USER'S GUIDE

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subsurface imaging solutions

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1 Introduction

Ground Penetrating Radar (GPR) data are collected as two dimensional cross-sections of the subsurface. The EKKO_Interp software is designed to plot cross-sectional GPR data images on a PC and allow the user to draw interpretations onto the image.

EKKO_Interp features:

1) Display data images in a variety of color palettes or as wiggle traces (or both).
2) Display of data files with tens to hundreds of thousands of traces.
3) Optimize the image by adjusting the color palette Contrast and Sensitivity.
4) Display multiple data images at once.
5) Draw different types of interpretations onto the data image including points, polylines, boxes and annotations.
6) Interpretations can span multiple data images.
7) Extract quantitative interpretation information to the Interpretation Report.
8) Plot data images with customizable position, time and depth axes and grid lines.
9) Apply same Gain and View Settings to all open data images at once.
10) Plot data images corrected for topography (if elevations integrated).
11) Zoom in/out and pan around the data images.
12) Print the data images with or without interpretations.
13) Save data images to graphics image files like BMP, JPG and TIF.
14) Save data images to the clipboard and paste into reports.
15) Apply Default, Auto or User Gains to the data.
16) Use cursor to display individual raw data traces, processed traces and Gain.
17) Simultaneous scrolling of linked data images.
18) Use Hyperbola-fitting to extract velocity information from the data.
19) Hyperbola-fitting can also extract velocities from CMP (Common Mid Point) data.
20) Plot the depth axis based on an average velocity value.
21) Quickly change units from meters to feet or feet to meters.
22) Reverse the line direction to easily compare lines collected in a zig-zag pattern.

23) Use the mouse cursor to determine the position, depth and signal amplitude of any point in the data image.

24) For data integrated with GPS, use the mouse cursor to determine the GPS position of any point in the data image.

25) F8 hotkey to save the position, depth, signal amplitude, etc. at the mouse cursor to the Clipboard and Paste into other documents.

26) Display data images with a legend with customizable GPR survey and processing parameters.

27) The program retains the display settings from the last time that cross-section was plotted.

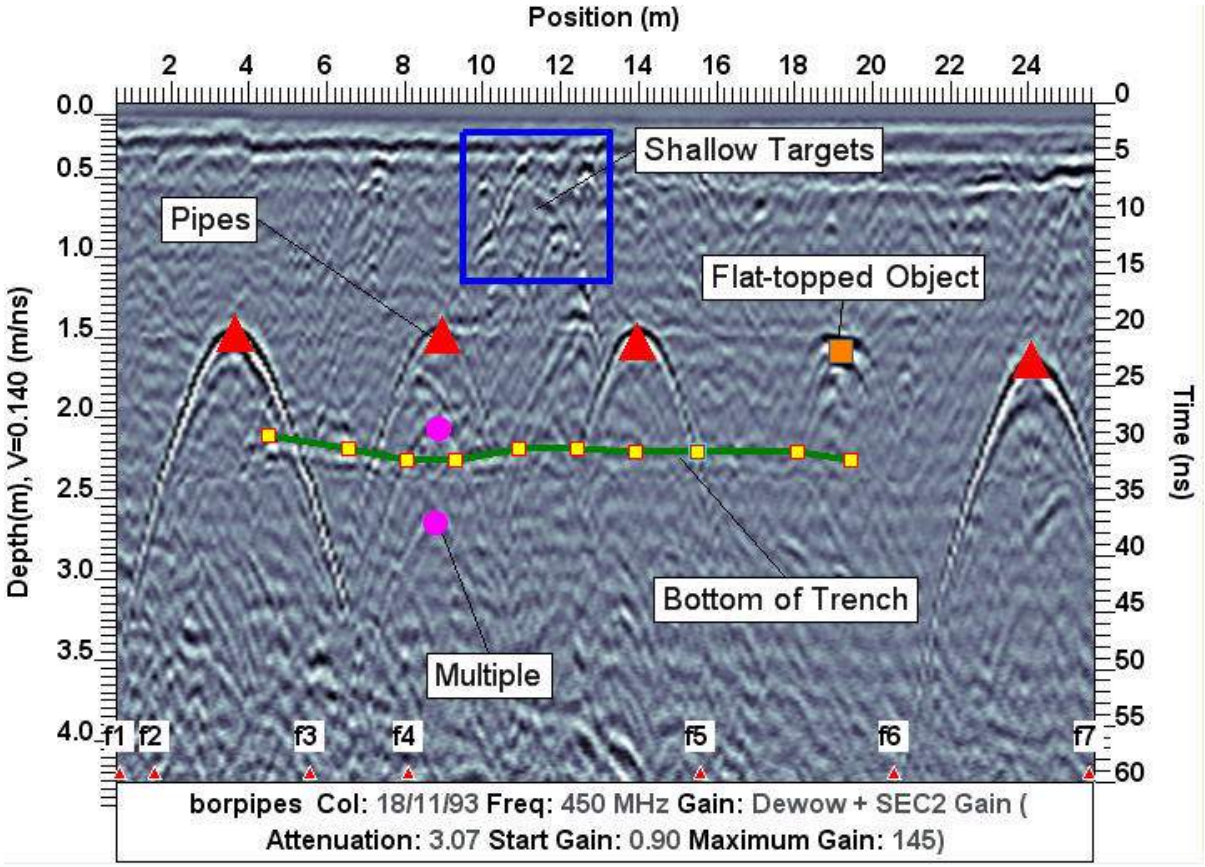


Figure 1-1: GPR cross-sectional image plotted with EKKO_Interp.

2 Software Registration

After installing EKKO_Interp, the first time the program is run the Registration dialog opens, prompting the user to enter a password. The Registration dialog is also accessible from the program by selecting **Help > Registration**.

The Registration dialog allows the user to enter a password, request to purchase a password or request a free password to try a demonstration.

2.1 Entering a Password

To enter a password provided by Sensors & Software, select the name of the Application or Module from the list.

Passwords are unique to the Hardware ID of the computer (shown on the bottom-left of the Registration dialog) and cannot be used on a different computer.

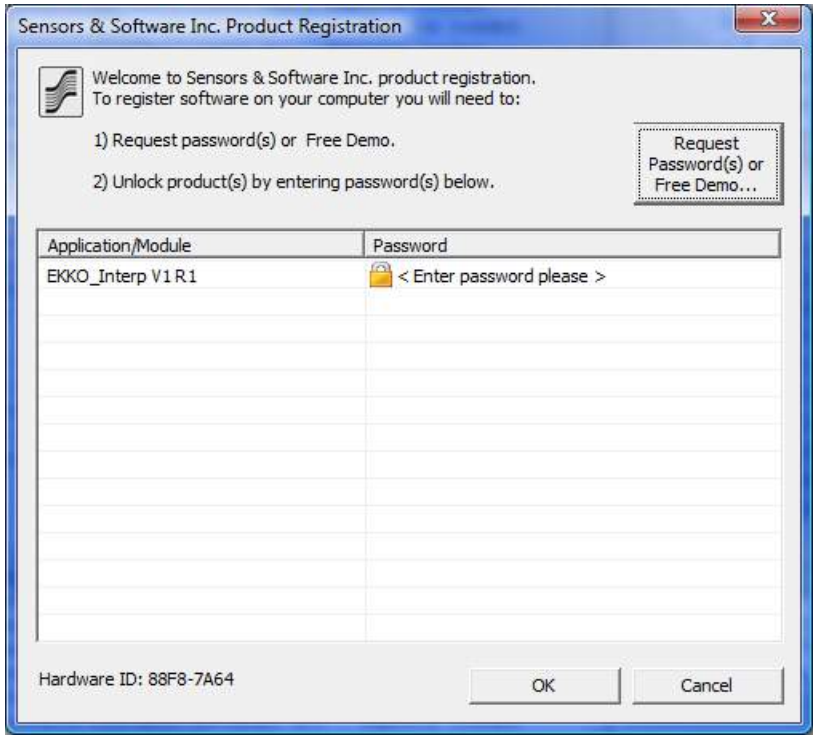


Figure 2-1: Enter a password for the software or module and then click OK. Or, to purchase a password or request a free demo, select the button on the right and proceed to the next dialog.

Enter the password beside the appropriate software application or module name in the space provided. By clicking outside the registration dialog the password is evaluated and the icon beside the password will change to indicate success or failure. The icon will also indicate whether the password is time-limited or unlimited.

If there is a typographical error in entering the password, the password entered is still visible and can be corrected. The software evaluates the password on the first three tries, then the user is warned. To prevent multiple tries, the software does not evaluate the password until the OK button is clicked.

Then click on OK. If the software was successfully registered, it will be enabled the next time the software is run.

2.2 Requesting a Password or Free Demo

If you do not have a password for the software or module but would like to purchase one, select the name of the software from the list. Then select the **Request Password or Free Demo** button on the right. The **Password Request** dialog will open.

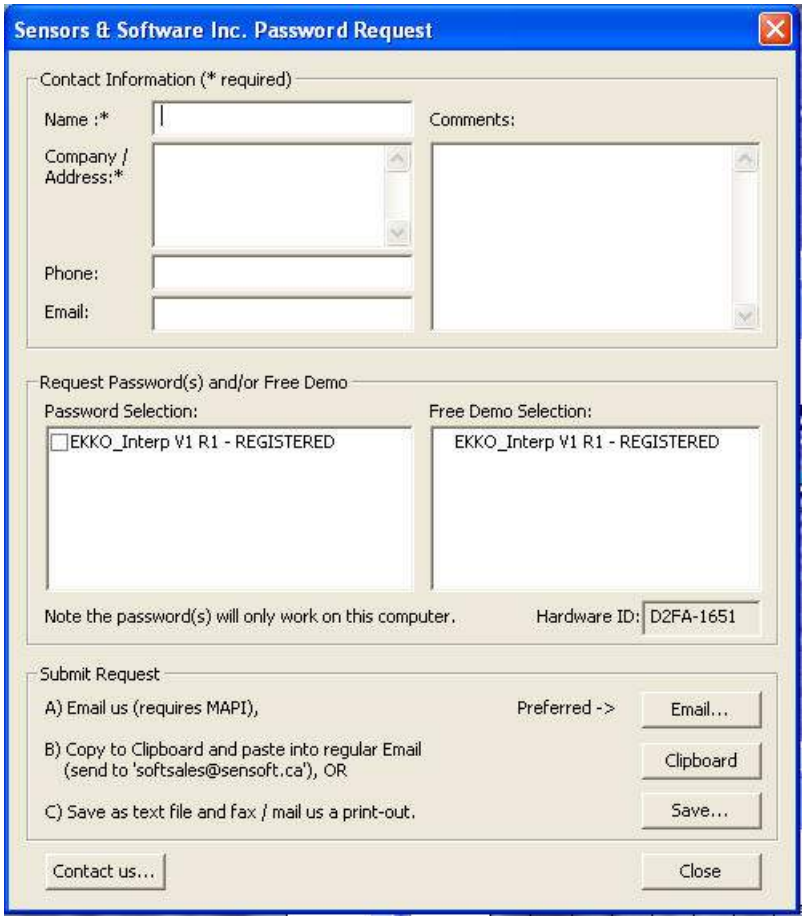


Figure 2-2: Request password or demonstration password.

1) Fill out the Contact Information in the top part of the dialog.

2) To request a password, select the name of the software or module in the list on the left.

3) To request a free demo, select the name of the software or module in the list on the right. The item can only be selected on one of the two lists, not both.

4) Submit the request using one of the following options:

   a) **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 ***M****essaging* ***A****pplication* ***P****rogramming* ***I****nterface,* 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.

   b) **Clipboard:** The Clipboard writes the request text to the clipboard so it can be quickly pasted into an email and sent.

   c) **Save**: This option prompts the user to save the request as a text file. This text file can be attached to an email or printed out and faxed or mailed to Sensors & Software.

5) After receiving your request, Sensors & Software will send you a time-limited demo password or contact you about purchasing a password for the software.

6) To enter a password see **Entering a Password**.

3 Overview

3.1 Using EKKO_Interp

The EKKO_Interp main screen displays a project of one or more GPR cross-sections in separate windows.

A new project of GPR data (.DT1) file(s) is opened by selecting **File > New**.

A window opens to display the first GPR data file in the project (**Figure 3-1**).

To open other GPR data files in the project, select the file name from the drop-down list on the **Project Toolbar**. To open all the GPR data files in a project, select **Window > Open All GPR Lines**.

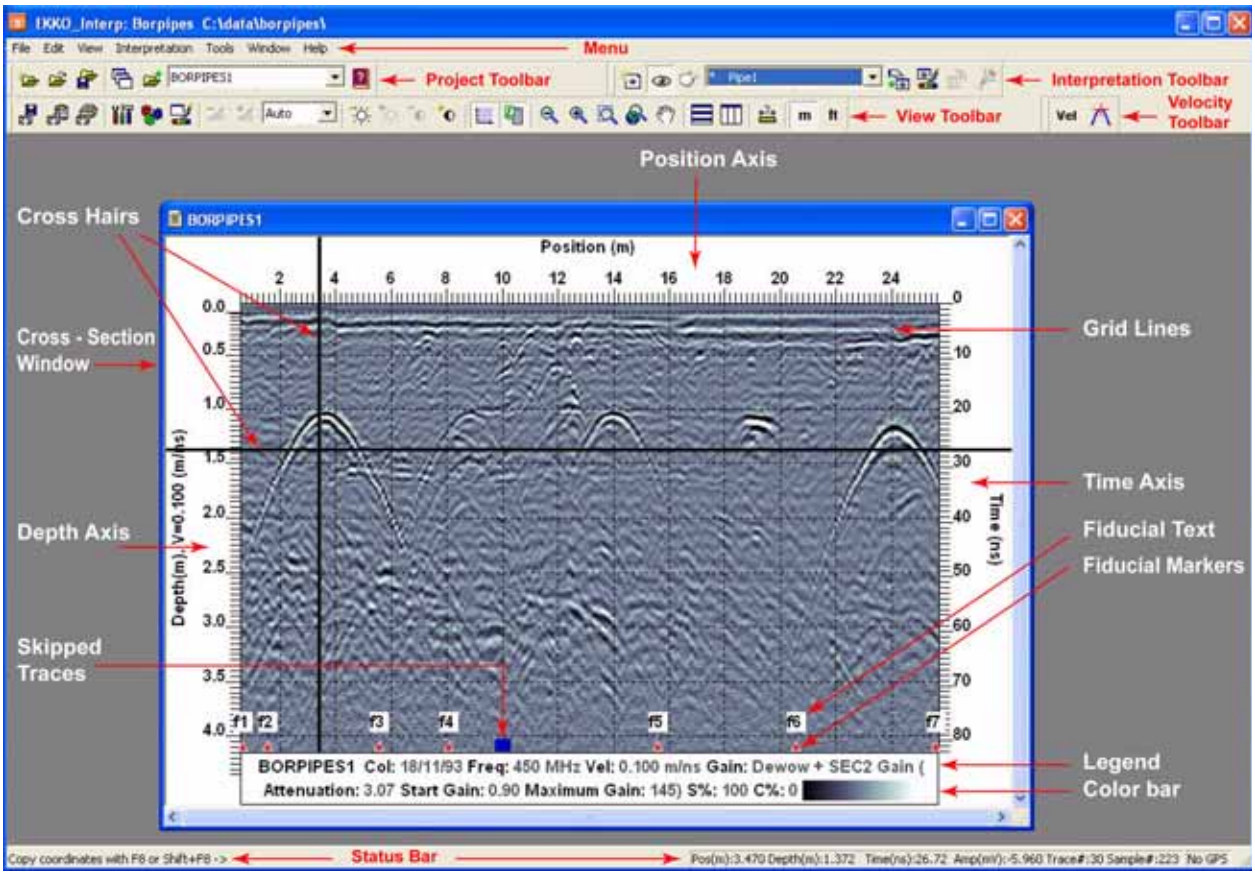


Figure 3-1: The EKKO_Interp main screen.

3.1.1 Displaying GPR Data Images

The data image(s) can be displayed in a **Color Scale**, **Wiggle Trace**, both or neither.

The **Legend** under the image provides details of the current cross-section image. The information specified in the Legend can be edited using the option under **View > Settings > Legend Tab**.

The **Menus and Shortcuts** and buttons on the **View Toolbar** allow the user to further modify and customize the images.

The Color Palette can be changed under the **View > Settings > Color Palette Tab** options from the menu or by selecting the **Color Palette Settings** button from the **View Toolbar**:

Gain is the amplification applied to the cross-sectional images. The **Gain Type** can be changed by selecting **View > Settings > Gain/Filter Tab> Gain Type**. The Gain **Level** can be changed in the **View > Settings > Gain/Filter Tab**.

The Gain **Level** can also be changed using the Gain dropdown on the **View Toolbar**:

If the Gain **Level** is set to a **Numbered Level**, the **Gain Increase** and **Gain Decrease** buttons on the **View Toolbar**:

can be used to quickly change the Gain Level.

Grid Lines corresponding to the major positions and depth labels can be superimposed on the cross-sections. Grid Lines are displayed by selecting **View > Grid Lines**. The specific grid lines are selected under **View > Settings > Axes Tab**.

The colors of the grid lines, fiducial markers and wiggle traces can be changed under **View > Settings > General Tab**.

The font for the axes and legend can be changed under **View > Font** or **View > Settings > General Tab**.

The Depth scale is based on the velocity set under **View > Settings > Axes Tab > Depth Axis**. The best way to determine this value is through the **Tool > Hyperbola Velocity Calibration** method.

If the data file has elevation data integrated with it, the data image can be plotted with topography by selecting **View > Settings > Axes > Elevation Axis**.

As the mouse cursor is moved over the data image, cross-hairs appear and information about the current position, depth, etc. of the cross-hairs in the data image are displayed on the **Status Bar** on the bottom of the main window.

3.1.2 Adding Interpretations

Interpretations are drawn on top of the GPR cross-section image using the mouse cursor.

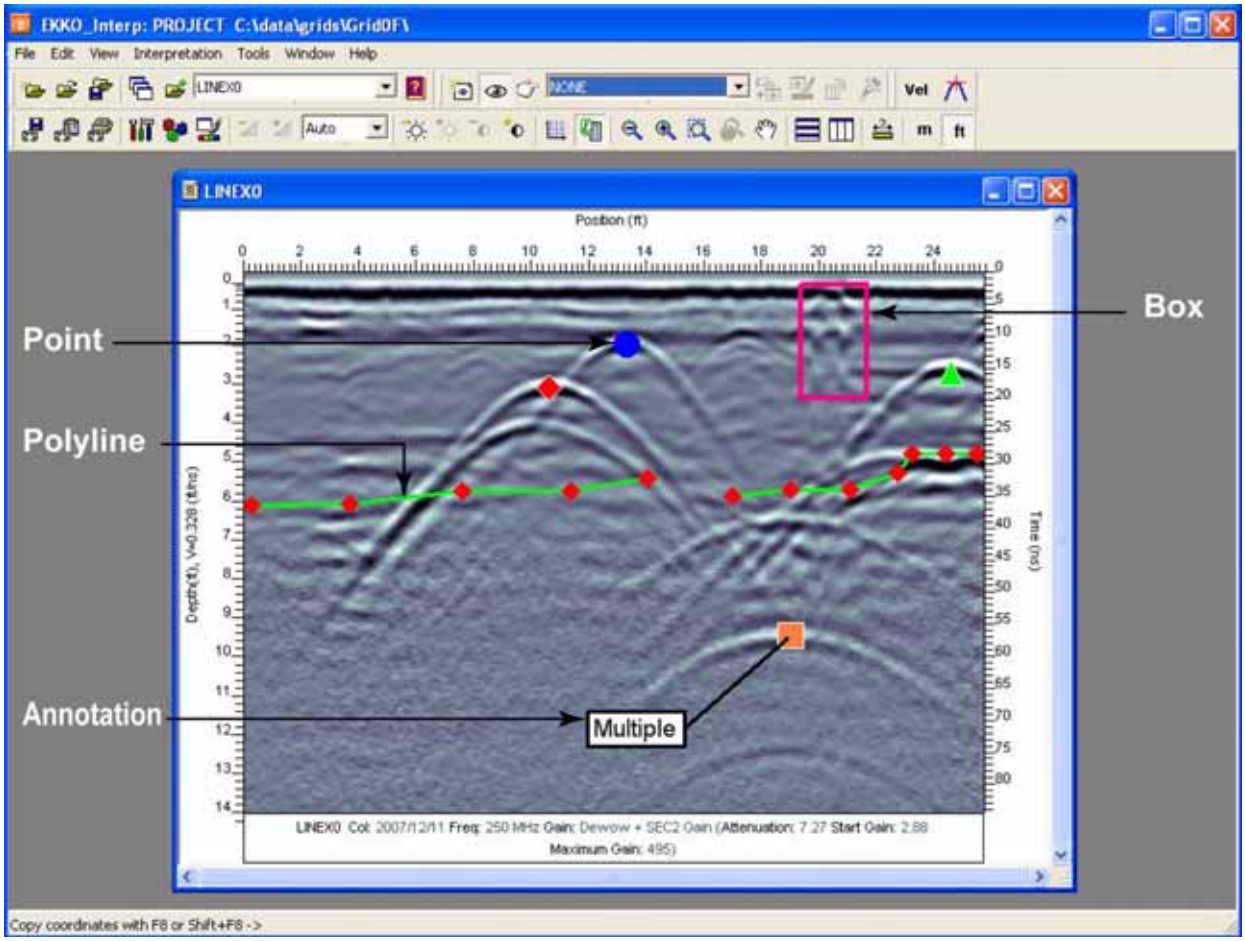


Figure 3-2: Interpretations are created and added to the cross-section image.

