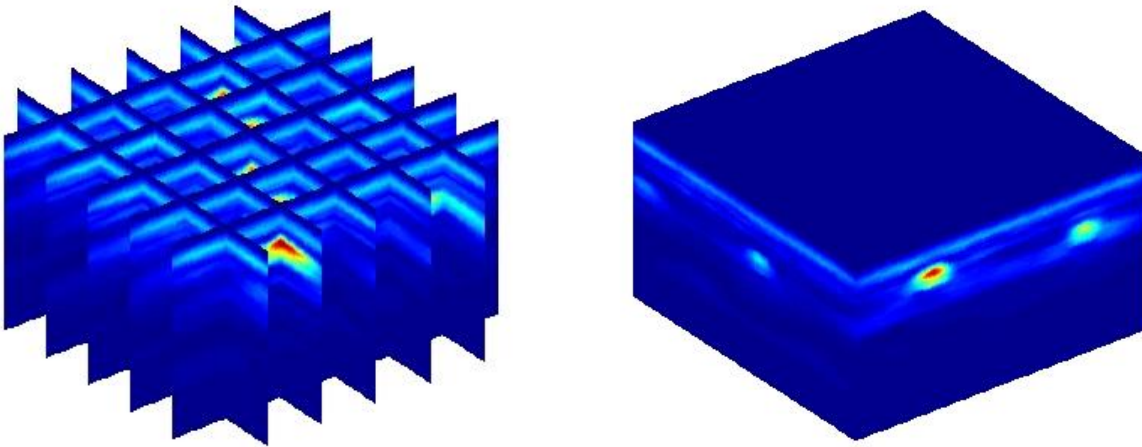
The Interpolation Limit defines the maximum distance (in meters or feet) that data will be interpolated. If the distance between two GPR lines exceeds this limit, a gap of zero data will be left between them. The following image displays a depth slice image from a Y line data grid showing a gap with zero data where the line separation exceeded the Interpolation Limit.
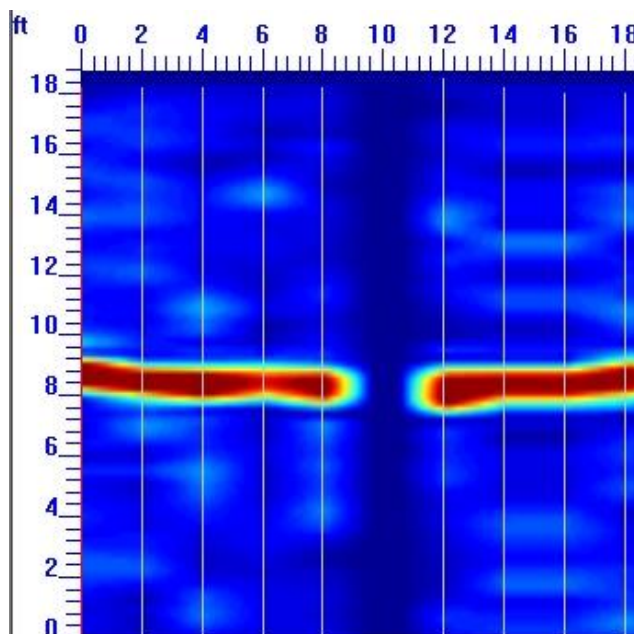
This value defaults according to the data set and can usually be left as Auto. The default setting is 1.5 times the average survey line separation.

The User setting allows you to define the interpolation distance.
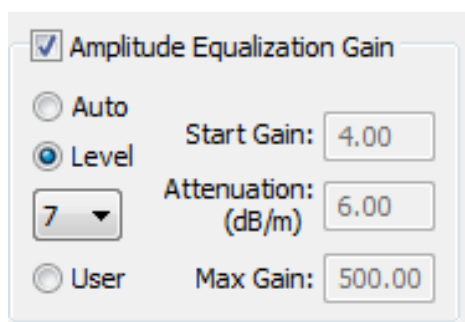
5.4.1.5.8 *Amplitude Equalization Gain*

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: <u>Attenuation</u>, <u>Start Gain</u>, and <u>Maximum Gain</u>.

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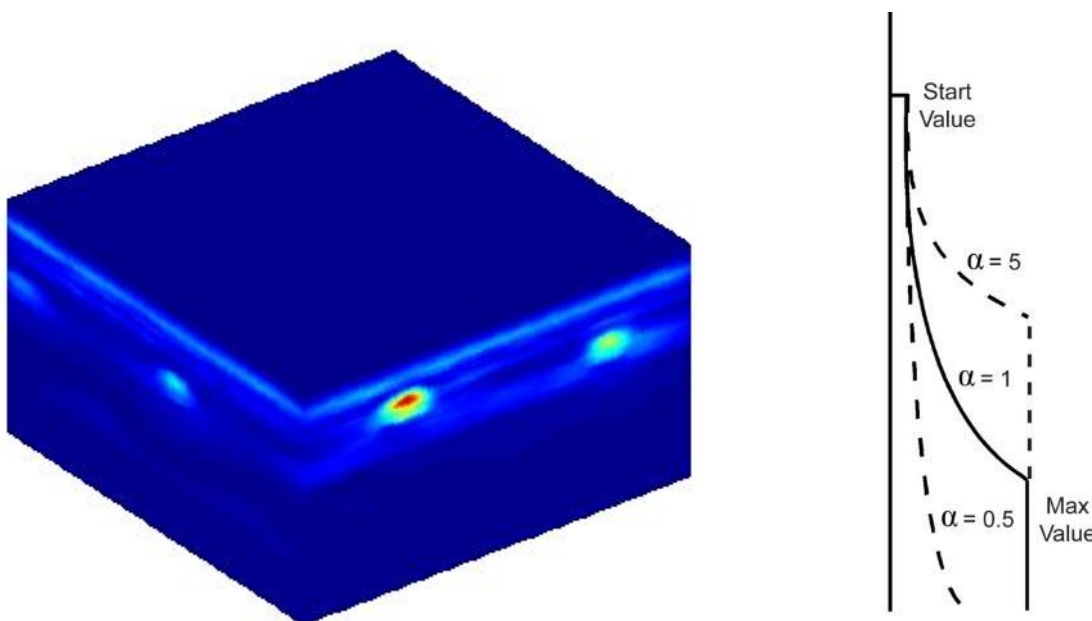
The Amplitude Equalization Gain setting is only applied to the depth slice image display. Changing the gain setting has no effect on GPR line images.

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

| Auto value too low | Good color balance | Auto value too high |
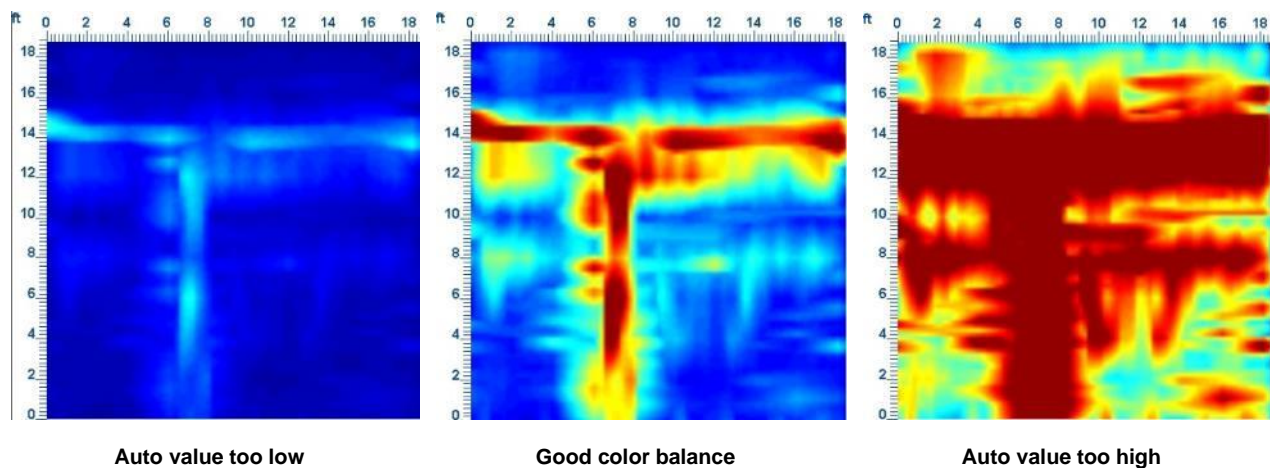
Typical attenuation values fall between 0.0 and 20.0, but you can enter any values by selecting the User option and then entering the value into the text box.

