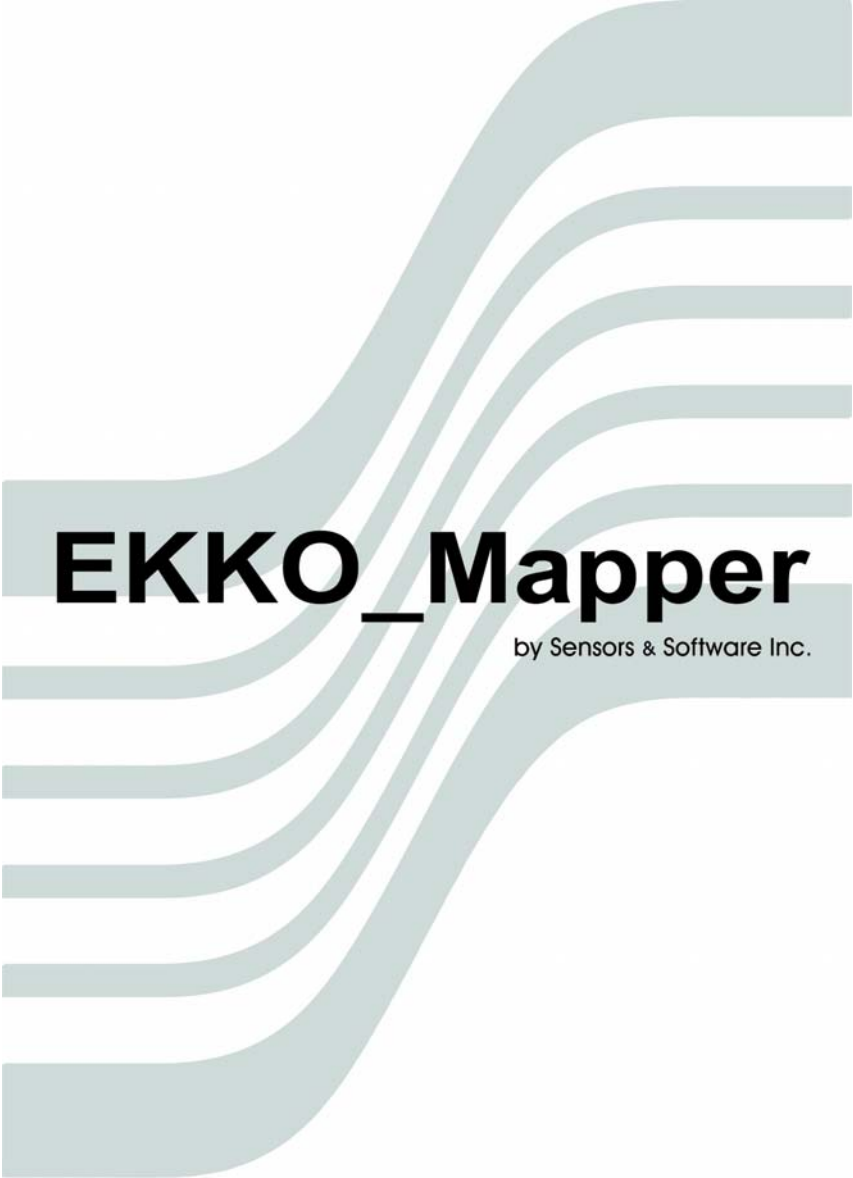



EKKO_Mapper

by Sensors & Software Inc.

USER'S GUIDE

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

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1 Introduction

Ground Penetrating Radar (GPR) data are usually presented as two dimensional cross-sections of the subsurface. However, in areas where GPR data have been collected in a grid of survey lines, data interpretation of many 2D cross-sections can often become confusing and tedious.

The interpretation and presentation of GPR data can often be enhanced through the use of plan map displays of the data. This type of display provides a powerful means of obtaining highly detailed subsurface information. The ability to see GPR responses as depth slices allows users to see the spatial correlation of targets. This can make interpretation easier as sought-after targets can be differentiated from targets of no interest. For example, responses from utilities will tend to produce linear targets while local targets like rocks will appear as point targets. This type of display can simplify the task of interpreting large volumes of data.

EKKO_Mapper is designed to create depth slices of GPR data collected in a grid. Data are quickly processed to enhance targets. EKKO_Mapper will permit you to analyze grid data by slicing through it horizontally, print and save color images and reprocess and display the data with different velocity values. If GPS was added to the GPR data, the GPS position for any point in the depth slice is displayed and can be extracted and written to other types of files for further analysis.

EKKO_Mapper also exports grid data to 3D data files for import into 3D visualization software like Golden Software's Voxler program (available from Sensors & Software).

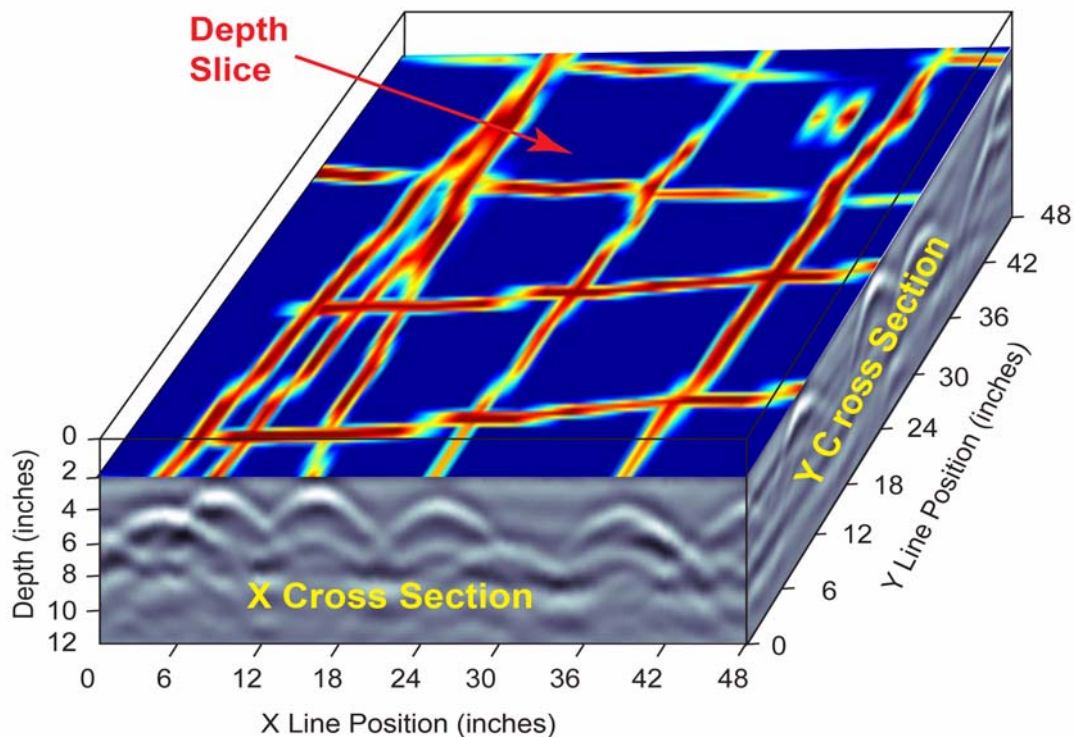


Figure 1-1: A conceptual Grid image to understand the relationship between depth slice images and X and Y cross-section images.

2 Overview

2.1 Using EKKO_Mapper

A GFP file can be opened by selecting **File > Open GFP File**.

When a GFP file is opened for the first time, the **Data Processing** dialog opens.

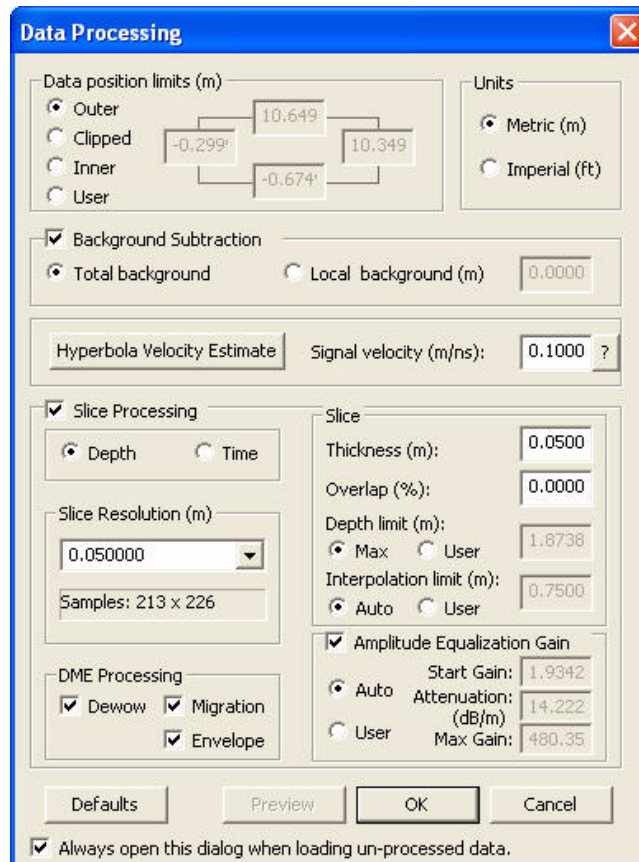


Figure 2-1: The Data Processing dialog sets the processing for the depth slices. Typically the default settings are used except the user should set the Velocity based on the Hyperbola Velocity Calibration.

The most important Data Processing value to set is the **Signal Velocity**. The best way to determine this value is through the **Hyperbola Fitting** method. To quickly generate images, the other data processing settings can usually be set to their default values and, if required, modified later. See **Data Processing** for details.

Selecting OK from the Data Processing dialog processes the data. Processing is indicated by an image of spinning gears and may take several minutes depending on the size of the grid. When processing is complete, the EKKO_Mapper main screen appears consisting of two windows displaying plan views and cross-section images.

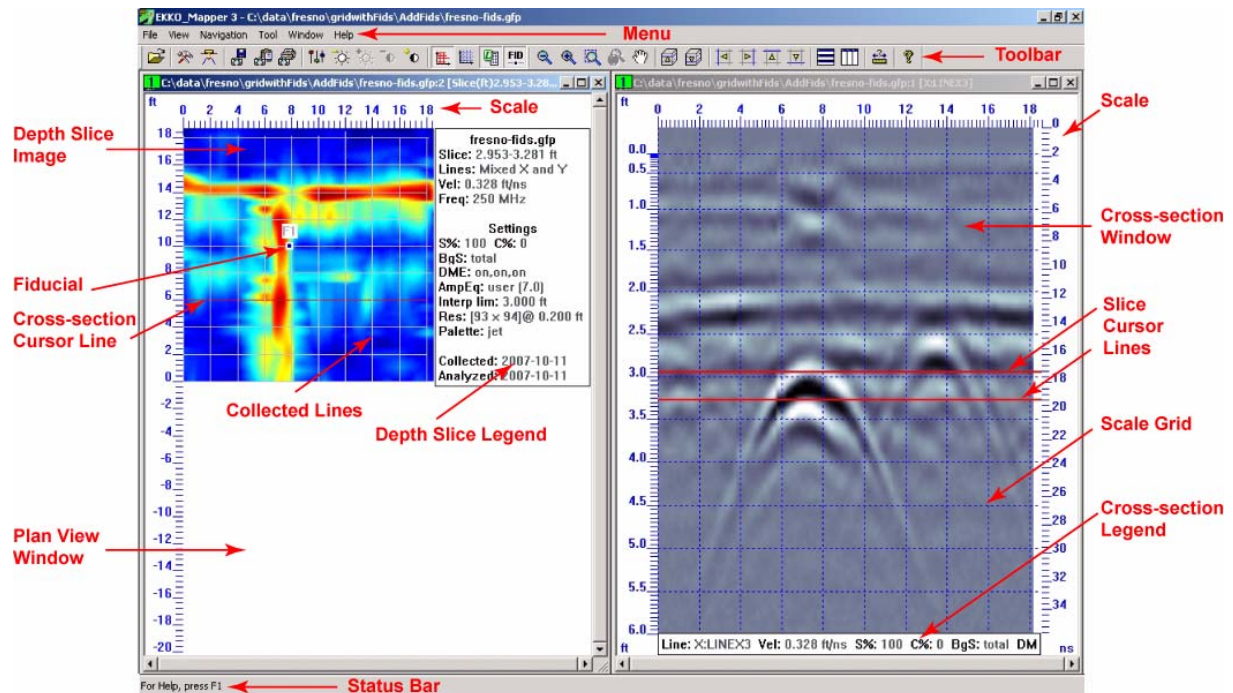


Figure 2-2: The EKKO_Mapper main screen.

One window is the **Plan View Window** displaying plan view images like depth slice images. This image is like looking down on the top of the 3D cube of GPR data (**Figure 1-1**).

The depth range of the current slice displayed is indicated by the **Slice Cursor Lines** (**Figure 2-2**) on the cross-section. Each slice image represents the average signal amplitude of a finite **Thickness** of the subsurface.

The user can scroll up and down through the slices (see **Plan View Window**).

Moving up and down through the slice image causes the **Slice Cursor Lines** (**Figure 2-2**) on the cross-section image to move up or down as well, indicating the depth range used to generate the current slice image in the plan view window.

The **Plan View Legend** beside the slice image provides details about the current slice image.

The second window is a **Cross-Section Window** for the particular X or Y line indicated by the **Cross-Section Cursor Line** on the slice image in the plan view window. The cross-section image is like looking on the sides of the 3D cube of Conquest data (**Figure 1-1**).

The user can move to different cross section images (see **Cross-Section Window**).

The **Cross-Section Legend** under the cross-section image provides details of the current cross-section image

The **Menus** and buttons on the **Toolbar** allow the user to further modify and customize the images, and when satisfied with the results, **Print** hard copy output or graphics file output (**Save As File**).

2.2 Plan View Window

The plan view window displays plan view images associated with the current grid survey data.

The plan view images currently supported in EKKO_Mapper are:

- 1) **Depth Slice** images of the average amplitude attribute in the specified depth range (or thickness). Depth slice images are dependent on the current **Signal Velocity** value.
- 2) **Time Slice** images of the average amplitude attribute in the specified time range.

Different types of plan view images, like other attributes, survey line location maps and surface maps will be added in future versions of EKKO_Mapper.

Axes scales corresponding to the X and Y positions appear on the left and top of the plan view image respectively. The right scale axis is time in nanoseconds.

For depth and time slices, the Plan View window title banner lists the current depth or time range used to generate the slice image. The **Plan View Legend** on the upper right also lists the depth or time range of the current slice image as well as other information.

The user can move through all the slices by:

- 3) clicking on the **Slice Up** and **Slice Down** buttons on the **Toolbar**.



- 4) using the Mouse Wheel (if present),
- 5) pressing the **Page Up** and **Page Down** keys on the keyboard,
- 6) selecting **Navigation > Slice Up and Slice Down** from the menus, or
- 7) clicking on a particular depth or time on the cross-section image. The slice image will change to the one that includes that depth or time point.

Each slice image represents a finite thickness of material; the **Thickness** defaults to a value appropriate for the antenna frequency used for the grid survey.

The **Slice Color Palette** can be changed under the **View > Settings > Slice** option from the menu or by selecting the **Settings** button from the **Toolbar**.



Lines corresponding to all the data lines collected during the grid survey can be displayed in the plan view window by selecting the **View > Show Collected Lines** or by selecting the **Toggle Collected Lines** button from the **Toolbar**.



The **Lines Color** can be changed under **View > Settings > Cross-Section**.

If **Show Collected Lines** option is on, fiducial markers added to the line data are displayed by selecting **Show Fiducials**:



The text associated with the fiducial is displayed by selecting **Show Fiducial Text**.

Grid lines corresponding to the major position labels can be displayed in the plan view window. The option is available by selecting **View > Show Scale Grid** from the menu or by selecting the **Toggle Show Grid** button from the **Toolbar**.



The **Scale Color** can be changed under **View > Settings**.

If **Show Collected Lines** is enabled, a colored line, called the **Cross-Section Cursor Line** (Figure 2-2), will appear in the plan view window. This line shows the position, on the data collection grid, of the cross-section currently displayed in the **Cross-Section Window**.

As the slice image is updated, the **Slice Cursor Lines**, superimposed over the cross-section image, change in depth. These lines indicate exactly what data on the cross-section are being used to create the current slice image in the plan view window.

The **Plan View Legend**, beside the slice image, provides details about the current slice image including the start and end depths (**Thickness**), velocity (**Hyperbola Velocity Calibration**), **Slice Color Palette**, **Contrast** and **Sensitivity**.

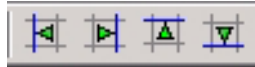
The font for the scales and **Legends** can be changed under **View > Font**.

2.3 Cross-Section Window

The cross-section window displays the current cross-section image ([Figure 2-2](#)).

The user can move to different cross-section images by:

- 1) clicking on the [Line Left and Line Right](#) and [Line Up and Line Down](#) buttons on the [Toolbar](#):



- 2) pressing the **Left Arrow**, **Right Arrow**, **Up Arrow** or **Down Arrow** keys on the keyboard,
- 3) selecting [Line Up and Line Down](#) or [Line Left and Line Right](#) under the [Navigation](#) menu.
- 4) clicking on a collected line in the plan view window. The **Cross-Section Cursor Line** ([Figure 2-2](#)) will immediately change to that line and the corresponding cross-section will be displayed.

There are two **Slice Cursor Lines** ([Figure 2-2](#)) superimposed on the cross-section image. These lines represent the depth range that is being displayed in the current slice image in the Plan View window. This is particularly useful for understanding how features that appear in the cross-sections correspond to the slice images.

The [Cross-Section Color Palette](#) can be changed under the **View > Settings > Cross Section** options from the menu or by selecting the **Settings** button from the [Toolbar](#).



Gain is the amplification applied to the cross-sectional images. It can be changed by selecting **View > Settings > Cross-section > Gain**.

Lines corresponding to the major positions and depth labels can be superimposed on the cross-sections. This option is available by selecting **View > Show Scale Grid** from the menu or by selecting the **Toggle Show Grid** button from the [Toolbar](#).



The [Scale Color](#) can be changed under **View > Settings**.

The [Cross-Section Legend](#) under the cross-section image provides details of the current cross-section image including the line name, velocity ([Hyperbola Velocity Calibration](#)), [Gain](#), [Cross-Section Color Palette](#), [Contrast](#) and [Sensitivity](#).

The font for the scales and [Legends](#) can be changed under **View > Font**.

2.4 Window Operations

2.4.1 Active Window

The EKKO_Mapper screen typically has two or more windows open. However, only one window at a time is “active” and can have changes made to it, for example, changing the **Contrast** value or enabling the **Show Legend** option. The Active Window is always indicated by its dark (usually) blue title banner.

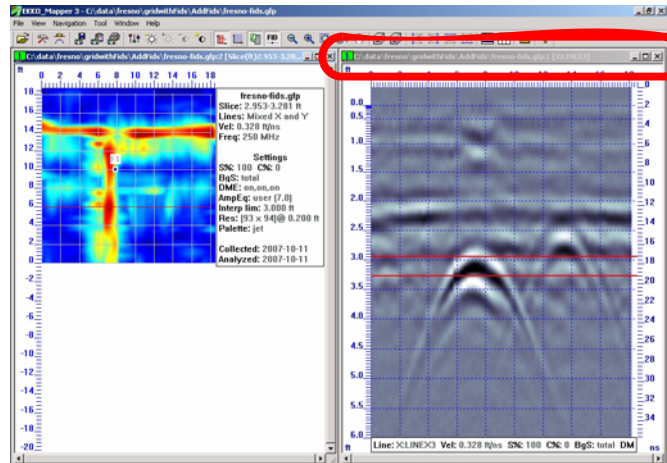


Figure 2-3: The Active Window is indicated by the darkly-colored title banner.

The current active window is also checked in the list under the **Window** menu.

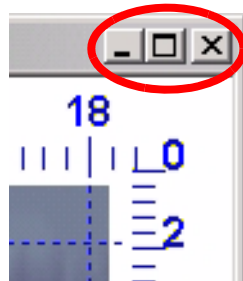
2.4.2 Resizing Windows

To change the size of a window, click and drag any frame or corner.

As the size of the plan view window changes, the size of the plan view image will also change to maintain the correct aspect ratio.

As the size of the cross-section window changes, the cross-section will distort to fill the maximum size within the window.

The windows can also be resized and closed using the buttons located in the upper right corner:



Any window can be maximized to take up the full screen by pressing the **maximize** button:



A maximized window can be restored by pressing the **restore down** button in the upper right corner of the window:



Any window can be minimized by pressing the **minimize** button:



2.4.3 Tiling Windows

Use the menu option **Window > Tile Horizontally** or the following **Toolbar** button to arrange the windows horizontally:



The current **Active Window** will always appear on top.

Use the menu option **Window > Tile Vertically** or the following **Toolbar** button to arrange the windows vertically:



The current **Active Window** will always appear on the left.

2.4.4 Opening a New Window

A new **Plan View Window** can be opened by selecting **Window > New Plan View Window**.

A new **Cross-Section Window** can be opened by selecting **Window > New Cross-Section View Window**.

When multiple Plan View Windows or Cross-section windows are opened at once, only one cross-section window and one plan view window can be modified. These two windows are indicated by the same bright green number in the upper left corner along the title banner.

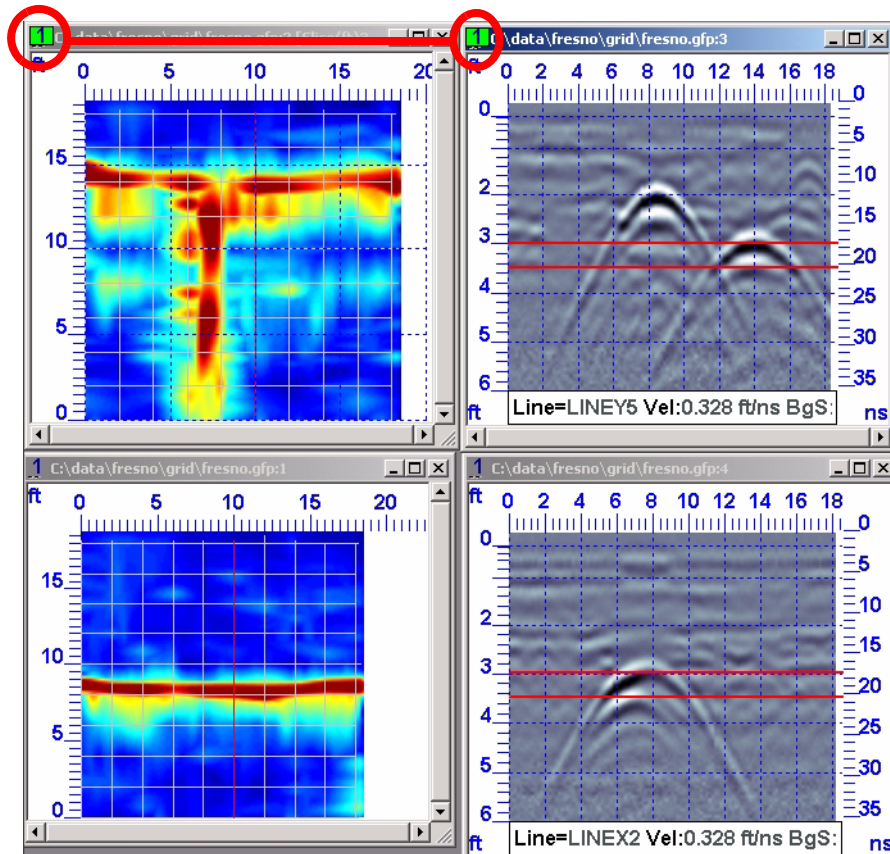


Figure 2-4: When multiple windows are opened, the current pair of windows are indicated by matching green numbers.

2.4.5 Closing a Window

Any window can be closed by pressing the close button in the upper right corner of the window:



2.5 Legends

The Plan View Window and the Cross-Section have a legend that displays information about the plan view or the cross-section (**Figure 2-2**) images.