To create a new interpretation, select **Interpretation > Create New Interpretation**.

In the **Create New Interpretation** dialog either create the interpretation automatically by selecting **Apply Template** or manually by entering a **Name**.

If manually, select the interpretation **Drawing Tool**. Interpretation types are **Point**, **Polyline**, **Box** and **Annotation**. Then use the **Settings** button to set the properties such as line color, marker style and text font manually.

Make the new interpretation the **Active Interpretation** by selecting it from the drop-down list on the **Interpretation Toolbar**.

After creating a new interpretation, EKKO_Interp is automatically in **Add** Observations mode (the Add Observations button on the **Interpretation Toolbar** is pressed). Use the mouse cursor to draw new observations on the GPR data image(s). Interpretations are not restricted to a single cross-section image; they can span multiple images to, for example, interprete the same pipe or the same horizon on several images.

Observations can also be **Moved** or **Deleted**. Polylines can be cut (see **Delete**), points inserted (see **Insert Point in Polyline**) and polylines joined together (see **Join Polylines**).

Often-used interpretations can be saved as Templates for use with other projects (see **Make into Template**).

Interpretation details are written to the **Interpretation Report**.

If the user desires observation values in the Interpretation Report in elevations rather than depths, **Interpretations** should only be added after the cross-section has been plotted with an **Elevation Axis**.

3.1.3 Image Outputs

When satisfied with the image display, select **File > Print Image** to print a hard copy output or **File > Export Image** to save the image to a graphics file.

To copy the image to the clipboard, select **Edit > Copy Image to Clipboard**.

Images can be created with or without the interpretations displayed (see **View > Hide > Inactive Interpretations**).

It is also possible to only output the interpretation image without the GPR data image (see **No GPR Image**)

3.2 Window Operations

3.2.1 Active Window

The EKKO_Interp screen may have two or more cross-section 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 **Legend** option. The Active Window is always indicated by its dark (usually) blue title banner.

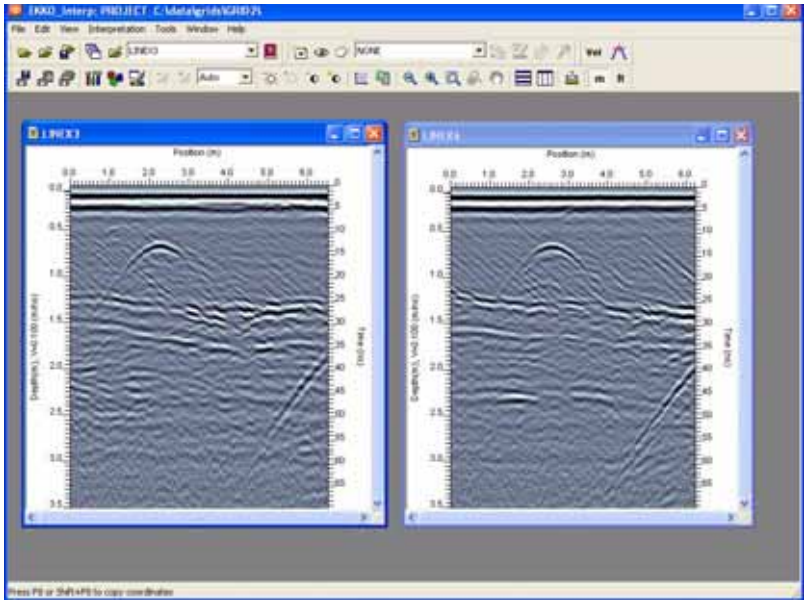


Figure 3-3: The Active Window is indicated by the darkly-colored title banner.

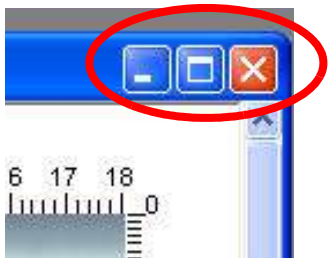
The current active window is listed in the Project List dropdown on the **Project Toolbar** and checked in the list under the **Window** menu.

3.2.2 Resizing Windows

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

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:

3.2.3 Tiling Windows

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

When tiling horizontally the current **Active Window** will always appear on top.

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

When tiling vertically the current **Active Window** will always appear on the left.

3.2.4 Opening a New Window

A second view into an already open cross-section window can be made by selecting **Window > New Window**.

3.2.5 Closing a Window

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

3.3 Legend

The data image has a legend that displays information about the cross-section (**Figure 3-1**).

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

3.4 Project Toolbar

Opening a New Project, opening an existing Project, saving Projects, Adding Lines to a Project and selecting a line to display from the Project list can be performed using the Project List Dropdown.

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

If the GPR line name is very long and does not fit on the Project List dropdown, hovering the mouse cursor over the Project List Dropdown displays the full name.

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

3.5 View Toolbar

Most operations involving changing the Cross-section image can be performed using the buttons on the View Bar. The View Bar is made visible by checking it under **View > Show/Hide > Toolbar > View**.

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.

3.6 Velocity Toolbar

Operations involving changing the velocity for the depth or elevation axis can be performed using the Velocity Bar. The Velocity Bar is made visible by checking it under **View > Show/Hide > Toolbar > Velocity**.

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.

3.7 Interpretation Toolbar

Operations for making new interpretations, picking the active interpretation, adding or deleting observations or editing interpretation templates can be performed using the Interpretation Bar. The Interpretation Bar is made visible by checking it under **View > Show/Hide > Toolbar > Interpretation**.

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.

3.8 Status Bar

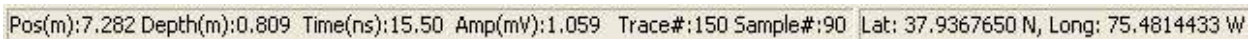
The status bar is visible on the bottom of the screen when the **View > Show/Hide > Status Bar** option is checked (**Figure 3-1**).

As the mouse cursor is moved over buttons on the toolbars, 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 **Legend** button will display the following on the Status Bar:

When the mouse cursor is located on the cross-section image, the right side of the status bar displays information about the data at that location:

3.8.1 GPS

If the GPR data file has GPS information integrated in (using the EKKO_View Deluxe or IcePicker software), the GPS position in Latitude-Longitude and/or UTM coordinates are also displayed on the Status Bar:



The format of the GPS information can be changed under **View > Settings > Legend Tab > GPS Configuration.**

3.8.2 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.

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

Distance(m)	Depth(m)	Time(ns)	Amplitude(mV)	Trace#	Sample#	Latitude	Longitude
4.73	1.046	20.17	-32.228	96	75	36.1091593 N	115.1413538 W
5.591	0.732	13.98	3.302	113	60	36.1091528 N	115.1413557 W
7.304	1.445	28.09	-10.665	147	95	36.1091395 N	115.1413584 W
8.832	1.261	24.44	-8.09	178	86	36.1091275 N	115.1413620 W
9.91	0.73	13.93	3.929	199	60	36.1091190 N	115.1413632 W

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.

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

4 Menus and Shortcuts

The following sections describe the EKKO_Interp menus.

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+E = Edit

Alt+V = View

Alt+I = Interpretation

Alt+T = Tools

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.

Popular sub-menus can be accessed directly by pressing Ctrl key followed by a letter:

Ctrl+N = New Project

Ctrl+O = Open Project

Ctrl+P = Print Image

Ctrl+C = Copy Image to Clipboard

Sensitivity can be increased by pressing the] key and decreased by pressing the [key. Pressing the Shift or Ctrl key at the same time changes the increment. For more details see **Sensitivity**.

Contrast can be increased by pressing the / key and decreased by pressing the . key. Pressing the Shift or Ctrl key at the same time changes the increment. For more details see **Contrast**.

Gain Level can be increased by pressing the + key and decreased by pressing the - key.

5 File Menu

5.1 New

The **File > New** option allows the user to open a new project file to display the GPR data file(s).

The user first provides a name for Project and then selects one or more GPR data (DT1) files from the same folder. All the DT1 files must reside in the same folder but files from sub-folders can be added later using the **File > GPR Lines > Add**.

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

Regardless of how many DT1 files are in the Project, initially only the first file in the list is displayed. However, other DT1 files can be displayed by:

1) Selecting the DT1 file name from the drop-down list on the **Project Toolbar**, or,
2) Opening all DT1 files in the Project by selecting **Window > Open All GPR Lines**.
3) Clicking the **Open All Lines in Project** button on the **Project Toolbar**.

When a New Project is saved, the DT1 and HD files are saved to a compressed project file called a GPZ file. Data files (DT1 and HD) can be added or removed from the GPZ project file at any time using the **File > GPR Line(s)** option. For more details about GPZ files, see **Open**.

5.2 Open

GPR data files are saved to a compressed project file called a GPZ file. A GPZ file contains one or more GPR cross-sectional data files (DT1 and HD) as well as other related files such as GPS and topographic (TOP) files that have the same name as the DT1 file.

The **File > Open** option allows the user to select a project file to display the GPR data file(s).

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

GPR data files (DT1 and HD) can be added or removed from the GPZ project file at any time using the **File > GPR Line(s)** option.

5.3 Close

The **File > Close** option closes the current project and all associated windows.

5.4 Save

The **File > Save** saves the current project to a .GPZ file.

The **File > Save** option can also be accessed by clicking on the **Save Project** button on the **Project Toolbar**:

5.5 Save As

The **File > Save As** option saves the current project to a different folder and name.

5.6 GPR Line(s)

The GPR Line(s) option is used to Add to, Delete from and Export GPR lines from the current Project (GPZ) file.

5.6.1 Add

The **Add** option adds additional GPR Lines (DT1) to the Project (GPZ) file. These lines MUST be in the same folder as the Project file or in a sub-folder.

The **File > GPR Line(s) > Add** option can also be accessed by clicking on the **Add Lines** button on the **Project Toolbar**:

5.6.2 Export All

The **Export All** option exports all the GPR Lines from the Project (GPZ) File to a different folder location. The exported files are the GPR data files (DT1 and HD) as well as other associated files like GPS, elevation (TOP) and INI files.

5.6.3 Export Current Line

The **Export Current Line** option export the GPR Line in the **Active Window** from the Project (GPZ) File to a different folder location.

5.6.4 Remove Current Line

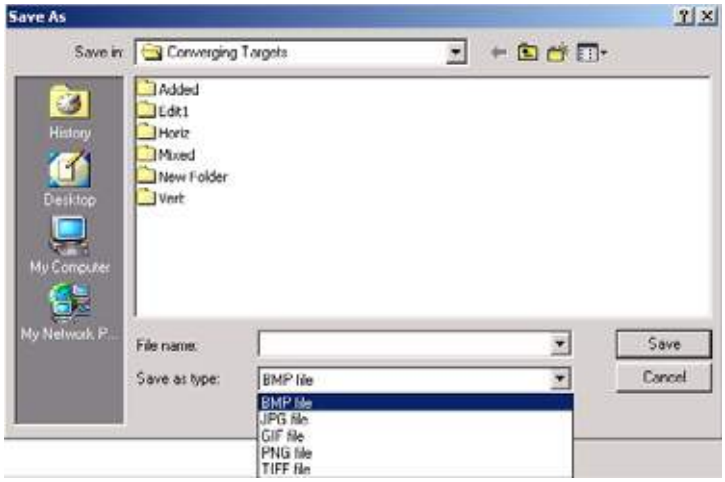
The **Remove Current Line** option deletes the GPR Line in the **Active Window** from the Project (GPZ) File.

T**he user is cautioned that removing the line from the Project File may result in the total loss of the GPR data line, interpretations and associated files (GPS, TOPO, INI) unless a copy of the original data files was made using Windows Explorer.**

5.7 Export Image

The **File > Export Image** 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 **View Settings Menu** for details on modifying the image.

This option can also be accessed from the **View Toolbar** by clicking on the **Export Image** button:

See **View Settings Menu** for details on modifying the image by turning on or off the scales, grid lines, legend, fiducial markers and 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.

Interpretations displayed on the image (see **Interpretation**) are saved to the exported image. If interpretations are not desired on the exported image, they can be temporarily turned off by setting the **Active Interpretation** in the interpretation drop-down list on the **Interpretation Toolbar** to **None** and then using the **Inactive Interpretations** option to turn off the display of inactive interpretations.

To obtain the best resolution in the exported image, stretch your display window to the largest size possible with the desired aspect ratio. The image can also be stretched to extend outside of application window to obtain even better resolution for the exported image. Even though part of the image is not visible in the application window, it will still be preserved in the exported image.

5.8 Print Image

The **File > Print Image** 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 **View Toolbar**:

See **View Settings Menu** for details on modifying the image by changing the processing, turning on or off the scales, grid lines, legend, fiducial markers and fiducial text.

Interpretations displayed on the image (see **Interpretation**) are saved to the printed image. If interpretations are not desired on the printed image, they can be temporarily turned off by setting the **Active Interpretation** in the interpretation drop-down list on the **Interpretation Toolbar** to **None** and then using the **Inactive Interpretations** option to turn off the display of inactive interpretations.

To obtain the best resolution in the printed image, stretch your display window to the largest size possible with the desired aspect ratio. The image can also be stretched to extend outside of application window to obtain even better resolution for very large printed images. Even though part of the image is not visible in the application window, it will still be preserved in the printed image.

5.9 Interpretation Report

The Interpretation Report writes the Interpretations to CSV (Comma Separated Values) files:

1) CSV files for each interpretation
2) CSV files for each GPR line data file
3) One CSV file that contains all interpretations sorted by interpretations
4) One CSV file that contains all interpretations sorted by GPR data file names

Exporting the Interpretations to spreadsheet-type files like CSV allows the information to be exported to third-party software like Excel and GIS programs.

An Interpretation Report (CSV) file is only created if the **Include in Report** option is enabled in the Interpretation Properties (**Interpretation > Properties**).

The following information is written to the Interpretation Report:

1) Header listing the Interpretation Name, **Description** and count of observations for each interpretation
2) Drawing Tool
3) Interpretation Name
4) GPR Line Name
5) Position along Line (m or ft)
6) X Position (if grid data)
7) Y Position (if grid data)
8) Depth (m or ft)
9) Time (ns)
10) Elevation (if available, m or ft)
11) Signal Amplitude (millivolts)
12) Velocity (ft/ns or m/ns)
13) Longitude or UTM Easting
14) Latitude or UTM Northing
15) Comments

The velocity value is used to calculate depths and elevations. Changing the velocity will change the depths and elevation values.

The Interpretation Report will only list either depth or elevation. If the GPR cross-sections are plotted with a **Depth Axis**, depth values are listed and the elevation column is blank. If the GPR cross-sections are plotted with an **Elevation Axis**, the elevation values are listed and depth column is blank.

If the user desires observation values in elevations rather than depths, **Interpretations** should only be added **AFTER** the cross-sections have been plotted with an Elevation Axis.

Adding Interpretations BEFORE applying Elevation may affect the accuracy of the elevation observations in the Interpretation Report.

The the case of a **Box** interpretation, the positions of the upper-left and bottom-right corners are listed.

If the **GPS Configuration** is set to both Latitude-Longitude and UTM, only UTM positions are written to the Interpretation Report.

An example In the Interpretation Report is shown in **Figure 5-1**.

Name	Description	Count											
Annotation1		2											
Box1	Shallow point targets	3											
Polyline1	Soil boundary	4											
Pipe1	Water pipe	3											
Tool	Interpretation	GPR Line	Position(m)	X(m)	Y(m)	Depth(m)	Time(ns)	Elevation(m)	Amplitude(mV)	Velocity(m/ns)	GPS-Latitude(deg)	GPS-Longitude(deg)	Comment
Annotation	Annotation1	LINE03.DT1	2.605			1.281	25.15		0.211	0.1	44.276155	-79.88712833	Boundary
Annotation	Annotation1	LINE06.DT1	1.658			2.275	45.02		36.622	0.1	44.27615333	-79.88716367	High Amplitude Reflector
Box	Box1	LINE03.DT1	4.802			0.125	2.41		-45	0.1	44.27617083	-79.88711667	
Box	Box1	LINE03.DT1	5.793			0.422	8.08		-3.226	0.1	44.27617833	-79.88711	
Box	Box1	LINE05.DT1	4.188			0.135	2.6		-45	0.1	44.27617333	-79.887145	
Box	Box1	LINE05.DT1	5.089			0.741	14.39		-6.74	0.1	44.27618	-79.88713667	
Box	Box1	LINE06.DT1	2.618			0.172	3.25		48.036	0.1	44.27616167	-79.887155	
Box	Box1	LINE06.DT1	3.578			0.422	8.08		3.934	0.1	44.27617	-79.88715	
Polyline	Polyline1	LINE03.DT1	0.061			1.179	23.11		15.201	0.1	44.27613167	-79.88714333	
Polyline	Polyline1	LINE03.DT1	1.052			1.165	22.83		7.553	0.1	44.27614	-79.88713708	
Polyline	Polyline1	LINE03.DT1	2.409			1.262	24.78		8.24	0.1	44.27615167	-79.88713	
Polyline	Polyline1	LINE03.DT1	3.323			1.337	26.27		4.595	0.1	44.27615833	-79.887125	
Polyline	Polyline1	LINE03.DT1	3.872			1.42	27.94		34.103	0.1	44.27616333	-79.88712167	
Polyline	Polyline1	LINE03.DT1	4.345			1.281	25.15		15.97	0.1	44.27616667	-79.88711917	
Polyline	Polyline1	LINE03.DT1	5.061			1.286	25.25		-45.616	0.1	44.27617333	-79.887115	
Polyline	Polyline1	LINE03.DT1	6.205			1.262	24.78		-30.697	0.1	44.27618167	-79.88710833	
Polyline	Polyline1	LINE05.DT1	0.015			1.067	20.88		7.384	0.1	44.27614	-79.88716667	
Polyline	Polyline1	LINE05.DT1	1.126			1.183	23.2		-17.939	0.1	44.27614833	-79.88716167	
Polyline	Polyline1	LINE05.DT1	3.543			1.253	24.6		-31.878	0.1	44.27616667	-79.88714889	
Polyline	Polyline1	LINE05.DT1	4.473			1.323	25.99		27.92	0.1	44.276175	-79.88714267	
Polyline	Polyline1	LINE05.DT1	4.909			1.244	24.41		19.304	0.1	44.27617833	-79.88713833	
Polyline	Polyline1	LINE05.DT1	6.38			1.253	24.6		19.869	0.1	44.27619	-79.88713167	
Polyline	Polyline1	LINE06.DT1	0.044			1.067	20.88		-7.28	0.1	44.27614167	-79.88717333	
Polyline	Polyline1	LINE06.DT1	1.105			1.234	24.23		-12.619	0.1	44.27614917	-79.88716667	
Polyline	Polyline1	LINE06.DT1	3.185			1.253	24.6		15.21	0.1	44.27616667	-79.88715267	
Polyline	Polyline1	LINE06.DT1	4.596			1.355	26.64		-12.465	0.1	44.27617778	-79.887145	
Polyline	Polyline1	LINE06.DT1	4.658			1.211	23.76		-4.033	0.1	44.27618	-79.88714333	
Polyline	Polyline1	LINE06.DT1	6.196			1.309	25.71		-10.16	0.1	44.27619	-79.88713667	
Point	Pipe1	LINE03.DT1	2.302			0.619	11.97		18.331	0.1	44.27615	-79.88713	
Point	Pipe1	LINE05.DT1	2.477			0.629	12.16		27.663	0.1	44.27616	-79.887155	
Point	Pipe1	LINE06.DT1	2.56			0.624	12.07		36.415	0.1	44.27616167	-79.887155	

Figure 5-1: Example Interpretation Report

5.10 Recent Files

If the desired project (GPZ) file is one of the last four (4) files opened, it can be opened by selecting it from the recent files list under File.