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 lines 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.

5.4.1.5.9 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 <u>View</u>).

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.

5.4.1.6   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.
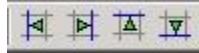
If necessary, you can change the value to make the hyperbola more visible.

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.

a. Select the colored band on the most visible hyperbola that has the longest tails.

b. 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.
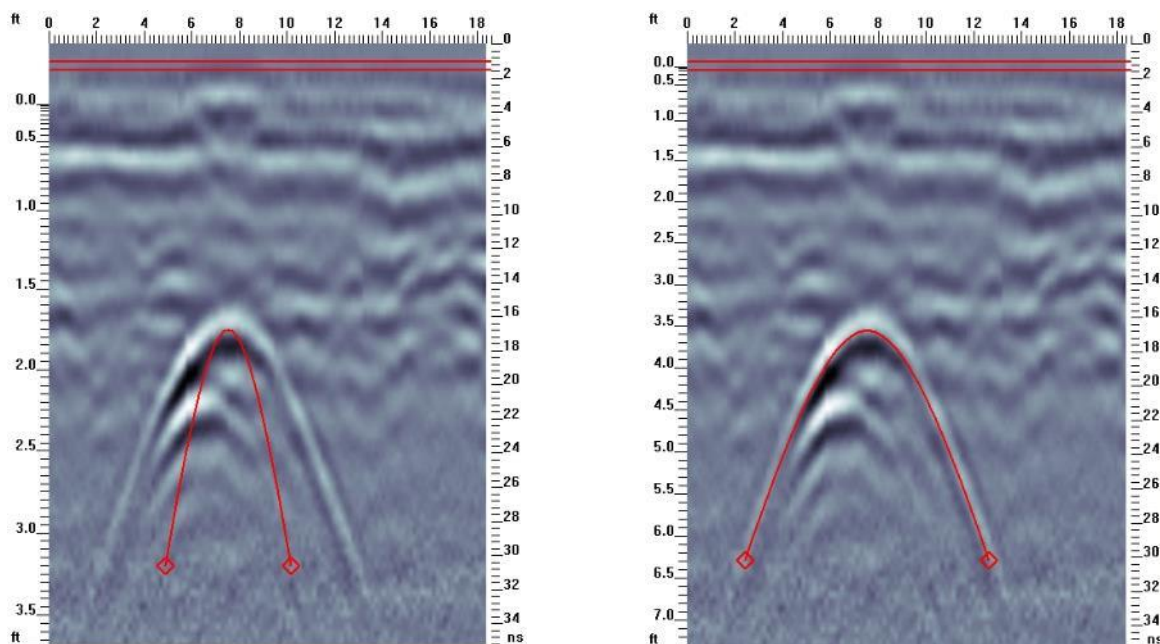
After the hyperbola has been positioned at the apex of the hyperbola in the GPR line image, match the shape of the hyperbola.

   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.

Once the hyperbolas are matched, click **Hyperbola Velocity Calibration** again to exit velocity calibration mode.

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-Grid 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.

a.   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.

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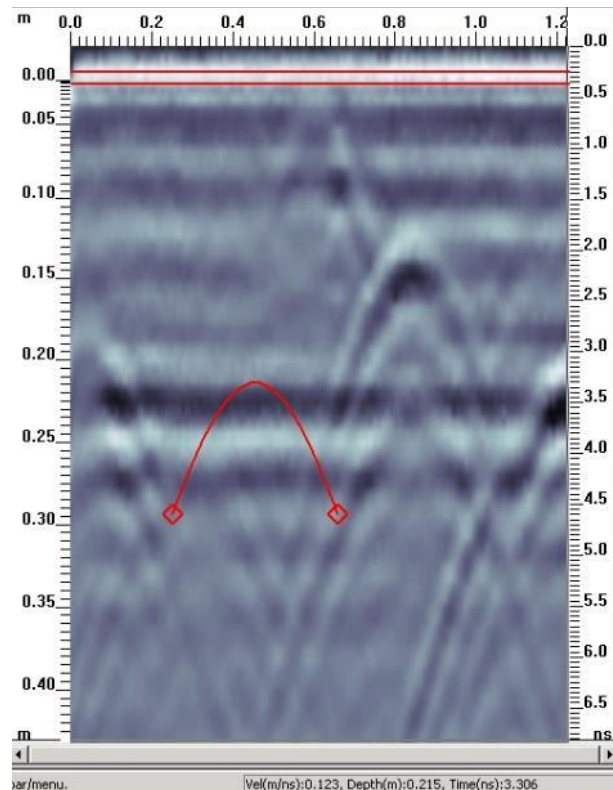
For example, if the reflection from the bottom of concrete is visible in the GPR line image, and the depth of the concrete is known, the apex of the hyperbola can be positioned on that reflection and the velocity changed until the depth value displayed on the bottom of the window matches the known depth.

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.

a.   To access the Measure tool, in the menu bar, click **Tool > Measure**.

To measure the distance between two points, click the start position.

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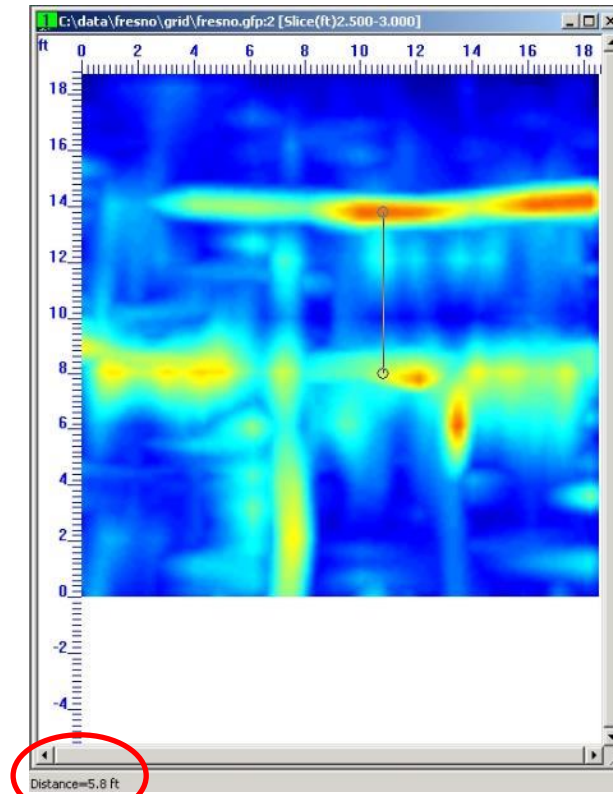
It is important to understand that measurements made on GPR lines are based on the velocity so an accurate velocity is critical for an accurate measurement.