The display of the legends can be enabled and disabled under the menu option **View > Show Legend** or pressing or depressing the **Toggle Legend Viewing** button on the **Toolbar**:



Make sure that the window you want to enable or disable the legend in is the current **Active Window**.

2.5.1 Plan View Legend

The legend in the **Plan View Window** lists the following information:

- 1) **GFP File name**
- 2) **Slice Range**: The start and end depths (or times) for the current slice in the plan view window. These values correspond to the Slice Cursor Lines on the cross-section images.
- 3) **Lines**: The type of lines used to create the depth slice (X Only, Y Only or X and Y Mixed). See **Lines to Include in Depth Slice Image**.
- 4) **Velocity**: in meters/nanosecond (m/ns) or feet/nanosecond (ft/ns). Used for depth calculations.
- 5) **Frequency**: the antenna center frequency (in MHz) used for the GPR grid survey data.
- 6) **Settings**:
 - a) **Sensitivity** (S) in percent listed under **View > Sensitivity**
 - b) **Contrast** (C) in percent listed under **View > Contrast**
 - c) **Background Subtraction** (BgS): Lists the current setting under **Tool > Data Processing**. Either Total, Local or Off.
 - d) **DME**: Dewow (D), Migration (M) and Envelope (E): Either on or off depending if selected under **Tool > Data Processing**.
 - e) **Amplitude Equalization Gain** (AmpEq): Lists the type and current value under **Tool > Data Processing**. Either Auto, User or Off. If Auto or User, the values for Start Gain (S), Attenuation (A) and Max Gain (M) are listed.
 - f) **Interpolation Limit** (Interp lim): Maximum interpolation distance under **Tool > Data Processing**.
 - g) **Resolution**: The total number of samples in the X and Y directions and the physical size that pixel (or sample) in the plan view image represents. Selected under **Tool > Data Processing**.

h) **Color Palette**: Listed under **View > Settings > Slice > Slice Color Palette**

7) **Grid Survey collection date**: The date the GFP file for the grid survey was created.

8) **Analyzed date**: The current date.

2.5.2 Cross-Section Legend

1) **Line Name**

2) **Velocity**: in meters/nanosecond (m/ns) or feet/nanosecond (ft/ns) as listed under **Tool > Signal Velocity**. Used for the depth scale.

3) **Sensitivity (S)** in percent listed under **View > Sensitivity**.

4) **Contrast (C)** in percent listed under **View > Contrast**.

5) **Background Subtraction (BgS)**: Lists the current setting under **Tool > Data Processing**. Either Total, Local or Off.

6) **DME**: Dewow (D), Migration (M) and Envelope (E): Either on or off depending if selected under **Tool > Data Processing**.

7) **Gain**: Listed if selected under **View > Settings > Cross-section > Gain** as the Attenuation, Start Gain and Maximum Gain applied to the cross-section images.

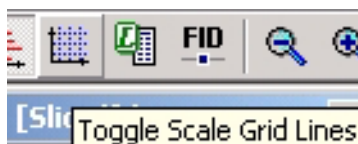
8) **Color Palette (CP)**: Listed under **View > Settings > Cross-section > Cross-Section Color Palette**

2.6 Toolbar

Most operations can be performed using the toolbar. The Toolbar is made visible by checking it under **View > Toolbar**.



A brief description of the function of a button is displayed by holding the mouse cursor on the button for about 1 second.



There is also a longer description of the button on the **Status Bar** on the bottom of the screen.

2.7 Status Bar

The status bar is visible on the bottom of the screen when the **View > Status Bar** option is checked (**Figure 2-2**).

As the mouse cursor is moved over buttons on the toolbar, the status bar, at the bottom of the screen, provides helpful descriptions of the purpose of the particular button. For example, holding the mouse over the **Settings** button will display the following on the Status Bar:

Change the current views display settings.

The right side of the status bar displays information about the position of the mouse cursor when it is located on the plan view image:

Slice: 2.953ft-3.281ft, X: 14.771ft, Y: 4.538ft

or the cross-sections:

[X:LINEX3] Depth: 4.697ft, Time: 27.835ns, Dist: 5.379ft

2.7.1 GPS on Status Bar

If GPS data were added to the GFP file using the GFP_Edit program, GPS positions are displayed on the right side of the Status Bar as the mouse cursor is moved around the slice or cross section images.

Lat: 53.2792790 N, Long: 9.0571550 W, E: +496189.09, N: +5903340.26, Z: 29U

The format of the GPS information is defined by the GPS format in the GFP_Edit program when the GPS was added. It could be Latitude-Longitude (in decimal degrees or degrees-minutes-seconds) or UTM (Universal Transverse Mercator) or both.

Note that there may be a difference between GPS positions on GPR Lines displayed in GFP_Edit/EKKO_Mapper software and the EKKO_View software.

For EKKO_View, which plots GPR cross-sectional lines, the GPS position is based interpolating the GPS positions saved to the GPS file during data collection.

For GFP_Edit/EKKO_Mapper, which use many 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 will differ slightly from the GPS file collected with that line. See the GFP_Edit User's Guide for more details.

2.7.2 Exporting Status Bar Information to Other Documents

The data information text on the Status Bar can be copied to the **Clipboard** by pressing the **F8** key. The text can then be Pasted into another document like a Word or Excel file.

This feature is handy for extracting significant positions from the data image and writing them to other documents.

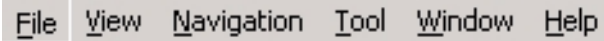
Pressing the “Shift” key while pressing F8 will also save the text for the column headings.

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

To create a file like the one above, press Shift F8 and paste the first line into the document. Then press F8 for all the subsequent lines.

3 Menus

The following sections describe the EKKO_Mapper menus.



File View Navigation Tool Window Help

Menu options can be accessed by clicking on them with the mouse cursor or by pressing the Alt key followed by the underlined letter.

Alt+F = File

Alt+V = View

Alt+N = Navigation

Alt+O = Tool

Alt+W = Window

Alt+H = Help

Sub-menus can then be accessed by pressing the next underlined letter. For example, to select the Open sub-menu under the File menu, press Alt+F and then O.

Sensitivity and **Contrast** can be increased and decreased using keys.

Navigating through Slices (**Slice Up and Slice Down**) and Lines (**Line Up and Line Down**, **Line Left and Line Right**) is also possible using specific keys on the keyboard.

4 File

4.1 Open GFP File

The **File > Open** option allows the user to select the GFP (GPR Files and Processing) file for the grid data to be displayed.

The Open dialog allows the user to select a file with a .GFP extension. For convenience, the GFP file usually resides in the same folder as the grid data files.

The File > Open option can also be accessed by pressing **Ctrl-O** on the keyboard or by clicking on the Open button on the Toolbar:



GFP files can contain more than one grid survey but EKKO_Mapper can only process one grid from a GFP file. If the GFP file opened contains more than one grid, the user must select one grid survey from the list.

More than one GFP file can be opened at the same time resulting in multiple windows open on the screen. Windows always have a green number on the left side of the title banner that indicates which data set they belong to (**Figure 2-4**). For example, all the windows associated with the first GFP file opened will have a number 1 in the banner, all windows associated with the second GFP file opened will have a number 2 in the banner, etc.

4.2 Close GFP File

The **File > Close** option closes all the windows associated with the current GFP file.

4.3 Create New GFP File for Grid Lines

Not all GPR grid data files will have an associated GFP file. Specifically, earlier grid data acquisition software on a PC or the DVL does not automatically generate a GFP file. Consequently, the user must create a GFP file for the grid data before continuing to use the EKKO_Mapper software for data analysis.

The **File > Create New GFP File for Grid Lines** option launches the GFP_Edit program used to create a GFP file for GPR data lines. The program allows the user to Import data lines and specify their positions within the grid. Data lines must be saved under the same Grid Name to be processed as one grid using EKKO_Mapper. GFP_Edit is also used to import fiducials (**Show Fiducials**) into the GFP file.

For more details, see the **GFP_View & GFP_Edit User's Guide**. This document can be viewed from the GFP_Edit program under Help or opened independently. The PDF document is located in the \\Program Files\\EKKO_Mapper\\manual folder or on the software CD under \\EKKO_Mapper\\manual.

4.4 Edit Current GFP File

This option opens the GFP_Edit program, loads the current GFP file and displays information about the file including the positions and geometry of the GPR line data files. GFP_Edit is used to edit the GFP file, specifically, adding and deleting line data files and changing the positions of the data lines.

For more details, see the GFP_Edit User's Guide. This document can be viewed from the GFP_Edit program under Help or opened independently. Look for the PDF document in the \Program Files\EKKO_Mapper\ manual folder or on the CD.

4.5 Export Data

EKKO_Mapper data can be exported as a 3D file or depth slices to various formats.

Specifically, 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.

4.5.1 3D

The **File > Export Data > 3D** option allows the user to export the grid survey data to an HDF (Hierarchical Data Format) or CSV (Comma Separated Values) file for use with third-party processing and visualization software like Golden Software's Voxler (available from Sensors & Software).

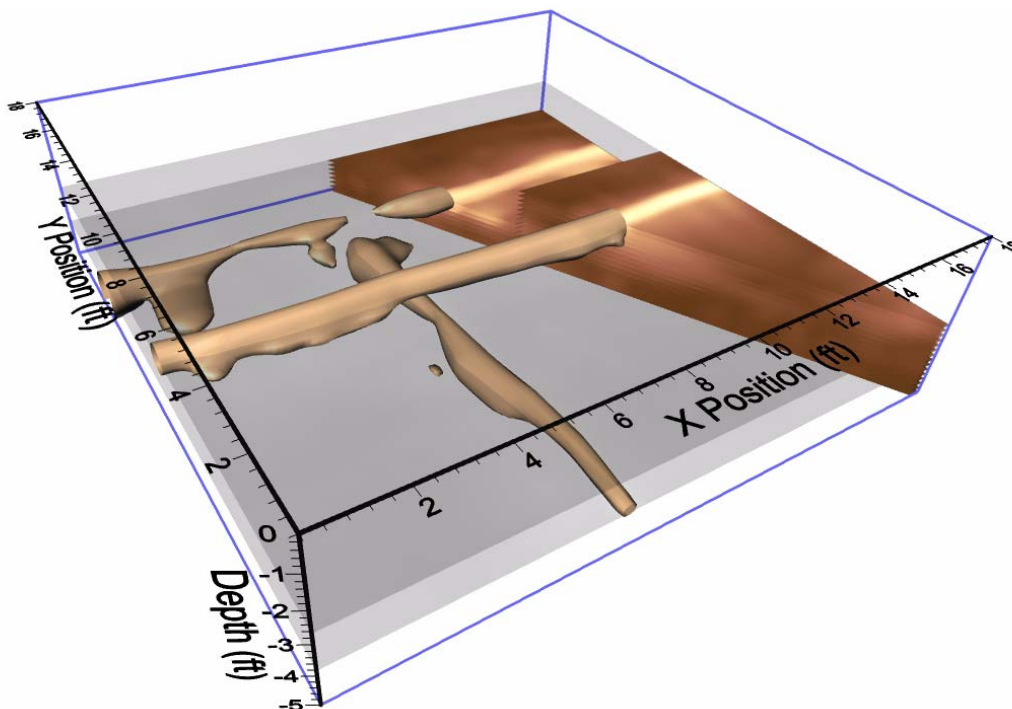


Figure 4-1: GPR data displayed in 3D using Voxler.

Data are 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 **Tool > Data Processing > Slice Resolution** value while the Z voxel dimension is controlled by the **Tool > Data Processing > Thickness** value.

For more resolution in the 3D visualization, it may be necessary to increase the **Slice Resolution** and reduce the depth slice **Thickness** from the default value before generating the 3D file.

The default processing for depth slices and 3D files is designed to reveal linear targets like utilities, rebar, foundations and point targets like archaeological artefacts and bodies. These processes may not be appropriate for all 3D GPR data, for example, geological data. To display geological data in 3D that looks like Figure 4-2, turn off the migration and enveloping processes (**Tool > Data Processing > DME Processing**). To preserve flat-lying layers in the data, also consider turning off the **Background Subtraction** process.

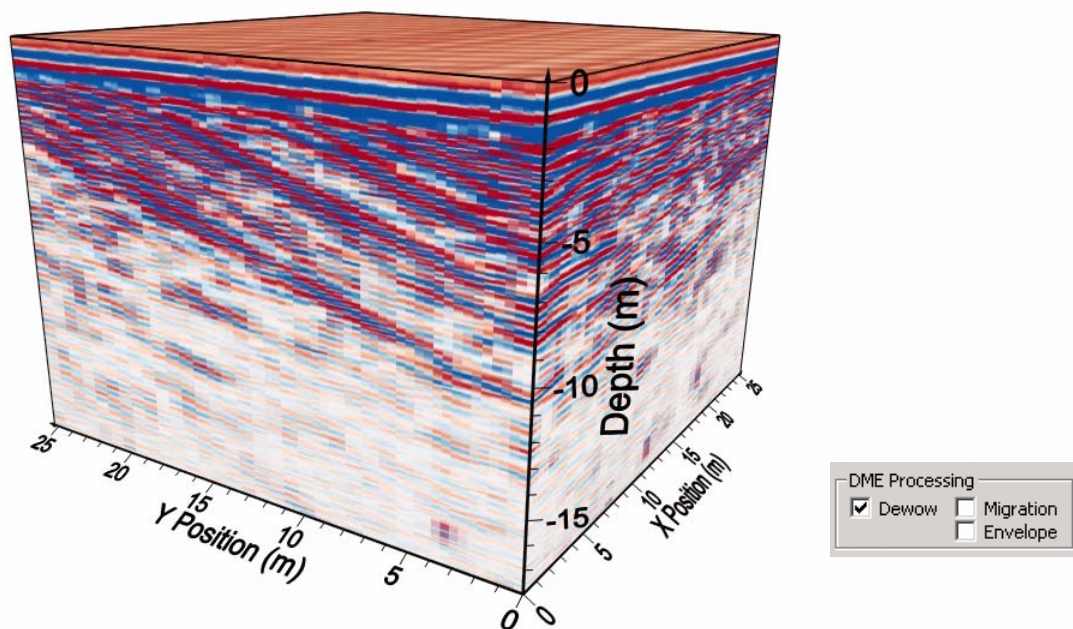


Figure 4-2: This 3D geological data displayed in Voxler was processed in EKKO_Mapper without Migration or Envelope.

Geological data that has not been enveloped looks best when the 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.

4.5.1.1 3D HDF File

HDF files are a binary format that cannot be easily viewed without software that imports this format. HDF files can be opened with the Voxler program (available from Sensors & Software).

To export the 3D data to an HDF file, select **File > Export Data > 3D** to open the **Export Slices to Files** dialog. Select **Voxler HDF file** from the file type drop-down list.

When a grid survey is exported to HDF, the HDF file has the same name as the GFP file, except with the name of the grid (listed in the GFP file) appended to the name, for example GPRData-Grid.HDF.

The HDF file will list X, Y and depth values in metres or feet depending on the setting under **Tool > Data Processing > Units**.

The HDF file will list depth or time depending on the setting under **Tool > Data Processing > Slice Processing > Slice Units**.

4.5.1.2 3D CSV File

CSV files can be imported into many programs like Microsoft's Excel.

To export the 3D data to a CSV file, select **File > Export Data > 3D** to open the **Export Slices to Files** dialog. Use the dropdown list to set the file type to **XYZ-Amplitude Pairs**.

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 will list X, Y and depth values in metres or feet depending on the setting under **Tool > Data Processing > Units**.

The CSV file will list depth or time depending on the setting under **Tool > Data Processing > Slice Processing > Slice Units**.

Depth

The format of the CSV file is X Y Z Depth Amplitude. The Amplitude values are the average signal strength in the thickness of the depth slice.

The Z values (column 3) are elevation values with the surface at elevation zero (0.0) so the values are negative. The Depth values (column 4) are the same as the Z values but positive.

X ± 0.0250m	Y ± 0.0250m	Z ± 0.0025m	Depth ± 0.0025m	58176 Values
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

Time

For time, the format of the CSV file is X Y Z Time Amplitude.

The Z values (column 3) are time values with the surface at time zero (0.0) so the values are negative. The Time values (column 4) are the same as the Z values but positive.

X ± 0.0250m	Y ± 0.0250m	Z ± 0.0500ns	Time ± 0.0500ns	57600 Values
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	467
0.025	0.275	-0.05	0.05	342

4.5.2 Current Slice or All Slices

4.5.2.1 Requirements for Exporting to Google Earth KMZ Files

Saving EKKO_Mapper depth slice images to Google Earth (.kmz) files is available if GPS data have been added to the GFP file.

Adding GPS: If a GFP file is opened in EKKO_Mapper that has GPS files residing in the same folder, the user is prompted to import the GPS files into the GFP file using the GFP_Edit program. Selecting "Yes" to this prompt launches the GFP_Edit program and automatically imports the GPS data using a best-fit routine.

If the GPR data were collected without GPS it is still possible to add GPS to the GFP file using two GPS positions at known points within the grid or one GPS position and the heading the Y axis of the GPR grid (see [Edit Current GFP File](#) and the GFP_Edit User's Guide).

GPS Accuracy: The accuracy of the GPS is indicated in the GFP_Edit program by displaying the Raw GPS lines and the corresponding GPR lines. The difference in linearity and the distance between the Raw GPS line and the corresponding GPR line is an indication of the accuracy of the GPS used for data collection. Non-linear Raw GPS lines indicate poor GPS accuracy and the user should be cautious when using the extracted GPS positions of targets in the GPR grid.

4.5.2.2 Export Slice(s) to Google Earth KMZ File

To export the current slice to a Google Earth KMZ file, select **File > Export Data > Current Slice** to open the **Export to File** dialog.

To export the all slices to a Google Earth KMZ file, select **File > Export Data > All Slices** to open the **Export to File** dialog.

Select the **Google Earth KMZ file** from the file type drop-down list.

The file defaults to the same name as the GFP file and the current folder but the user can change this before saving the file.

4.5.2.3 Viewing Slices in Google Earth

To display Google Earth (.kmz) files, Google Earth must be installed and the computer have internet access. Open the .kmz file using one of the following methods:

- 1) After saving the .kmz file, Google Earth is automatically launched and the kmz file displayed.
- 2) Using Windows Explorer to find the folder where the kmz file is saved and double-click the file name.
- 3) Running Google Earth, selecting File > Open and finding the kmz file and opening it.

When the kmz file opens, Google Earth will "fly" to the location of the GPR slice and superimpose it over the ground image.

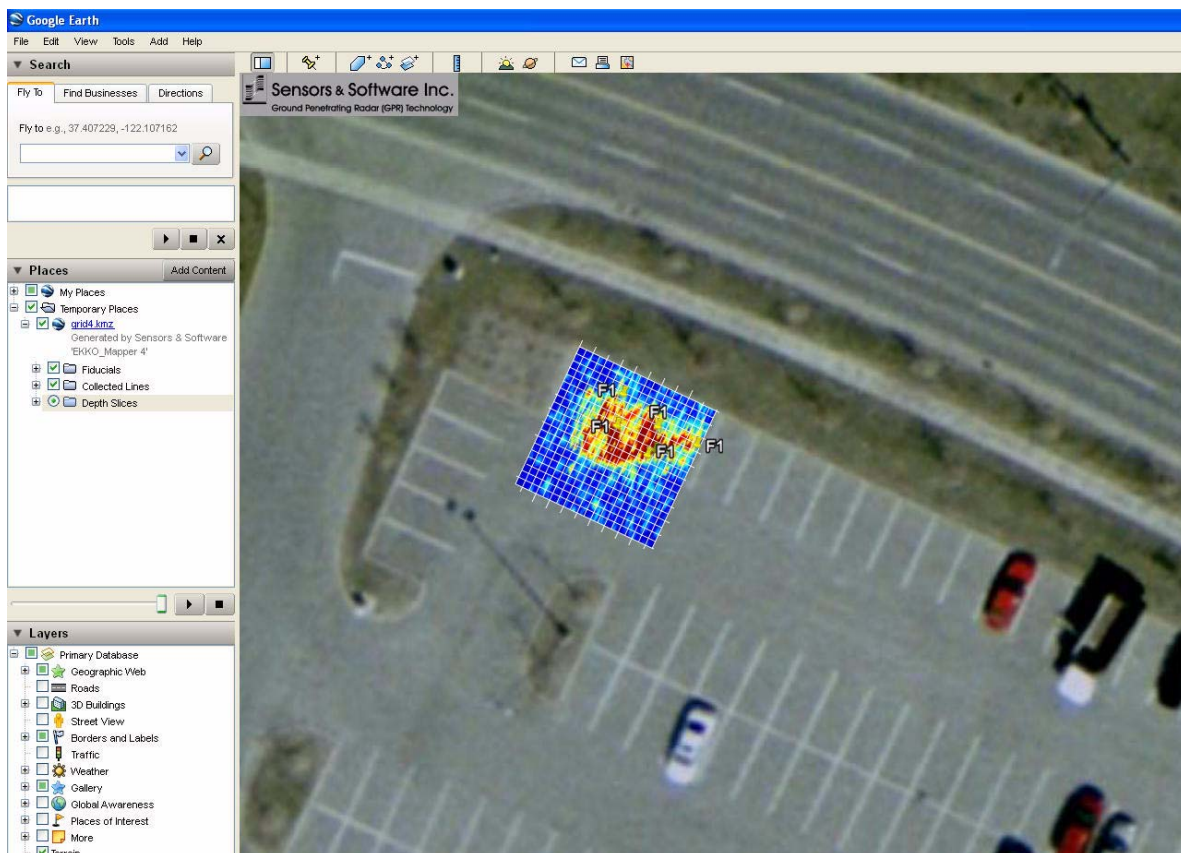


Figure 4-3: GPR slice plotted in Google Earth. Use the controls under Places to enable and disable the display of the slice, collected lines and fiducial markers.

The kmz file is listed in **Temporary Places** under **Places** on the left side of the Google Earth screen. When exiting Google Earth, the user is prompted if they want to save the kmz file to the **My Places** list.

Initially, the slice image is displayed with the **Collected Lines** and **Fiducial Markers** on the data image.

Collected Lines

Collected Lines are listed by clicking on the plus sign (+) beside the kmz file name and can all be turned off by unchecking the "Collected Lines" checkbox.

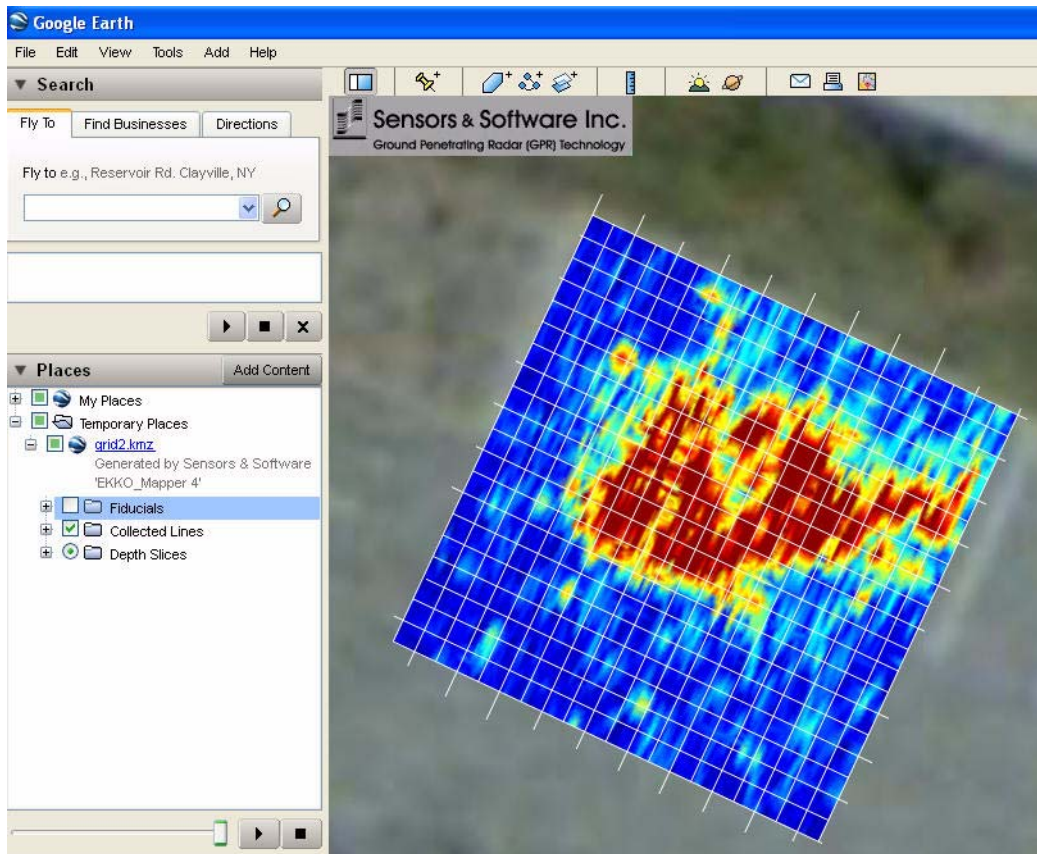


Figure 4-4: Use the controls under Places to enable and disable the display of the collected lines.