5.11 Exit

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

6 Edit

6.1 Copy Image to Clipboard

The **Edit > Copy Image 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 e-mail message.

See **View Settings Menu** for details on modifying the image by changing the processing, turning on or off the axes, grid lines, legend, fiducial markers and 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.

Interpretations displayed on the image (see **Interpretation**) are saved to the clipboard image. If interpretations are not desired on the clipboard image, they can be temporarily turned off by setting the **Active Interpretation** in the interpretation drop-down list on the **Interpretation Toolbar** to **None** and then using the **Inactive Interpretations** option to turn off the display of inactive interpretations.

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

The resolution of the image sent to clipboard is controlled by the size of the image on the screen. The bigger the image on the screen, the higher the resolution of the image sent to the clipboard.

6.2 Copy Interpretation to Clipboard

The **Edit > Copy Interpretation to Clipboard option** copies the current **Active Interpretation** to the Clipboard so it can be pasted into other documents like an Excel or Word document.

Copy Interpretation to Clipboard can also be accessed by right-clicking on the data image and selecting it from the menu.

Tool	Interpretation	GPR Line	Position(m)	X(m)	Y(m)	Depth(m)	Time(ns)	Elevation(m)	Amplitude(mV)	Velocity(m/ns)	GPS-Latitude(deg)	GPS-Longtitude(deg)
Polyline	Polyline1	LINEX5.DT1	0.015			1.067	20.88		7.384	0.1	44.27614	-79.88716667
Polyline	Polyline1	LINEX5.DT1	1.126			1.183	23.2		-17.939	0.1	44.27614833	-79.88716167
Polyline	Polyline1	LINEX5.DT1	1.726			1.165	22.83		-4.572	0.1	44.27615333	-79.88715833
Polyline	Polyline1	LINEX5.DT1	2.282			1.155	22.65		-1.624	0.1	44.27615708	-79.887155
Polyline	Polyline1	LINEX5.DT1	2.807			1.244	24.41		2.821	0.1	44.27616167	-79.88715333
Polyline	Polyline1	LINEX5.DT1	3.543			1.253	24.6		-31.878	0.1	44.27616667	-79.88714889
Polyline	Polyline1	LINEX5.DT1	4.473			1.323	25.99		27.92	0.1	44.276175	-79.88714267
Polyline	Polyline1	LINEX5.DT1	4.909			1.244	24.41		19.304	0.1	44.27617833	-79.88713833
Polyline	Polyline1	LINEX5.DT1	5.689			1.225	24.04		9.148	0.1	44.276185	-79.887135
Polyline	Polyline1	LINEX5.DT1	6.38			1.253	24.6		19.869	0.1	44.27619	-79.88713167

Figure 6-1: Interpretation copied to the clipboard and pasted into Microsoft Excel

7 View Settings Menu

The **View > Settings** option allows the user to change various aspects of the images including processing, color palettes, axes, data limits, legend, contrast and sensitivity values.

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

The settings are displayed in various tabs in the dialog (**Figure 7-1**).

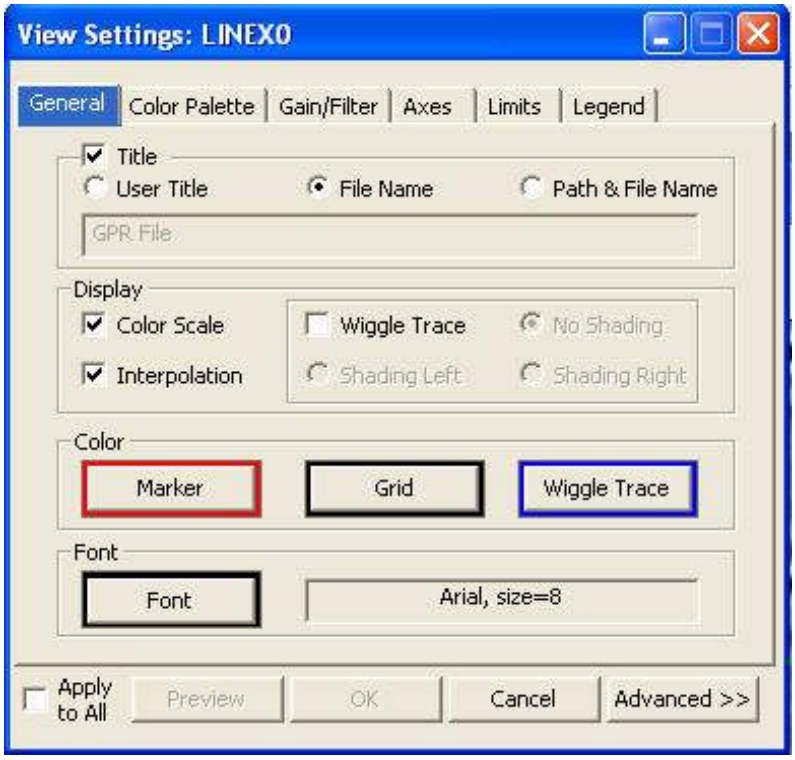


Figure 7-1: The View Settings dialog has 6 tabs for setting various parameters of the image display.

7.1 Preview

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

For example, to interactively experiment with a variety of gain methods and settings, select the Gain Type and appropriate parameters and then select Preview to update the display.

7.2 OK

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

7.3 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**).

7.4 Apply to All

The **Apply to All** checkbox is used to apply all the current settings (on ALL the View Settings tabs) to all open cross-section windows. Check the **Apply to All** checkbox and then press **OK**.

Be cautious when using this option because there is no “undo” available once the settings have been changed by pressing **OK**.

If you press **Preview** but then decide to abandon the changes, pressing **Cancel** will “undo” all the changes.

If the **Apply to All** option is not selected, any changed settings only apply to the current **Active Window**.

7.5 Basic / Advanced

The Basic View Settings screen is shown in **Figure 7-1**.

Selecting the **Advanced** button adds five buttons for saving and loading View Settings Configuration files, loading and saving the Default settings as well as loading the **Factory Defaults**.

The **Advanced View Settings** screen is shown in **Figure 7-2**.

Figure 7-2: The Advanced View Settings dialog adds 5 buttons on the side for configuration files.

Every GPR data file opened in EKKO_Interp has a configuration file saved with it that saves all the display settings specified in the **View Settings** dialog box. The configuration file has the same name as the data file but has an .ini extension. Any settings changed in the **View Settings** dialog are automatically saved to the configuration file so that the next time the GPR data file is opened in EKKO_Interp, it is displayed exactly the same as the last time.

The current View Settings can be saved to a configuration file by selecting the **Save As** button.

The current View Settings can be changed to previously-saved View Settings by selecting the **Load** button and selecting a configuration file.

The first time a GPR data file is opened in EKKO_Interp, it uses the **Default Settings**. The very first time that EKKO_Interp is run, the Default Settings are set to the same values as the **Factory Settings**.

The user can define their own Default Settings, to be used with every GPR data file opened for the first time in EKKO_Interp, by selecting the desired View Settings and then pressing the **Save As Defaults** button.

7.5.1 Load

The **Load** button loads a previously-saved View Settings configuration (.ini) file and applies it to the current View Settings.

7.5.2 Save As

The **Save As** button saves all the current View Settings to a configuration (.ini) file. Use this option to save the current View Settings to an .ini file to load and use in the future.

The user can specify the name and location of this configuration file but it is commonly kept in the same folder as the GPR data file(s).

7.5.3 Load Defaults

Pressing the **Load Defaults** button overwrites the current View Settings with the Default settings.

7.5.4 Save As Defaults

The **Save As Defaults** button saves the current View Settings and makes them the Default settings. The Default View Settings are used with all GPR data files opened for the first time in EKKO_Interp.

7.5.5 Factory Defaults

The **Factory Defaults** button resets the current and default View Settings to the default “factory” settings.

7.6 General Tab

The **General tab** under **View Settings** allows the user to edit the image title, display type, color of various features and the font for all the axes, titles and the legend.

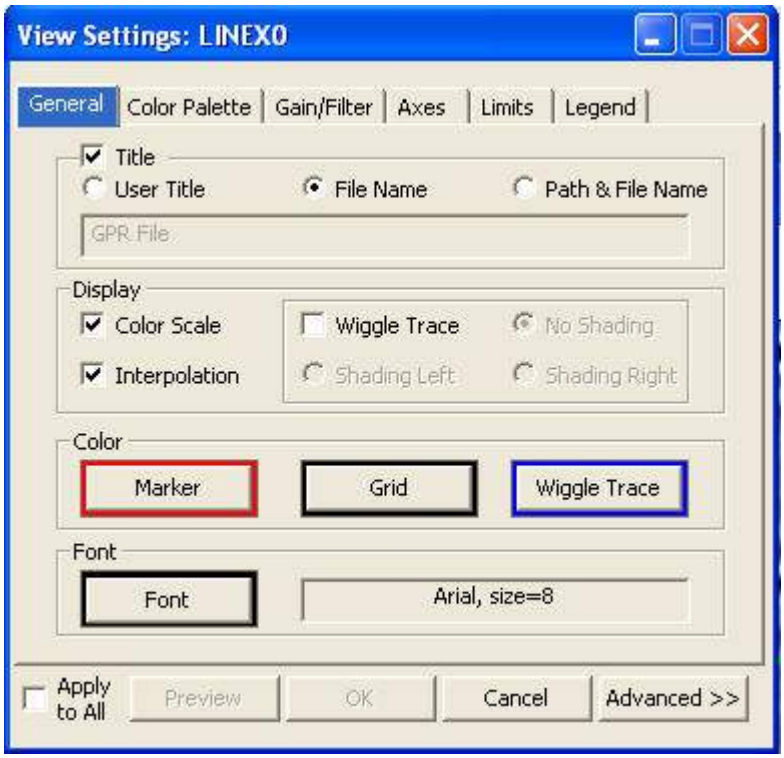


Figure 7-3: General tab.

7.6.1 Title

The Title option allows the user to change the title displayed in the Legend. Note that the Title must be selected in the **Legend Tab**.

Options for the title are: **User Title**, **File Name** only or **Path & File Name**. The default title is the file name.

The title will appear in the font specified under **Font**.

7.6.2 Color Scale

When selected, the GPR data will be displayed as a color scale image (**Figure 7-4**). This means that the GPR signal amplitude, which typically varies from negative to positive values, is displayed as different colors depending on the amplitude.

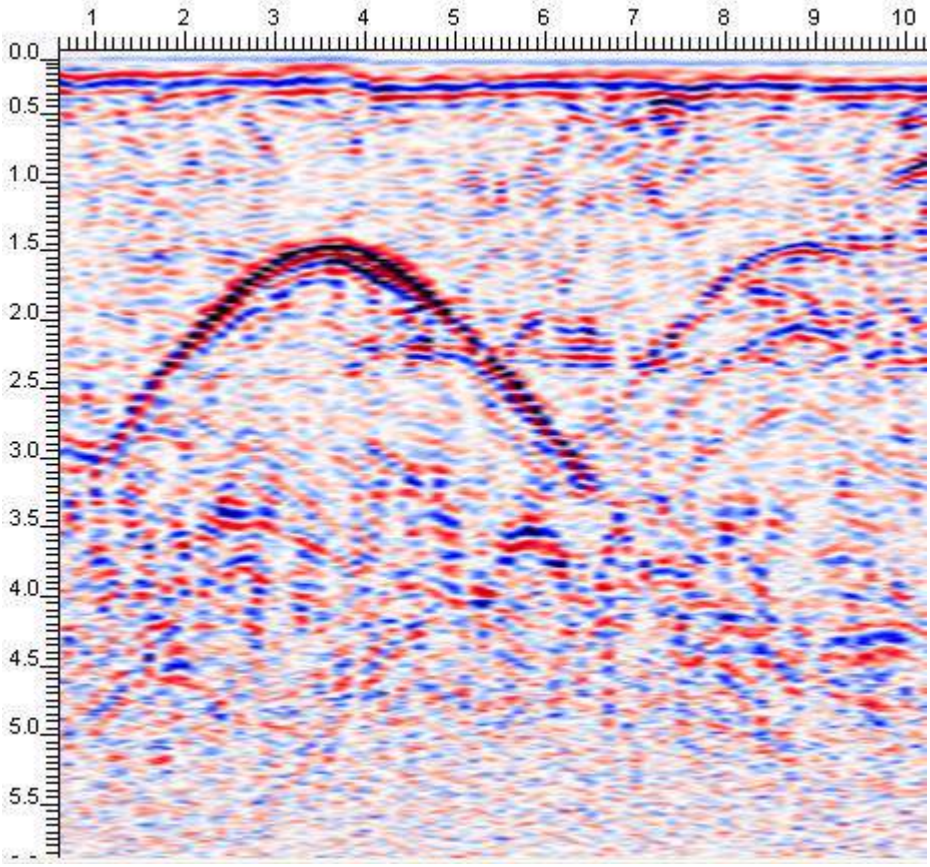


Figure 7-4: Color Scale image

A variety of color palettes can be chosen for the display (see **View > Settings > Color Palette Tab**).

The data traces can be displayed interpolated (smoothed) or uninterpolated (see **Interpolation** below).

7.6.3 Interpolation

When **Color Scale** display is selected, the data image may appear “blocky” or pixellated when zoomed in or if the traces were collected with a long step size between them. Selecting the **Interpolation** option smooths the appearance of the GPR data image (see **Figure 7-5**).

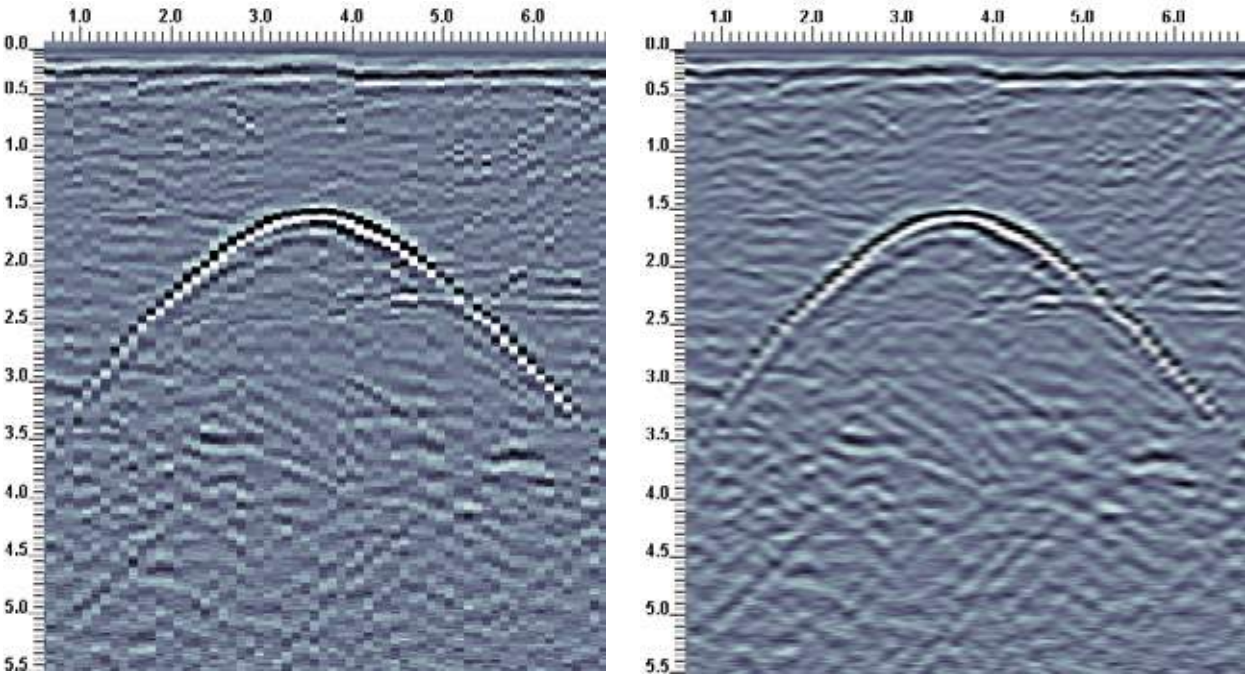


Figure 7-5: Interpolation is used to smooth the raw data image on the left to the one on the right.

Interpolation of large files can be a computer resource intensive process.

Interpolation is not available when only Wiggle traces are displayed.

7.6.4 Wiggle Trace

When **Wiggle Trace** is selected, the GPR data are displayed in wiggle trace format. The GPR signal amplitudes of each trace are plotted in overlapping vertical columns with the center of the column representing zero signal amplitudes, the left of the column representing negative amplitudes and the right of the column representing positive amplitudes. The trace is plotted as a line that oscillates with the direction and amount of deflection dependent on with the amplitude of the signal at that point (see **Figure 7-6**).

Depending on the size of the display window, the total number of traces in the file and the current Zoom setting, not all traces will necessarily be displayed in Wiggle format. The number of wiggle traces displayed is optimized depending on the space available to avoid a crowded-looking image.

If only wiggle traces are displayed, interpolation is not enabled (see **Interpolation** above).

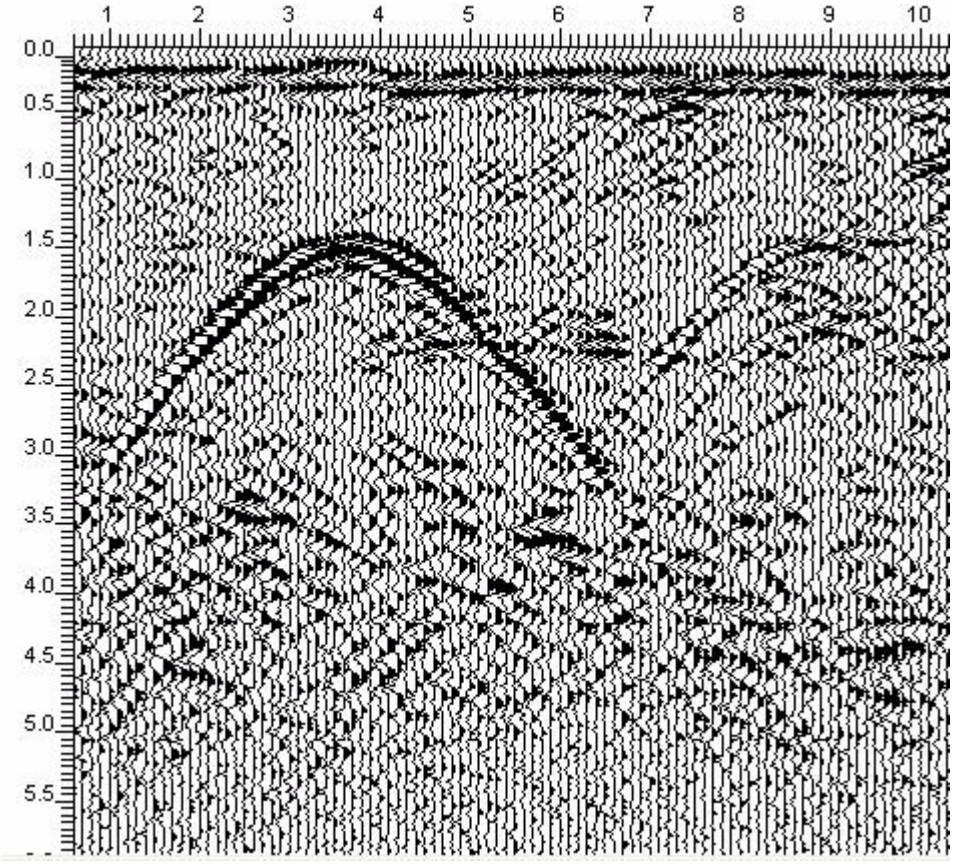


Figure 7-6: Wiggle Trace format with shading on the right.

Both Wiggle Trace and Color Scale can be displayed at the same time (**Figure 7-7**).