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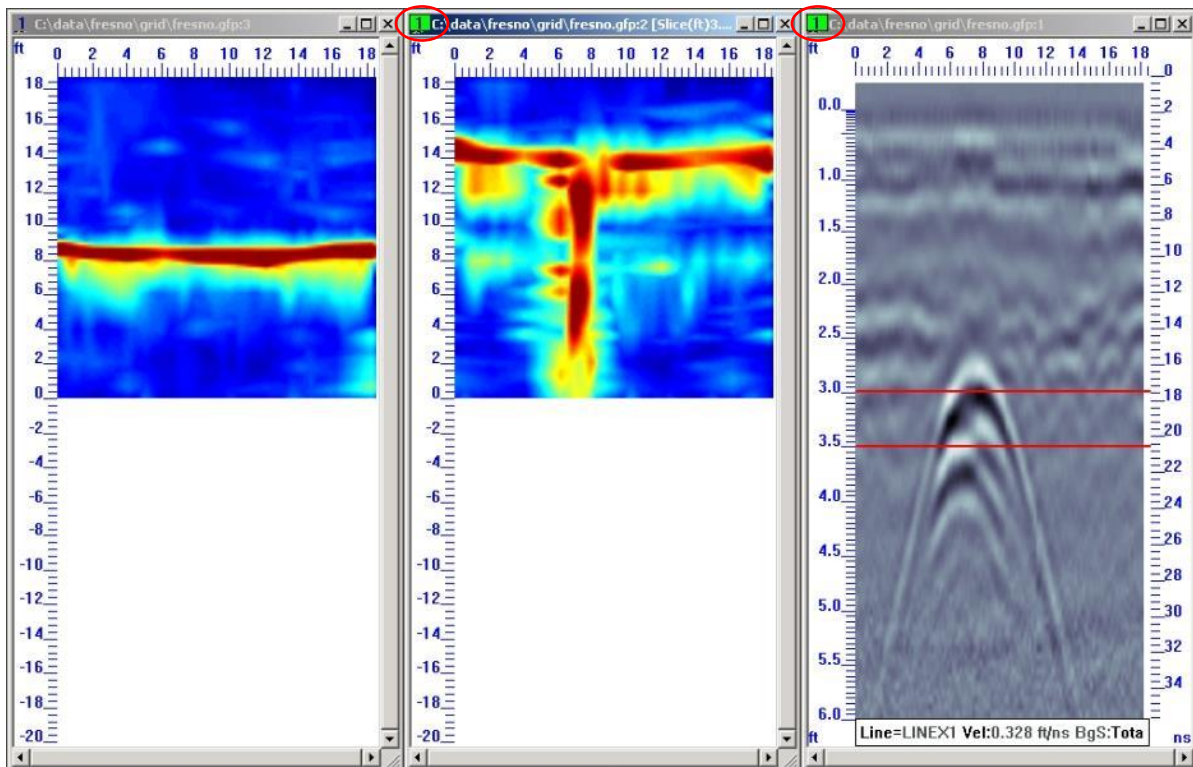
When multiple plan view windows open, only one can be active at one time. However, changing some variables, such as data processing parameters, velocity, slice thickness, and color palette, change the value for all plan view window instances. Other variables, such as Show Collected Lines, Show Scale,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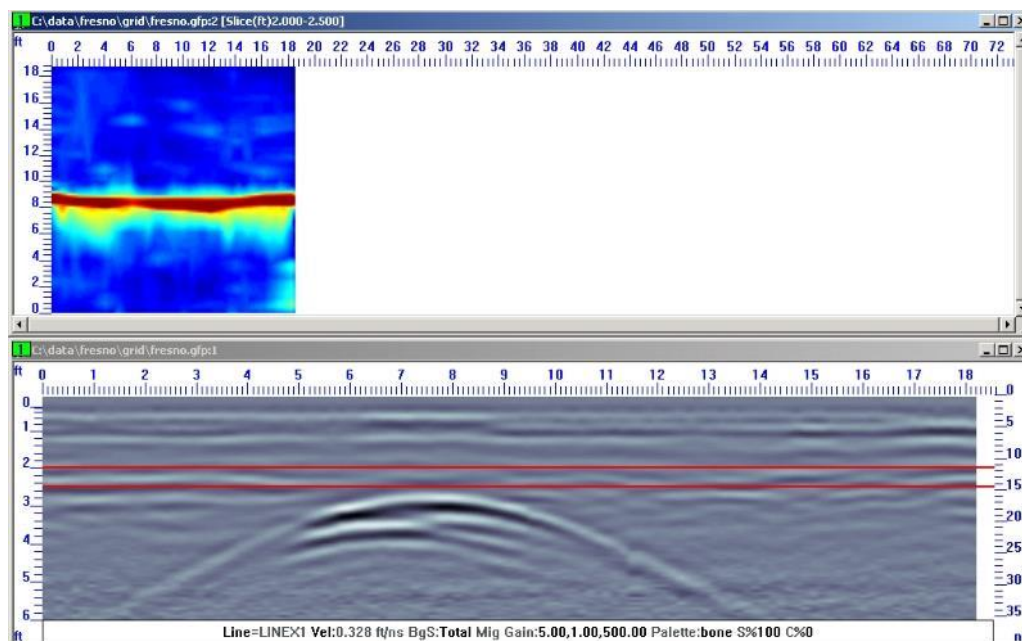
5.5.3   Cascade

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.
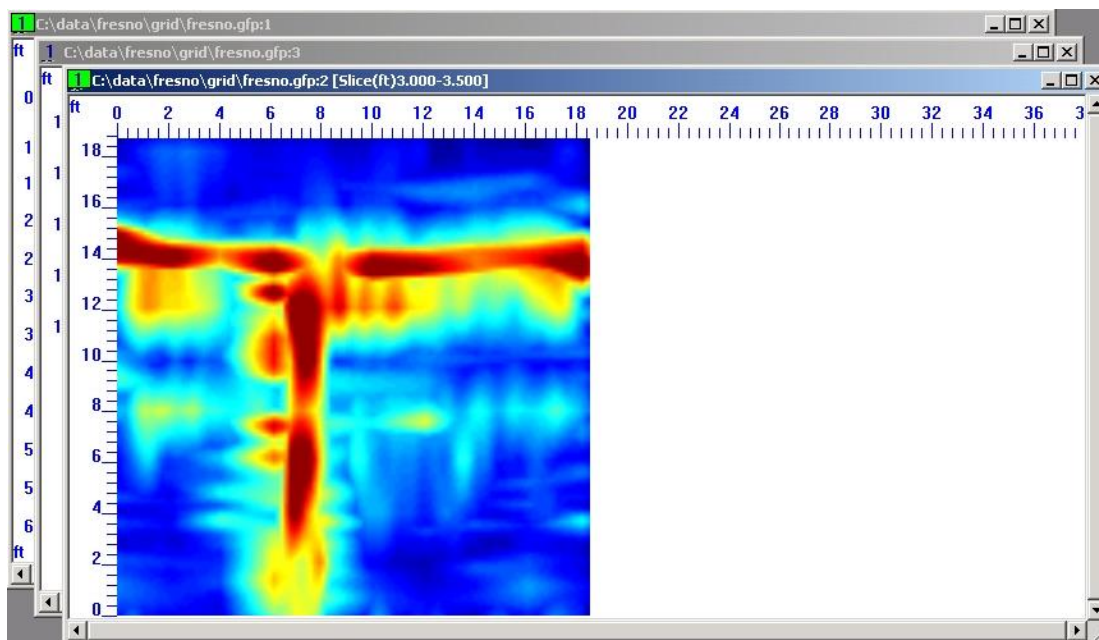
5.5.4   Tile Horizontally

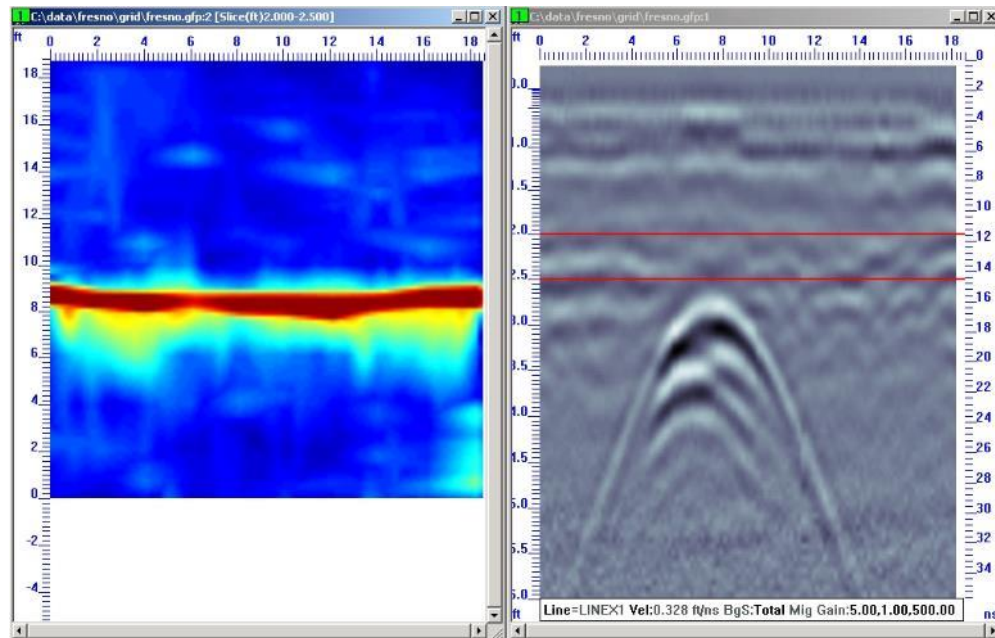In the menu bar click **Window > Tile Horizontally** to display all open windows so they are tiled horizontally.