Fiducial Markers

Fiducial Markers are listed by clicking on the plus sign (+) beside the kmz file name and can all be turned off by unchecking the "Fiducials" checkbox. Individual Fiducial Markers can be listed by clicking on the plus sign (+) beside Fiducials. Specific Fiducials in the list can be turned off by unchecking the corresponding checkbox.

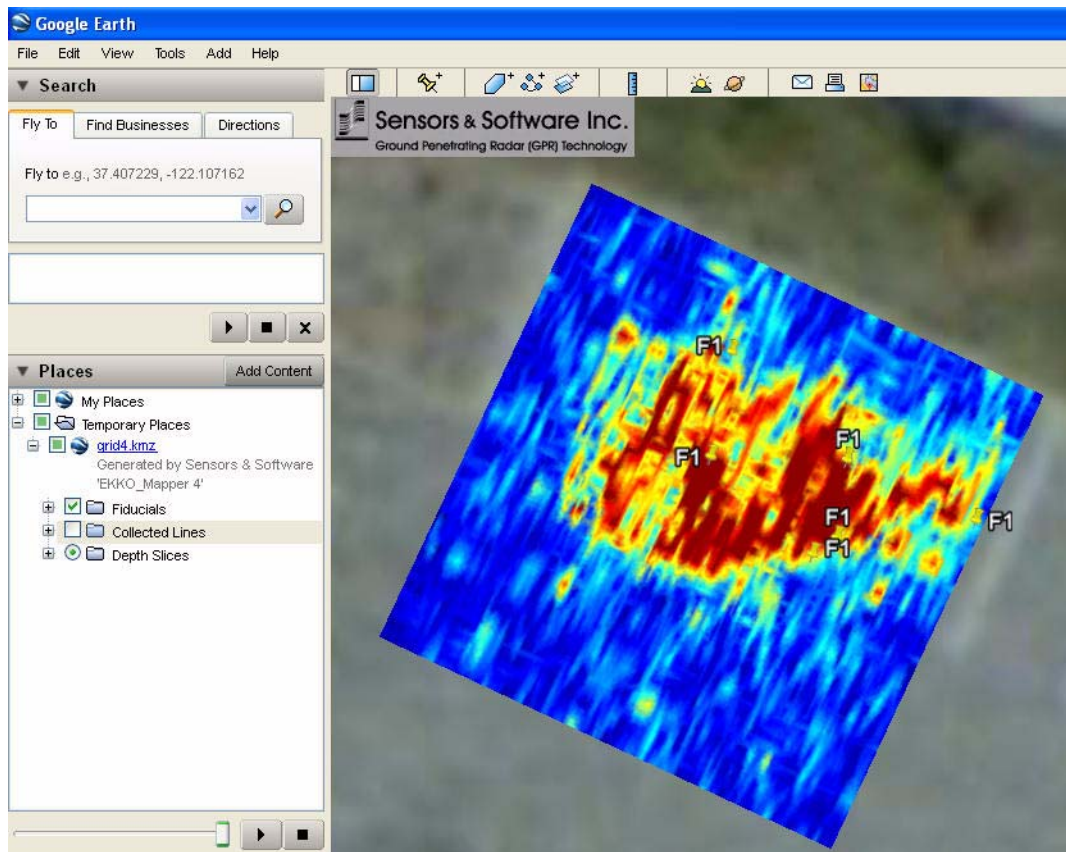


Figure 4-5: Use the controls under Places to enable and disable the display of the fiducial markers.

Slices

If more than one Depth Slice is saved to the kmz file, the list of slices is displayed by clicking on the plus sign (+) beside the kmz file name. To change the depth slice image to a different one, click on the desired slice in the list (**Figure 4-6**).

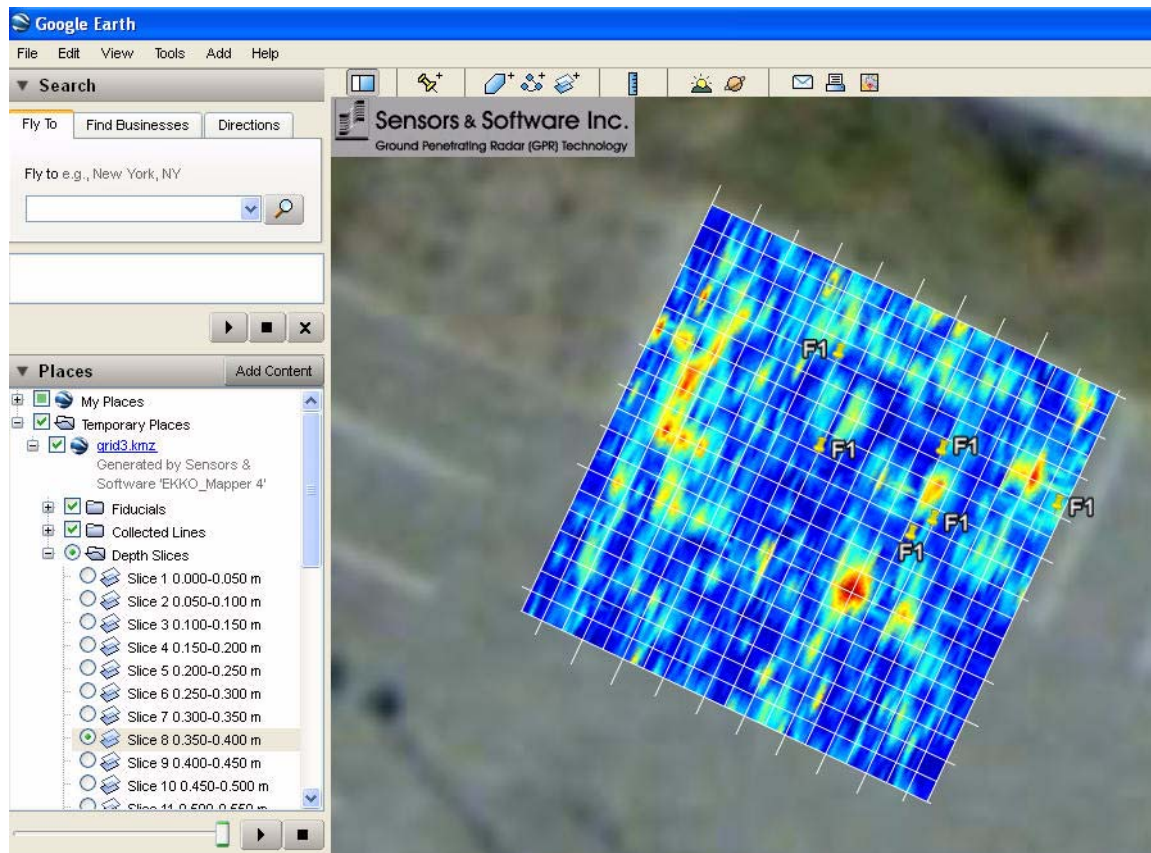


Figure 4-6: When the Google Earth KMZ file contains multiple slices, select the slice to display using the controls under Places.

Google Earth Accuracy

It is important to be aware that Google Earth images may be out several meters from the actual GPS location.

Google Earth also seems to have problems placing Depth slice images accurately at high latitudes.

4.5.2.4 Surfer ASCII Grid (.GRD) File

Surfer is a popular third-party processing and visualization software developed by Golden Software for plotting two-dimensional data like GPR slices.

To export the current slice to a Surfer ASCII Grid (.grd) file, select **File > Export Data > Current Slice** to open the **Export to File** dialog.

To export the all slices to Surfer ASCII Grid files, select **File > Export Data > All Slices** to open the **Export to File** dialog.

Use the dropdown list to set the file type to **Surfer ASCII Grid (grd)**.

The file(s) name defaults to the same name as the GFP file and the current folder but the user can change this before saving the file.

The GRD file will list X, Y and depth values in metres or feet depending on the setting under **Tool > Data Processing > Units**.

The GRD file will list depth or time depending on the setting under **Tool > Data Processing > Slice Processing > Slice Units**.