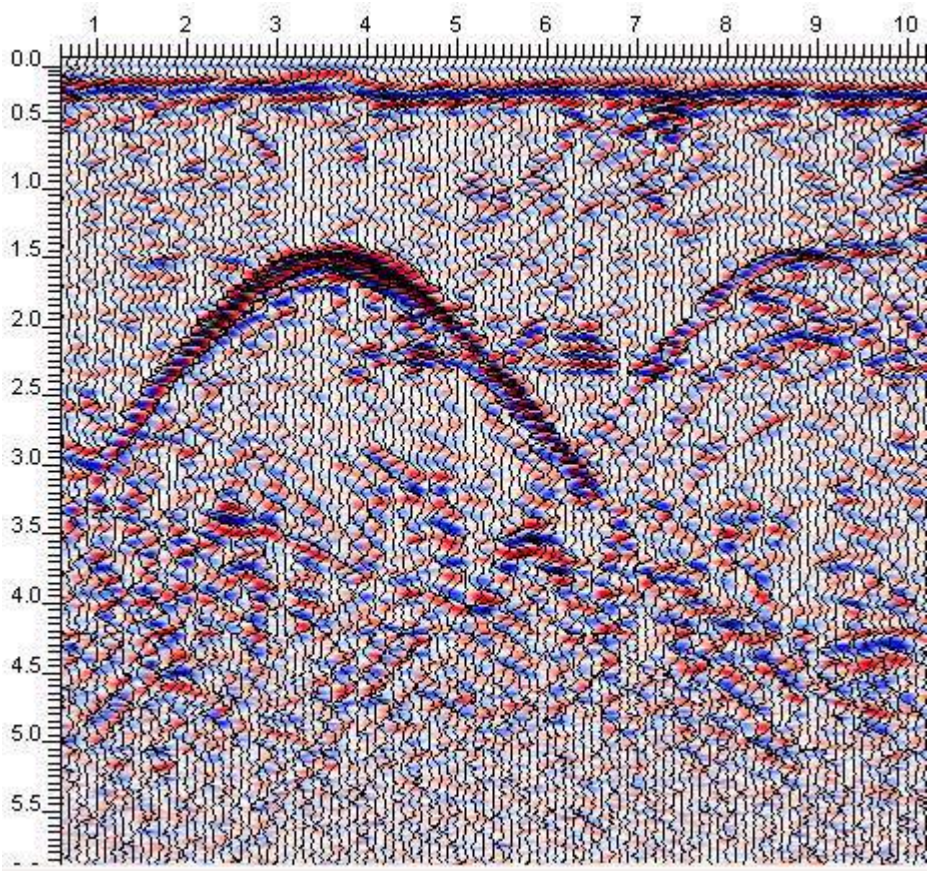


Figure 7-7: Color Scale and Wiggle traces plotted together. The wiggle traces can be plotted with or without shading (no shading in this example).

Wiggle trace requires a finite pixel width in order to display the trace amplitudes whereas color scale only needs a single pixel width to display a trace. Therefore, more data can be viewed in a narrow image in color scale than in wiggle trace.

7.6.4.1 Wiggle Trace Properties

When the Wiggle Trace display is selected, the **Wiggle Trace Properties** can be edited so that the right side (positive amplitude peaks) or the left side (negative amplitude troughs) of the traces are shaded with color. No shading is also an option. **Figure 7-6** shows a wiggle trace display with shading on the right.

The color of the wiggle traces can also be changed using the **Wiggle Trace Color** option.

7.6.5 No GPR Image

If neither the **Color Scale** or the **Wiggle Trace** options are checked, no cross-section image is displayed in the **Active Window**. This option is useful to show **Interpretations** with a white background and no GPR data image (see **Figure 7-8**).

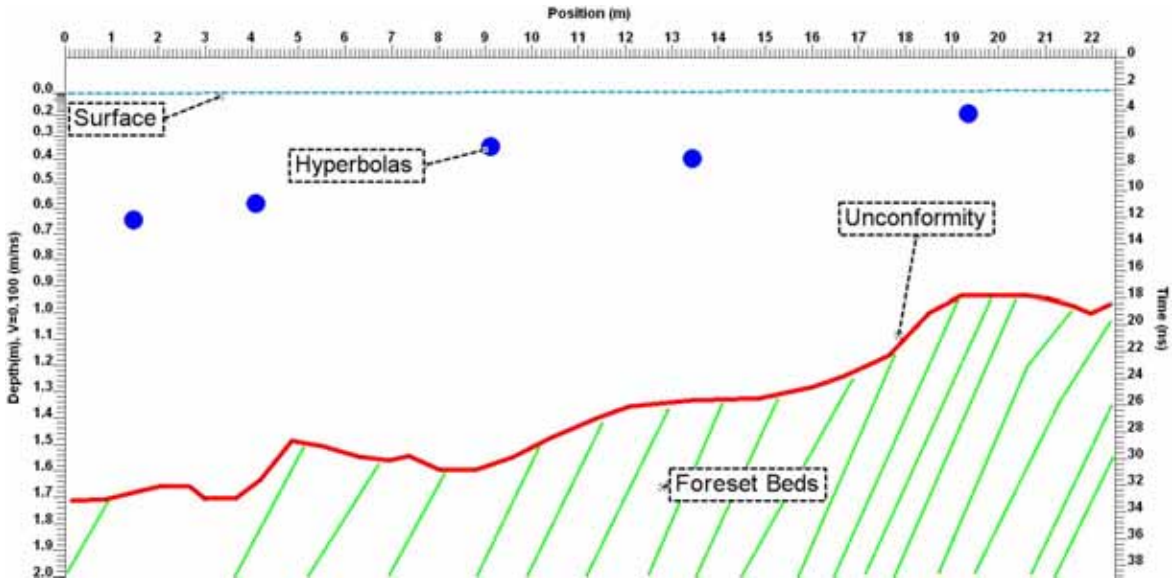


Figure 7-8: If both Color Scale and Wiggle Trace options are turned off, no GPR cross-section image is plotted. This is useful for plotting the interpretations without the data.

7.6.6 Marker Color

The Marker color sets the color of fiducial markers (see **Fiducials**), skipped trace flags (see **Skipped Traces**), the **Hyperbola Velocity Calibration** tool and the **Measure** tool.

Fiducial Markers are markers or comments added during data acquisition at specific trace positions along the survey line. Fiducial Markers appear as triangles at the bottom of the data image (**Figure 3-1**). They are displayed if the **View > Show/Hide > Fiducials** option is enabled.

Skipped Trace Flags displayed if there is skipped traces in the data and if the **View > Show/Hide > Skipped Traces** option is enabled. Skipped Trace Flags appear as rectangles at the bottom of the data image (**Figure 3-1**).

The color of the various markers can be changed by clicking the **Marker** button and selecting a color from the standard Windows dialog. It is recommended to choose a color that provides high visibility on the cross-sectional image.

7.6.7 Grid Color

Grid Lines corresponding to the major positions and/or depth or time labels can be superimposed on the cross-sectional image (**Figure 3-1**). This option is available by selecting Grid Lines in the **Axes Tab**.

The color of the Grid Lines can be changed by clicking the **Grid** button and selecting a color from the standard Windows dialog. It is recommended to choose a color that provides high visibility on the cross-sectional image.

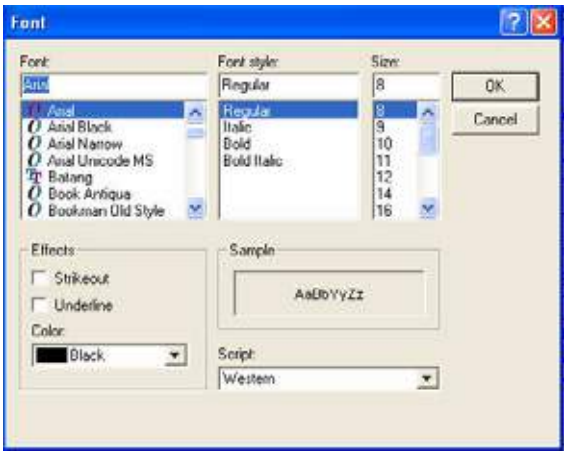
7.6.8 Wiggle Trace Color

Wiggle Trace display is described above (**Wiggle Trace**).

The color of the Wiggle Traces can be changed by clicking the **Wiggle Trace** button and selecting a color from the standard Windows dialog.

7.6.9 Font

The Font option determines the font used for the position, depth and time axes as well as the text in the legend (see **Legend Tab**). When selected, the standard Windows font dialog opens allowing the user to select the Font, Font Style and Size. Increasing the font type and size decreases the data image size but will improve the readability of printed images or graphics image files.



7.7 Color Palette Tab

The **Color Palette tab** under **View Settings** allows the user to change the color palette and edit the Sensitivity and Contrast values for the image.

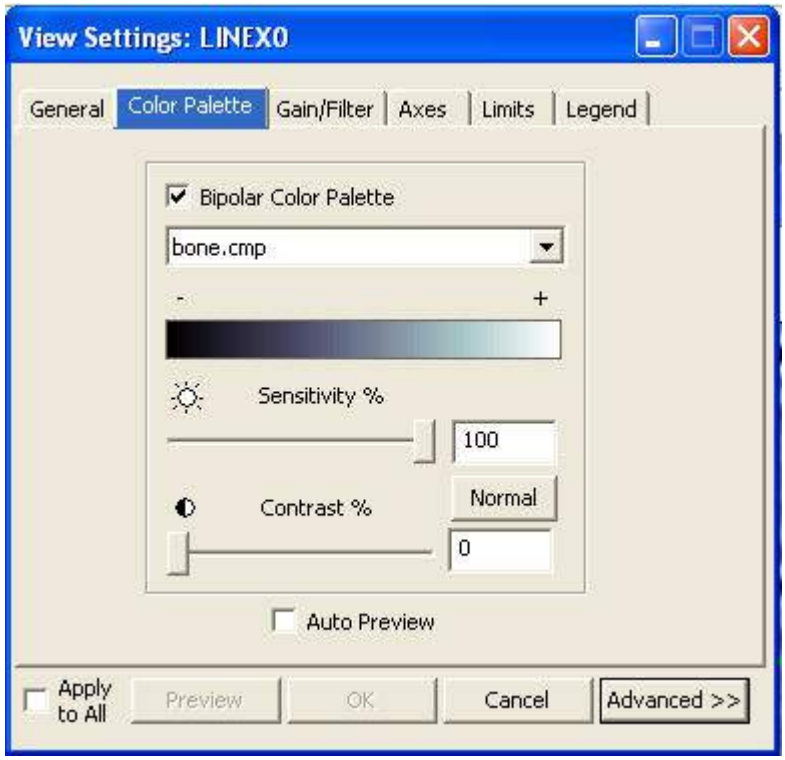
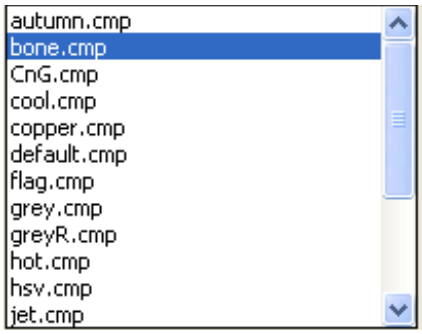


Figure 7-9: Color palette tab.

The **Color Palette** tab can also be accessed by selecting **View > Color Palette Settings** from the menu or clicking on the Color Palette Settings button on the **View Toolbar**:

7.7.1 Color Palette

The default color palette for cross-sections is bone. This option allows the user to choose from a number of pre-defined color palettes for the cross-section image(s). 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. Most users find that “bone” allows for the easiest interpretation of a wide range of data.



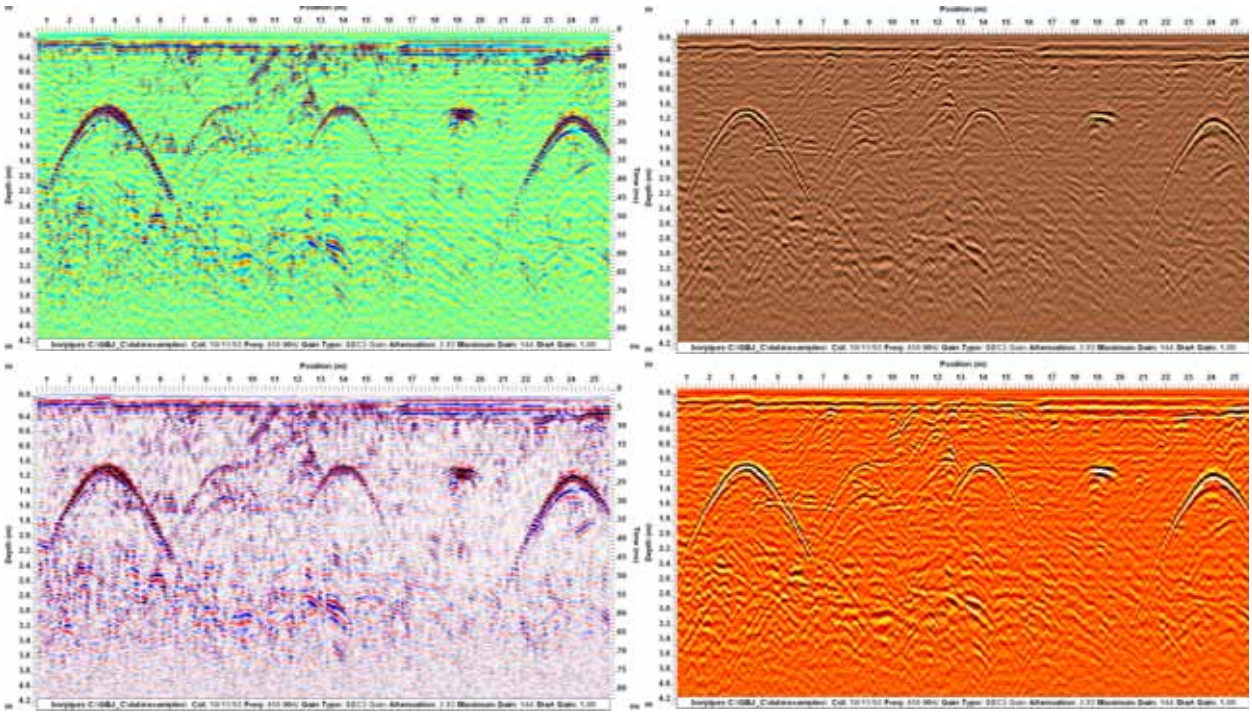


Figure 7-10: Data displayed with different color palettes.

7.7.2 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). Pressing the **Normal** button (see **Figure 7-9**) sets the Sensitivity to 100%.

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 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.

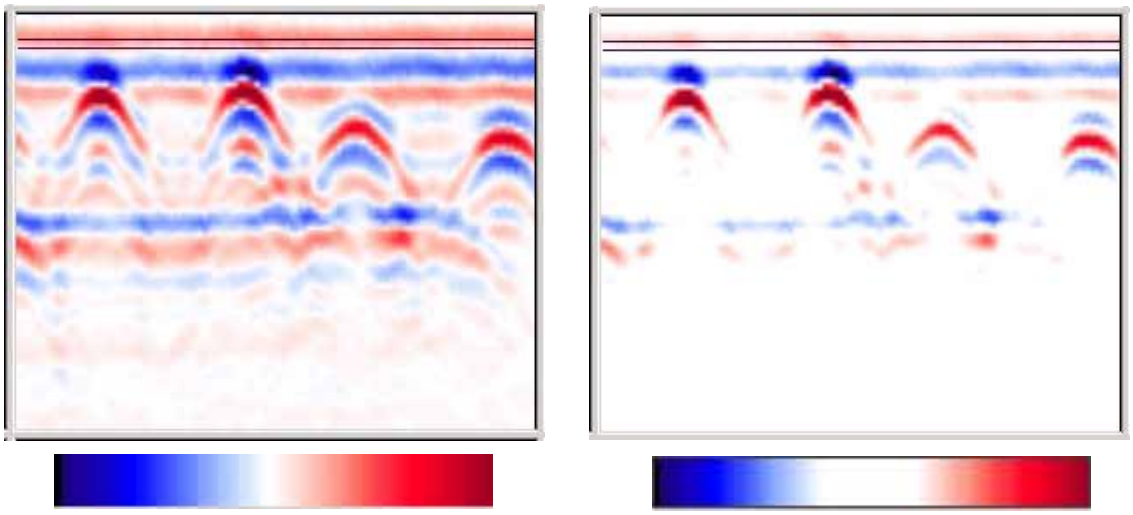


Figure 7-11: The Sensitivity value defaults to 100% (left) meaning the image is most sensitive to weak signals. As Sensitivity is decreased, the color in the middle of the color bar associated with weaker signals around zero, widens, removing weaker signals from the image (right, Sensitivity=80).

The Sensitivity is changed using the appropriate slider bar in the dialog box.

The Sensitivity setting for the image can also be modified by clicking on the slider bar and then using the right and left 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.

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

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

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

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%.

7.7.3 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). Pressing the **Normal** button (see **Figure 7-9**) sets the Contrast to 0%.

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 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.

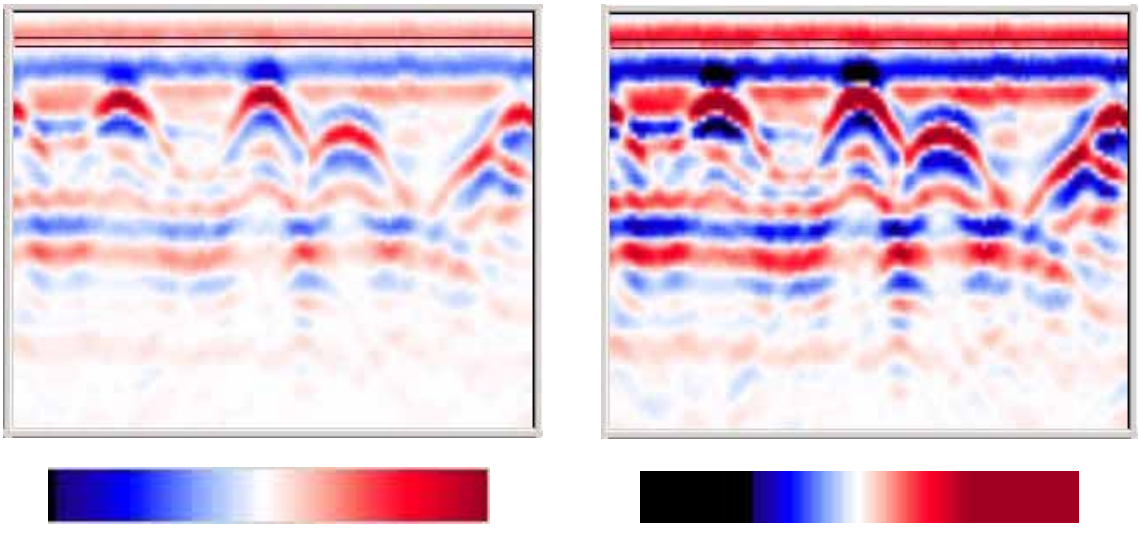
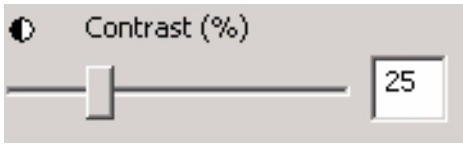


Figure 7-12: The Contrast value defaults to 0% meaning no contrast is added to the image (left, Contrast=0). As Contrast is increased, the colors on the left and right of the color bar associated with the strongest signals, widen into the middle, resulting in weaker signals looking stronger in the image (right, Contrast=50).

The Contrast is changed using the appropriate slider bar in the 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.

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

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

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

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%.

7.7.4 Auto Preview

Selecting **Auto Preview** allows the user to instantly see the effect of changes made to the settings in the Color Palette tab, including Sensitivity, Contrast and the color palette. This is much faster than changing the settings and then clicking on the **Preview** button. However, it may be undesirable for large data files especially with **Interpolation** turned on because the screen update may be sluggish.

7.7.5 Bipolar Color Palette

A bipolar color palette has colors for both positive and negative values with zero in the middle. Since GPR cross-section images are normally displayed with amplitude values varying from negative to positive values, a bipolar color palette is the default and is not normally changed.

When the **Bipolar Color Palette** option is unchecked, the color palette becomes monopolar, meaning that zero amplitude moves from the middle of the color palette to the extreme left. The color palette only applies to the positive values of the signal amplitude; negative amplitudes are all colored the same color as zero amplitude data.