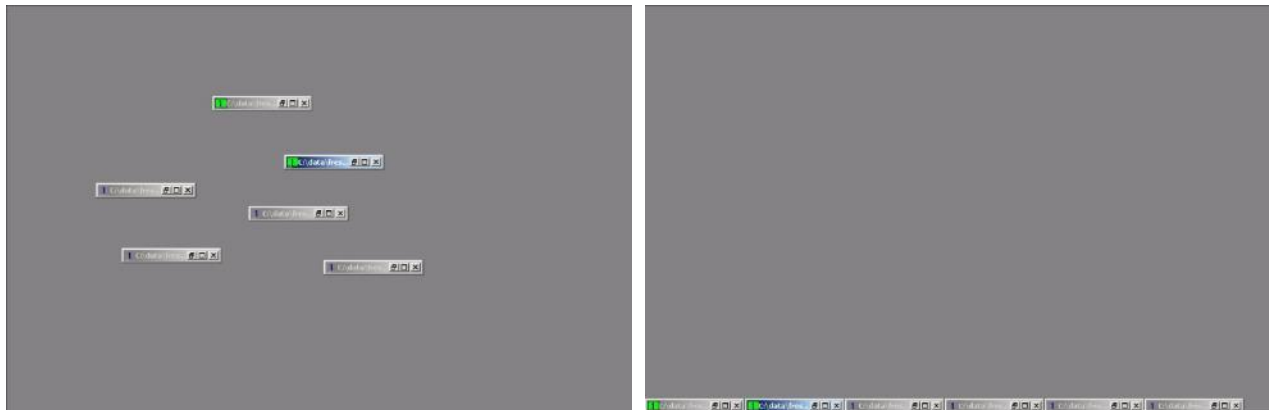Alternatively, in the toolbar click ▤.

5.5.5 Tile Vertically

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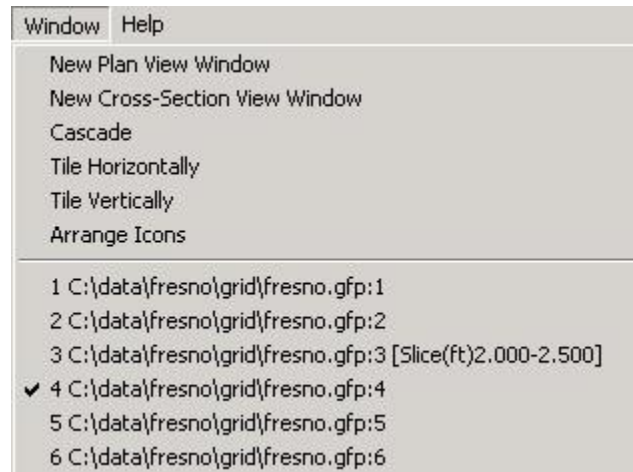
Alternatively, in the toolbar click ⊞.

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-Grid.

6 Opening SliceView-Lines

SliceView is an optional module of the EKKO_Project software. To access SliceView-Lines, you must first open EKKO_Project.

SliceView-Lines is only accessible when the project (gpz) file contains lines with 2D positioning, either through GPS or by manually adding Line Positioning to the GPR lines (see the Line Positioning routine in the EKKO_Project manual).

a. 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 project file containing the line(s) to process into depth slices.

In the **Getting Started** dialog box, click ➜ Browse for Project File...
Alternatively, click **Add Lines** or **Add all Lines in a Folder** to create a new project with lines.
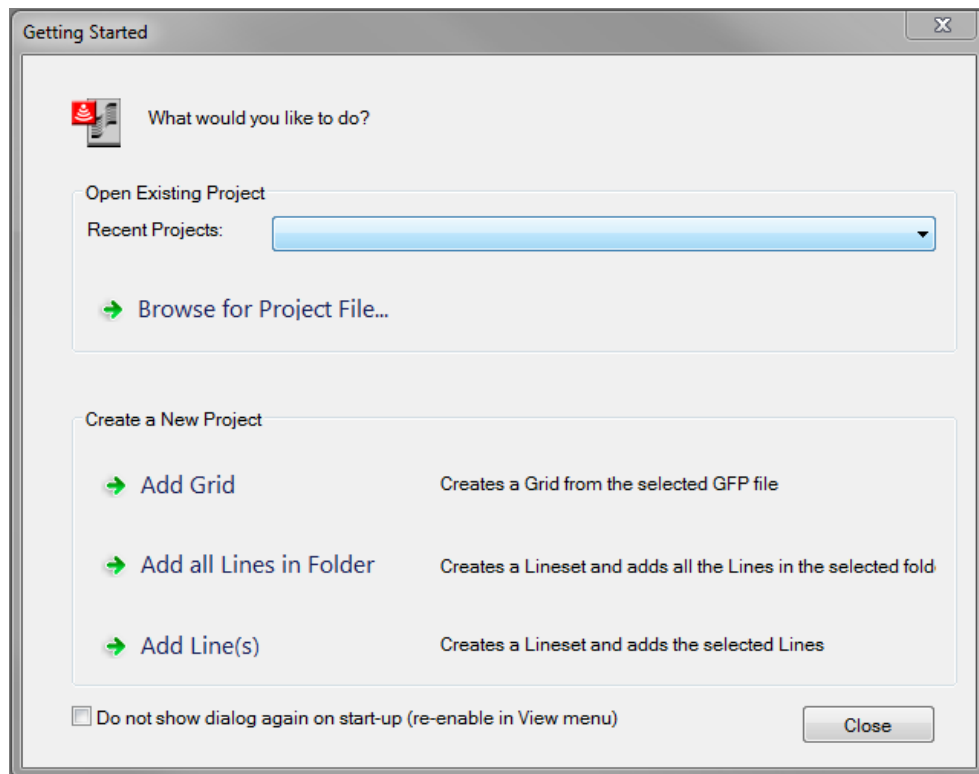
In the **Open** dialog box, navigate to and then select GPR lines, a folder containing GPR lines or project file.

> **Note**: If you are opening a project only gpz files are listed. If you are adding lines to a project file, only .hd files are listed.

Click **Open**. The line(s) are displayed in the **Project Explorer**:
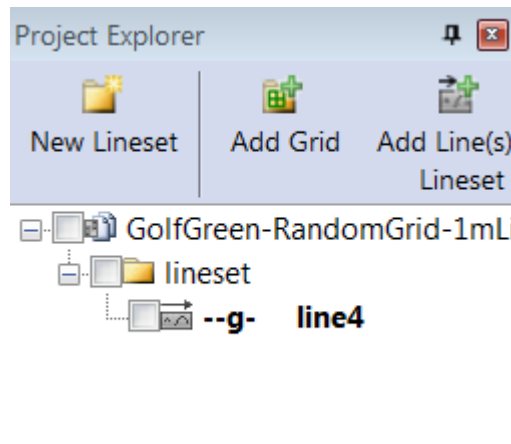
In **Project Explorer**, select a GPR line or check one or more lines to process into depth slices.