Here is an example of the 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
```

For specific details on the GRD file format, contact Golden Software.

4.5.2.5 CSV File

CSV (Comma Separated Values) files can be imported into many programs like Microsoft's Excel.

To export the current slice to a CSV file, select **File > Export Data > Current Slice** to open the **Export to File** dialog.

To export the all slices to CSV files, select **File > Export Data > All Slices** to open the **Export to File** dialog.

Use the dropdown list to set the file type to **Comma Separated Values (.CSV)**.

The file(s) name defaults to the same name as the GFP file and the current folder but the user can change this before saving the file.

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) will list X, Y and depth values in metres or feet depending on the setting under **Tool > Data Processing > Units**.

The CSV file(s) will list depth or time depending on the setting under **Tool > Data Processing > Slice Processing > Slice Units**.

Depth

The format of the CSV file is X Y Z Depth Amplitude. The Amplitude values are the average signal strength in the thickness of the depth slice.

The Z values (column 3) are elevation values with the surface at elevation zero (0.0) so the values are negative. The Depth values (column 4) are the same as the Z values but positive.

X ± 0.0250m	Y ± 0.0250m	Z ± 0.0025m	Depth ± 0.0025m	58176 Values
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

Time

For time, the format of the CSV file is X Y Z Time Amplitude.

The Z values (column 3) are time values with the surface at time zero (0.0) so the values are negative. The Time values (column 4) are the same as the Z values but positive.

X ± 0.0250m	Y ± 0.0250m	Z ± 0.0500ns	Time ± 0.0500ns	57600 Values
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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	467
0.025	0.275	-0.05	0.05	342

4.6 Advanced File Options

The **File > Advanced File Options** menu allows the user to perform advanced operations to clean up folders of intermediate files, remove all processing from the current GFP file or restore the Default Application Settings.

4.6.1 Clean Intermediate Files on Exit

After opening a GFP file and processing the GPR data files, EKKO_Mapper generates intermediate files for the display of depth slices and cross-section images. These intermediate files allow images to be quickly displayed on the main screen while working with the GFP file. They are also stored to allow the images to be quickly displayed the next time the GFP file is opened.

The option automatically deletes the intermediate files every time the user exits EKKO_Mapper to reduce the volume of files saved with a grid of data.

In general, if hard disk space is not an issue, it is better to leave this option off so that data images are quickly displayed without having to reprocess the data every time the GFP file for a grid of data is opened. For small grids, the data can be reprocessed and displayed fairly quickly but for large grids this process may take many minutes.

4.6.2 Clean Intermediate Files

After opening a GFP file and processing the GPR data files, EKKO_Mapper generates intermediate files for the display of depth slices and cross-section images. These intermediate files allow images to be quickly displayed on the main screen while working with the GFP file. They are also stored to allow the images to be quickly displayed the next time the GFP file is opened.

The option automatically deletes the intermediate files for the current grid data and GFP file. Deleting these files and then reprocessing the data may fix file errors. If this step does not fix the file problem, try the option **Remove EKKO Mapper Processing from GFP** below.

4.6.3 Remove EKKO_Mapper Processing from GFP

The GFP files saves the data files names, grid geometry and the selected data processing for a survey of GPR data files. Selecting this option deletes the data processing settings from the GFP file. This option should only be used when trying to recover from an error with the processing of the data.

4.6.4 Restore Default Application Settings

Selecting this option will reset all the settings in the GFP file to default values. Use this option only when a severe error has occurred and recovery using other means has not solved the problem.

4.7 Recent Files

If the desired GFP file is one of the last four (4) GFP files opened, rather than using the File > Open option, it can be opened by selecting it from the recent files list under File.

4.8 Exit

Selecting this option will close all windows that are open as part of the current EKKO_Mapper session and exit the application.

5 View

5.1 Export Image

This option is used to export any depth slice or cross-section view to the clipboard, save it as a graphics image file or send it to a printer.

The image can be modified by having the following options, accessible under the View menu, turned on or off:

- 1) Show Collected Lines (depth slices only)
- 2) Show Scale
- 3) Show Scale Grid
- 4) Show Legend
- 5) Show Slice
- 6) Show Fiducials
- 7) Show Fiducial Text

These options are useful if you want to add your own scales or annotations using a graphics program or if you want to tile several individual images together into one larger image.

5.1.1 Copy to Clipboard

The **View > Export Image > Copy to Clipboard** option copies the image in the current **Active Window** to the Clipboard so it can be pasted into other documents like a Word document or an email message. This image can be a depth slice image or a cross-section image.

See **Export Image** for details on modifying the image.

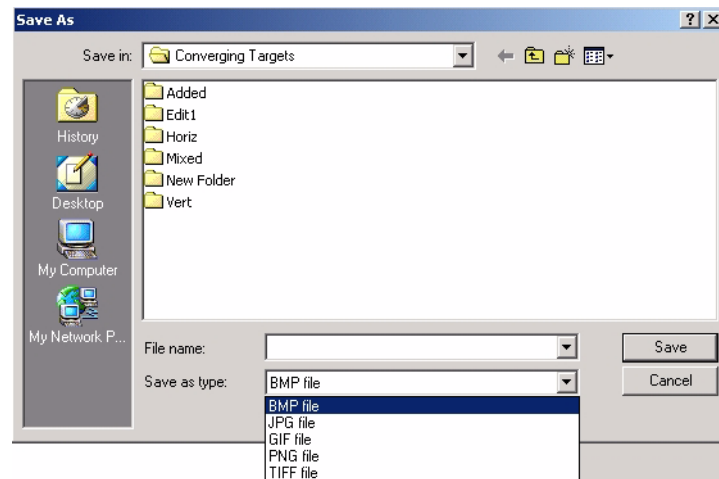
This option can also be accessed from the **Toolbar** by pressing the **Ctrl+C** keys or by clicking on the **Copy Screen to Clipboard** button on the Toolbar.



5.1.2 Save As File

The **View > Export Image > Save As File** option allows the user to save an electronic copy of the image in the current **Active Window**. The plot can be saved in BMP, JPG, PNG, TIFF or GIF graphics file formats.

Select the graphics format file type from the drop-down list. Then input a filename and folder to save the image to.



In general, the BMP file is the largest while the JPG image is quite small and good for emailing.

See [Export Image](#) for details on modifying the image.

This option can also be accessed from the [Toolbar](#) by clicking on the **Save As File** button:



5.1.3 Print

The **View > Export Image > Print** option allows the user to produce hard copies of the image in the current **Active Window**. After selecting this option, a standard print dialog opens which allows the user to select the printer they wish to print to as well as customize other printing parameters. For example, the user can select to print the data image to a Landscape rather than a Portrait orientation.

The image can be sent directly to the default printer by pressing the **Ctrl-P** keys or by clicking the **Print** button from the [Toolbar](#):



5.2 Settings

The **View > Settings** option allows the user to change various aspects of the cross-section and slice images including color palettes, line, scale and cursor colors, contrast and sensitivity values.

The Settings option can also be accessed from the **Toolbar** by clicking on the **Settings** button:



The Settings dialog box allows changes in the settings for Slices or Cross-Sections by toggling the buttons at the top:

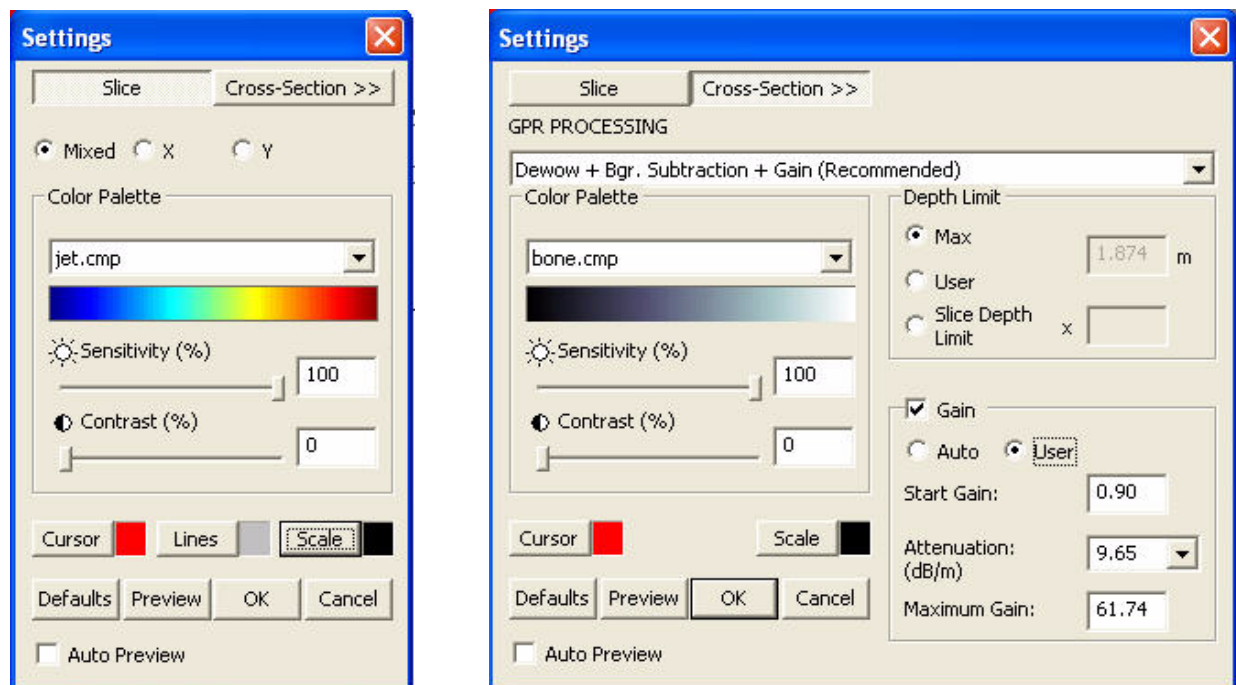


Figure 5-1: The Settings dialog box toggles from Slice to cross-section by pressing the buttons on the top.

5.2.1 Slice

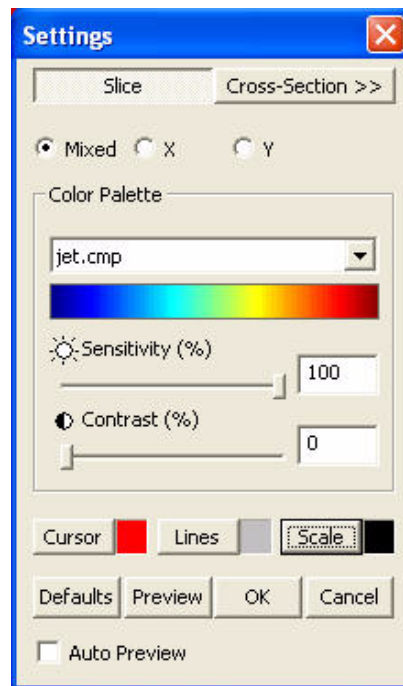


Figure 5-2: Slice Settings dialog.

5.2.1.1 Lines to Include in Depth Slice Image

Grid data can be collected in three different ways:

- 1) X grids, where the area is covered by a series of parallel lines in the X direction,
- 2) Y grids, where the area is covered by a series of parallel lines in the Y direction and
- 3) Mixed grids, where the area is covered by lines in both the X and Y directions.

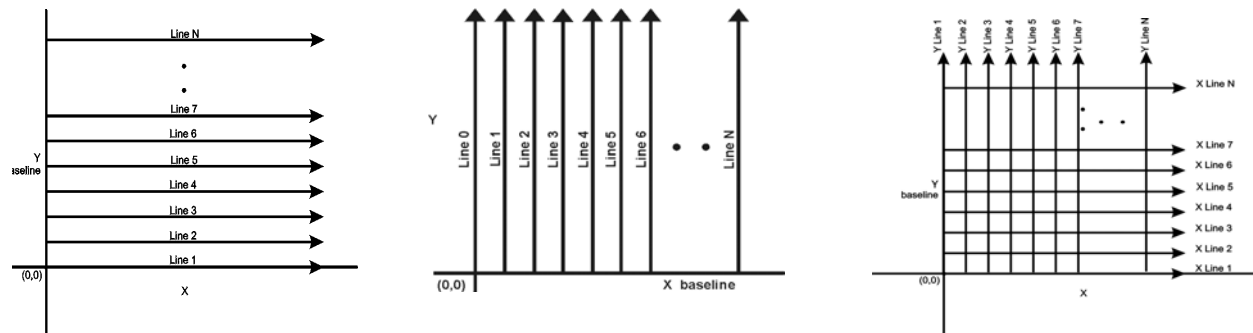


Figure 5-3: Grids are collected as X grids (left), Y grids (middle) or Mixed (XY) grids (right). With an XY grid, the user has the option of generating depth slice images based on the X line data only, the Y line data only or both the X and Y lines. If both X and Y lines are available, it is recommended that the Mixed (XY) setting be used.

EKKO_Mapper can be used to plot data in any of these survey types. As well, in the case of an XY grid, the user can generate depth slices based on only the X lines, only the Y lines or a combination of both the X and Y lines.

When X and Y lines are available in a grid, the setting recommended for most users is Mixed because it uses all the data lines.

When **Mixed** is selected, the slice image in the **Plan View Window** is generated using both X and Y data lines in the grid. Any **Cross-Section Window** can display an X line or a Y line.

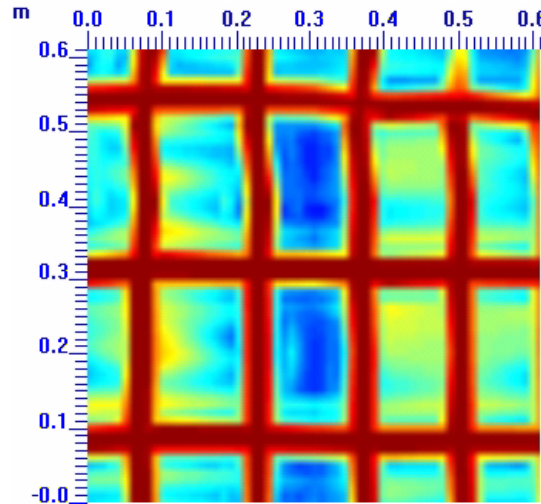


Figure 5-4: Depth slices based on a combination of both X and Y Lines. X or Y lines can be displayed in the cross-section Window.

When **X** is selected, the slice image in the **Plan View Window** is generated using only X data lines in the grid. Any **Cross-Section Window** will only display X data lines.

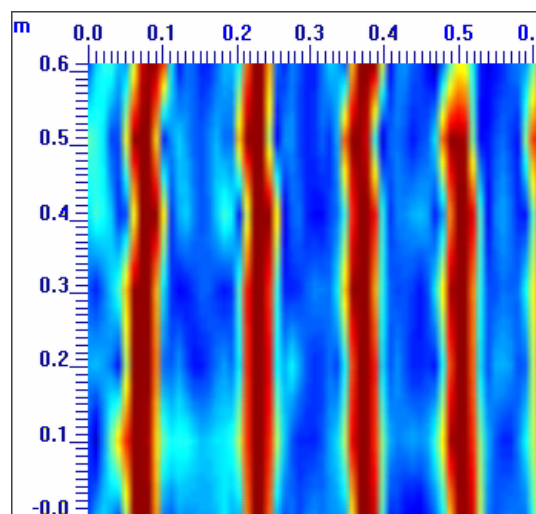


Figure 5-5: Depth slices based on X Lines only. The depth slice image emphasizes targets perpendicular to the X line direction. X lines can only be displayed in the cross-section Window.

When **Y** is selected, the slice image in the **Plan View Window** is generated using only Y data lines in the grid. Any **Cross-Section Window** will only display Y data lines.

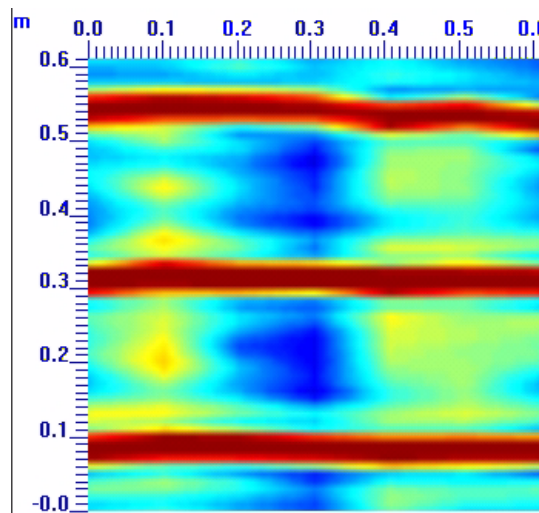


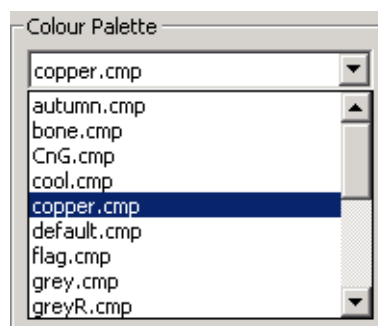
Figure 5-6: Depth slices based on Y Lines only. The depth slice image emphasizes targets perpendicular to the Y line direction. Y lines can only be displayed in the cross-section Window.

Selecting to display X or Y lines only can help to emphasize targets perpendicular to the line direction. In the figures above, rebar are actually running in two directions but the rebar parallel to the X lines have been eliminated. Selecting to display Y lines only would do the opposite, that is, show the rebar perpendicular to the Y lines and eliminate the rebar parallel to that direction. Compare the depth slice images above to see this effect.

5.2.1.2 Slice Color Palette

The default color palette for cross-sections is jet. This option allows the user to choose from a number of predefined color palettes for the depth slice image. Quite often one color palette may bring out features in a data set better than others so some experimentation may be required to determine the optimal color palette for a particular grid scan data set.

The CnG color palette displays data on the screen in color and prints well to a black and white printer.



5.2.1.3 Cursor Color

The position of the cross-section image is indicated by a colored line superimposed on the slice image in the plan view window. As well, the thickness range of the slice image is indicated by two parallel lines superimposed on the cross-section image. All these lines are called the **Cursor Lines** ([Figure 2-2](#)).

The color of the lines can be changed in this option under **View > Settings**.

It is recommended to choose a color that provides high cursor line visibility on the slices and cross-sections.

The **Cross-Section Cursor Line** ([Figure 2-2](#)) on the slice image in the plan view window will not be visible if the **Show Collected Lines** option has been turned off.

5.2.1.4 Lines Color

Lines corresponding to all the data lines collected during the grid survey can be displayed in the plan view window ([Figure 2-2](#)). This option is available under **View > Show Collected Lines** or by selecting the **Toggle Collected Lines** button from the **Toolbar**:



This option is only available if the plan view window is the current **Active Window**. Otherwise, the **View > Show Collected Lines** option and button on the Toolbar are greyed out and not accessible.

The color of the lines can be changed in this option under **View > Settings**.

It is recommended to choose a color that provides high line visibility on the depth slices.

5.2.1.5 Scale Color

Scale Grid Lines corresponding to the major position and depth labels can be superimposed on the depth slice and the cross-sections ([Figure 2-2](#)). This option is available by selecting **View > Show Scale Grid** from the menu or by selecting the **Toggle Show Scale Grid** button from the **Toolbar**:



The Show Scale Grid option only applies to the image in the current **Active Window**. To turn on the Scale Grid for a plan view window, make sure that window is the current active window. Similarly, to turn on the Scale Grid for a cross-section window, make sure that window is the current active window.

The color of the lines can be changed in this option under **View > Settings**.

It is recommended to choose a color that provides high line visibility on the image.

5.2.1.6 Defaults

Clicking the Default button will return all the Slice Settings to their default values.

5.2.1.7 Preview

Clicking on the Preview button allows the user to see the effect of changes they have made to the Slice Settings before permanently applying those changes by clicking on the OK button.

5.2.1.8 OK

Clicking the OK button applies any changes to the settings for the current slice image and closes the Settings dialog box.

5.2.1.9 Cancel

Clicking the Cancel button closes the Settings dialog box ignoring any changes that may have been made to the settings, including any changes made using the Preview button (**Preview**).

5.2.1.10 Auto Preview

Clicking on the **Auto Preview** checkbox from the **Settings** dialog allows the user to instantly see the effect of changes made to the settings, including Sensitivity, Contrast and the color palette. This is much faster than changing the settings and then clicking on **Preview**. However, it may be undesirable for large grids or grids with a fine resolution because the screen update may be sluggish.

5.2.2 Cross-Section

Cross-section settings are displayed in the Settings > Cross-Section dialog (**Figure 5-7**). These settings apply to all cross-section windows with the exception of the GPR Processing which only applies to the current active cross-section window (see **Active Window**).

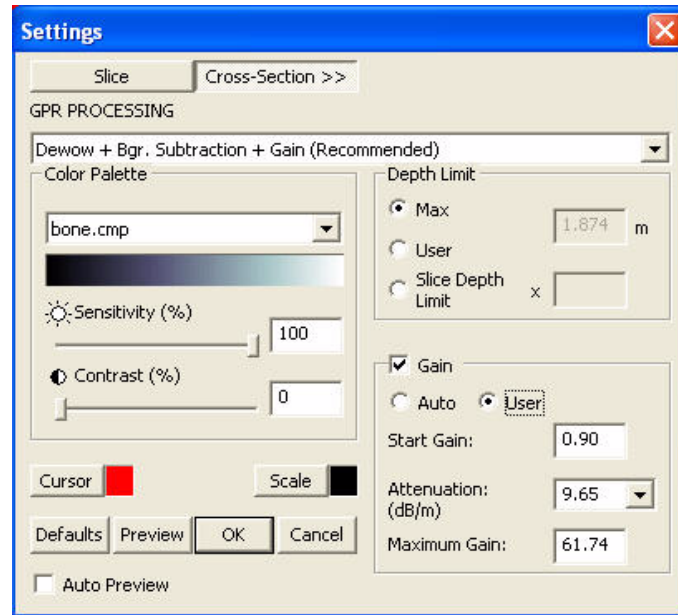


Figure 5-7: Cross-Section Settings dialog Need new fig.

5.2.2.1 GPR Processing

The GPR Processing dropdown list allows the user to select the type of processing that will be applied to the current active cross-section image.

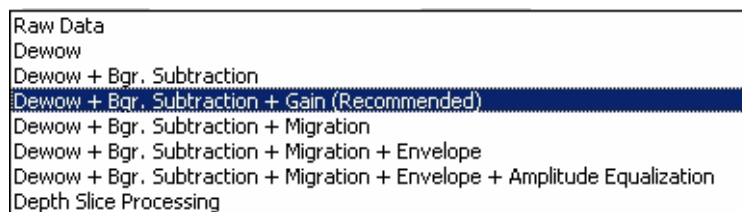


Figure 5-8: Cross-section data processing list.

This setting is generally for advanced users who understand GPR data processing routines like Dewow, background subtraction, migration and enveloping. Descriptions of these processing techniques are described in **Data Processing**.

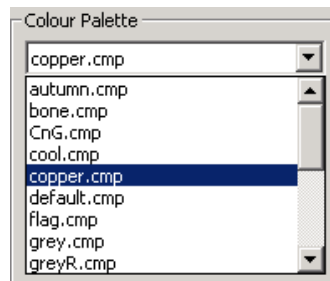
The default GPR Processing and the one highly recommended for most users, is: “Dewow + Bgr. Subtraction + Gain”.

To display the cross-sections with exactly the same processing as the depth slices, select "Depth Slice Processing" from the list. The cross-section images becomes a "side view" of the depth slice data. The cross-sections and depth slices are automatically plotted with the same color palette, amplitude equalization, contrast and sensitivity. Contrast, Sensitivity and Gain are "locked" to the **Slice** Settings dialog and cannot be changed in the **Cross-Section** Settings dialog.

The number of processing streams in the list varies depending on the processing routines selected under Tool > **Data Processing**. For example, if the Migration process is not selected under Data Processing, then the processing streams listed will not include Migration.

5.2.2.2 Cross-Section Color Palette

The default color palette for cross-sections is bone. This option allows the user to choose from a number of predefined color palettes for the cross-section images. Quite often one color palette may bring out features in a data set better than others so some experimentation may be required to determine the optimal color palette for a particular data set.



5.2.2.3 Cross-Section Depth Limit

The Depth Limit option allows the user to change the maximum depth displayed on cross-section images. There are 3 options for this depth limit setting:

- 1) **Max** (the default) displays the full depth range of the cross-section data,
- 2) **User** allows the user to input the maximum depth to be displayed in the cross-section image, and