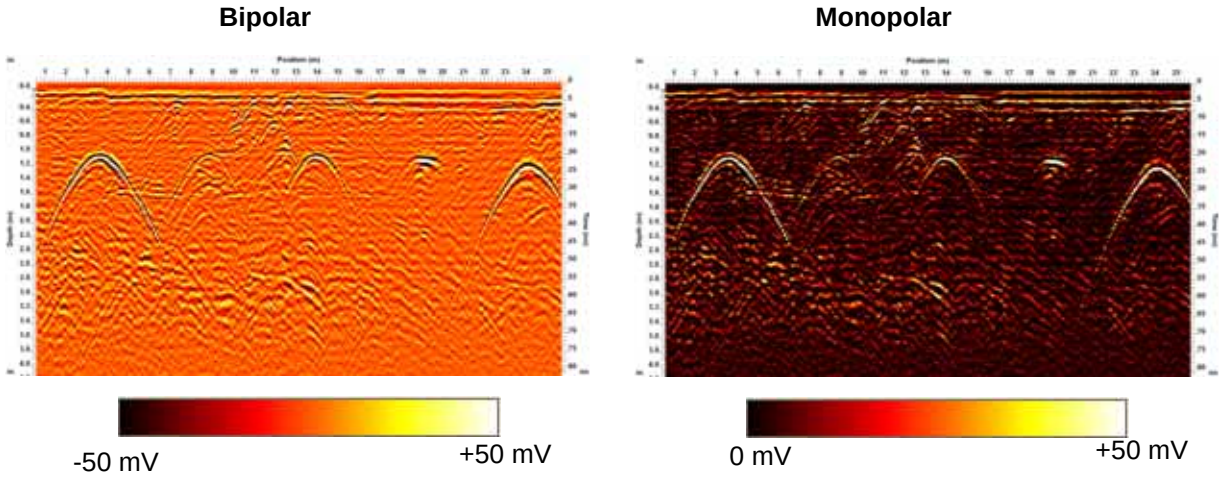


Figure 7-13: Bipolar color palettes (left) are typically used for displaying GPR data images. Both negative and positive signal amplitudes are displayed using the color palette. If a monopolar color palette is used (right), only positive signal amplitudes are plotted using the color palette. Any negative signal amplitudes in the data are all plotted with the color corresponding to zero (0) signal amplitude.

Processes available in the EKKO_View Deluxe software like rectifying and enveloping GPR data as well as CMP Analysis, result in data with all positive amplitude values. In this case, unchecking the **Bipolar Color Palette** option when viewing data allows the full color palette to be used for the positive values.

7.8 Gain/Filter Tab

The **Gain/Filter Tab** under **View Settings** is used to set the parameters for the processing of the GPR cross-section image, specifically, Dewow and Gain.

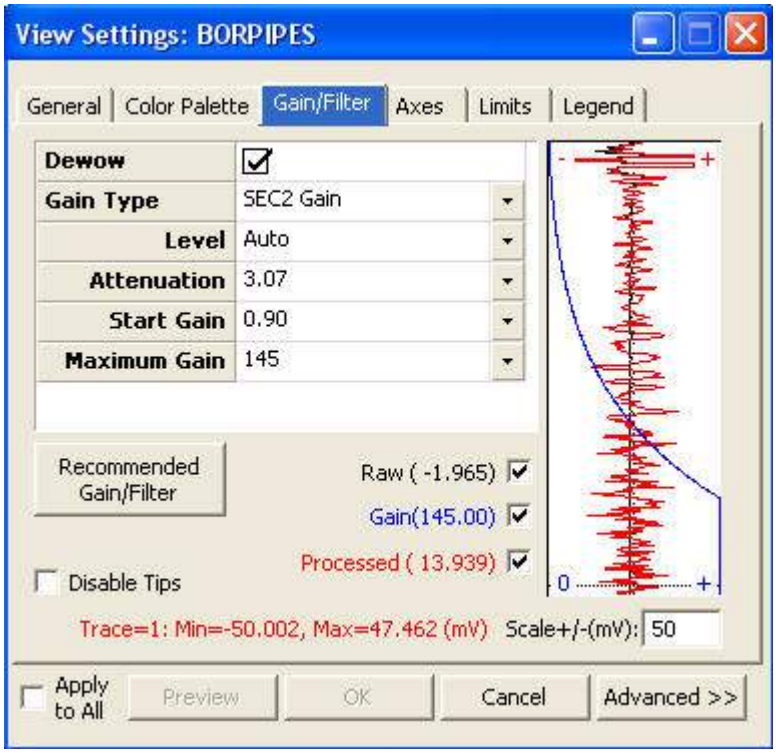


Figure 7-14: Gain/Filter Tab for setting the Dewow Filter and Gain. The Trace View on the right displays the Raw and Processed trace and the Gain.

A description of each parameter is displayed by holding the mouse cursor on the parameter input field. These descriptions are disabled by selecting the **Disable Tips** checkbox.

The **Gain/Filter** tab can also be accessed by selecting **View > Gain/Filter Settings** from the menu or clicking on the Gain/Filter Settings button on the **View Toolbar**:

7.8.1 Trace View

The **Trace View** is displayed on the right side of the dialog. It is a wiggle trace plot of the current trace at the mouse cursor position. A wiggle trace plot depicts the signal amplitude as a positive or negative deflection from zero (indicated by the + and - signs on the top corners).

After editing the Dewow or Gain parameters, the **Preview** and **OK** buttons become accessible. Pressing the **Preview** button re-displays the cross-section image and the **Processed** trace in the **Trace View** using the new Dewow and Gain parameters.

Moving the mouse cursor horizontally to a different trace in the cross-section image will display that trace in the **Trace View**.

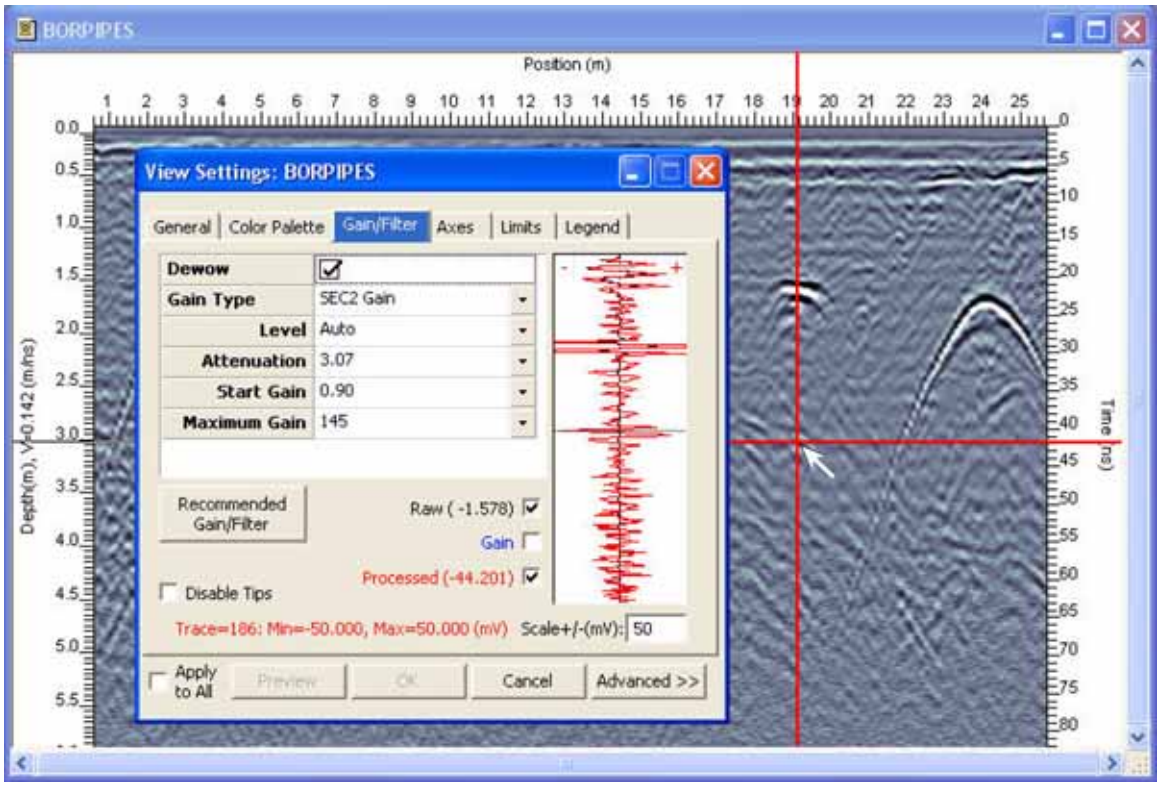


Figure 7-15: Moving the mouse cursor horizontally in the cross-section image behind the Gain/Filter Tab will display the trace corresponding to the mouse cursor in the Trace View. Moving the mouse cursor vertically in the cross-section image moves the Trace View cross-hair along the current trace. The raw and processed amplitudes are displayed to the left of the Trace View (if selected).

7.8.1.1 Trace Amplitudes

Using the checkboxes beside the **Trace View**, the user can select to display the **Raw** trace (in black), the **Processed** trace (in red) and the **Gain** (in blue).

Moving the mouse cursor vertically along a trace in the cross-section image moves the corresponding horizontal cross-hair in the Trace View. The cross-hair makes it easy to see the signal amplitude at any point on the trace. The raw (in black) and/or processed (in red) signal amplitudes are displayed to the left of the Trace View (if checked).

7.8.1.2 Min and Max Trace Amplitude

Below the Trace View, the current trace number and amplitude information is displayed. The minimum and maximum amplitude values in millivolts (mV) for the trace at the current mouse cursor position is shown.

If the **Raw** checkbox is checked, the minimum and maximum amplitude values correspond to the raw trace and are displayed in black.

If the **Processed** checkbox is checked, the minimum and maximum amplitude values correspond to the processed trace and are displayed in red.

If both the Raw and Processed checkboxes are checked, the minimum and maximum trace amplitudes displayed are for the Processed trace (in red).

Change the scale of the **Trace View** plot by editing the **Scale** value to any number between 1 and 50 mV. The default scale is 50 mV.

7.8.1.3 Gain

The current Gain is displayed as a blue line in the Trace View by selecting the **Gain** checkbox (see **Figure 7-14**). The shape of the gain will change depending on the **Gain Type** and the gain parameters.

Gain values are always positive with zero on the left of the Trace View plot. The zero (0) and + in blue on the lower corners of the Trace View refer to the gain plot.

The Gain value at any point along the trace is displayed by moving the mouse cursor vertically along a trace in the cross-section image and following the corresponding cross-hair in the **Trace View**. The cross-hair makes it easy to see the gain value at any point on the trace.

The Gain value is displayed in blue to the left of the Trace View.

The minimum and maximum values for the Gain function can only be displayed (in blue) under the Trace View if the Gain checkbox is checked and the both the Raw and Processed checkboxes are not checked.

When displaying the Gain function only, the **Scale** can be changed to any value up to 32767.

7.8.2 Recommended Gain/Filter

Pressing the **Recommended Gain/Filter** button will automatically set the processing for the current GPR data file; Dewow is always selected and the Gain Type is set to SEC2 with a Level of Auto. Values for Attenuation, Maximum Gain and Start Gain parameters are calculated from the data and displayed.

To modify the Recommended Gain/Filter values slightly, change the **Level** from **Auto** to **User** and then adjust the individual parameter values (see **SEC2**).

7.8.3 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 signal while preserving the high frequency signal. The removal of this wow in the data is also called the “signal saturation correction”.

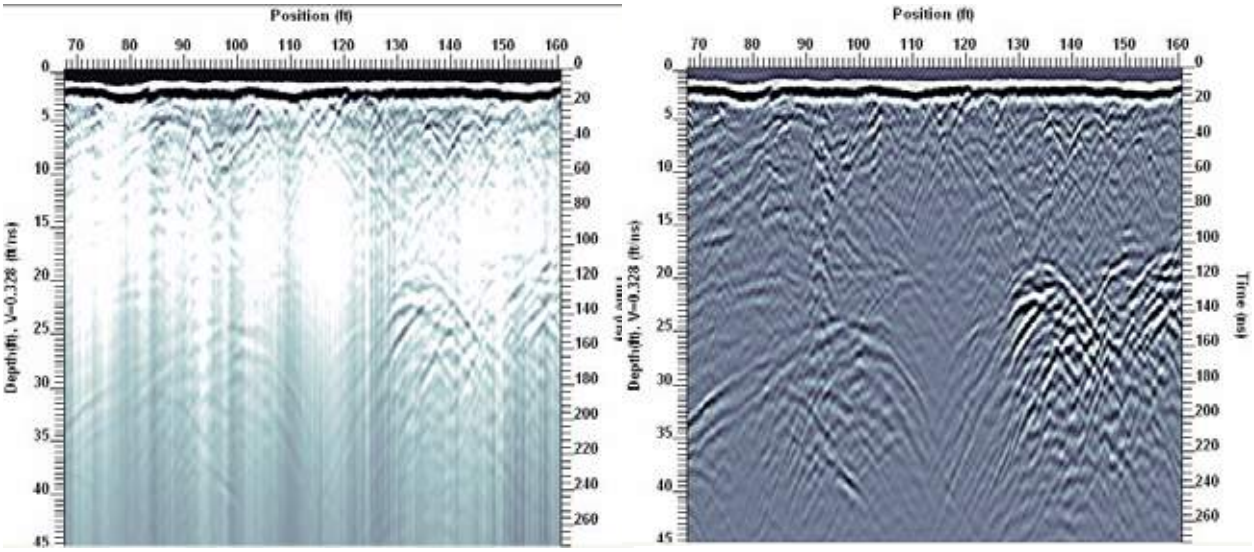


Figure 7-16: Data line showing raw data with the low frequency “wow” component (left) and after the Dewow process removes the low frequency component (right). The Dewow process is highly recommended when displaying cross-sections and slices.

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 displaying cross-sections.

7.8.4 Gain Type

In general, GPR signals decrease rapidly with depth and in most cases it is necessary to amplify the signal using a "gain" function. Gain is used to amplify the strength of the GPR data signals in the cross-section images. Applying gain to GPR data is similar to adjusting the volume knob on a music stereo.

There are 5 Gain Types that can be applied to the GPR data:

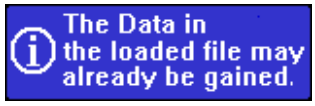
1) None
2) SEC2
3) AGC
4) DVL
5) Constant

The current Gain Level is displayed in the Gain dropdown list on the **View Toolbar**. This dropdown list can be used to change the Level. The Gain Type is changed in the Gain/Filter Tab.

The current Gain Type and parameter values can be displayed in the Legend (see **Legend Tab**).

The shape of the current Gain is displayed in the **Trace View** by selecting the **Gain** checkbox (see **Figure 7-14**).

Some data may have had a permanent gain applied in other software, like the EKKO_View Deluxe program. If the data file is opened in EKKO_Interp, a warning message will appear.



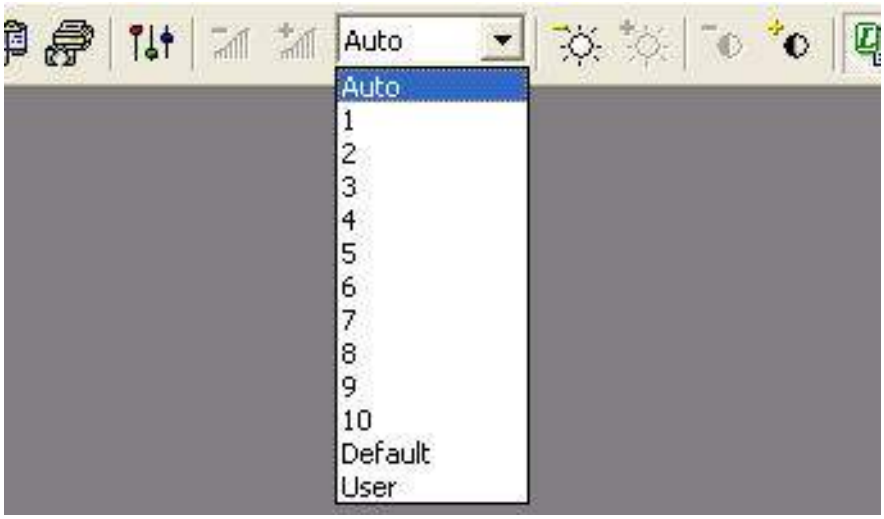
Typically, data that has already been gained should be plotted with the EKKO_Interp gain set to **None**.

7.8.4.1 Level

With the exception of No Gain (**None**), each **Gain Type** has one or more parameters that must be set. The **Level** option is used to set the gain parameter values.

Level options are: **Default**, **Numbered Levels, User** and, in the case of the SEC2 gain, **Auto**.

The Level is changed in this dialog but can also changed using the Gain Level dropdown list on the **View Toolbar**:



Default: Sets the gain parameters to defined values that will work for most typical data sets but may not be optimized for the particular data being displayed.

When the Default Level is selected, the Gain buttons on the **View Toolbar** are disabled (see **Gain/Filter Settings**).

Numbered Levels: Each gain also has up to 10 Numbered Levels. These are pre-defined gain parameter values that gradually increase the gain from Level 1 to the last level.

When the Level is set to a numbered level, it can be changed using the Gain buttons or the Gain dropdown list on the **View Toolbar** (see **Gain/Filter Settings**). This makes it easy to quickly scroll through several pre-set gains and find one that makes the data look the best.

User: Allows the user to input values for the gain parameters.

The best way to set the **User** gain parameters for the **SEC2** gain type is to use the **Recommended Gain/ Filter** button or the **Default**, **Auto** or **Numbered Levels** to determine the gain parameters close to the gain you want. Then, simply select and edit the gain parameter you want to change and press **Preview** or **OK**. The Level automatically changes to **User** with the changes to the parameter you edited.

When the User Level is selected, the Gain buttons on the **View Toolbar** are disabled (see **Gain/Filter Settings**).

Auto: The **SEC2** gain also has the **Auto** Level available. Using the GPR data file, 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.

Implement those values by pressing **Preview** or **OK**.

When the Auto Level is selected, the Gain buttons on the **View Toolbar** are disabled (see **Gain/Filter Settings**).

7.8.4.2 None (No Gain)

Selecting a **Gain Type** of None means that no gain will be applied to the GPR data before it is displayed. The “raw” data will be displayed.

This gain is not normally selected unless the material has very low attenuation and/or the targets of interest are shallow, for example, in ice profiling, snow and perhaps concrete.

As well, if the data has already had a gain permanently applied to the data (for example in EKKO_View Enhanced or Deluxe), the Gain menu item should be set to None by the user or else the data will be gained a second time and may appear over-gained.

When a Gain Type of None is selected, the Gain buttons and dropdown list on the **View Toolbar** are disabled (see **Gain/Filter Settings**).

7.8.4.3 SEC2

The Spherical Exponential Calibrated Compensation (SEC2) gain attempts to boost weaker signals by compensating for spherical spreading losses and exponential ohmic dissipation of energy in the radar data.

SEC Gain = Start Gain * Exponential

Since radar wave signal strength decays exponentially in the ground, the SEC gain represents the gain function closest to physical reality. The advantage of the SEC2 gain is that after it is applied, relative signal strengths at different depths can be compared. This is not the case with other gains like AGC and Constant.

There are 3 input parameters for the SEC gain: **Start Gain**, **Attenuation** and **Maximum Gain**.

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 **Start Gain** and **Attenuation** value and levels off to a constant multiplier when the **Maximum Gain** value is reached.