Select SliceView-Lines in one of these ways:

a. In the EKKO_Project menu bar, click **SliceView-Lines** from the dropdown menu on the side of the SliceView button on the toolbar.
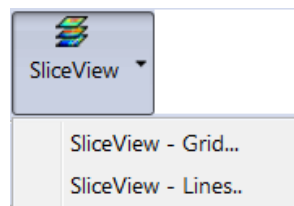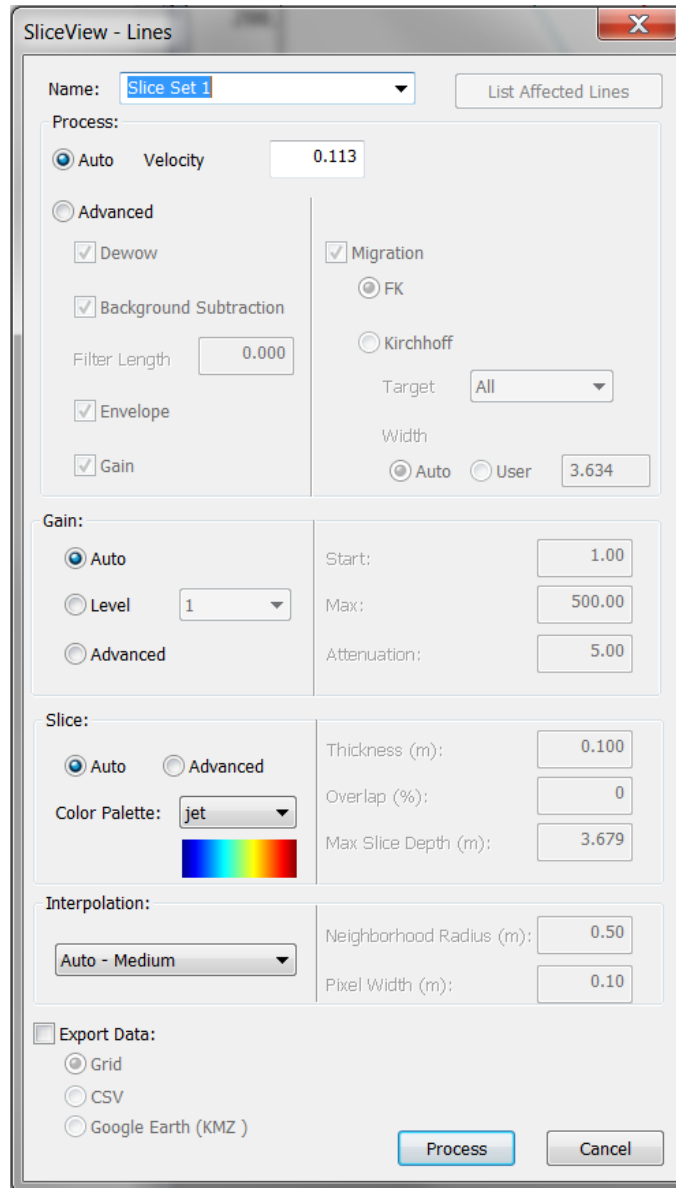
b. Another method is to select the menu item **Tools > SliceView-Lines**.

c. To process a single line, right-click on the line in the Project Explorer window and click **SliceView-Lines**.

LineView...   [Enter]

SliceView - Grid...

SliceView - Lines...

3D Preview

Rename

Edit Flags/Fiducials...

Add Grid...

Add Lineset...

New Lineset

Add Line(s) to Lineset...

Attach File...

Zoom To

Position Relationship   ▶

Export Line...

Process...

Undo Process

Average Trace Amplitude (ATA) Plot...

Average Frequency Spectrum (AFS) Plot..

Trace Plot...

Cut

Copy

Paste   Ctrl+V

Delete
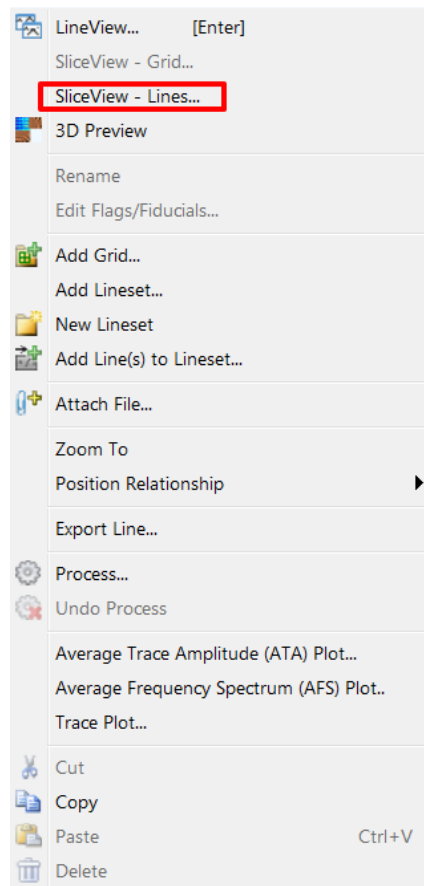
The SliceView-Lines settings dialog opens.

6.1 SliceView-Lines Settings

The first time the SliceView-Lines dialog opens, the settings are set to default values.

6.1.1   Name

Name is the name of the Line Slice generated. This name is displayed in the Layer View window and can be checked to display the line slice data image in MapView or unchecked to hide it.

The SliceView-Lines dialog always opens with a new default name. Use the dropdown list to select previously processed Line Slice name; useful when reprocessing a Line Slice with modified settings.
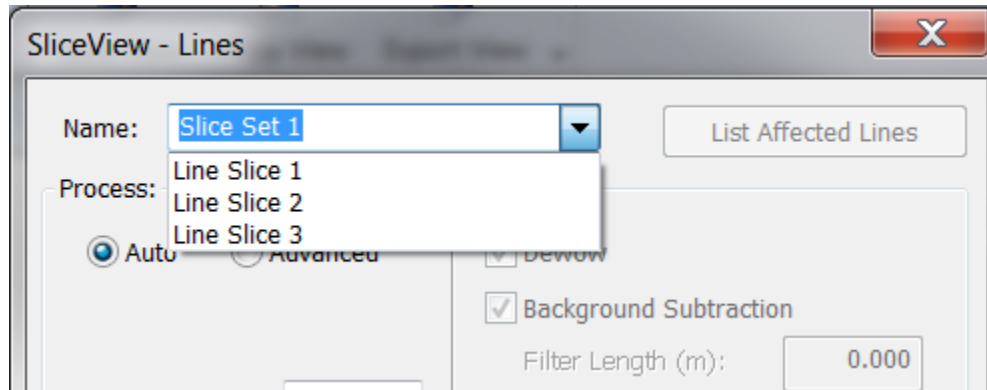
6.1.2   List Affected Lines

The **List Affected Lines** button displays a list of the GPR lines used to generate the current Line Slice. This button is not accessible when generating a new Line Slice; it is only accessible if the selected Line Slice was generated previously and is now being edited.

6.1.3   Process

There are several processes that are usually applied to the GPR Lines before generating the depth slice. These are listed in the Process box at the top of the dialog.

When **Auto** is selected, the default settings for all the processes are applied before generating the depth slice.

When **Advanced** is selected, the user can decide which processes to include and modify the parameters for that process.

In general, it is best to run in **Auto** mode, so all the recommended processes are included in generating the depth slice.

6.1.3.1 Velocity

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

The default velocity is 0.10 m/ns or 0.328 ft/ns but, if possible, the user should open the GPR line or lines in the LineView module and measure the velocity by using the hyperbola-fitting method (see the LineView manual). If processing more than one line and the velocity varies between lines, the average velocity is used.

6.1.3.2   Processes

If Advanced is selected, the process checkboxes are enabled for the user to modify the processing applied to GPR line(s) before depth slices are generated.

Dewow is explained in DME Processing.