- 3) **Slice Depth Limit** allows the user to input a multiplication factor for the Slice Depth Limit listed under **Tool > Data Processing > Slice Depth Limit**. For example, a multiplication factor of 2 will set the cross-section depth limit to 2 times the current slice depth limit. A multiplication factor of 0.5 would result in half the slice depth limit "zooming in" on the shallow data in the cross-section image.

If the Depth Limit is set to a value larger than the maximum depth of the cross-section, the cross-section will show full depth and time axes but the data below the maximum depth will be blank.

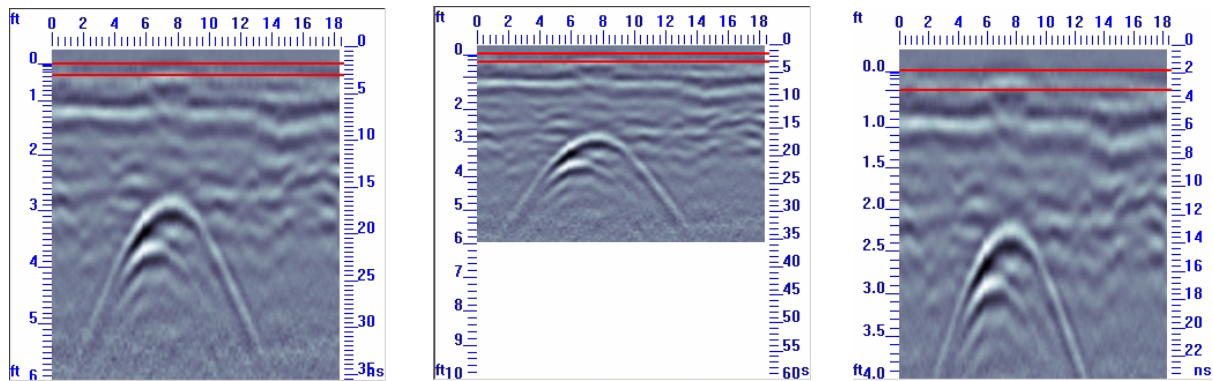


Figure 5-9: The Max Depth Limit (left) shows the full depth of the cross-section (left) while User and the Multiplier options can be set to show more (middle) or less (right) data.

Note that the Depth Limit is strictly for the display of the cross-section images. If the depth limit is set to less than the maximum depth, it does NOT limit the cross-section data used for generating depth slices. Depth slices deeper than the depth limit are still visible. In fact, the **slice cursor lines** (Figure 2-2) on the cross-section that define the thickness of the depth slice, will disappear off the bottom of the cross-section as you scroll down through the depth slices.

If you want to limit the maximum depth of the data used for generating depth slices, see the Depth **Slice Depth Limit**.

5.2.2.4 Gain

Gain is used to "amplify" the strength of the GPR data signals in the cross-section images. Applying gain is similar to adjusting the "volume" knob on a music stereo.

Gain requires three parameters: Attenuation, Start Gain and Maximum Gain. Attenuation is the most important parameter. The other parameters are considered Advanced Options.

The strongest GPR signals come from shallow targets at the top of the GPR cross-section while deeper targets lower in the cross-section have weaker signal strength. Therefore, the gain applied to the GPR cross-section increases with increasing depth. The gain is a ramp that starts off at the **Start Gain** value at the top of the cross-section, ramps up on a slope with the steepness depending on the **Attenuation** value (alpha) and levels off to a constant multiplier when the **Maximum Gain** value is reached.

The gain setting is only applied to the display of the cross-section images. Changing the gain setting has no effect on depth slice images.

The current gain value is displayed in the **Cross-Section Legend**.

Gain can be turned off by unchecking the Gain checkbox in the **View > Settings > Cross-Section** dialog box (Figure 5-7).

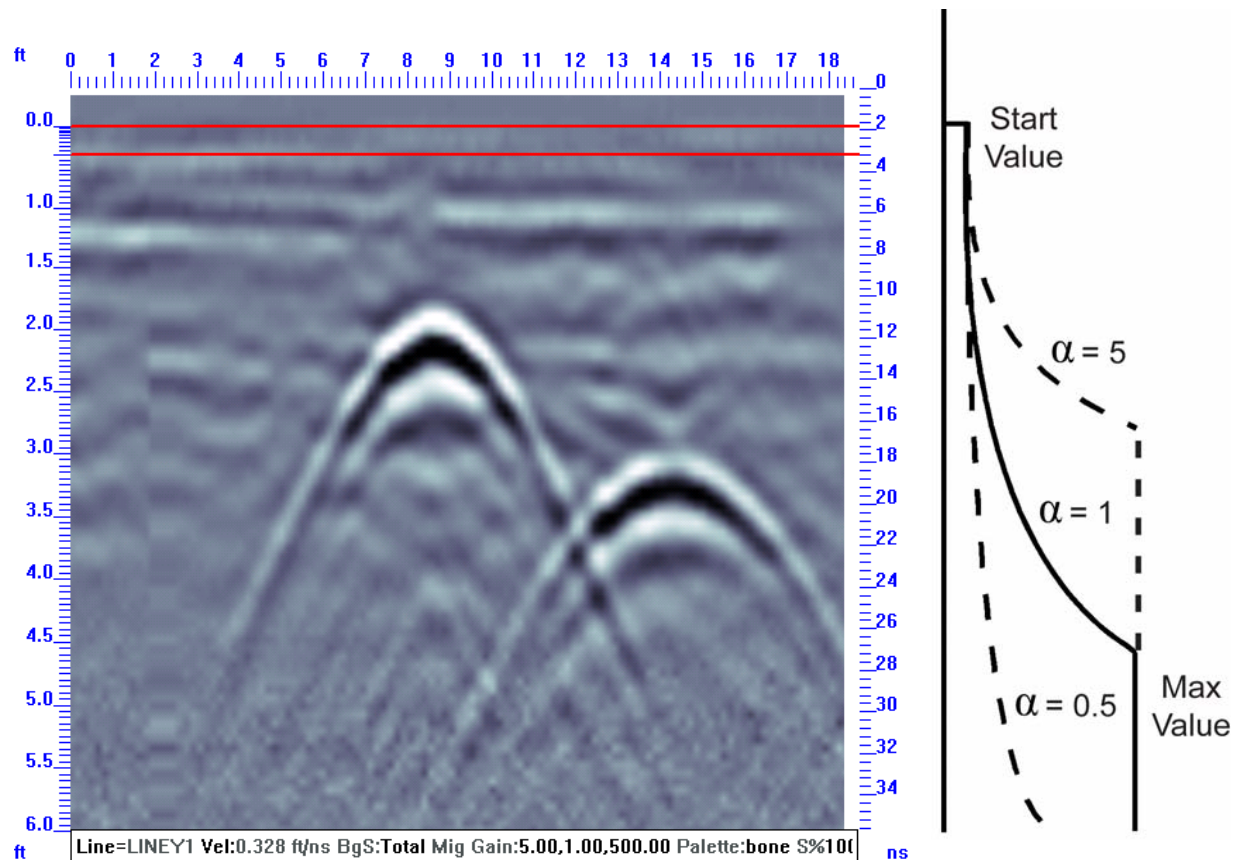


Figure 5-10: Cross-section image with the gain function shape and parameters on the right. In general, the Start Value is usually 1 or 0, attenuation (α), which controls the steepness of the slope is usually 0.5 to 8 and the Maximum Gain, which cuts off the exponential rise is usually 20 to 1000. Try to avoid over-gaining the data. Start with low values for Attenuation and Maximum Gain and increase as necessary.

The gain parameters can be set manually in **User** mode or automatically in **Auto** mode by clicking the desired option (see [Figure 5-7](#)).

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 cross-section images look good using the Auto values and are not over-gained or under-gained, then using Auto Gain is acceptable.

However, Auto does not always gain the data properly, especially if the data has strong, high amplitude signals deep in the section. In this case, it tends to use an attenuation value that may be too low, resulting in under-gained data and cross-sections with low amplitude signals at depth which makes interpretation more difficult. When this occurs, use **Auto** to set the initial values for the gain parameters and then switch the gain to **User** and then experiment using different values.

The following describes, in more detail, each gain parameter.

Attenuation

The Attenuation values defines the “steepness” of the gain function ramp. Lower values mean a more gradual slope while higher values are steeper. The ramp starts at the Start Gain value and ramps up to the Maximum Gain value.

Low values for Attenuation are typically used but higher values may help to improve the imaging of deeper targets. Try to use the lowest value possible as the data can be "overgained" making it more difficult to understand.

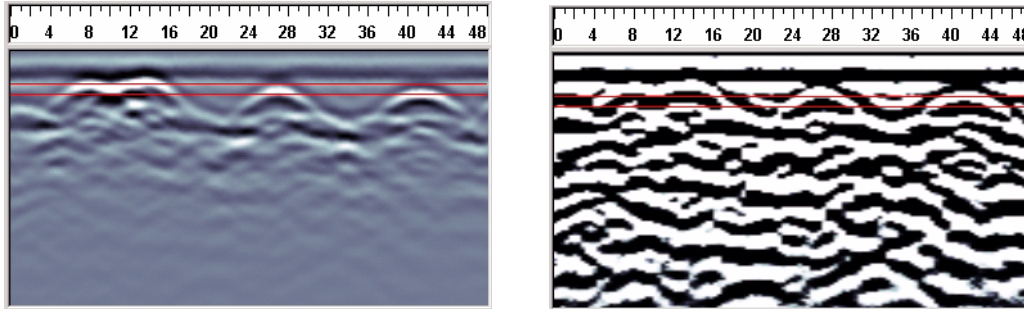


Figure 5-11: A low value for Attenuation makes the cross-section image look good (left) while a high value overgains the data, in this case (right).

Typical values for the Attenuation are 0.0 to 20.0 (selected from the dropdown list) but any value can be input by typing it directly into the field.

The Attenuation value applies a gain to the cross-sections in the same way that the Amplitude Equalization Gain value applies gain to the slices. Therefore, when an Attenuation value is found that makes the cross-section images look “good” without being over-gained, the same value can be used as a User Amplitude Equalization Gain value to make the depth slice images look their best (see [Amplitude Equalization Gain](#)).

Start Gain

The Start Gain is the gain value at zero depth at the top of the GPR cross-section. Typically values for the Start Gain are 0 or 1 with 1 being the default value.

Maximum Gain

The Maximum Gain is the highest multiplication factor for the GPR cross-section data. The ramp defined by the Attenuation stops increasing once it has reached the Maximum Gain value. Typically values for the Maximum Gain are 20 to 1000 with 500 being the default value.

5.2.2.5 Defaults

Clicking the Default button will return all the cross-section Settings to their default values.

5.2.2.6 Preview

Clicking on the Preview button allows the user to see the effect of changes they have made to the cross-section settings before permanently applying those changes by clicking on the OK button.

5.2.2.7 OK

Clicking the OK button applies any changes to the settings for the cross-section image and closes the Settings dialog box.

5.2.2.8 Cancel

Clicking the Cancel button closes the Settings dialog box ignoring any changes that may have been made to the settings.

5.3 Contrast

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

Before changing the Contrast value, make sure that the depth slice or cross-section image you want to change is the **Active Window**.

The Contrast is increased by five percent (5%) by selecting **View > Contrast > Increase** or clicking the following button on the **Toolbar**:



The Contrast is decreased by five percent (5%) by selecting **View > Contrast > Decrease** or clicking the following button on the **Toolbar**:

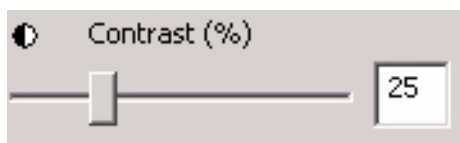


Pressing the “Shift” key while increasing or decreasing the contrast will cause the value to increase or decrease by 10% rather than 5%.

Pressing the “Ctrl” key while increasing or decreasing the contrast will cause the value to increase or decrease by 1% rather than 5%.

Contrast can also be increased by 5% by pressing the “/” key and decreased by 5% by pressing the “.” key on the keyboard.

The Contrast can also be changed by using the appropriate slider bars in the **Settings** dialog box.



The Contrast setting for the image can also be modified by clicking on the slider bar and then using the left and right arrows on the keyboard to increase or decrease the value respectively. If you select the **Auto Preview** checkbox beforehand, the changes made to the Contrast setting will be instantly visible on the image.

As Contrast increases, more and more of the data is displayed at the extreme value of the color palette. Contrast can be useful for making weak targets more visible in the image.

Cross-section images: Cross-section signals vary from extreme negative values to extreme positive values with the zero signal in the middle. As the Contrast setting 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 looking stronger in the image.

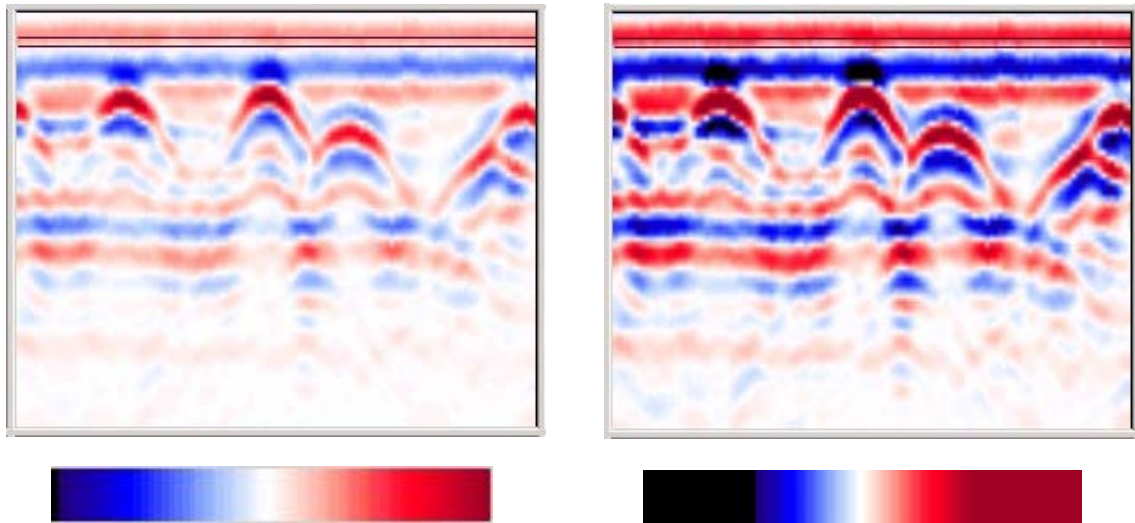


Figure 5-12: For cross-sections, the Contrast value defaults to 0% meaning no contrast is added to the image (left, Contrast=0). As Contrast is increased on cross-section images, the colors on the left and right of the color bar associated with the strongest signals, widen into the middle, resulting in weaker signals looking stronger in the image (right, Contrast=50).

Depth Slice Images: Depth Slice signals vary from zero to extreme positive values. As the Contrast setting 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 looking stronger in the image.

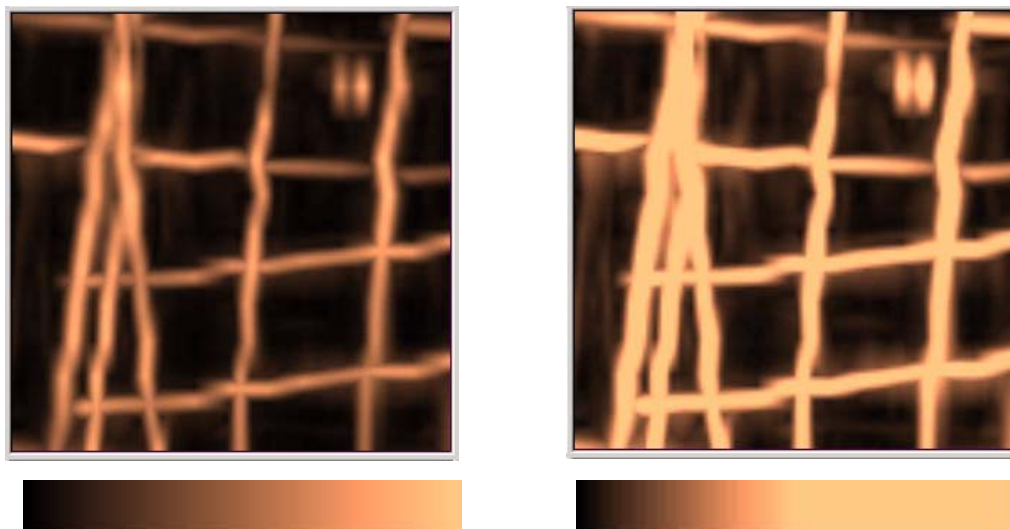


Figure 5-13: For Depth Slice images, the Contrast value defaults to 0% (left). As Contrast is increased on depth slice image, the colors on the right of the color bar associated with the strongest signals, widen to the left, resulting in weaker signals looking stronger in the image (right, Contrast=50%).

5.4 Sensitivity

The Sensitivity setting controls how sensitive the image is to small signal variations. The sensitivity value is from 0 to 100%, least sensitive to most sensitive. The default setting is 100% (most sensitive).

Before changing the Sensitivity value, make sure that the depth slice or cross-section image you want to change is the **Active Window**.

The Sensitivity is increased by five percent (5%) by selecting **View > Sensitivity > Increase** or clicking the following button on the **Toolbar**:



The Sensitivity is decreased by five percent (5%) by selecting **View > Sensitivity > Decrease** or clicking the following button on the **Toolbar**:

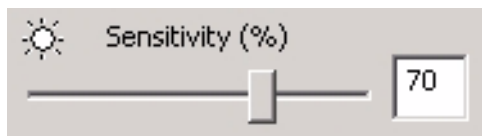


Pressing the “Shift” key while increasing or decreasing the sensitivity will cause the value to increase or decrease by 10% rather than 5%.

Pressing the “Ctrl” key while increasing or decreasing the sensitivity will cause the value to increase or decrease by 1% rather than 5%.

Sensitivity can also be increased by 5% by pressing the “]” key and decreased by 5% by pressing the “[” key on the keyboard.

The Sensitivity can also be changed by using the appropriate slider bars in the **Settings** dialog box.



The Sensitivity setting for the image can also be modified by clicking on the slider bar and then using the left and right arrows on the keyboard to increase or decrease the value respectively. If you select the **Auto Preview** checkbox beforehand, the changes made to the Sensitivity setting will be instantly visible on the image.

Decreasing the Sensitivity from 100% widens the color palette around the zero signal level, removing the weaker signals in the image so only the strongest signals are visible.

Cross-section images: Cross-section signals vary from extreme negative values to extreme positive values with the zero signal in the middle. As the Sensitivity setting decreases, the color associated with the zero signal level in the middle of the color palette widens, resulting in the weaker signals being removed from the image.

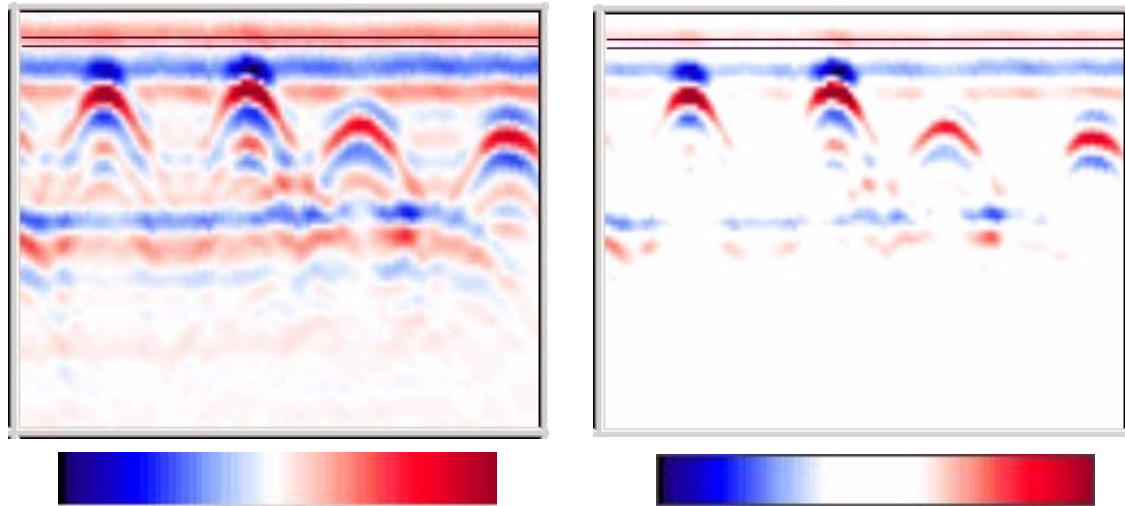


Figure 5-14: For cross-sections, the Sensitivity value defaults to 100% (left) meaning the image is most sensitive to weak signals. As Sensitivity is decreased on cross-section images, the color in the middle of the color bar associated with weaker signals around zero, widens, removing weaker signals from the image (right, Sensitivity=80).

Depth Slice Images: Depth Slice signals vary from zero to extreme positive values. As the Sensitivity setting 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.

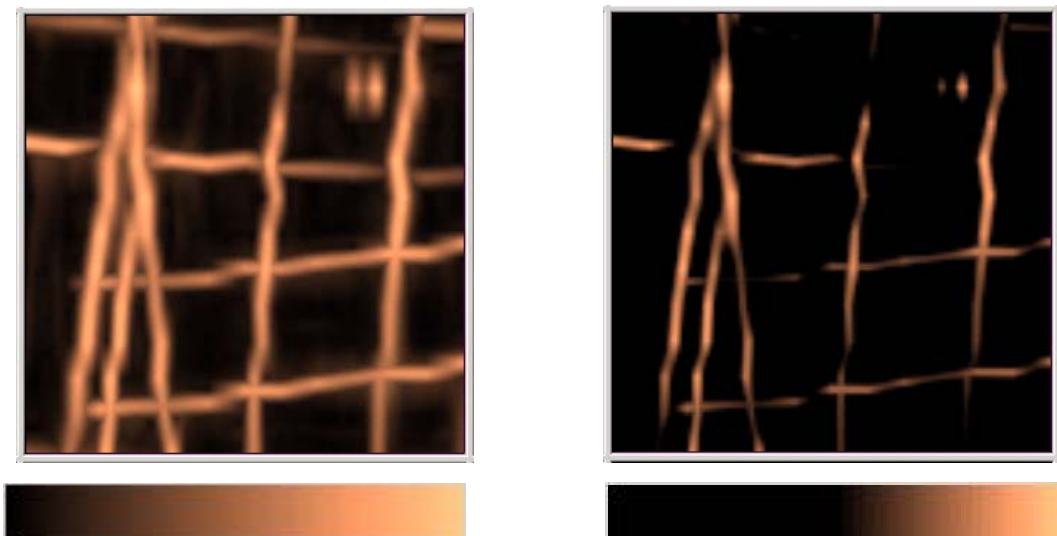


Figure 5-15: For depth slice images, the Sensitivity value defaults to 100% (left). As Sensitivity is decreased on depth slice images, the color in the left of the color bar associated with weaker signals around zero, widens to the right, removing weaker signals from the image (right, Sensitivity=50%).

5.5 Apply Default to Contrast Sensitivity

The **View > Apply Default to Contrast Sensitivity** option sets the Contrast and Sensitivity values for the **Active Window** to the defaults of zero (0) and 100 respectively.

5.6 Zoom

The Zoom options zoom in and out of the depth slice or cross-section image.

Before zooming, make sure that the depth slice or cross-section image you want to zoom is the **Active Window**.

There are 4 ways of using the Zoom option:

- 1) Zoom into the current image size by selecting **View > Zoom > In** or by pressing the following button on the Toolbar:



- 2) Zoom out of the current image size by selecting **View > Zoom > Out** or by pressing the following button on the Toolbar:



- 3) Draw a box around the area to zoom to by selecting **View > Zoom > Select Area** or by pressing the following button on the Toolbar:



After selecting the option to zoom to an area, draw a box on the image by clicking and dragging from one corner diagonally to the opposite corner. A box will be superimposed on the image as you drag it. Dropping the box will cause the image in the box to zoom to the full window size.

- 4) Zoom to the full grid size by selecting **View > Zoom > Fit to Window** or by pressing the following button on the Toolbar:



This option is usually selected to quickly return to the full image view after zooming in.

After zooming into an image, scroll bars will appear on the edges. Use the scroll bars to move around on the image and view different areas. The width of the scroll bar gets narrower each time the image is zoomed in to indicate that a smaller percentage of the full image range is displayed.

A zoomed in image will still display the X and Y scales.

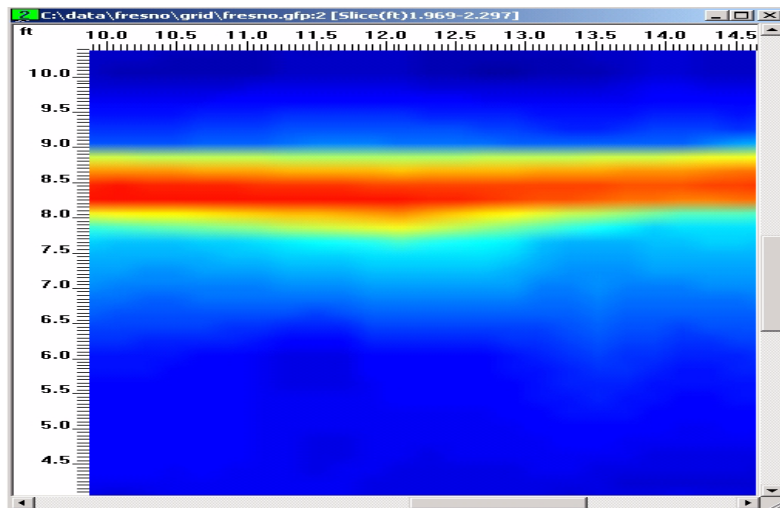


Figure 5-16: Zoomed image. Use the scroll bars on the right and bottom to move the zoomed area around the image.

The zoomed in 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.

5.7 Pan

Pan allows the user to move around a zoomed in image. In Pan mode, the mouse cursor becomes a hand that can be dragged and dropped to view different areas of the image.

It can be selected under **View > Pan** or by pressing the following button on the **Toolbar**:



Once in Pan mode, click and drag the data image 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 from Pan mode, select the option again under **View > Pan** or depress the same button on the Toolbar.

5.8 Show Collected Lines

Checking the **Show Collected Lines** option superimposes lines onto the depth slice image to show where data lines were collected during the data collection of the grid (see **Figure 2-2**).

Before selecting the Show Collected Lines option, make sure that the depth slice is the **Active Window**. The Show Collected Lines option is greyed out and not accessible if the Active Window is a cross-section window.

The **Show Collected Lines** option is available under **View** or by selecting the **Toggle Collected Lines** button from the **Toolbar**:



This feature is especially useful when only a partial grid or partial lines were collected in a survey so the user does not interpret a target in an area where no data were collected.

Show Collected Lines is sometimes turned off because the lines can add clutter to the depth slice image.

The color of the collected lines can be changed by selecting the **View > Settings > Lines Color** button.

5.9 Show Scale

Checking the **Show Scale** option displays scales around the image (see **Figure 2-2**). For slice images, X and Y position scales are displayed across the top and left side of the image respectively. For cross-section images, 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.

Before selecting the Show Scale option, make sure that the image you want to add the scales to is in the **Active Window**.

The **Show Scale** option is available by selecting **View > Show Scale** from the menu.

Show Scale is sometimes turned off to avoid the scale being superimposed on a zoomed in image (see **Apply Default to Contrast Sensitivity**).

The **Scale Color** can be changed under **View > Settings**.

5.10 Show Scale Grid

Checking the **Show Scale Grid** option superimposes a grid of dashed lines onto the depth slice or cross-section image (see **Figure 2-2**). Horizontal and vertical grid lines appear at major positions and depths as indicated on the position and/or depth scales.

Before selecting the Show Scale Grid option, make sure that the image you want to add the scale lines to is in the **Active Window**.

The **Show Scale Grid** option is available by selecting **View > Show Scale Grid** from the menu or by selecting the **Toggle Scale Grid** button from the **Toolbar**:



The **Scale Color** can be changed under **View > Settings**.

In normal operation the Scale Grid is turned off because it adds clutter to the image. Leave the grid scale off unless you need detailed positioning information to assist with the interpretation.

5.11 Show Legend

Checking the **Show Legend** option adds a legend to the depth slice or cross-section image (see **Figure 2-2**).