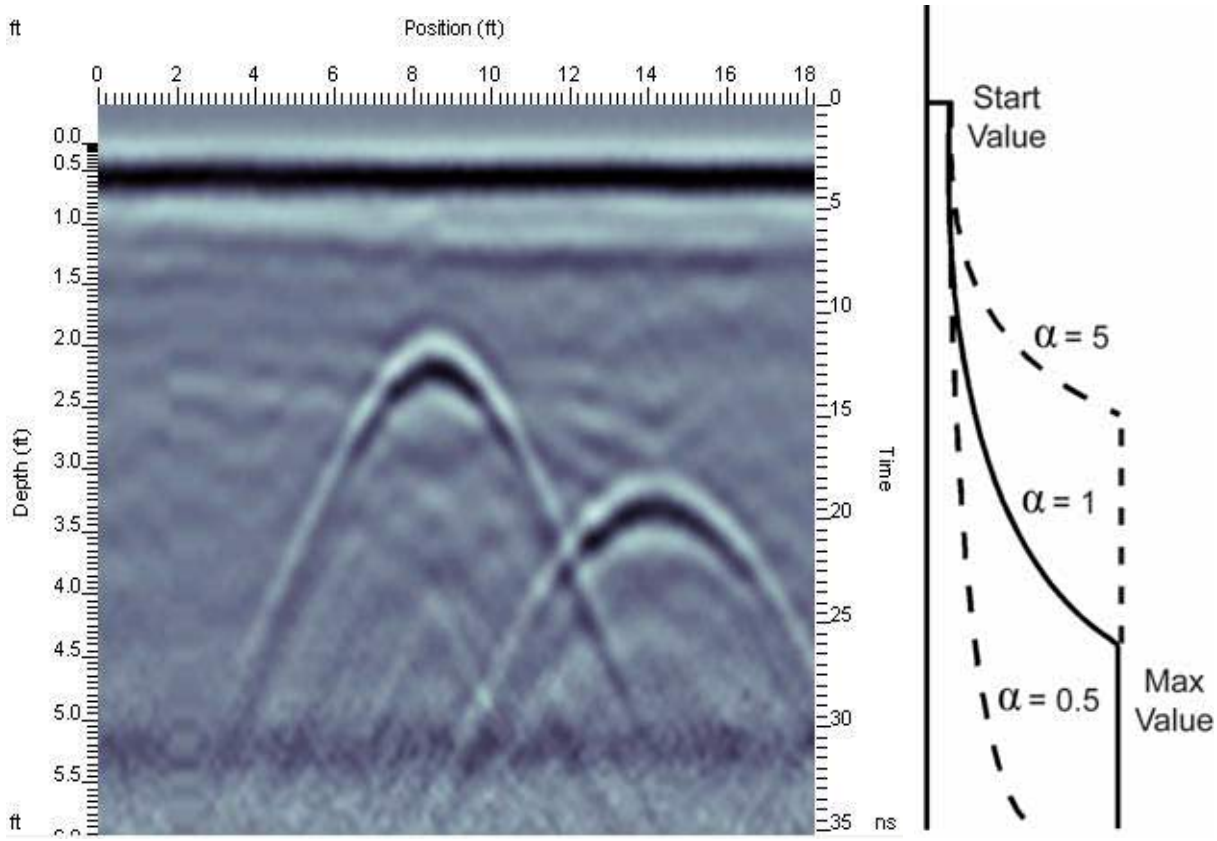


Figure 7-17: Cross-section image with the gain function shape and parameters on the right. In general, the Start Value is usually 1 or 0, attenuation (a), which controls the steepness of the slope is usually 0.0 to 20 and the Maximum Gain, which cuts off the exponential rise is usually 20 to 1000. Try to avoid over-gaining the data. Start with low values for Attenuation and Maximum Gain and increase as necessary.

Attenuation

The Attenuation represents the radar wave attenuation (in dB/m) and this determines the steepness of the ramp created for the SEC2 function. 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.

Changing the attenuation usually has the biggest effect on the data display as compared to the Start Gain and Maximum Gain values.

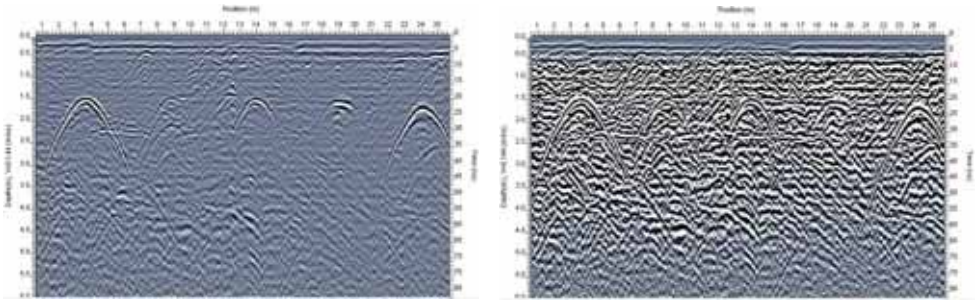


Figure 7-18: A low value for Media Attenuation makes the cross-section image look good (left) while a high value overgains the data, in this case (right).

Typical values for the Attenuation are 0 to 20 (selected from the drop-down list) but any value can be input by typing it directly into the field. Attenuation values over 20 may be necessary for materials with very high attenuation. The default value is 5.

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 "over-gained" making it more difficult to understand.

Start Gain

The Start Gain is the gain value at zero depth at the top of the GPR cross-section.

A Start Gain less than 1 can be used to reduce signal amplitudes prior to first-break time (also called time zero). If the Start Gain is 1 or more it is only applied after first-break time (leaving pre-first-break data unchanged).

Typically values for the Start Gain are 0 to 5 with 1 being the default value. Data with high attenuation may require a higher value for Start Gain, perhaps as high as 10.

Since the Start Gain is a multiplier for the exponential (Attenuation) value, the Start Gain value affects the steepness of the ramp associated with the Attenuation value. Higher values for the Start Gain will result in steeper ramps (more gain).

Maximum Gain

Since the SEC gain is an exponential function, it could go to infinity. 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.

7.8.4.4 AGC (Automatic Gain Control)

The Automatic Gain Control (AGC) attempts to bring weak and strong signals to the same level by applying a gain function that is inversely proportional to the signal strength.

This type of gain is most useful for defining continuity of reflecting events. The user should realize that AGC does not preserve relative amplitude information. Hence once the data have been AGC gained, one can no longer make reliable deductions concerning the strength of any particular reflector relative to other reflectors.

Each trace in the GPR section is processed such that the average signal is computed over a time window and then the data point at the center of that time window is amplified (or attenuated) by the ratio of the desired output value to the average signal amplitude.

Note that if a data point value multiplied by the gain value exceeds 50 mV absolutely, the new data point value becomes 50 or -50.

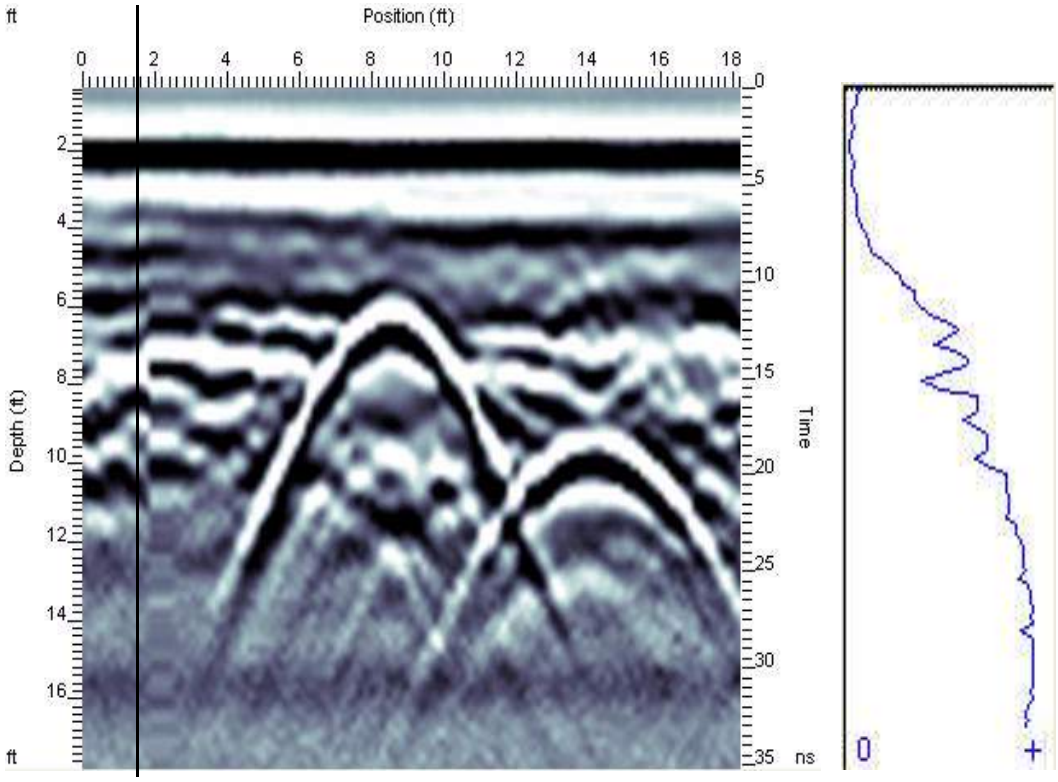


Figure 7-19: Cross-section image with an AGC gain applied. The AGC is calculated for each trace so varies for each trace. The AGC gain for the trace at position 1.5m is shown on the right. In general, the Window Width is usually 1.5 pulse widths and the Maximum Gain is 500.

There are two input parameters for the AGC gain, Window Width and Maximum Gain. **Figure 7-19** shows the data with an AGC gain applied using a Maximum Gain value of 500 and a Window Width of 1.5.

Window Width

In computing the gain to be applied at each point, the program calculates the average signal level over a window of points given by Window Width and centered about the point. The Window Width is specified in units of pulsewidth based on the nominal antenna frequency. In the case of data collected at 100 MHz with a sampling interval of 0.8 ns, and a window width of 1.5, 28 points would be used to compute the average signal strength.

The Default of 1.5 for Window Width is perfectly adequate in most cases.

Maximum Gain

Since the AGC gain is inversely proportional to the signal strength, very small signals can produce very large gains. Therefore some type of gain limiting scheme must be applied. The Maximum Gain value represents an upper limit on the gain that can be applied to the data and weaker signals that would produce gains larger than this value, are capped at this maximum value.

The Maximum Gain can vary from 1 to 32767. The Default value is 500.

A typical value would be 50 - 2000 depending on the noise and average signal levels.

7.8.4.5 DVL Gain

The DVL Gain applies the same type of gain that is used on the DVL with Noggin systems. The DVL Gain is a two-staged gain.

First, it applies a linearly increasing gain (Beta) as a function of time. The second stage adjusts the sensitivity to smaller signals by an “S” curve gain (Alpha).

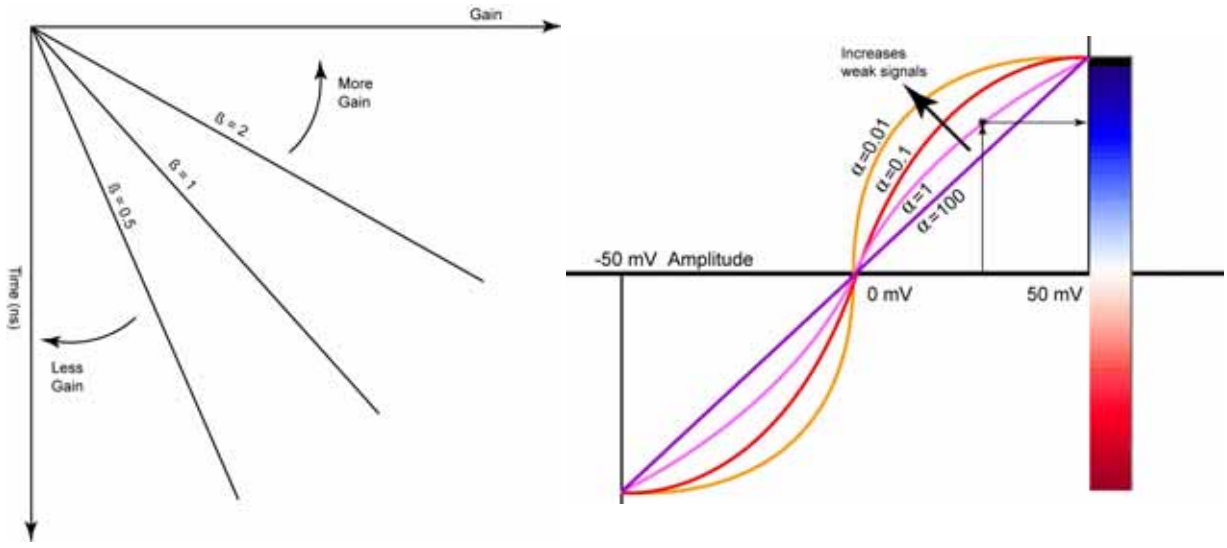


Figure 7-20: The DVL Gain is a two-stage gain. First, the Beta value applies a linear gain with a ramp (left). The higher Beta is, the steeper the ramp and the higher the gain. Then Alpha defines an S-shaped curve used to translate amplitude values to a color on the color palette (right).

There are two input parameters for the DVL Gain: Alpha and Beta:

Beta

Beta defines the linear gain as a function of time. The units are in gain per nanosecond. The higher the beta value, the steeper the slope and more gain applied to the data (see Figure 7-20).

Beta varies from 0.01 to 100. The Default value is 0.04.

Alpha

Alpha defines the S shape of the second gain. If Alpha is 100, curve is linear and all signals have the same sensitivity. As Alpha decreases below 100, the S curve is larger, increasing the small signal sensitivity and decreasing the large signal sensitivity.

Alpha varies from 0.01 to 100. The Default is 1.0.

7.8.4.6 Constant

A constant gain will multiply all data by the user specified value. Thus if the user enters the number 10, all data points will be multiplied by a factor of 10.

Since both strong and weak signals are multiplied by the same amount, a constant gain factor has the potential to over-gain and clip the stronger signals shallow in the section and under-gain the weaker signals deeper in the section.

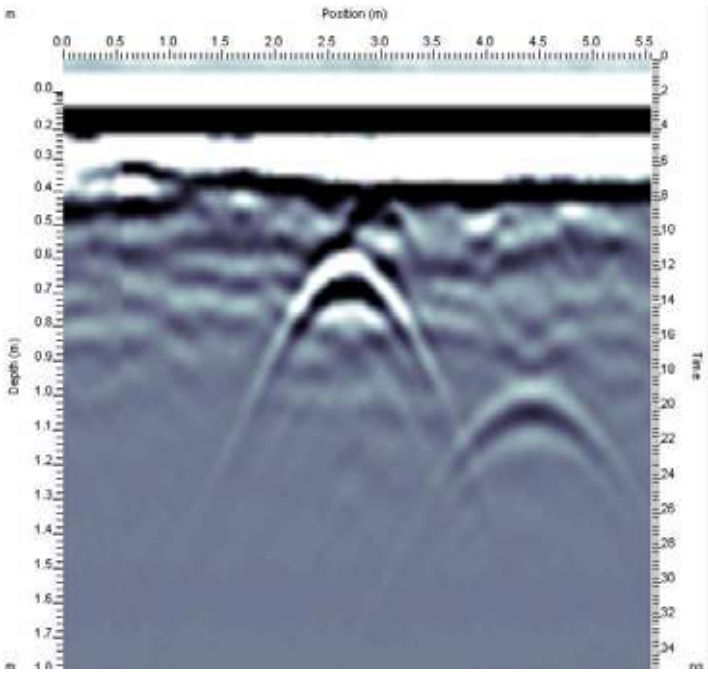


Figure 7-21: A Constant Gain of 20. The top of the section is overgained while the bottom is under-gained.

The constant gain is the only parameter required:

Gain

The constant gain factor that the GPR data will be multiplied by.

Values can vary from 0.01 to 32767. Typical values for the Constant gain are in the range from 5 to 1000. The Default value is 100. A Gain value less than 1 will reduce the signal amplitudes.

7.9 Axes Tab

The **Axes Tab** under **View Settings** changes axes settings including units, titles, increment and grid lines. The image direction can also be changed.

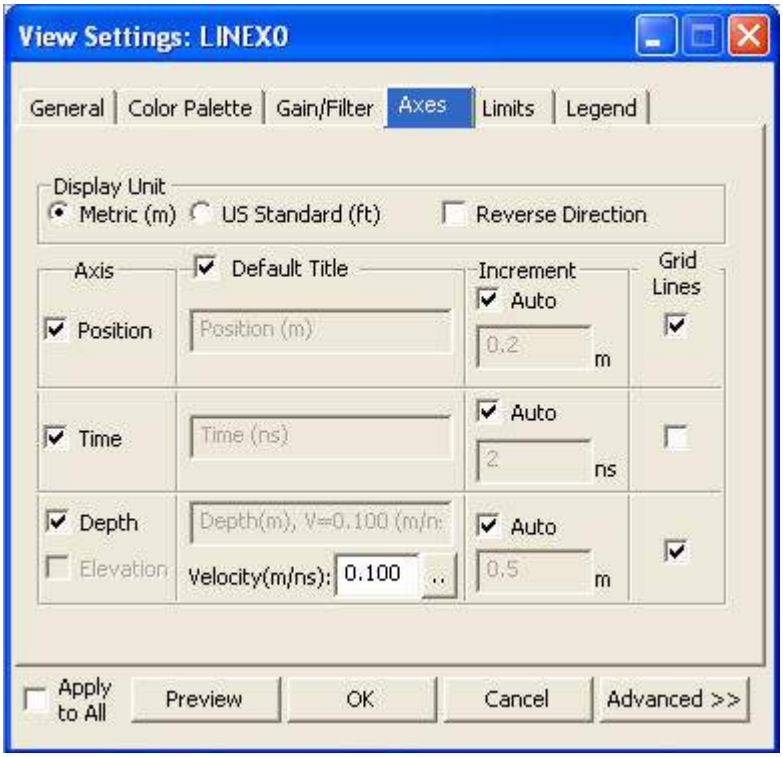


Figure 7-22: Axes tab to specify axes to display, grid lines, units and line direction.

7.9.1 Display Units

The **Display Units** setting determines the units that will be used for the Position and Depth axes; either meters or feet.

The units default to those used during the original data collection but can be converted and displayed in either meters (m) or feet (ft). For example, data collected in feet can be plotted in meters.

The display units can also be changed by pressing the “meters” or “feet” buttons on the **View Toolbar:**

7.9.2 Reverse Direction

The Reverse Direction checkbox is used to reverse the direction of the cross-section image, for example, if the data positions go from 0 to 10m, reversing the direction will display the data from 10 to 0m.

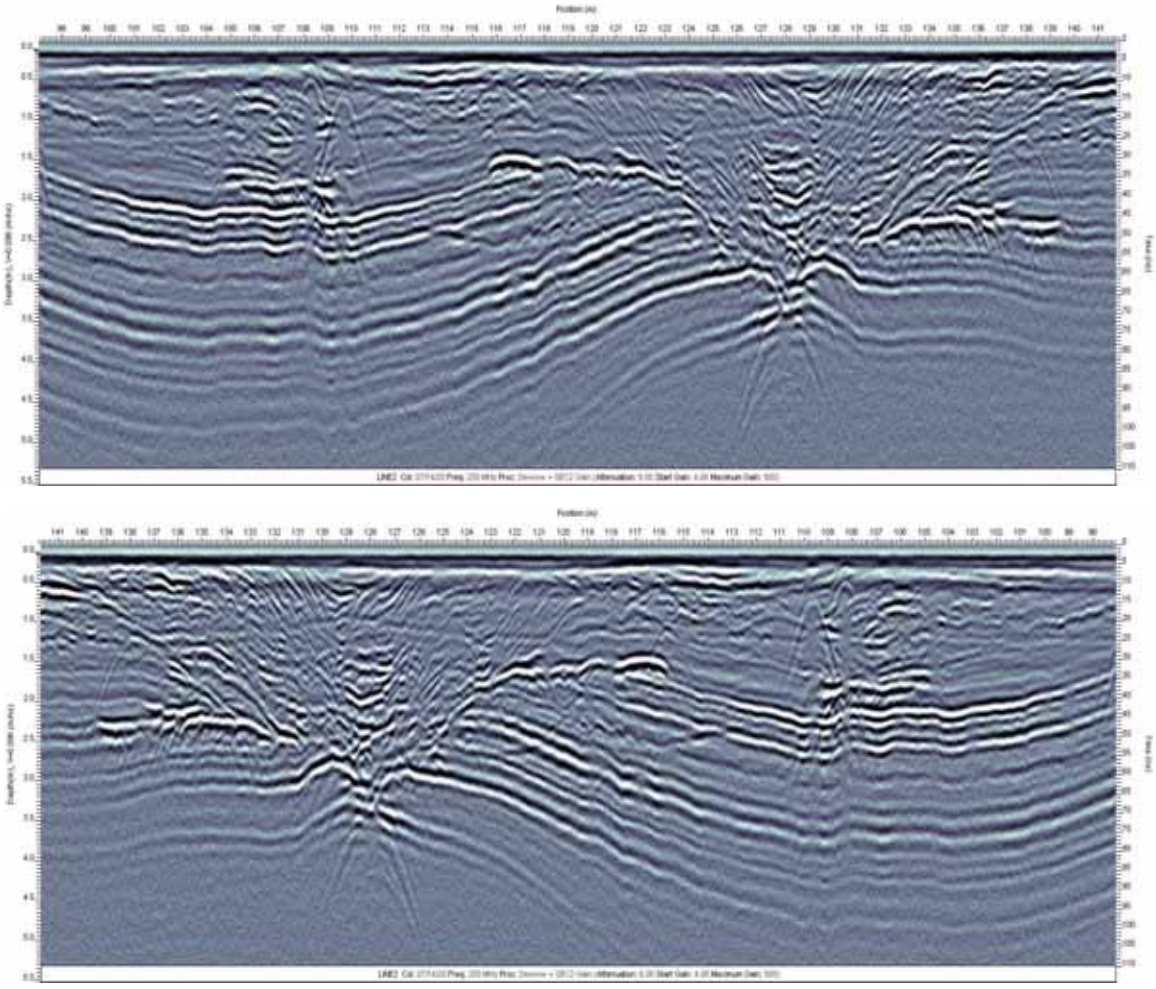


Figure 7-23: The Reverse Direction option.