Background Subtraction is explained in Background Subtraction

The Background Subtraction Filter Length defaults to zero (0). This uses the total length of the GPR line (see Total Background) which may not always create the best depth slices, especially if your GPR line data is very long, crosses different surface materials, has many horizontal bands in it or the terrain is rough. In these cases, set Process to **Advanced** and experiment with a few different Filter Length values (see Local Background) and see which one works best. Remember that the shorter the Filter Length, the more horizontal signals are removed from the data so if your goal is to emphasize hyperbolic targets, use a shorter Filter Length but remember that a shorter filter length removes more data. Three good Filter lengths to try are 10m (30 ft), 2m (6 ft) and 1m (3 feet).

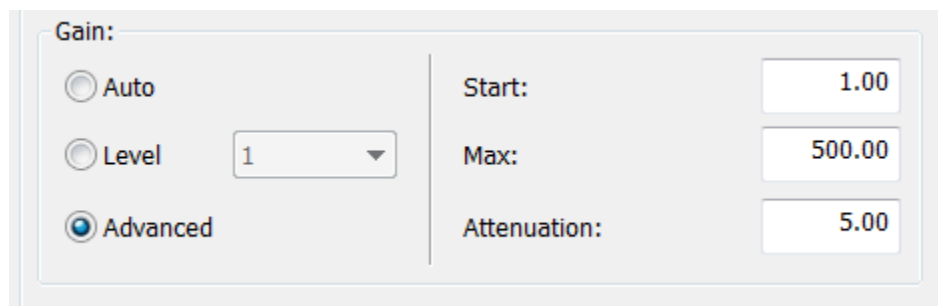**Migration** is explained in DME Processing.

Envelope is explained in DME Processing.

Gain is explained in Amplitude Equalization Gain. If Gain is unchecked, the Gain options lower down in the dialog box are greyed out and not accessible:

6.1.3.3   Gain

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.

Select **Auto**, **Level** or **Advanced**. These options are explained in <u>Amplitude Equalization Gain</u>.

Note that Auto may not provide enough gain for depth slices. If your depth slices are not showing the full range of the color palette (see below), change the Gain from Auto to Level and reprocess the depth slices with a gain level from 1 to 12, increasing the Level and reprocessing the depth slices until there is a full range of colors visible in the depth slices.
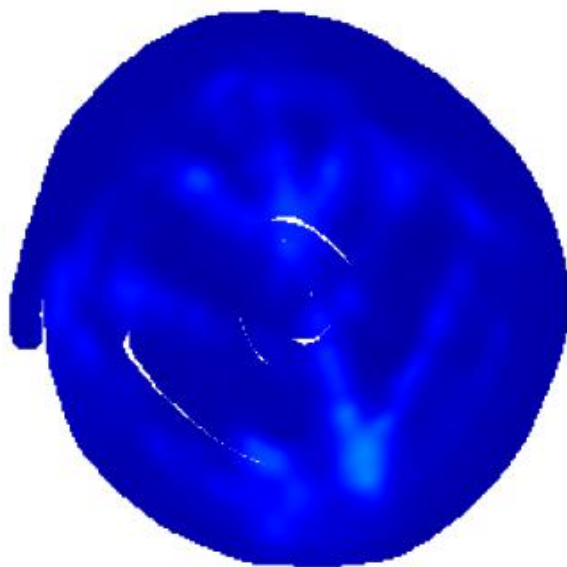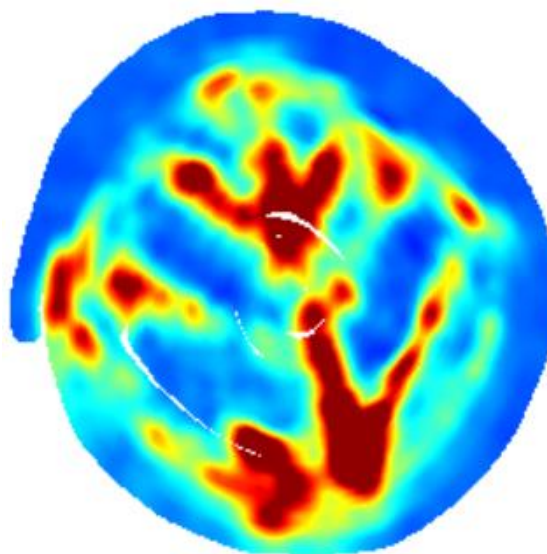
Gain = Auto   Gain Level = 6

6.1.3.4   Slice

The Slice settings include the Color Palette the depth slices are displayed with, the Slice Thickness, the percent of Overlap between slices and the Maximum Slice Depth. If the Slice settings are set to **Auto**, default values are used. Selecting **Advanced** allows the user to modify the settings.

Use the dropdown to select the **Color Palette**. For more information, see Slice Color Palette.

Thickness is explained in Slice - Thickness

Overlap percentage is explained in Slice - Overlap
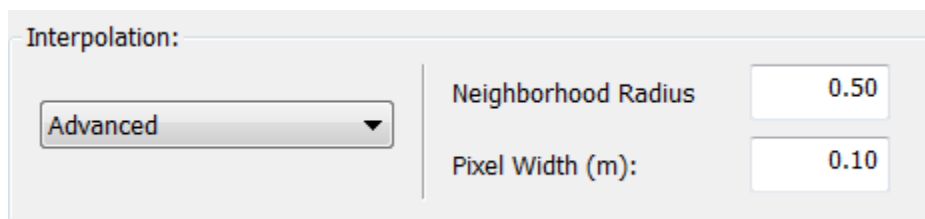
Maximum Slice Depth is explained in Slice Depth Limit

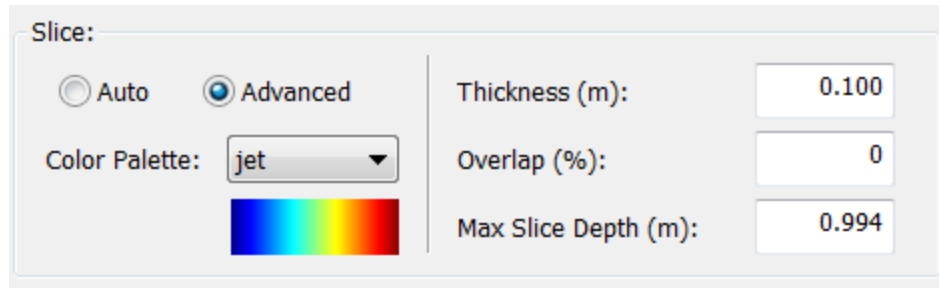## 6.1.3.5   Interpolation

After the GPR line data are processed, it is interpolated based on the Neighborhood Radius and the Pixel Width values. From the dropdown, the options are Low, Medium, High and Advanced.

The values for the Neighborhood Radius and Pixel Width are based on low, medium and high settings for the recommended line spacing for grid data collected with the antenna frequency. The lower the frequency (and the longer the GPR antenna), the higher the values for the Neighborhood Radius and Pixel width (see table below).

If the Interpolation is set to Advanced, the user can set the values for the Neighborhood Radius and Pixel Width.

Neighborhood Radius
The GPR signal amplitudes are interpolated over an area defined by the Neighborhood Radius.

To generate a continuous depth slice with few or no gaps, the Neighborhood Radius should be set to the ½ the average distance between lines. Use the Measure tool in EKKO_Project to measure this distance (see the EKKO_Project manual).