The **Plan View Legend** appears as a box to the right of the slice image. It contains additional information about the depth slice including the slice range, resolution, velocity, data collection date, data analysis date and settings including data processing, color palette, sensitivity and contrast.

The **Cross-Section Legend** appears as a line of text below the cross-section image. It contains information about the cross-section including the line name, velocity, data processing, gain, color palette, contrast and sensitivity.

Before selecting the Show Legend option, make sure that the image you want to add the legend lines to is in the **Active Window**.

The **Show Legend** option is available by selecting **View > Show Legend** from the menu or by selecting the **Toggle Legend** button from the **Toolbar**:



The plan view legend is often turned off to allow the slice image to be as large as possible in the plan view window.

5.12 Show Slice

Checking the **Show Slice** option displays the depth slice image in the plan view window. This option defaults to being on. The user has to specifically turn it off.

Before selecting the Show Slice option, make sure that the plan view window is the **Active Window**. The Show Slice option is greyed out and not accessible if the Active Window is a cross-section window.

The **Show Slice** option is available by selecting **View > Show Slice** from the menu.

This feature is useful when you only want to see the position of collected lines without the clutter of the slice image.

5.13 Show Fiducials

Fiducials are markers and/or comments added during data acquisition at specific trace positions along the line. Fiducials can also be edited or added after the survey using a routine in the EKKO_View Deluxe software.

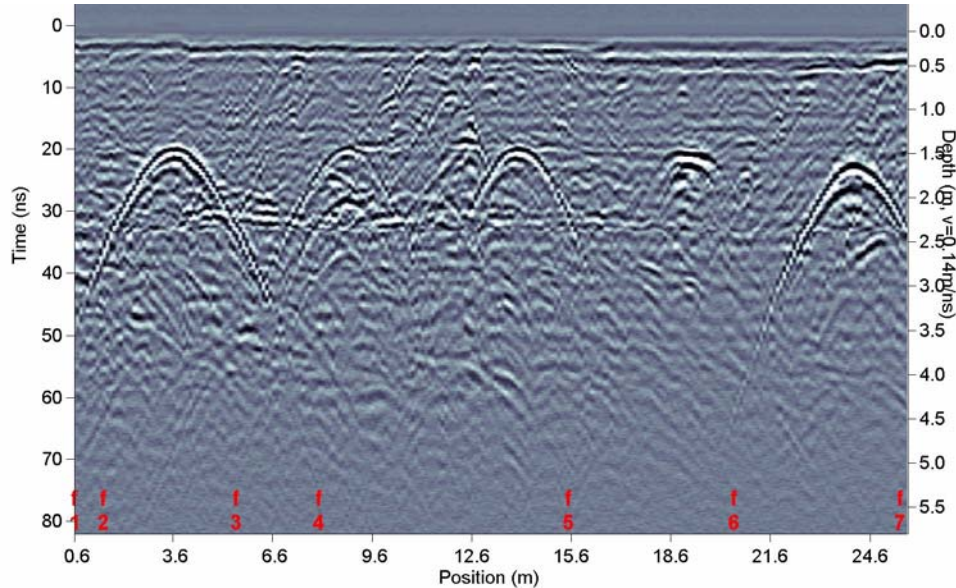


Figure 5-17: Fiducial markers (bottom of image) are added at significant positions during data collection. They usually consist of an “F” followed by an incrementing value. Existing fiducials are edited and new ones inserted using the EKKO_View Deluxe software.

When a GFP file is created using the GFP_View or GFP_Edit utility program, fiducials are automatically imported into the GFP file when the lines are imported.

However, there are two cases when it is necessary to manually import fiducials into the GFP file using the GFP_View or GFP_Edit utility program:

- 1) Some legacy GPR systems do not write fiducials to the GFP file created during grid data acquisition. In this case, fiducials **must** be imported separately into the GFP file.
- 2) If fiducials in the DT1 files are edited using the EKKO_View Deluxe software package, they are **not** automatically changed in any GFP files associated with those DT1 files. To ensure the GFP file contains the latest fiducials from the DT1 files, the fiducials must be imported again.

If the GFP file contains Fiducials on any of the data lines, they are automatically displayed on the image in the **Plan View Window** providing the **Show Collected Lines** option is on. The fiducials will appear as small squares on the line.

Fiducials can be turned on and off by checking or unchecking the **View > Display Fiducials** option or by clicking the Fiducial toggle button on the **Toolbar**:



Fiducials do not appear if **Show Collected Lines** is off.

If **Show Fiducial Text** is on, the text associated with the Fiducial is also displayed.

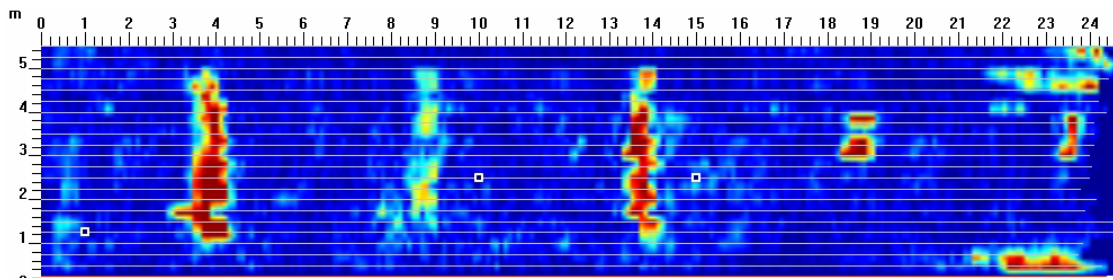


Figure 5-18: Fiducial markers added during data acquisition or added later are displayed by turning on the Show Fiducials option. Fiducials appear as little squares on the plan view image.

If the grid survey data does not contain any fiducials, this option is greyed out and not accessible.

5.14 Show Fiducial Text

If **Show Fiducials** is enabled, the **View > Show Fiducial Text** option is accessible. This option displays the text associated with the fiducials.

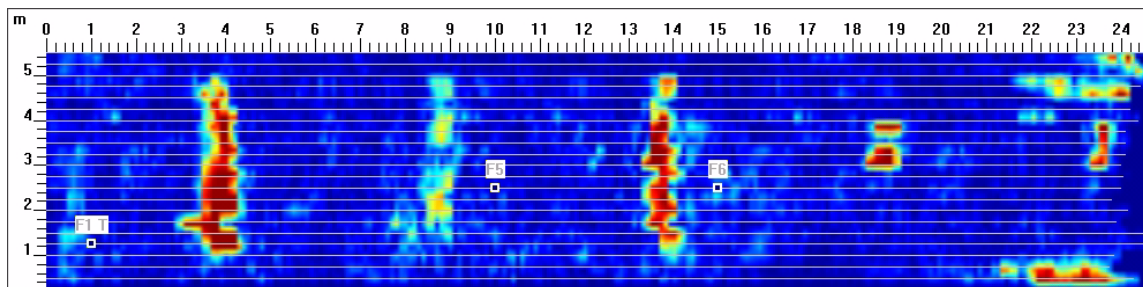


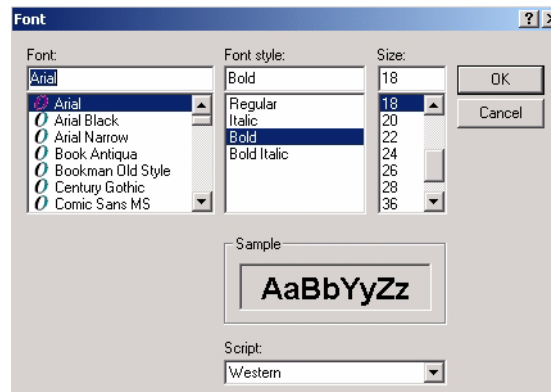
Figure 5-19: The text associated with fiducials is displayed by enabling the Show Fiducial Text option.

Fiducials and fiducial text do not appear if **Show Collected Lines** is off.

If the grid survey data does not contain any fiducials, this option is greyed out and not accessible.

5.15 Font

The Font option determines the font used for the position, depth and time axes as well as the text in the Legends. When selected, the standard Windows font dialog opens allowing the user to select the Font, Font Style and Size. Changing the 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.



5.16 Toolbar

If **View > Toolbar** is checked, the **Toolbar** appears below the menu bar (**Figure 2-2**).

5.17 Status Bar

If **View > Status Bar** is checked, the **Status Bar** appears along the bottom of the EKKO_Mapper Window (**Figure 2-2**).

6 Navigation

6.1 Slice Up and Slice Down

These options allow the user to scroll up and down through the depth slices. When **Navigation > Slice: Up** or **Navigation > Slice: Down** is selected, the depth slice image is incremented up or down by a single depth slice.

The same actions can be performed by pressing the **Page Up** and **Page Down** keys on the keyboard, using the wheel on the mouse or by clicking on the following **Toolbar** buttons to move the depth slice up or down respectively:



When the highest or lowest depth slice is reached, the depth slice image does not change even if the user continues to try moving higher or lower.

If there is a cross-section window open, notice that as you move up and down through the slices in the plan view window, the **slice cursor lines** (**Figure 2-2**) on the cross-section image move up and down corresponding to the slice image.

Stepping Up and Down through the slice images provides insight into the depth of various features in the three dimensional volume.

6.2 Line Up and Line Down

If X lines were collected and are being included to generate the depth slice image (see **Lines to Include in Depth Slice Image**) and there is a **Cross-Section Window** open, the user can move through the various X cross-section images one at a time by using the **Up Arrow** and **Down Arrow** on the keyboard or by selecting **Navigation > Line: Down** or **Navigation > Line: Up** from the menu. The user can also move through the X line cross-sections by clicking on the following buttons on the **Toolbar**:



If the **Show Collected Lines** option is on, a horizontal **Cross-Section Cursor Line** (**Figure 2-2**), corresponding to the grid position of the current X line will be displayed on the slice image in the plan view window. As the X line cross-section image changes, the cross-section cursor line on the slice image moves to a new position corresponding to the new X line cross-section.

The cross-section window can be quickly switched from X lines to Y lines by clicking on any of the options under **Line Left and Line Right**.

These buttons are active when selecting an X line for **Hyperbola Velocity Calibration**.

6.3 Line Left and Line Right

If Y lines were collected and are being included to generate the depth slice image (see [Lines to Include in Depth Slice Image](#)) and there is a [Cross-Section Window](#) open, the user can move through the various Y cross-section images one at a time by using the **Left Arrow** and **Right Arrow** on the keyboard or by selecting **Navigation > Line: Left** or **Navigation > Line: Right** from the menu. The user can also move through the Y line cross-sections by clicking on the following buttons on the [Toolbar](#):



The cross-section window can be quickly switched from Y lines to X lines by clicking on any of the options under [Line Up and Line Down](#).

If the [Show Collected Lines](#) option is on, a vertical **Cross-Section Cursor Line** ([Figure 2-2](#)), corresponding to the grid position of the current Y line will be displayed on the slice image in the plan view window. As the Y line cross-section image changes, the cross-section cursor line on the slice image moves to a new position corresponding to the new Y line cross-section.

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

7 Tool

7.1 Data Processing

The **Data Processing** dialog box is used to set the parameters for the processing of the depth slice images.

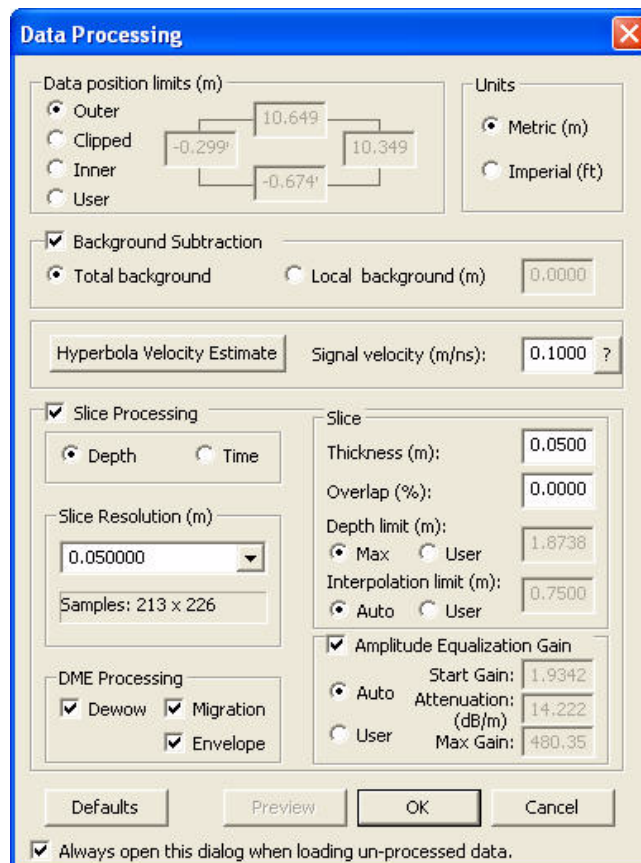


Figure 7-1: Data Processing dialog.

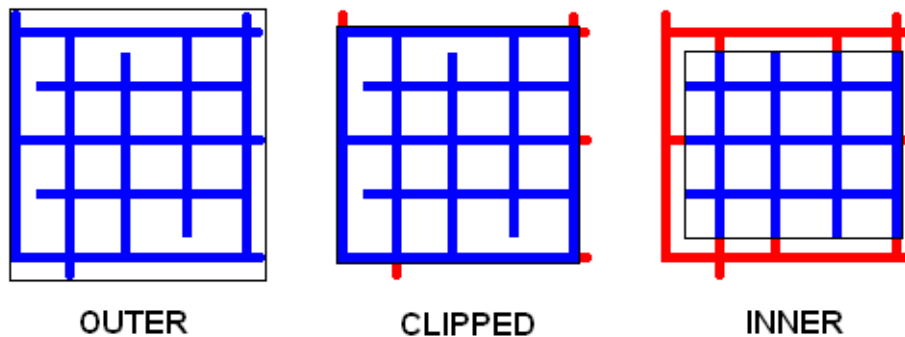
The Data Processing dialog box is accessed by selecting the **Tool > Data Processing** menu item or the following button on the **Toolbar**:



Slices produced by EKKO_Mapper are displays of GPR signal amplitude versus XY position. The amplitude value is the average amplitude value over the depth or time thickness. Keep in mind that data processing steps such as Dewow, migration, background subtraction and envelope affect the original amplitude.

7.1.1 Data Position Limits

The 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 but the user can select other settings like **Clipped**, **Inner** or **User** to define other grid dimensions.



7.1.1.1 Outer

Selecting the **Outer** Data Position Limit for the grid means the longest lines in the X and/or Y direction are used 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. Cross-sections 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 one in the Y direction that is 10.2m, the grid size plotted in the depth slice will be 10.5 x 10.2m.

7.1.1.2 Clipped

It is quite common during grid data collection to collect extra data that slightly exceeds the desired grid size. This means that some cross-sections are longer than others.

Selecting **Clipped** Data Position Limit means that X lines are cropped by the furthest Y lines on the left and the right and the Y lines are limited likewise by the X lines.

If we only have X lines or Y lines then clipped data limit option is not available (there is no Y lines to clip the X lines and vice versa).

7.1.1.3 Inner

Selecting the **Inner** Data Position Limit for the grid means the shortest lines in the X and/or Y direction are used to define the size of the grid so the grid contains solid data with no padding of zeroes. This option is useful when you have one or more cross-sections that exceed the desired size of the grid but you want to truncate those lines and display a grid with no padding of zero data.

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

Sometimes the inner limit might not be available.

7.1.1.4 User

Selecting the **User** Data Position Limit for the grid means the user can define exactly what positions they want for the minimum X, maximum X, minimum Y and maximum Y of the grid. Cross-sections are truncated and/or padded with zero data as necessary to fit the grid size defined.

7.1.2 Units

The distance and depth units displayed on the axes around the depth slice and cross-section images can be displayed in metres or feet. The units default to those used during the original grid data collection but can be converted and displayed in either metres (m) or feet (ft). For example, data collected in feet can be plotted in metres.

7.1.3 Background Subtraction

At the top of all GPR cross-sections are the horizontal events associated with the direct air wave and the direct ground wave. These events are not reflections from within the ground and therefore, it is often desirable to remove them from the data before generating depth slice images. The background subtraction process is primarily used to remove these events. It can also be used to remove other horizontal reflectors in the cross-section data.

The background subtraction filter defaults to on and including this process is recommended for most data sets, however, it can be turned off by unchecking the checkbox.

One situation where it may be desirable to turn off background subtraction is when exporting geological data to 3D (see [Export Data](#)).

7.1.3.1 Total Background

When the **Total Background** is used, the average trace for the entire grid survey is calculated and subtracted from every trace in the survey. This results in the removal of the air wave - ground wave events on the top of each cross-section.

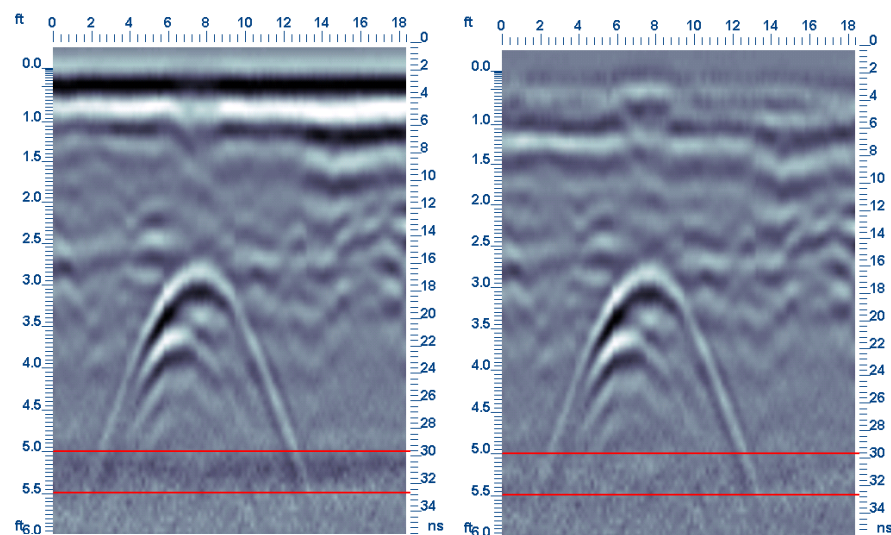


Figure 7-2: A cross-section image before (left) and after (right) Total Background Subtraction has been applied. This process removes the direct air and ground waves on the top of the data to improve the very shallow depth slice images.

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

7.1.3.2 Local Background

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

This background subtraction filter is more effective for removing local flat-lying events in the data, for example, when the air wave - ground wave varies or when there is localized banding on one cross-section in the grid.

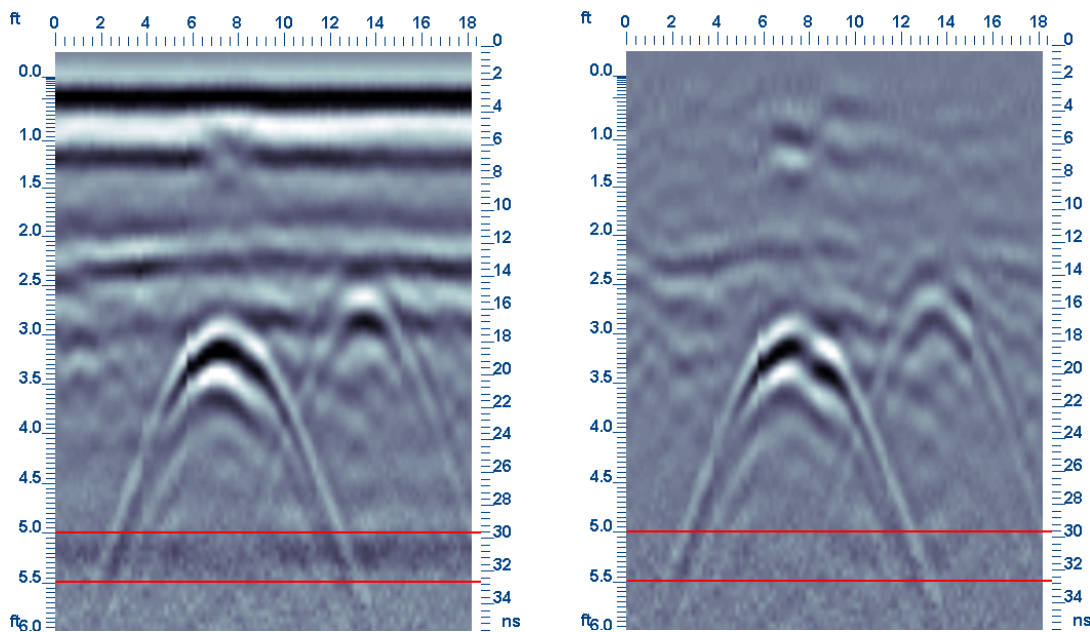


Figure 7-3: A cross-section image before (left) and after (right) Local Background Subtraction of 2 feet has been applied. This process removes the direct air and ground waves on the top of the data as well as local flat-lying reflectors.

To determine an appropriate window width for the local background subtraction filter, scroll through the cross-sections in your grid survey and determine the length of the shortest flat-lying reflection that you want removed from the data.

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

7.1.4 Signal Velocity

An accurate signal velocity is necessary for creating the best depth slice images. A poor value for the velocity may result in fuzzy images that are difficult to interpret and inaccurate depth estimates.

The velocity defaults to a typical average velocity of 0.10 m/ns or 0.328 ft/ns.

The user can directly input a velocity into the Signal Velocity field in the units displayed (either metres per nanosecond, m/ns or feet per nanosecond, ft/ns). Clicking on the:



button displays a list of typical velocities for different materials.

The other method of determining the velocity is to measure it from a hyperbola in the grid data set. Select the **Hyperbola Velocity Estimate** button from this dialog box, **Tool > Hyperbola Velocity Calibration** from the menu or the **Hyperbola Velocity Calibration** button from the **Toolbar**:



Velocity is calibrated by fitting a curve to hyperbolas from rebar or other targets in the cross-section images. Details of this method are described in **Tools > Hyperbola Velocity Calibration**.

7.1.5 Slice Processing

Slice Processing allows the user to select the type of processing that will be applied to the current active slice before it is displayed.

The Slice Processing checkbox defaults to checked, meaning that slice processing will be performed when the OK button is pressed from the Data Processing dialog. Unchecking the Slice Processing checkbox means that no slice processing will be performed so no slice images will be displayed. Unchecking this option is useful when the user just wants to display cross-sections, perhaps in a situation when the user is still trying to determine the best Slice Processing options for a large grid and knows that slice processing will take a substantial period of time.

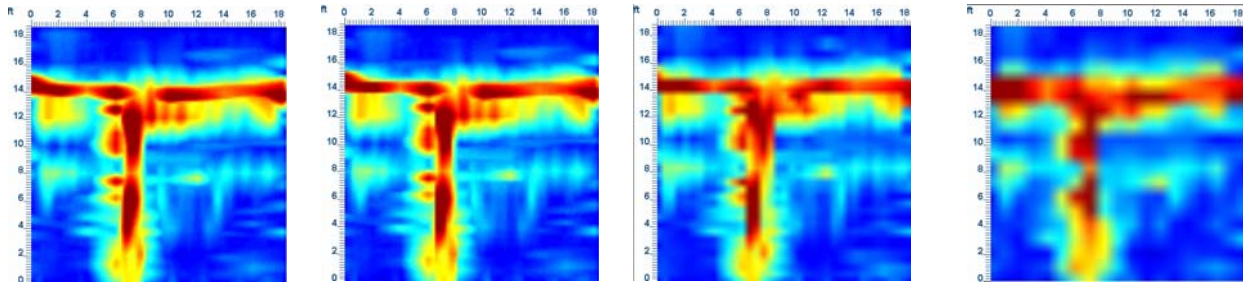
7.1.5.1 Slice Units

The **Slice Units** setting determines the units that will be used for the slice thickness parameter, either depth in metres or feet or time in nanoseconds. Some users may prefer to use time in nanoseconds.

The Slice Units defaults to depth in the same units that the data were collected in, i.e. metres or feet, but these units can be changed (see **Units**).

7.1.5.2 Slice Resolution

In the depth slice image, the smallest “box” that is one solid color 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 consequently the details of the images increase but so does the time required to process and display the image. Increasing the sample size decreases the total number of samples and decreases data processing time but the “fuzzier” the image is.



0.16ft (116x117 samples) 0.20ft (93x94 samples) 0.50ft (37x37 samples) 1.0ft (19x19 samples)

Figure 7-4: Slice Resolution can be selected as Max, High, Medium or Low or a user-defined value. As the Pixel or sample size gets smaller, the total number of samples increases and the image has more detail but the processing time increases.

Depth slices with a very small sample size are very detailed but take longer to process. The increase in processing time can be very significant.

The Slice Resolution defaults to value appropriate for the step size (the distance between traces) and the screen resolution. The slice resolution can be changed but cannot be made finer (smaller) than the smallest step size (the distance between traces) in the data. A coarser (larger) resolution value will result in faster data processing.

The **Plan View Legend** displays the current Slice Resolution value along with the total number of samples in the X and Y direction. To change the Slice Resolution value, input a new value or use a value from the drop-down list. There are 4 values available from lowest resolution to highest: low, medium, high and max.