Note that all features associated with position get reversed. This includes the position axis, GPS, fiducial markers and skipped traces.

This option is designed to allow users to compare lines collected in a zig-zag (also called Forward - Reverse) survey format in the same orientation.

7.9.3 Axes

Cross-section images are typically displayed with a position axis across the top, time axis on the right side and depth or elevation axis on the left side. The axes settings are changed in this tab.

The **Axes** tab can also be accessed by clicking on the **Vel** button on the **Velocity Toolbar**:

Features common to all axes are:

1) Any axis can be removed from the cross-section image by unchecking the appropriate Axis checkbox.

2) All Axes can be quickly displayed or removed from the cross-section image by checking or unchecking the **View > Show/Hide > Axes** option.

3) The position, depth and elevation axes units default to the units used during data acquisition but can be changed under **Display Units**.

4) The **Title** for the axis can be left as the Default Title or the user can uncheck the Default Title checkbox and enter a custom title.

5) The axis **Label Increment** is automatically set from the data limits if **Auto** is selected. The user can define the axis label increment by unchecking the Auto checkbox and entering a value. The axis labels are displayed with the number of decimal places specified in the input value; for example, a value of 10.00 will display axis label values of 0.00, 10.00, 20.00 etc.

6) Grid lines associated with an axis can be removed from the cross-section image by unchecking the appropriate Grid Lines checkbox.

7) All **Grid Lines** can be quickly displayed or removed from the cross-section image by checking or unchecking the **View > Show/Hide > Grid Lines** option.

7.9.3.1 Position Axis

The Position Axis is displayed along the top of the cross-section image (see **Figure 3-1**) if it is checked in this dialog box.

Vertical **Grid Lines** corresponding to the Position Axis labels are displayed on the cross-section image if the Grid Lines option is checked (see **Figure 3-1**).

7.9.3.2 Time Axis

The Time Axis is displayed in nanoseconds (ns) along the right side of the cross-section image (see **Figure 3-1**) if it is checked in this dialog box. If, however, the Depth axis is unchecked and removed from the image, the Time axis moves to the left side of the cross-section image.

Horizontal **Grid Lines** corresponding to the Time Axis labels are displayed on the cross-section image if the Grid Lines option is checked (see **Figure 3-1**). Note that only time OR depth horizontal grid lines can be displayed; not both.

7.9.3.3 Depth Axis

The Depth Axis is displayed on the left side the cross-section image (see **Figure 3-1**) if it is checked in this dialog box. The depth axis is non-linear (squished on the top) to correct for the antenna separation.

GPR data are measured in time and to convert time to depth, a velocity value for the material scanned must be entered in the **Velocity** field on the Axes tab. This velocity value is displayed in the Depth Axis title.

Depth Axis Velocity

If you need help selecting an appropriate velocity, click on the ".." button beside the velocity value and a table of typical velocity values for various materials is displayed. The default velocity is 0.10 m/ns or 0.328 ft/ns.

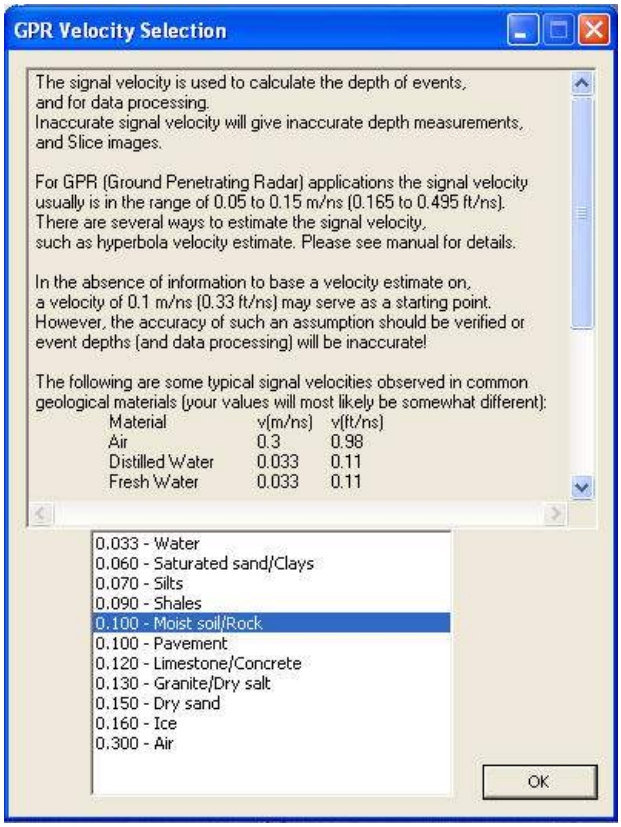


Figure 7-24: Velocity Table

An inaccurate velocity value will result in an inaccurate depth scale. If a hyperbolic response is observed in the data, the velocity can be extracted from the data by performing a calibration (see **Velocity Calibration for Depth Determination**). Velocity can also be extracted from CMP/WARR data (see **CMP/WARR Velocity Calibration**)

Horizontal **Grid Lines** corresponding to the Depth Axis labels are displayed on the cross-section image if the Grid Lines option is checked (see **Figure 3-1**). Note that only time OR depth horizontal grid lines can be displayed; not both.

7.9.3.4 Elevation Axis

If topographic data were added to GPR data file using the “Add Topography” routine in EKKO_View Enhanced or EKKO_View Deluxe software, the cross-section image can be shifted to compensate for topography and plotted with an elevation axis.

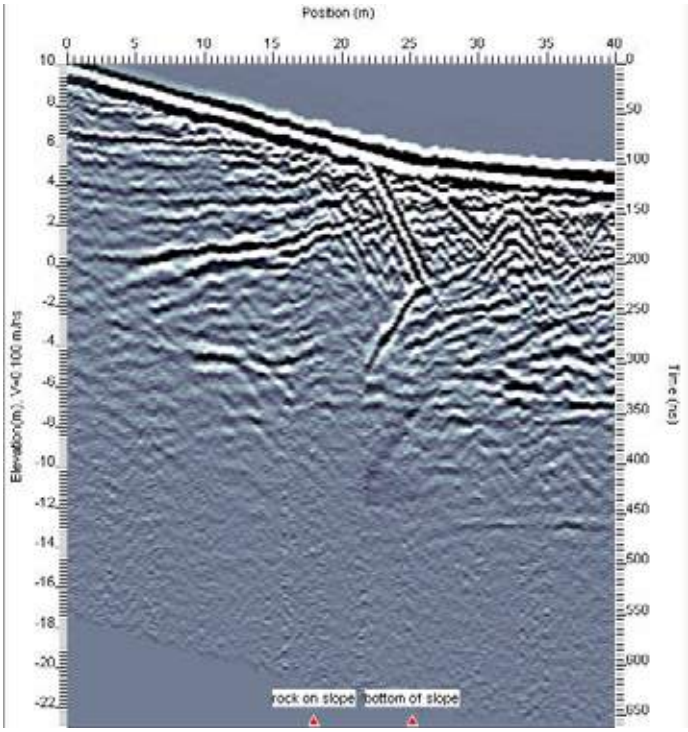


Figure 7-25: Cross-section image displayed with an elevation axis.

The Elevation Axis is displayed on the left side the cross-section image (see **Figure 7-25**) if it is checked in the dialog box under **View > Settings > Axes tab**.

GPR data are measured in time and to convert time to elevation, a velocity value for the material scanned must be entered in the **Velocity** field on the Axes tab. This velocity value is displayed in the Elevation Axis title. An inaccurate velocity value will result in an inaccurate elevation scale.

Elevation Axis Velocity

If you need help selecting an appropriate velocity, click on the “..” button beside the velocity value and a table of typical velocity values for various materials is displayed (**Figure 7-24**). The default velocity is 0.10 m/ns or 0.328 ft/ns.

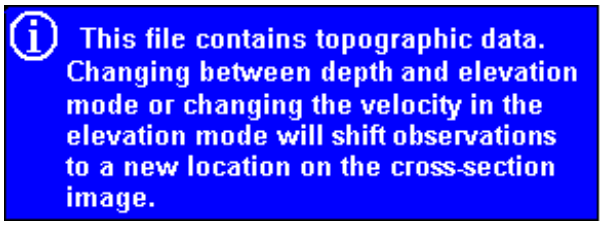
Horizontal **Grid Lines** corresponding to the Elevation Axis labels are displayed on the cross-section image if the Grid Lines option is checked (see **Figure 3-1**). Note that only time OR elevation horizontal grid lines can be displayed; not both.

On a normal depth plot, the depth axis is non-linear (squished on the top) to compensate for the antenna separation. When plotting data with topography, part of the topographic shifting of the data file includes correcting for the antenna separation so the elevation axis is linear. This correction results in the upper part of the cross-section image being slightly stretched.

Interpretations and Elevations

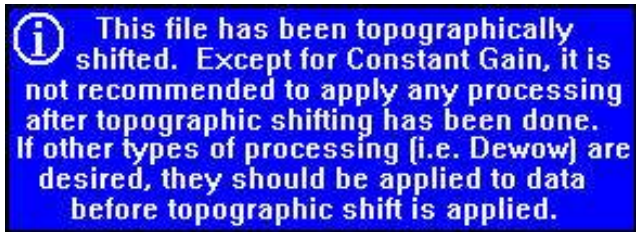
If the user desires observation values in the **Interpretation Report** in elevations rather than depths, **Interpretation**s should only be added **AFTER** the cross-section has been plotted with an Elevation Axis.

Adding Interpretations BEFORE applying Elevation may affect the accuracy of the elevation observations in the Interpretation Report. You may see a warning message like this:



Previously Topo-Shifted Data Files

If a historical GPR data file was topographically shifted using the “Shift Topography” routine in the EKKO_View Deluxe program, when the file is opened in EKKO_Interp, a warning message is displayed:



In this case topographic shifting should be the last process performed after the Dewow and Gain have been applied. When a topographically shifted file is opened, the user is advised against applying more Gain or Dewow in the **Gain/Filter Tab**.

Previously topo-shifted data can only be plotted with an elevation axis, not a depth axis.

With EKKO_Interp’s ability to apply topographic corrections without altering the data file, it is no longer necessary or desirable to use the “Shift Topography” routine in EKKO_View Deluxe. EKKO_View Deluxe should only be used to integrate the elevation data into the GPR data file using the “Add Topography” routine.

7.10 Limits Tab

The **Limits Tab** under **View Settings** changes depth, elevation or time limits for the cross-section image.

If data are plotted with a **Depth Axis** (set under the **View Settings > Axes Tab**), the limits of the data image can be set using time and/or depth limits. In this mode Elevation limits are not accessible (**Figure 7-26**).

If data are plotted with an **Elevation Axis** (set under the **View Settings > Axes Tab**), the limits of the data image can be set using time and/or elevation limits. In this mode Depth limits are not accessible (**Figure 7-29**).

The **Available Data Range** box shows the depth and time ranges. Depth ranges from zero (0.0) to the maximum depth of the data based on the velocity set under the **Depth Axis**. Time ranges from the start time (which is usually negative) to the end time in nanoseconds.

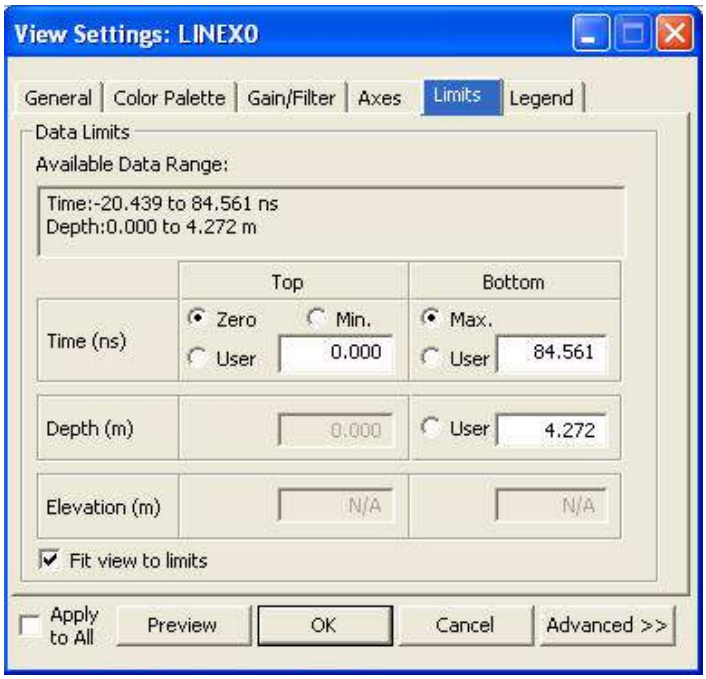


Figure 7-26: The View Settings > Limits Tab when the axis under the Axes Tab is set to Depth. In this case the Elevation limits are not accessible.

The Limits option and the **Apply to All** checkbox are useful for plotting multiple data files, even those with different time window lengths, with the same limits so they can be easily compared on-screen.

7.10.1 Time Limits

7.10.1.1 Top Time

The Top Time Limit option allows the user to set the minimum time displayed on cross-section images (**Figure 7-27**). There are 3 options for this setting:

1) **Zero Time** (the default) displays data starting at time zero.
2) **Min Time** displays the data starting at the minimum time; a negative time that includes all the data before zero time.
3) **User Time** allows the user to input the minimum time to be displayed in the cross-section image. **Be cautious when using a positive top User Time because it will remove data at the top of the cross-section image (Figure 7-27, bottom image).**

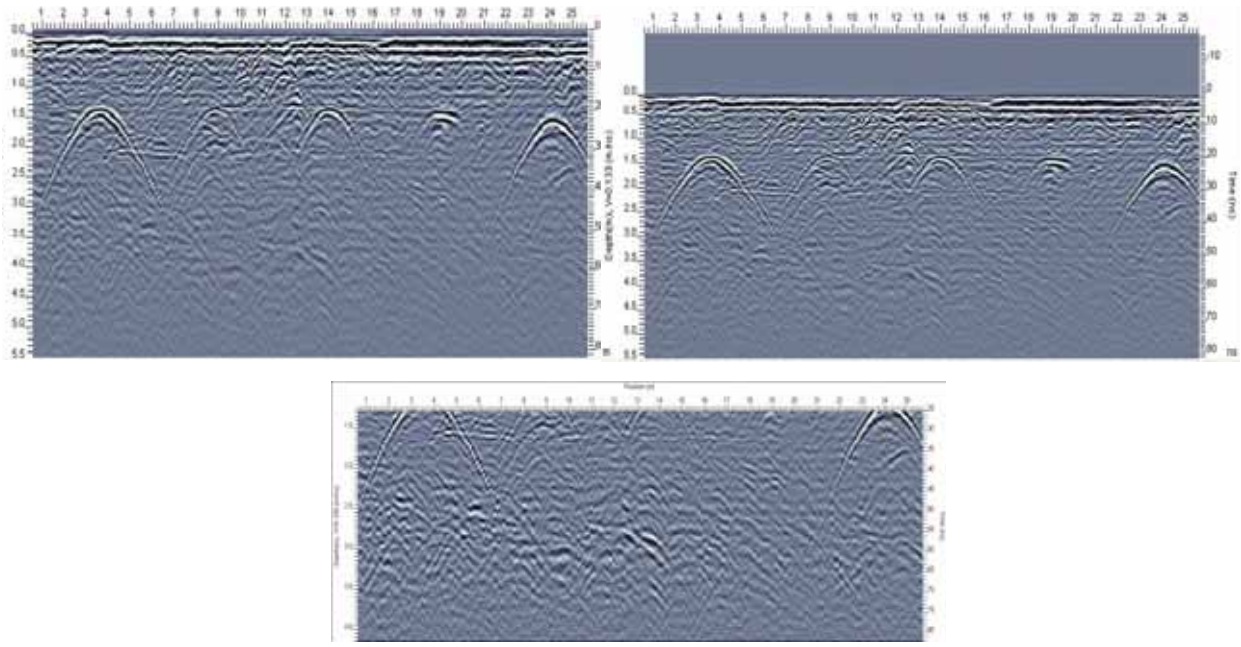


Figure 7-27: Zero Time (top left), Min Time (top right) and User Time (bottom) settings for the Top Time Limit.

7.10.1.2 Bottom Time

The Bottom Time Limit option allows the user to set the maximum time displayed on cross-section images.

There are 2 options for this setting:

1) **Max** (the default) displays the full time range of the cross-section data,

2) **User Time** allows the user to input the maximum time to be displayed in the cross-section image. A User Time less than the Max time will crop data from the bottom of the image.

If the Bottom **User Time** is set to a value larger than the maximum time of the cross-section, the cross-section will show the time axes but the data below the Maximum time will be blank (**Figure 7-28, middle image**).

7.10.2 Depth Limit

The Bottom Depth Limit option allows the user to change the maximum depth displayed on cross-section images.

If the maximum depth value is less than the maximum depth in the data, the bottom of the cross-section image is cropped. If the maximum depth value is greater than the maximum depth in the data, white space is added to the bottom of the cross-section image (**Figure 7-28, middle image**).

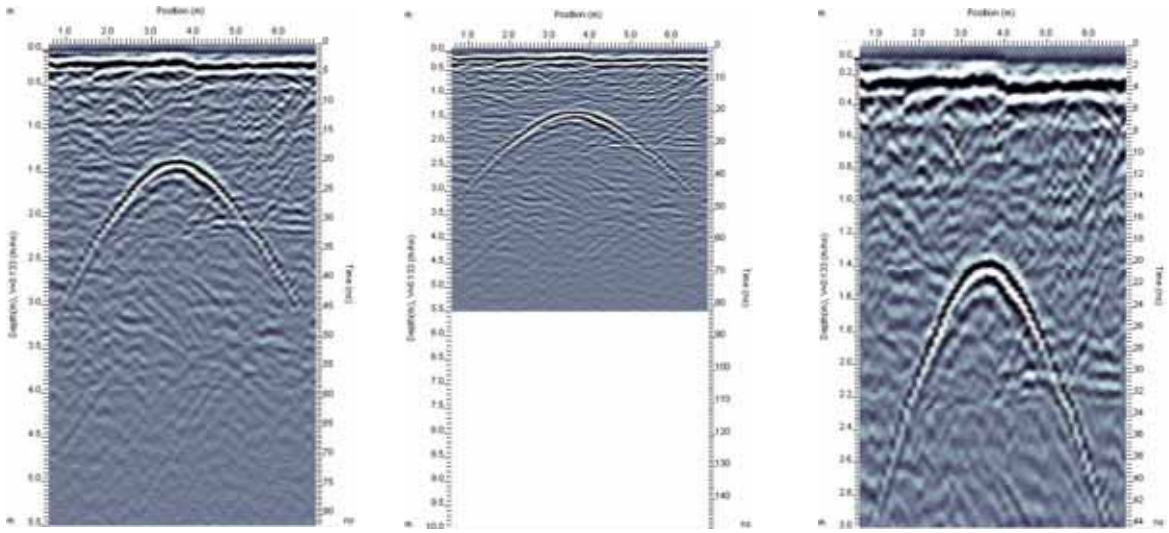


Figure 7-28: The Bottom Depth/Time Limit (left) shows the full depth/time of the cross-section (left) while the User Depth and User Time options can be set to show more (middle) or less (right) data.

7.10.3 Elevation Limit

The Elevation Limits are only accessible if data are plotted with an **Elevation Axis** (set under the **View Settings > Axes Tab**).