If the Neighbourhood Radius is less than the ½ the actual line spacing, the depth slices will have gaps in them. In the example below,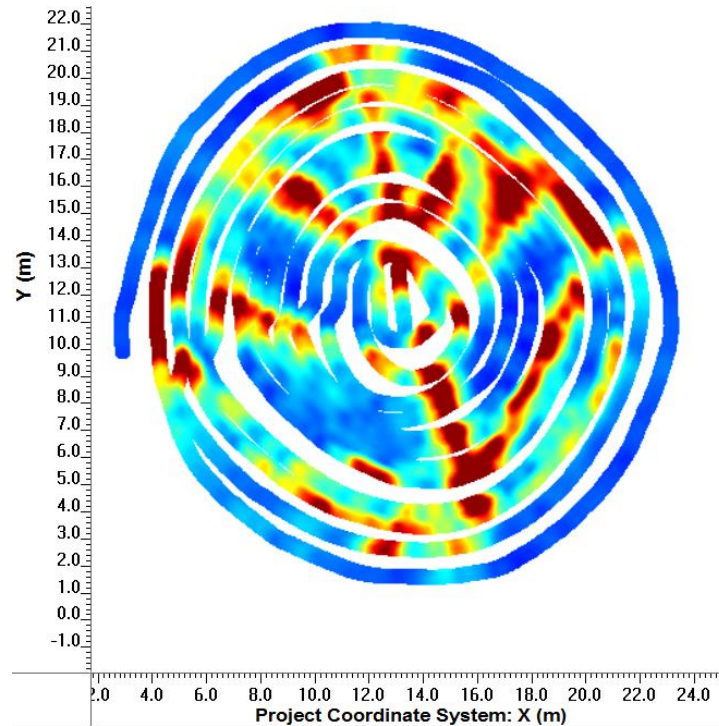 the actual line spacing is about 0.5 to 1.2m and the Neighborhood Radius is 0.25m (diameter is 0.5m), so some areas of the depth slice show gaps up to 0.7m wide (1.2m actual – 0.5m interpolation = 0.7m).

Beware of setting the radius too high; this interpolates the data over a larger area which reduces amplitudes, spreads responses over a larger area and may give a false sense of where data were actually collected.

Pixel Width

Pixel Width is the physical size of the smallest pixel of data in the depth slice.

Smaller pixel widths will produce higher resolution depth slices but will take longer to generate.

In general, the Pixel Width should be about 1/4 to 1/10th the Neighborhood Radius; the default value is 1/5th.

Beware of making too small a pixel size as it may create a false sense of data resolution. For example, if the data traces are actually spaced 0.25 meter apart, it does not make a lot of sense to set a pixel size of 0.01 metres.

The following table shows the default values for Neighborhood Radius and Pixel Width based on the antenna frequency and the level of interpolation (Low, Medium, High).

Centre Frequency (MHz)	Low Interpolation		Medium Interpolation		High Interpolation	
	Radius	Pixel Width	Radius	Pixel Width	Radius	Pixel Width
1000	0.2	0.04	0.1	0.02	0.05	0.01
500	0.5	0.1	0.25	0.05	0.125	0.025
250	1	0.2	0.50	0.1	0.25	0.05
200	1	0.2	0.50	0.1	0.25	0.05
100	2	0.4	1.00	0.2	0.50	0.1
50	4	0.8	2.0	0.4	1.0	0.2
25	8	1.6	4.0	0.8	2.0	0.4
12.5	16	3.2	8.0	1.6	4.0	0.8

For example, here is the same depth slice from the same GPR line plotted using Interpolation settings of low, medium and high:

Low   Medium   High
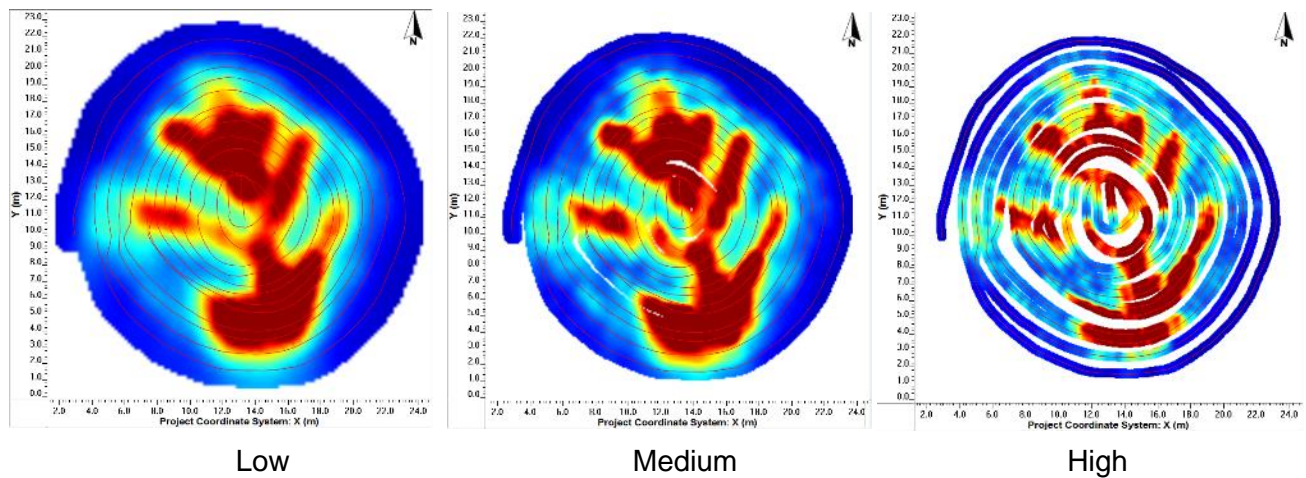
6.2 Viewing Depth Slices in MapView

After the depth slices are generated they are displayed as a layer in the MapView window.
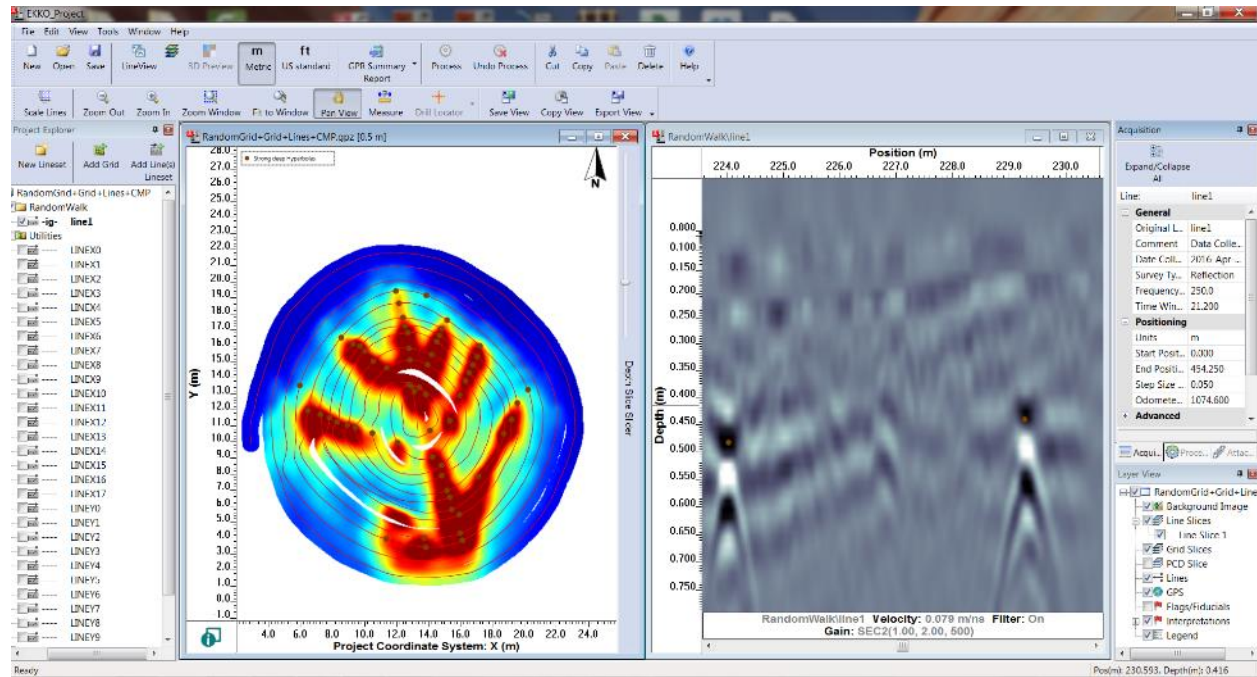
Note that the checkboxes in the Layer View window control what is displayed in MapView so if you do not see the depth slice, it may be because the Line Slices checkbox is not checked.
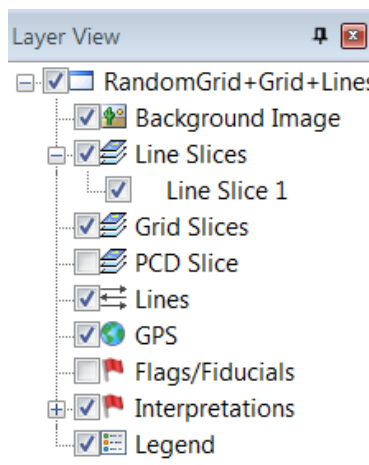
It is possible to display more than one Line Slice at the same time. The most recently generated image is on top.