Changing the Slice Resolution is most effective for large grid data sets. It is often a good idea to set the Slice Resolution to a coarse value at first and make sure that the depth slices generated are what you expect before proceeding with a finer sample size that will take longer to process.

7.1.5.3 DME Processing

DME stands for **D**ewow, **M**igration and **E**nveloping. These are standard processing routines for GPR data and are used especially before generating slice images. These options are generally for advanced users who understand these GPR data processing routines.

The default setting (and the one highly recommended for novice users) is to have all these processes checked so that they are performed before generating the slice images.

The processes selected in this option affect the number of processing streams available in the dropdown list under View > Settings > Cross-Section > **GPR Processing**. For example, if the Migration process is not selected, then the GPR processing streams listed will not include Migration.

One situation when DME should all be turned off (unchecked) is when the user has processed the grid data in some other program (like EKKO_View Deluxe) and now just wants to use EKKO_Mapper as a visualization tool of the data. In this case, Dewow, Migration and Envelope should be turned off as well as **Background Subtraction**. Depending on whether the grid data were gained, the user may also want to 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 is designed to remove this unwanted low frequency while preserving the high frequency signal. The removal of this wow in the data is also called the “signal saturation correction”.

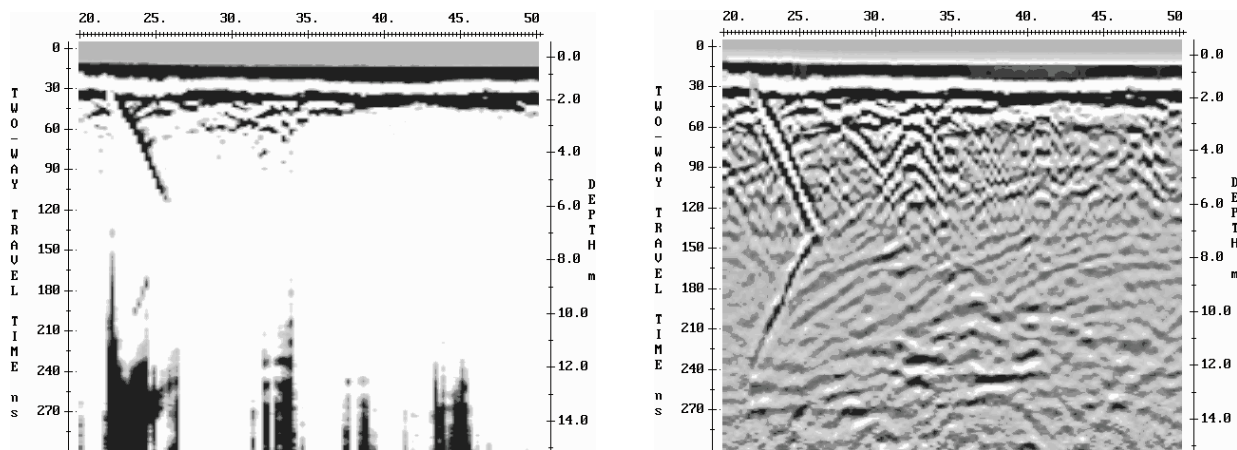


Figure 7-5: Data line showing raw data with the low frequency “wow” component (left) and after the Dewow process removes the low frequency component (right). The Dewow process is highly recommended when data processing cross-sections and slices.

The wow is removed from the data by applying a running average filter on each trace. A window with a width the same as that of one pulsewidth 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 cross-sections and slices.

Migration

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

The actual location of the target is at the apex or top of the hyperbola. Migration is a process that focuses the energy spread over the hyperbolic shape back to the apex of the hyperbola. This is an essential and highly recommended part of the data processing when generating depth slice maps. Migration allows linear targets viewed on depth slice images look like linear objects rather than hyperbolic shapes that can make interpretation difficult.

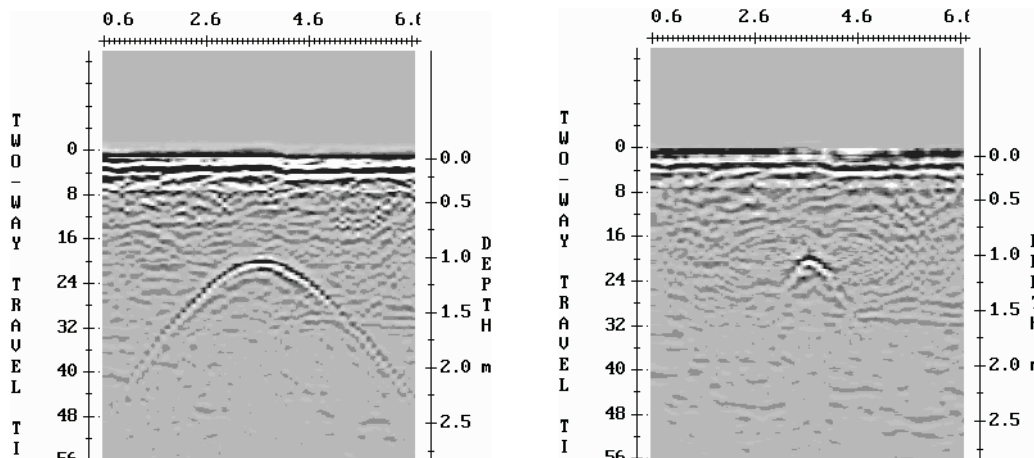


Figure 7-6: The Migration process focuses hyperbolas back to a point at the location of the object. It is a critical processing step for most depth slice images.

Migration requires an accurate **Signal Velocity** value. If the velocity value is too low, hyperbolic reflectors will not be focussed back to a point and the target will have fuzzy edges in the depth slice. If the velocity value is too high, hyperbolic reflectors will over-migrate and become inverted, again resulting in a target with fuzzy edges in the depth slice image.

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

Envelope

The basic idea behind enveloping a trace is to convert the trace from a wavelet with both positive and negative components to a monopulse wavelet with all positives. This is illustrated in **Figure 7-7**. The process removes the oscillatory nature of the radar wavelet and shows the data in its true resolution.

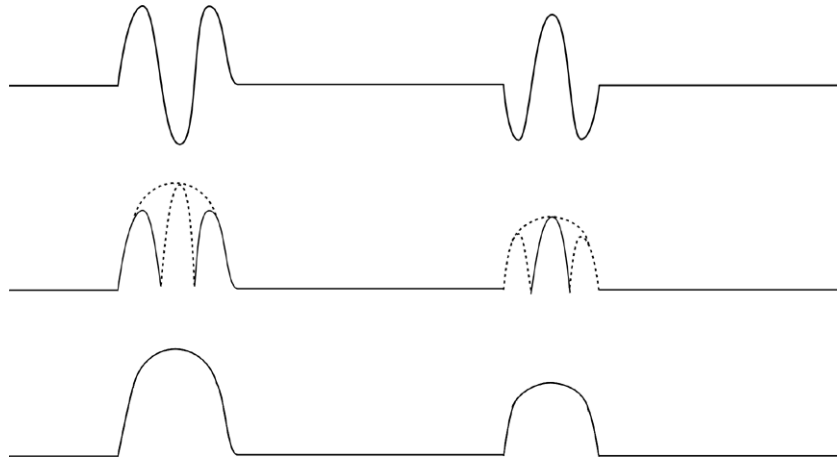


Figure 7-7: The original trace (top) consists of positive and negative components. The enveloping process makes the negative component positive (middle) and smooths the outline of the wavelet (bottom).

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

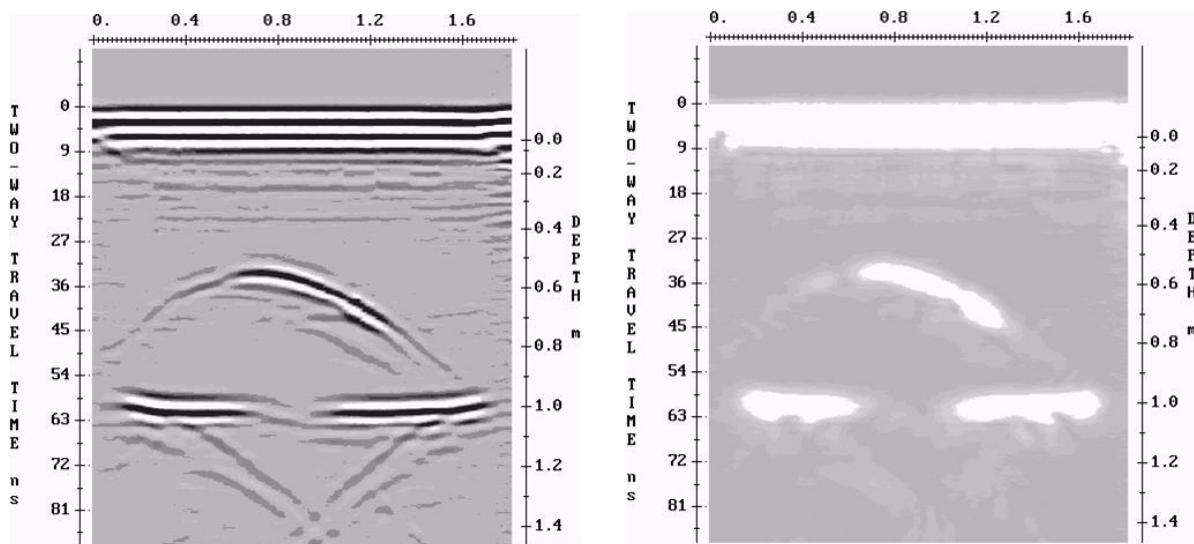


Figure 7-8: The enveloping process replaces the negative signal amplitudes visible in the raw data (left) with positive values (right). This process is important because amplitudes are averaged over a depth or time thickness and if it was not done the positive and negative amplitudes would cancel each other out, resulting in uninterpretable slice images.

Envelope is highly recommended for the display of slices. Slices are generated by averaging all the amplitude values in the thickness range. If data are not enveloped the negative values are retained and averaging can result in the positive or negative amplitudes cancelling each other out and producing slices with zero or low amplitudes.

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

7.1.5.4 Thickness

The Slice Thickness defines the thickness of the depth slices. It is indicated by the **slice cursor lines** on the slice image (**Figure 2-2**) in the plan view window.

It is important to understand that depth slices are a plot of the *average* signal amplitude between two depths or two times. A depth slice with a thickness of 0.5 foot uses the signal amplitudes in 0.5 foot thick 3D slabs and averages those into 2D plan images.

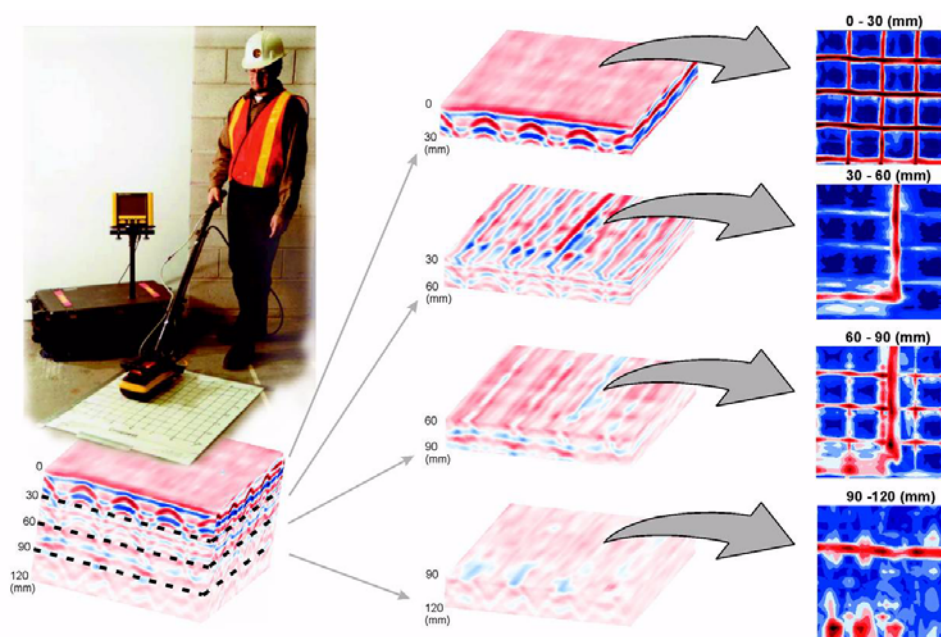


Figure 7-9: Conceptually, EKKO_Mapper divides the data volume into slabs of equal thickness and displays depth slice images of the average amplitude in each slab.

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

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

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

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

Events with a large depth extent will be seen over several depth slices. In this case it may be possible to increase the thickness of the 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.

Similarly, to see reflectors with a small depth extent or low amplitude, you may need to set the thickness to a smaller value.

7.1.5.5 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 1 foot, depth slice depth ranges would be 0.0-1.0, 0.5-1.5, 1.0-2.0 etc.

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.

7.1.5.6 Slice Depth Limit

The **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 cross-section data. The value can be changed by selecting **User** and entering a new value that is less than or equal to the maximum depth value. If the user depth limit value is set higher than the maximum depth, the value is ignored and maximum depth value is used.

Reducing the depth limit decreases the number of depth slice images. It is most useful when the GPR signal depth of penetration is significantly less than the maximum depth of the cross-section data. The depth limit can be set to the actual depth of penetration so depth slice images of the background noise signals towards the bottom of the cross-sections are not generated and displayed.

7.1.5.7 Interpolation Limit

EKKO_Mapper generates depth slice images by interpolating data into the gaps between the cross-sections (see [Figure 7-10](#)). As the line separation or the distance between cross-sections increases, interpolating data into the gap is less desirable as artifacts may be created in the depth slice.

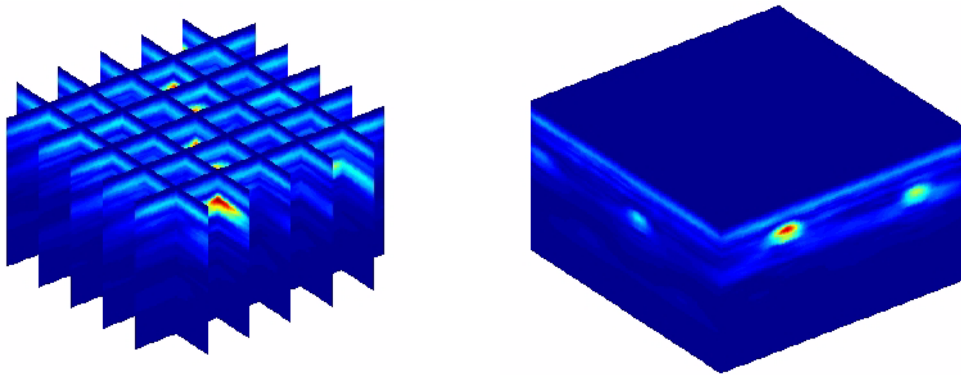


Figure 7-10: Conceptually, EKKO_Mapper interpolates data between cross-sections to generate a solid data set that is then displayed as depth slices.

The **Interpolation Limit** defines the maximum distance (in metres or feet) that data will be interpolated. If the distance two cross-sections exceeds this limit, a gap of zero data will be left between them (see [Figure 7-11](#)).

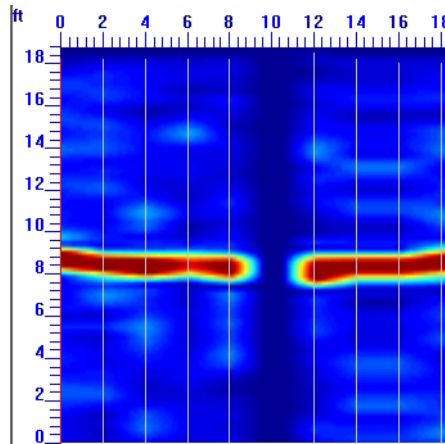


Figure 7-11: Depth slice image from a Y line data grid showing a gap with zero data where the line separation exceeded the Interpolation Limit.

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 the user to define the distance.

7.1.5.8 Amplitude Equalization Gain

Amplitude Equalization Gain applies a gain to the depth slice data to compensate the weaker signals at depth. When done properly, this allows the user to compare the relative signal strengths of targets in different depth slices.

Amplitude Equalization Gain requires three parameters: Attenuation, Start Gain and Maximum Gain.

The strongest GPR signals come from shallow targets while deeper targets have weaker signal strength. Therefore, the gain applied to the GPR data increases with increasing depth. The gain is a ramp that starts off at the **Start Gain** value at the top of the data, ramps up on a slope with the steepness depending on the **Attenuation** value and levels off to a constant multiplier when the **Max Gain** value is reached.

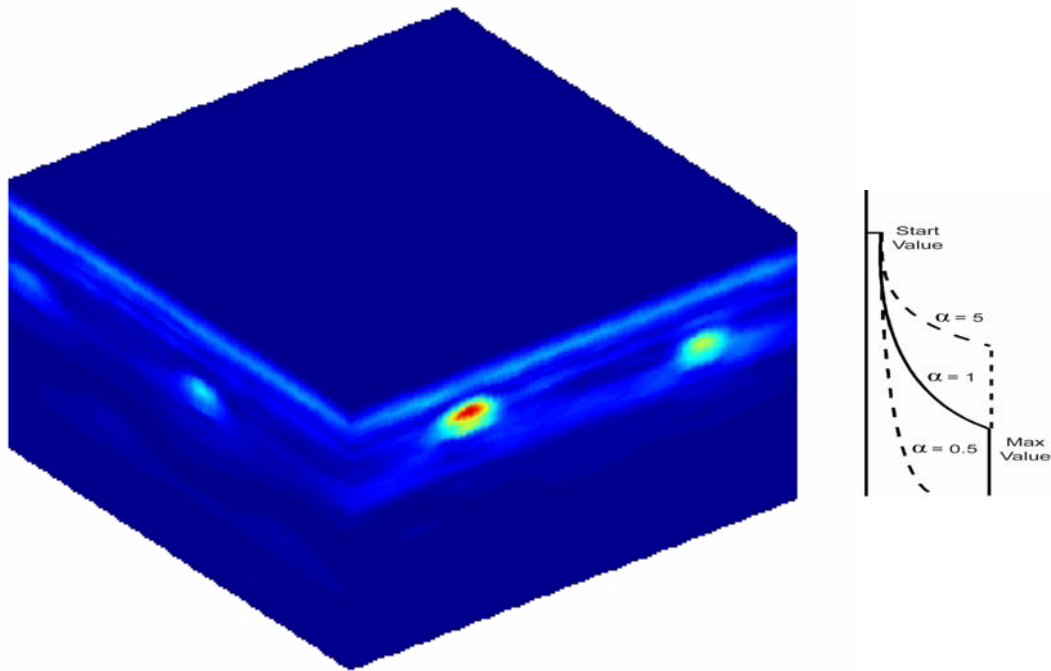


Figure 7-12: The concept of applying Amplitude Equalization Gain to the grid data. The gain at the shallowest depth slice is set by the Start Gain. The gain increases for deeper slices on a ramp set by the Attenuation. If the attenuation value is low, the gain ramp increases slowly with depth. If the attenuation value is high, the gain ramp increases quickly with depth. The ramp 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 display of the depth slice images. Changing the gain setting has no effect on cross-section images.

The current Amplitude Equalization Gain value is displayed in the **Plan View Legend**.

The Amplitude Equalization Gain can be turned off by unchecking the checkbox (**Figure 7-1**). If Amplitude Equalization Gain is turned off, the slice images are generated using the raw data amplitudes with no gain applied. When this is done, it is not advised to compare the signal amplitudes of targets in different slices.

The Amplitude Equalization Gain parameters can be set manually in **User** mode or automatically in **Auto** mode by clicking the desired option (see **Figure 7-1**).

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 depth slices look good using the Auto values and are not over-gained or under-gained, then using Auto Amplitude Equalization Gain is acceptable.

However, Auto does not always gain the data properly, especially if the data has strong, high amplitude signals deep in the section. In this situation, it tends to use an attenuation value that may be too high, resulting in overgained 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 then experiment using different values.

The following describes, in more detail, each gain parameter.

Attenuation

The Attenuation values defines the “steepness” of the gain function ramp. Lower values mean a more gradual slope while higher values are steeper. The ramp starts at the Start Gain value and ramps up to the Maximum Gain value.

Low values for Attenuation are typically used but higher values may help to improve the imaging of deeper targets. Try to use the lowest value possible as the data can be "overgained" making it more difficult to understand.

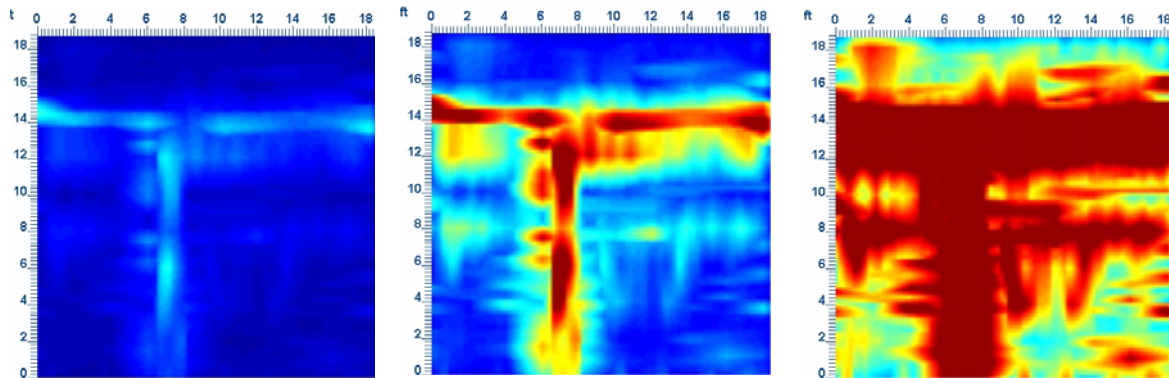


Figure 7-1: Amplitude Equalization applies a gain to the weaker signals at depth. If the Auto value is not high enough (left) or is too high (right), set it to User and experiment with different values that generate images with a good balance of colors (middle).

Typical values for the Attenuation are 0.0 to 20.0 but any value can be input by typing it directly into the field.

The Amplitude Equalization Gain value applies a gain to the slices in the same way that the Attenuation value applies gain to the cross-sections. Therefore, when a Attenuation value is found that makes the cross-section images look “good” without being over-gained (see [Attenuation](#)), the same value can be used as the **Attenuation** value to make the depth slice images look their best.

Start Gain

The Start Gain is the gain value at zero depth at the top of the GPR cross-section. Typically values for the Start Gain are 0 or 1 with 1 being the default value.

Maximum Gain

The Maximum Gain is the highest multiplication factor for the GPR cross-section data. The ramp defined by the Attenuation stops increasing once it has reached the Maximum Gain value. Typically values for the Maximum Gain are 20 to 1000 with 500 being the default value.

7.1.6 Defaults

Clicking the Default button will return all the Data Processing Settings to their default values.

7.1.7 Preview

Clicking on the Preview button allows the user to see the effect of changes they have made to the Data Processing Settings before permanently applying those changes by clicking on the OK button.

7.1.8 OK

Clicking the OK button closes the dialog box and, if the Data Processing settings have changed, processes (or reprocesses) the current grid survey data and generates slice images. Depending on the changes made to the processing, the time to process the data could take longer (or shorter) than before.

7.1.9 Cancel

Clicking the Cancel button closes the Data Processing dialog box ignoring any changes that may have been made to the settings.

7.1.10 Un-Processed Data

Checking the **Always open this dialog when loading un-processed data** checkbox from the Data Processing dialog means that, after opening a GFP file (**Open GFP File**), this dialog will automatically open for the user to confirm that all the data processing settings, especially the velocity and the slice thickness, are correct before starting the data processing.

If you do not want to automatically see this dialog when a GFP file is opened and want to select it manually before processing the data and generating slice images, uncheck this checkbox.

7.2 Hyperbola Velocity Calibration

The correct velocity is necessary for generating the clearest depth slice images and accurately determining the depth of an object from the cross-section images.

The Hyperbola Velocity Calibration allows the user to calculate the a velocity value using the hyperbola-fitting method. This method requires the user to fit a typical response curve (a hyperbola) to the raw data to extract the velocity.

It is very important that hyperbola fitting only be performed on target responses where the GPR system has crossed the target perpendicularly. Hyperbola-fitting on a target that was crossed at an angle will result in a poor velocity value, fuzzy depth slice images and inaccurate depth measurements.

The velocity calibration is accessed by selecting **Tool > Hyperbola Velocity Calibration** from the menu or by selecting the **Toggle Hyperbola Velocity Calibration** button from the Toolbar:

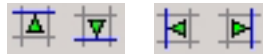


Note that this button toggles the Hyperbola Velocity Calibration window on and off so it must be clicked again after calibration is completed. If the velocity value has changed, the user is prompted to answer Yes or No to changing the velocity value.

7.2.1 Velocity Calibration Window

When Hyperbola Velocity Calibration is selected, a hyperbola is superimposed on the current cross-section image. If no cross-section window is opened, a new one is automatically opened.

The window always first displays the current cross-section. The user can use the **Line Up and Line Down** and **Line Left and Line Right** options to move through the cross-sections and display one with a good hyperbola for the velocity calibration.



If necessary, the user can also change the **Gain** value used for the cross-section to make the hyperbola more visible.

7.2.1.1 Hyperbola Fitting

The objective for hyperbola fitting is to move the hyperbola superimposed over the data on top of a hyperbola in the cross-section image and match the shape by dragging the handles on the end of the hyperbola tails.

To determine the velocity, the superimposed hyperbola does not necessarily need to be placed at the very top of hyperbola in the image. Try to choose the colored band on the hyperbola that has the longest tails and looks the most complete.

The superimposed hyperbola can be moved by clicking on the position on the cross-section image where you want the apex (top) of the hyperbola to go. The hyperbola will immediately jump to this location.

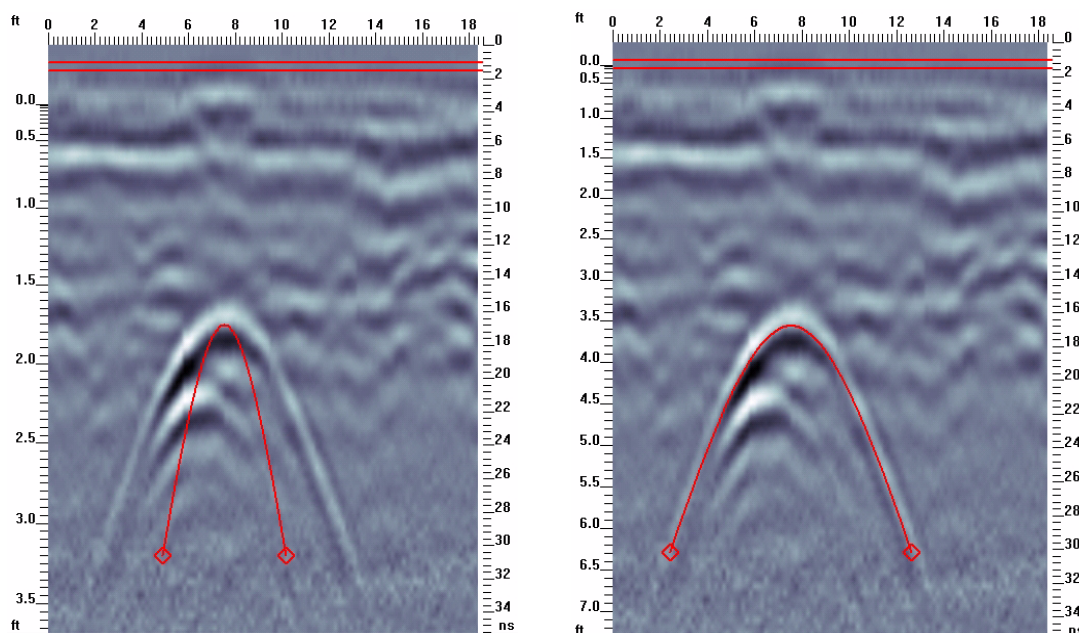


Figure 7-1: Hyperbola-fitting is done by first clicking or dragging the superimposed hyperbola onto one of the colored bands on the hyperbola in the data. Choose a band that has long tails. This is not necessarily the top band (left). Then, click and drag one of the diamond-shaped handles on the ends of the hyperbola until the shape matches (right). During this process, the velocity, depth and time are displayed on the Status Bar on the bottom of the screen.

After the hyperbola has been positioned at the apex of the hyperbola in the cross-section image, the next step is to match the shape. The shape of the hyperbola can be changed by clicking on either diamond-shaped handle on the ends of the hyperbola tails and dragging it to the position that best matches the shape of the image hyperbola.

Once the desired fit has been achieved, select Hyperbola Velocity Calibration again, using the menu or the button, to exit from velocity calibration mode.



If the velocity value has changed, the user is prompted to answer Yes or No to changing the velocity value. Click Yes to accept the new velocity. The grid data will automatically be reprocessed using the new velocity. Depending on the size of the grid, the reprocessing may take several minutes. The depth slice images and depth axis in the cross-section window will automatically update.

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

7.2.1.2 Target of Known Depth

The Hyperbola Velocity Calibration window can also be used to determine the velocity using a target at a known depth.

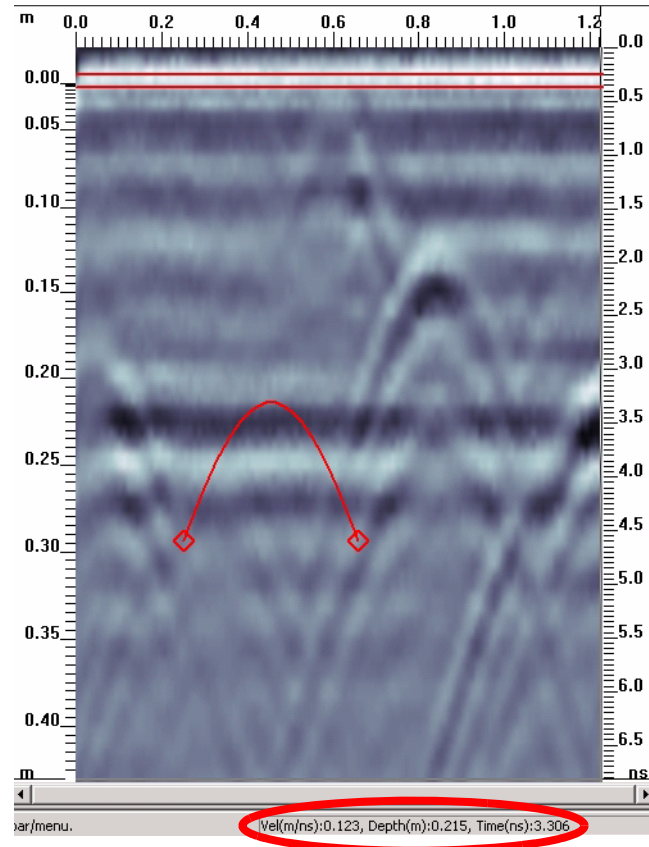


Figure 7-2: For a target at a known depth, like in this case the known thickness of a concrete slab, the apex of the hyperbola is placed on the reflection of the target and the velocity adjusted by dragging the hyperbola handles until the depth value listed at the bottom of the screen matches the known depth. The velocity will then be listed on the bottom of the screen as well.

For example, if the reflection from the bottom of the concrete is visible in the cross-section 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.

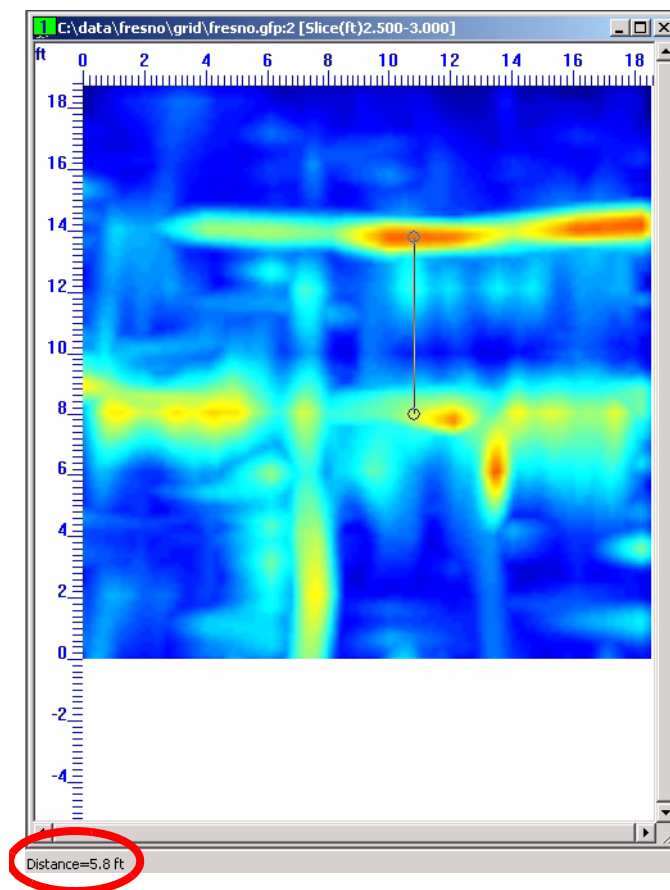
7.3 Measure

The measure tool allows the user to measure the straight-line distance between any two points on a depth slice or cross-section image.

The Measure tool is accessed by selecting **Tool > Measure** from the menu or by selecting the **Toggle Measure Tool** button from the Toolbar:



To measure the distance between two points, click the mouse at the start position and drag and drop the mouse cursor at the end position. The distance between the two points (in the current units) will be displayed on the **Status Bar** at the bottom of the screen.



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

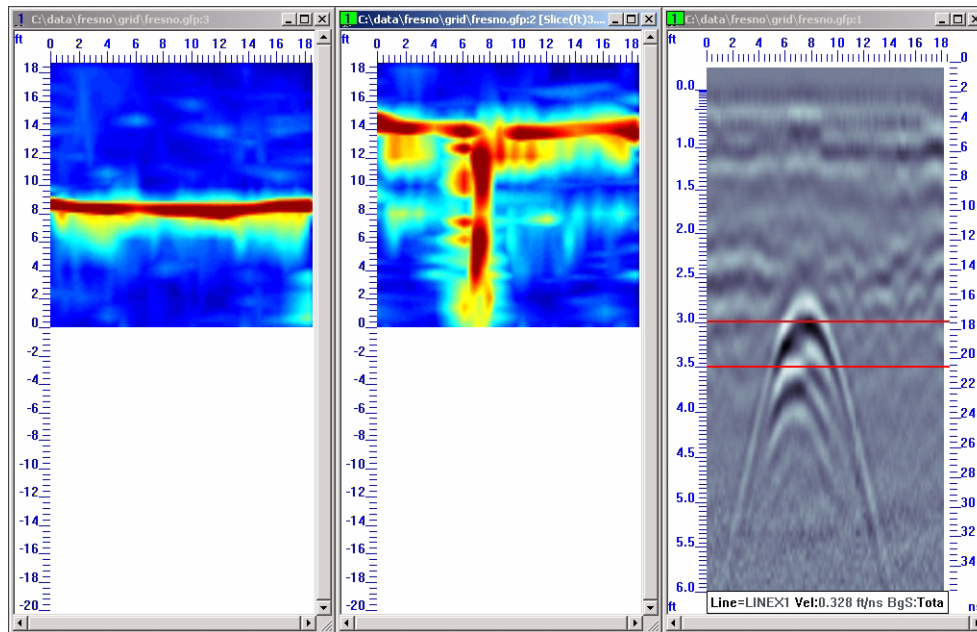
To exit from the Measure tool, select **Toggle Measure Tool** again, either by using the menu or by clicking the button on the **Toolbar**.

8 Window

8.1 New Plan View Window

Selecting **Window > New Window** opens another window (instance) of the current plan view window.

This is especially useful for looking at different plan views (like slices) at the same time.



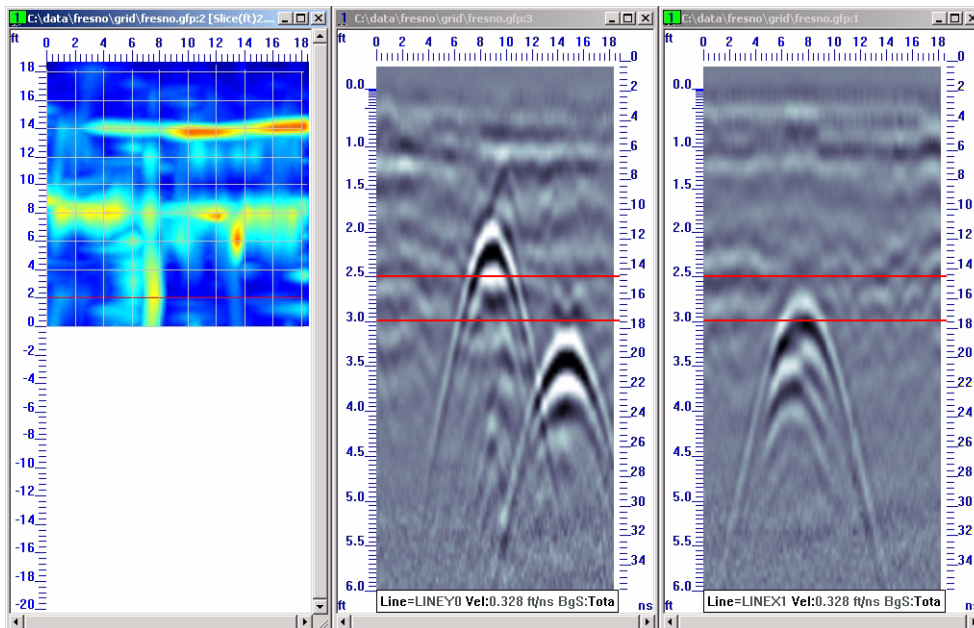
Windows always have a green number on the left side of the title banner that indicates which data set they belong to. For example, all the windows associated with the first GFP file opened will have a number 1 in the banner, all windows associated with the second GFP file opened will have a number 2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

When there are multiple plan view windows on the screen, only one is active at a time. However, changing some variables such as data processing parameters like velocity and slice thickness and color palette, changes the values for all instances of a plan view window. Other variables, such as Show Collected Lines, Show Scale, Show Scale Grid, Show Legend and Show Slice only apply to the current **Active Window**.

8.2 New Cross-Section View Window

Selecting **Window > New Cross-Section View Window** opens another cross-section window for the current grid survey.

This is especially useful for looking at different cross-section images at the same time.

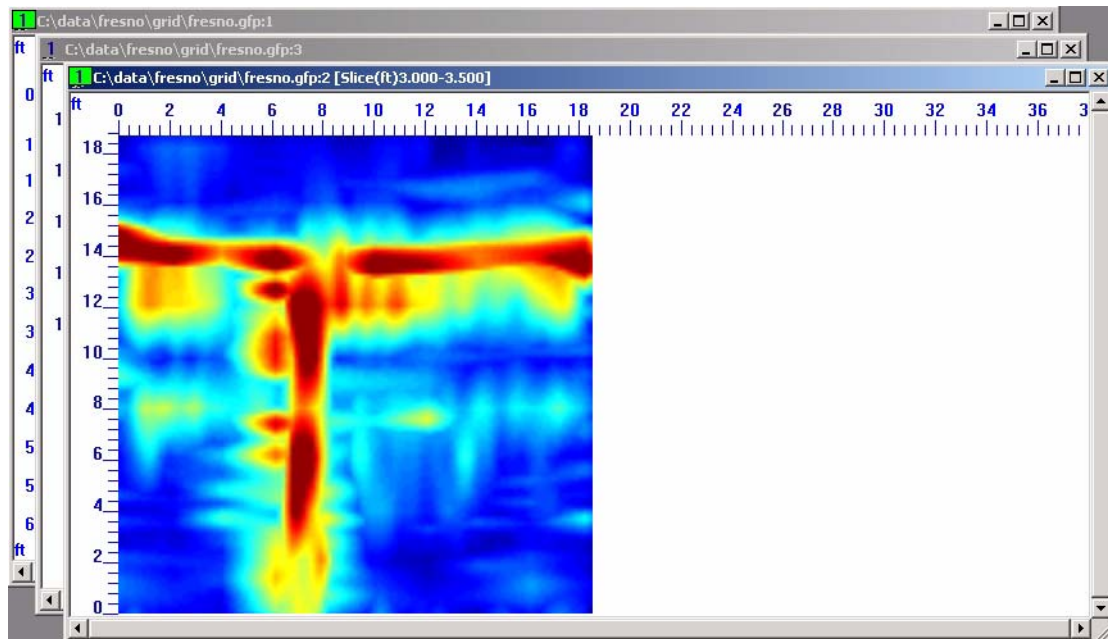


Windows always have a green number on the left side of the title banner that indicates which data set they belong to. For example, all the windows associated with the first GFP file opened will have a number 1 in the banner, all windows associated with the second GFP file opened will have a number 2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

When there are multiple cross-section windows on the screen, only one is active at a time. However, changing some variables such as gain, velocity and color palette changes the values for all instances of a grid scan. Other variables, such as GPR Processing, Show Scale, Show Scale Grid and Show Legend only apply to the current **Active Window**.

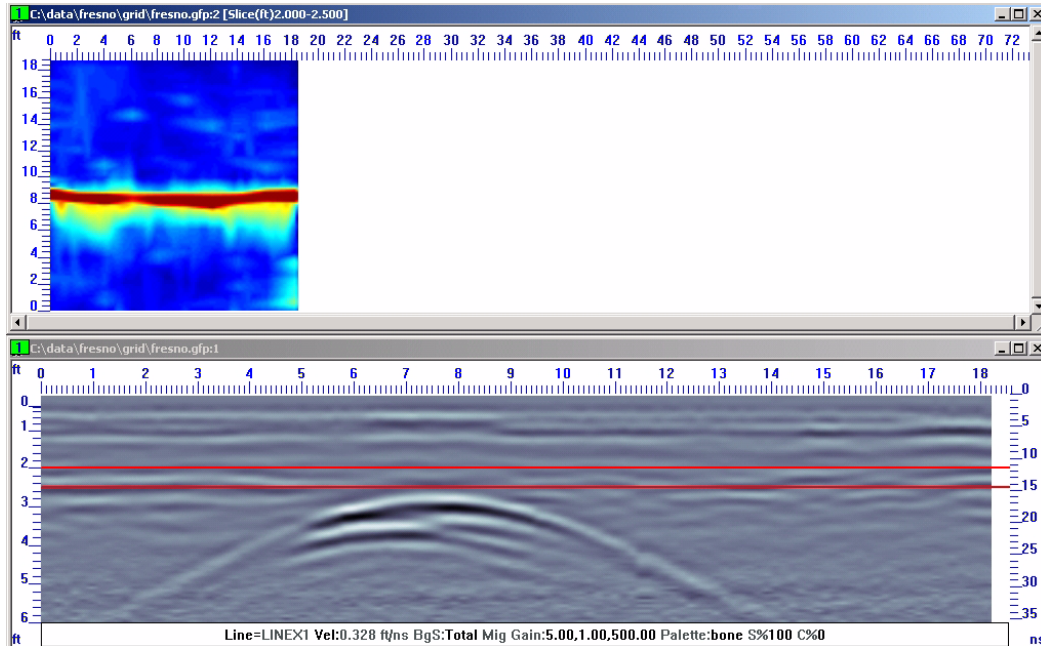
8.3 Cascade

Selecting **Window > Cascade** will rearrange open sections so they cascade on the screen, that is, the front section is completely visible and the title lines from the other sections are visible and accessible.



8.4 Tile Horizontally

Selecting **Window > Tile Horizontally** will rearrange all open windows so they are tiled horizontally on the screen, that is, all sections are resized so they are all visible and accessible.

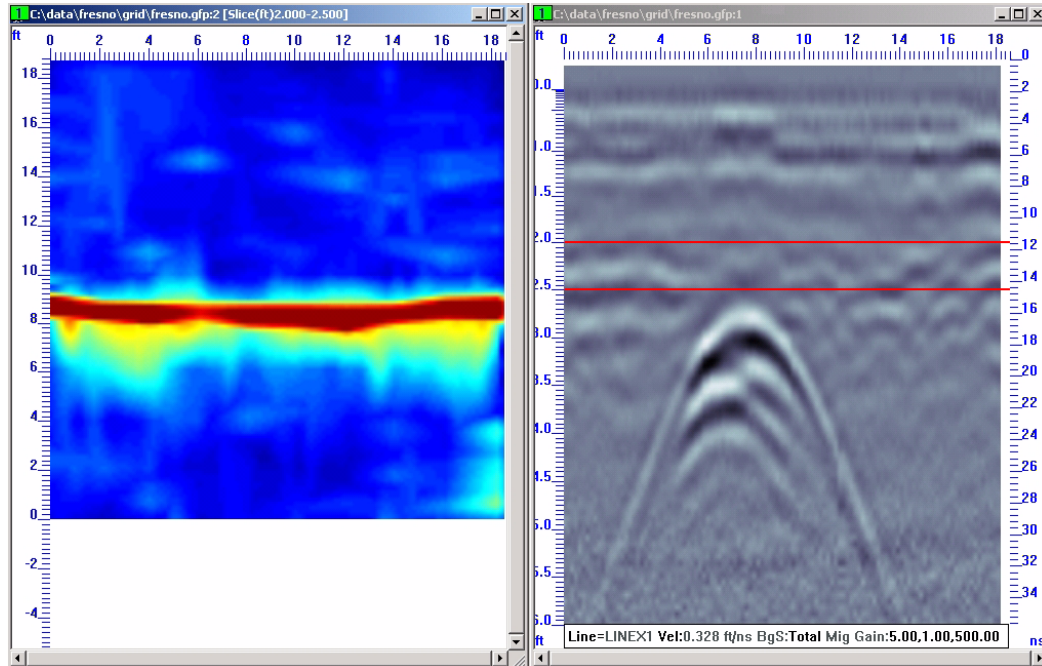


The **Tile Horizontally** option can also be accessed by clicking the following button on the **Toolbar**:



8.5 Tile Vertically

Selecting **Window > Tile** will rearrange all open sections so they are tiled vertically on the screen, that is, all sections are resized so they are all visible and accessible.

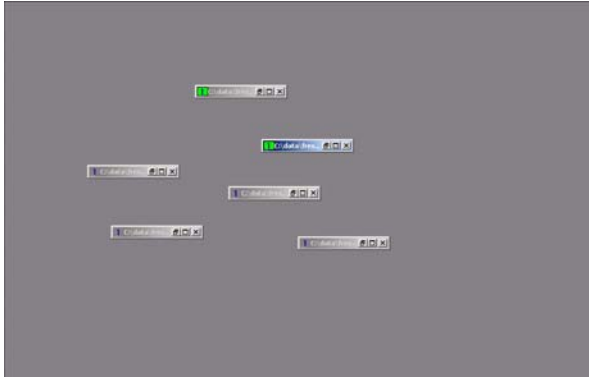


The **Tile Vertically** option can also be accessed by clicking the following button on the **Toolbar**:



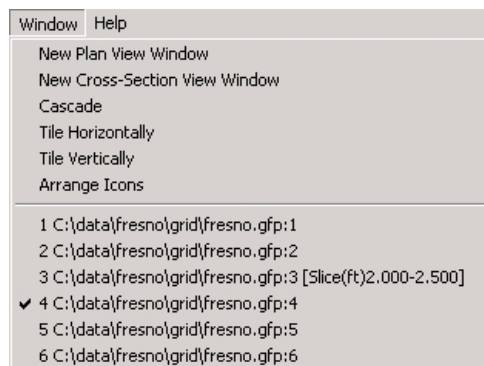
8.6 Arrange Icons

Selecting **Window > Arrange Icons** will order all the icons (minimized windows).



8.7 Selecting an Open Window

A list of all the currently open windows is available under the **Window** menu option. The current **Active Window** is indicated by a check-mark. The active window can be changed by selecting a different one from the list.



9 Help

9.1 Contents

The Contents option opens this document in PDF for viewing.

The Adobe Acrobat Reader program must be installed on the PC to open this document. If not, the user is prompted to download it from the Adobe website.

9.2 Sensors & Software contact information...

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

9.3 Feedback Form

The Feedback Form allows the user to document a problem about or suggestion for the EKKO_Mapper software and report it to Sensors & Software by email, fax or letter.

9.3.1 Suggestions

To send a suggestion for the EKKO_Mapper software, select the Suggestion button.

The screenshot shows a Windows-style dialog box titled "FEEDBACK FORM". At the top, it displays "EKKO_Mapper 3", "Version 3", "Release 1", and "PN:2006-00214-00". Below this, there are input fields for "Contact Name:" (containing "User"), "Contact Phone:" (containing "905 624-8909"), and "Email:" (containing "radar@sensoft.ca"). To the right of these fields is a "Company and Address:" section with a text area containing "Sensors & Software Inc.", "1040 Stacey Court", "Mississauga, ON", and "L4W 2X8". Below the input fields are two tabs: "Suggestion" (which is selected) and "Problem Description". A large text area for the feedback is located below the tabs. To the right of the text area is a "Fax Header" checkbox (unchecked). At the bottom left, there is a checked checkbox for "Send Diagnostic Information". At the bottom right, there is a "Report Options" section with buttons for "Email*", "Save To File...", "Notepad...", "Clipboard...", and "Close". A footnote at the bottom right states "* Requires MAPI".

9.3.2 Problems

To report a problem with the EKKO_Mapper software, select the Problem Description button

FEEDBACK FORM

EKKO_Mapper 3
Version 3
Release 1
PN:2006-00214-00

Contact Name: User
Contact Phone: 905 624-8909
Email: radar@senssoft.ca

Company and Address: Sensors & Software Inc.
1040 Stacey Court
Mississauga, ON
L4W 2X8

☐ Fax Header

☒ Send Diagnostic Information

Steps to reproduce:

Reproducible:
☐ Yes
☐ No

Severity:
Type of Defect:
Frequency:

Report Options:

* Requires MAPI

The more information you include about the problem, the better chance we have of solving it. If the error is reproducible, list the steps that generate it. You must also fill-in the **Severity**, **Type of Defect** and **Frequency** descriptions from the drop down lists.

Checking the **Send Diagnostic Information** checkbox will scan a log file saved with the ConquestView software on your PC and add additional text to your message that may help Sensors & Software to diagnose why the problem is occurring.

To help us troubleshoot the problem, you can ZIP the grid scan data files and attach them to your email message.

9.3.3 Contact Information

The upper part of the form is your contact information. Any information filled in here will be included in the report sent to Sensors & Software. You are not required to fill in these fields but remember that, if you want us to contact you about the report you send, we need your contact information.

Clicking the **Fax Header** checkbox will automatically add Sensors & Software's fax information to the top of the email or text file.

After writing the suggestion or problem description in the field provided, select one of the report options.

9.3.3.1 Email

Clicking on the Email option will automatically generate an email to Sensors & Software as long as your system is MAPI-enabled. MAPI is short for *Messaging Application Programming Interface*, a system built into Microsoft Windows applications like Outlook.

If selecting the Email option does not open your email application program, contact your IT department or consider using one of the other methods below.

9.3.3.2 Save to File

This option prompts the user to save the report as a text file. This text file can be attached to an email or printed out and faxed or mailed to Sensors & Software.

9.3.3.3 Notepad...

The Notepad option opens the Notepad program and automatically writes the report text into the program. The report can then be saved as a text file can be attached to an email or printed out and faxed or mailed to Sensors & Software.

9.3.3.4 Clipboard

The Clipboard open writes the report text to the clipboard so it can be quickly pasted into an email and sent or pasted into any word processing software like Microsoft Word. The report can then be saved and attached to an email or printed out and faxed or mailed to Sensors & Software.

9.4 Diagnostic Mode

Diagnostic Mode is used to help resolve the issue when EKKO_Mapper unexpectedly terminates or freezes without a warning or error message.

If you have a grid survey that consistently causes the program to crash or freeze, the next time you run the program, turn **Diagnostic Mode** on. Then, open the GFP file for the grid survey and perform the steps necessary for the crash to occur again. Diagnostic Mode causes the program to run much slower than normal, because it is logging all the data processing steps, so please be patient.

After the crash, run the program again but DO NOT open any data. Immediately go to **Help > Feedback Form** and send a message to Sensors & Software. The message will contain valuable diagnostic data to help us determine the cause of the problem. Please mention that the attached message is to report a crash and the program was in diagnostic mode.

Large data grids or small Slice Resolution values can take a long time to process so give the program a good chance to recover before concluding that the program has crashed or is frozen.

9.5 About EKKO_Mapper

This option displays a description, version number and product number of the EKKO_Mapper program currently in use.

Appendix A: EKKO_Mapper Glossary

Grid	is the term describing a square or rectilinear set of straight lines which cover 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 Survey	is the term to describe the process of acquiring data on a grid over an area with the end goal being to create depth or time slice images.
Line:	is the term used to identify the location of data acquisition. A line is normally straight and data are recorded from the start to the end of the line.
Line Profiling	is the term to describe collecting data along one or more lines for immediate site assessment using cross-section images. A series of lines can be used to help define site conditions prior to a grid survey
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 Line:	A line oriented in the X direction. (i.e. Y = constant while X position varies).
Y Line:	A line oriented in the Y direction. (i.e. X = constant while Y position varies).
X Line Spacing:	the term used to refer to the spacing between X lines when a grid is covered by equi-spaced X lines.
Y Line Spacing:	the term used to refer to the spacing between Y lines when a grid is covered by equi-spaced Y lines.
Maximum Depth:	is the term which describes the maximum depth selected for viewing, processing or data acquisition along a line.
Maximum Time:	is the term which describes the maximum time selected for viewing, processing or data acquisition along a line.
Time Window:	same as Maximum Time.
Depth Slice:	is the term to describe 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.
Time Slice:	is the term to describe 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.
Depth Slice Image:	is the term used to describe a depth slice when the slice attribute is displayed as a computer generated image. This term will normally be shortened to depth slice.

- Time Slice Image:** is the term used to describe a time slice when the slice attribute is displayed as a computer generated image. This term will normally be shortened to time slice.
- MultiSlice or MultiSlice View:** is the 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.
- Grid Size:** term used to describe a real extent of a grid (i.e. 5m x 10m, 20ft x 50ft.).
- Grid Resolution:** is the term used to describe the XY spatial resolution attained in a grid and is controlled by the largest line or trace spacing.
- Velocity:** is the 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.
- Color Palette:** is the term used to refer to 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.
- Line Name/Number:** is the identifier for a line of data saved when surveying along a line. (e.g. XL0010.DT1)
- 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.
- Depth Gain:** is a display gain applied that varies with depth along a trace.
- Time Gain:** is a display gain applied that varies with time along a trace.
- 3D View:** the term used when displaying depth or time slices and selected cross sections through a volume and used to enable 3D visualization of grid survey data.
- Cross-Section Image:** the term used when line profiling data are displayed as a computer generated image, showing signal amplitude varying in time or depth versus position along the line. Quite often the term is shortened to cross-section or section.
- Depth or Depth-Section Image:** the term used when line profiling data are displayed as a cross-section with the vertical depth scale. Quite often the term is shortened to depth-section or section.
- Time or Time-Section Image:** the term used when line profiling data are displayed as cross-section with the vertical time scale. Quite often the term is shortened to time-section or section.
- Slice Type:** standard grids use line names beginning with X for lines in X direction and line names beginning with Y for lines in Y direction. Time or depth slice images can be formed from X lines or Y lines, or combined XY. Combined slices are the standard but sometimes advanced users can benefit from viewing alternate slice types.

X Slice:	time or depth slice image created from X lines in a grid.
Y Slice:	time or depth slice image created from Y lines in a grid.
XY Slice:	time or depth slice image created from combining both X and Y lines in a grid.
Amplitude Depth / Time Equalization:	process of equalizing the average amplitudes in all depth/time slices such that equivalent features in slices from different depths/times will appear to have the similar amplitude in the generated image.
Slice Image Resolution:	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.
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.
Attribute	term applied to some characteristic derived from original data. Examples are the average amplitude of the dominant frequency between two times or depths.
Line Spacing Conversion Factor	When 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 $N \times \text{Factor}$. 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 $10 \times 0.5 = 2$ meters from origin along Y axis.
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)
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)
Cross Section Maximum Slice Depth Multiplier:	Multiplication factor used to set the maximum depth displayed on the cross-section view. Maximum depth displayed is this factor multiplied by the Max Depth Limit specified in the slice processing. (shortened to Max Slice Depth Multiplier)
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)
Hyperbola Velocity Estimate	A point source GPR reflection appears as a hyperbola in the Cross Section Image. Hyperbolic fitting enables the media velocity and target depth to be estimated.

Hyperbolic Fitting	Process of 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.
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.