Right-clicking on a Line Slice item opens a sub-menu.
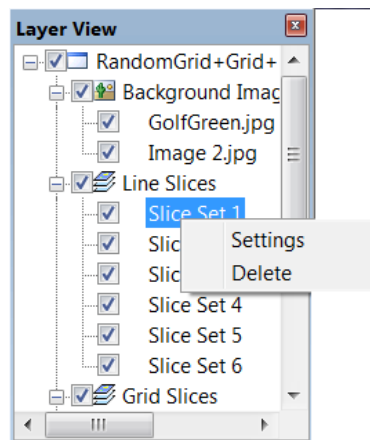
Selecting **Settings** opens the SliceView-Lines dialog to allow the Line Slice settings for that Line Slice to be modified.

Selecting **Delete** deletes the Line Slice image.

For more details about Layer View, see the EKKO_Project manual.

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

a.   In the Project Explorer, select the grid you want to export.

In the menu bar, click **File > Export Line(s) > Line Data**.

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

a.   In Windows Explorer, click the exported grid.

b.   In the folder, right-click the .gfp file GRID1-Grid #0001.gfp

c.   In the drop-down list, click **Open with**.

d.   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
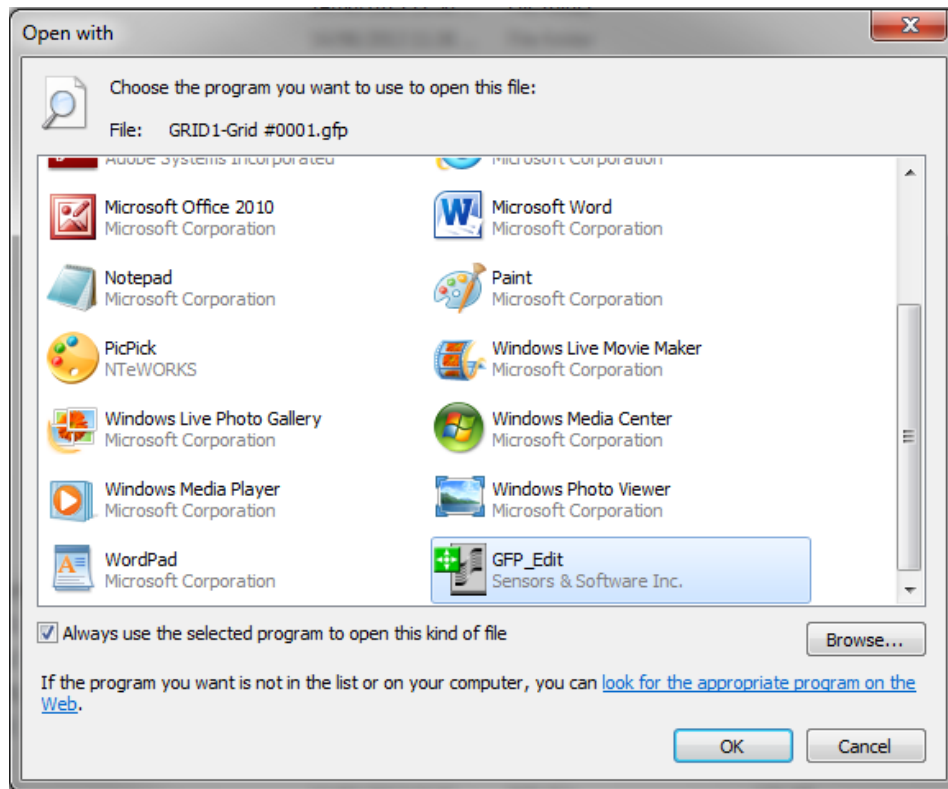
Click **OK**.

Edit the grid in GFP_Edit.
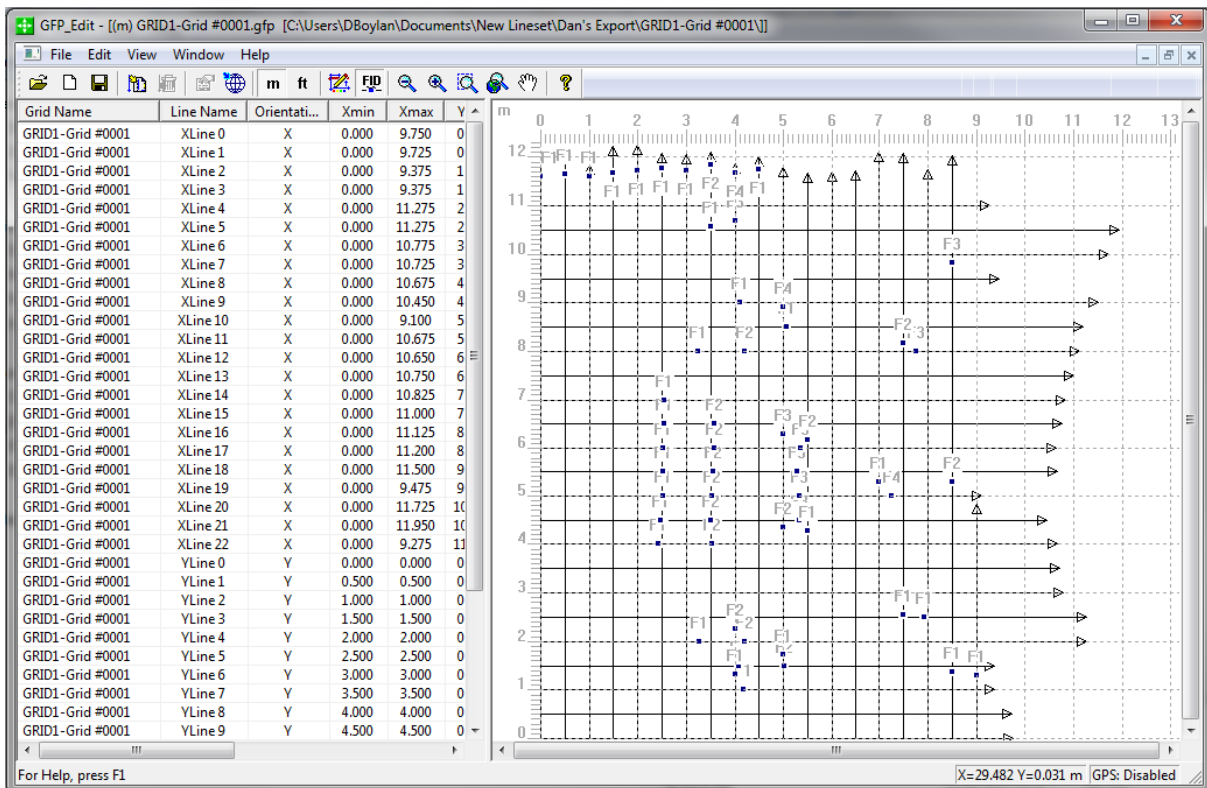
Save your GFP file.

To Import the gfp file as a new grid to EKKO_Project, in EKKO_Project, click **Add Grid**.

In the **Open** dialog box, select the edited gfp file.

Click **Open**.

   The new grid is displayed in Project Explorer

Right-click the new grid.

In the drop-down list click SliceView.

   The new grid is displayed in SliceView-Grid.

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 refection 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.