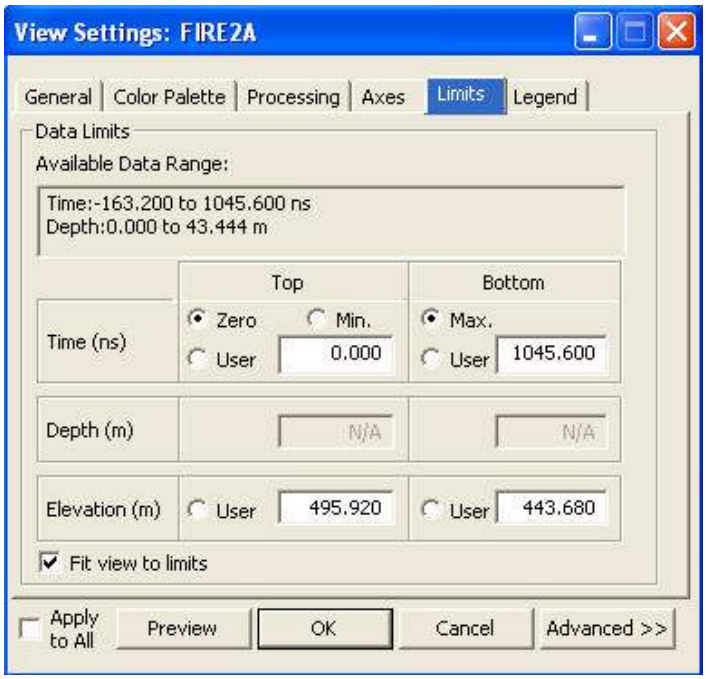


Figure 7-29: The View Settings > Limits Tab when the axis under the Axes Tab is set to Elevation. In this case the Depth limits are not accessible.

The Elevation Limits allow the user to change the maximum and minimum elevations displayed on cross-section images.

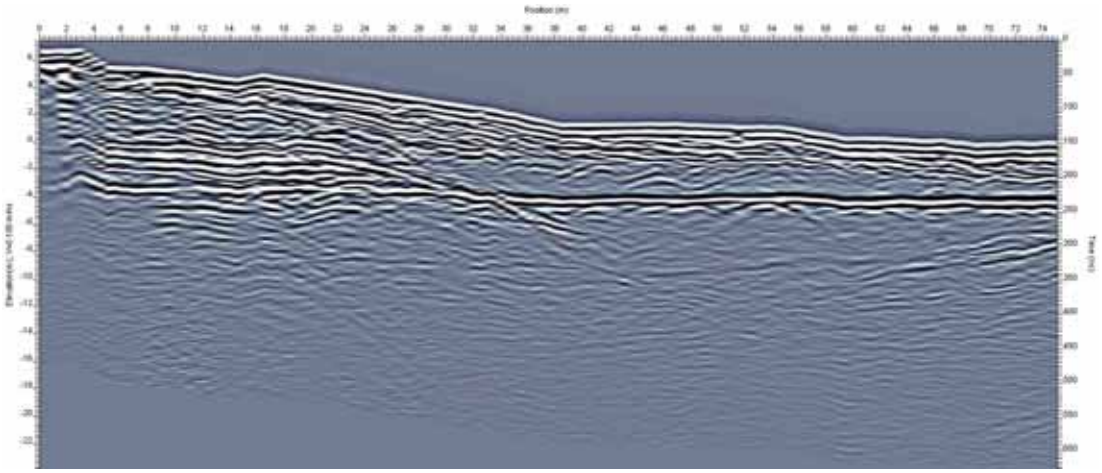


Figure 7-30: The elevation limits default to the highest and lowest elevations in the data file. These values can be edited in the Limits dialog.

7.10.3.1 Top Elevation

The Top Elevation defaults to the highest elevation value in the data file (**Figure 7-30**).

If the Top Elevation is set greater than the highest elevation in the cross-section, the full elevation axis is displayed but white space is added to the top of the cross-section image (**Figure 7-31**).

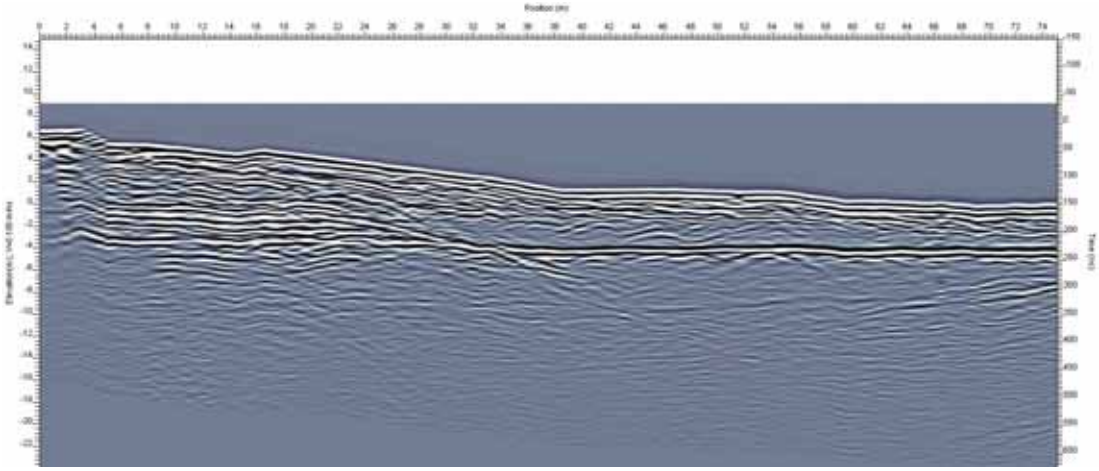


Figure 7-31: If the Top Elevation value is higher than the highest elevation value in the data file, white space is added to the top of the image.

Be cautious when using a Top Elevation that is set less than the highest elevation in the data because it will remove data at the top of the cross-section image (Figure 7-32).

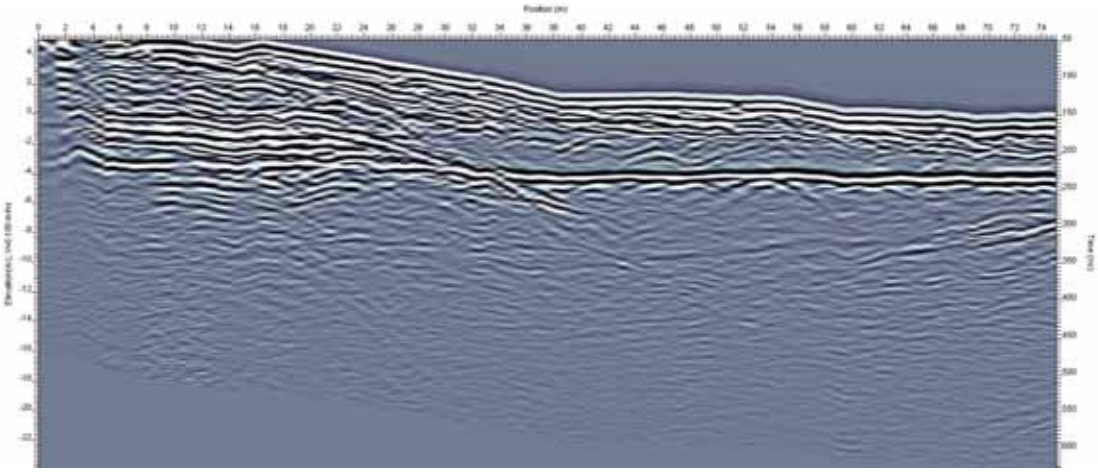


Figure 7-32: If the Top Elevation value is lower than the highest elevation value in the data file, data at the top of the image is cut off.

A popular use of the Top User Elevation value is to set a common datum value for a number of related cross-sections so they can be easily compared.

7.10.3.2 Bottom Elevation

The Bottom Elevation defaults to the lowest elevation value in the data file (**Figure 7-30**).

If the Bottom Elevation is set less than the lowest elevation in the cross-section, the full elevation axis is displayed but white space is added to the bottom of the cross-section image.

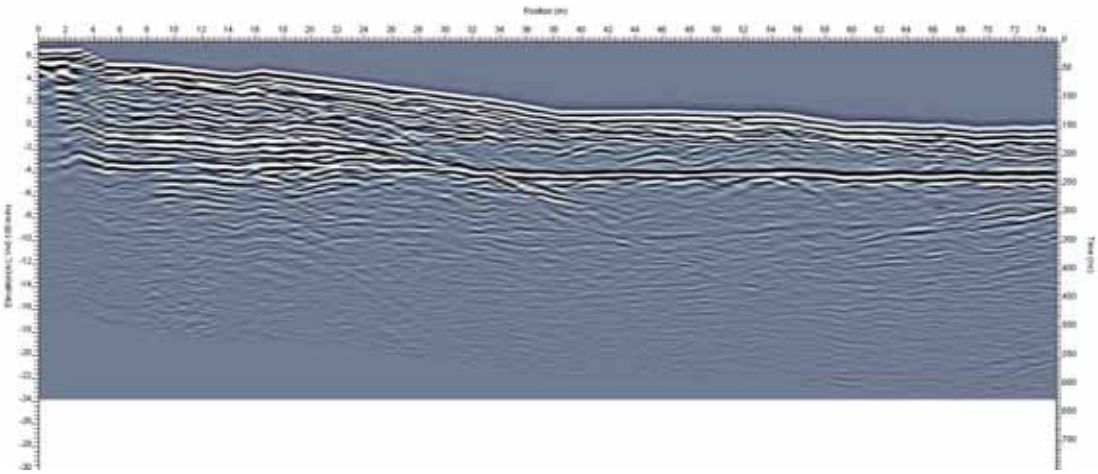


Figure 7-33: If the Bottom Elevation value is lower than the lowest elevation value in the data file, white space is added to the bottom of the image.

If the Bottom Elevation is set greater than the lowest elevation in the cross-section, data is cropped off the bottom of the image.

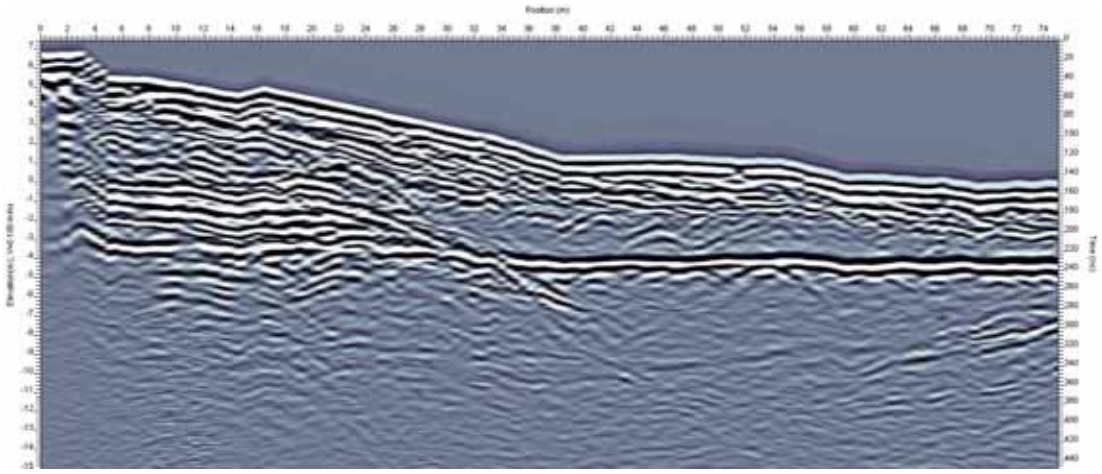


Figure 7-34: If the Bottom Elevation value is higher than the lowest elevation value in the data file, data at the bottom of the image is cut off.

7.10.4 Fit to View Limits

If the **Fit to View** option is selected, the Top and Bottom Limits defined are displayed in the full window.

For example, the original data has a Bottom Limit set to the Max of 9.5m. If the Bottom Limit is changed to 5m, the data image is expanded vertically to fill the full window (**Figure 7-35**).

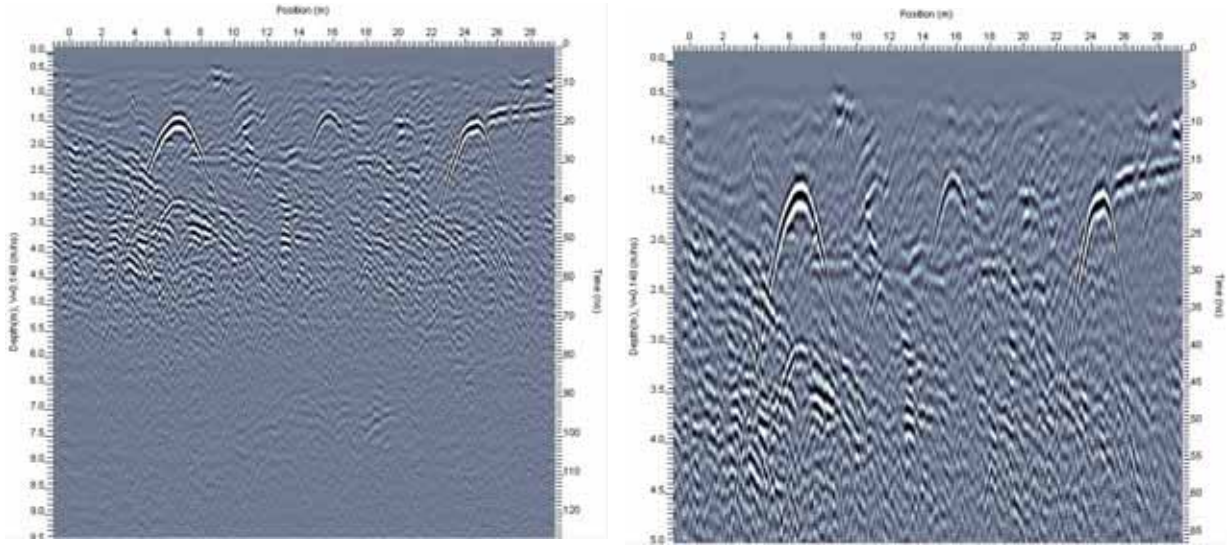


Figure 7-35: Fit to View On: The Bottom Limit is set to the maximum of 9.5m (left). If the Bottom Limit is changed to 5m and Fit to View is on, the data image is expanded vertically to fill the window with a maximum depth of 5m (right).

If the Fit to View option is not selected, the Top and Bottom Limits are displayed in the window at the original vertical scale and the data will be truncated and white space will appear at the bottom of the image. For example, the original data has a Bottom Limit set to the Max of 9.5m. If the Bottom Limit is changed to 5m, the vertical scale remains the same as the original and the data image is truncated at 5m (**Figure 7-36**).

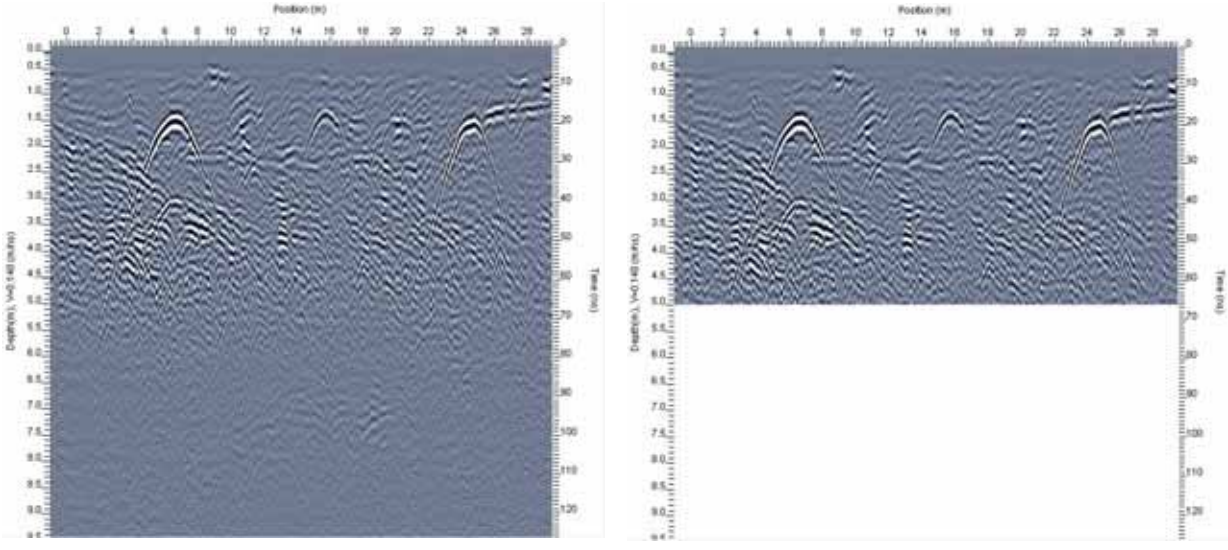


Figure 7-36: Fit to View Off: The Bottom Limit is set to the maximum of 9.5m (left). If the Bottom Limit is changed to 5m and Fit to View is off, the vertical scale does not change and the data image is truncated at 5m (right).

7.11 Legend Tab

The Legend Tab is used to select the options and order of the options displayed on the legend (see **Figure 3-1**).

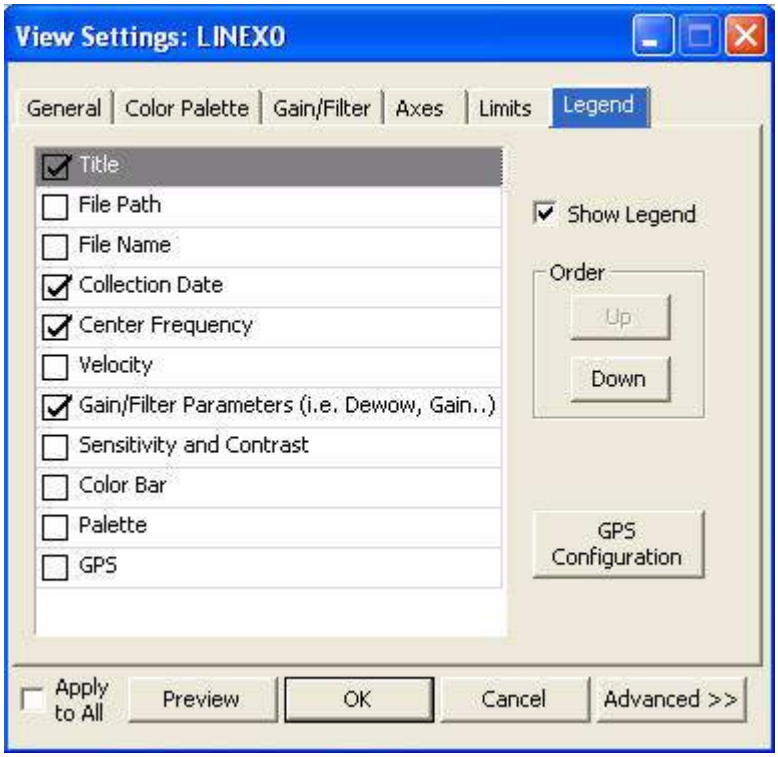


Figure 7-37: The Legend tab controls the options and order of the options displayed on the legend under the data image.

The Legend appears on the bottom of the data image if:

1) the **Show Legend** checkbox is checked in this dialog,

2) the Show Legend button on the **View Toolbar** is pressed, or

3) the **Legend** option under the **View** menu is selected.

To show the legends for multiple data images at once, check the **Show Legend** and **Apply to All** checkboxes and then press **OK**. To hide the legends for multiple data images at once, uncheck the **Show Legend** checkbox, check the **Apply to All** checkbox and then press **OK**.

Check the options that you want to appear in the legend. Change the order by highlighting the option and then using the **Up** and **Down** buttons to move the option.

The legend options are:

1) **Title**: as defined in the **View > Settings > General Tab**. The default Title is the File Name, so if that Title and the File Name (below) is selected in this dialog, the file name will appear twice in the Legend.

2) **File Path**: the string of folders and sub-folders where the data file is located on the computer. The path makes it easy to find the original data files after they have been printed or pasted into a report.

3) **File Name**: the name of the data file.

4) **Collection Date**: the date the data file was collected.

5) **Center Frequency**: the antenna frequency the data file was collected with.

6) **Velocity:** in meters/nanosecond (m/ns) or feet/nanosecond (ft/ns) as listed under **View > Settings > Axes > Depth Axis**. The **Velocity** is also automatically displayed on the **Depth Axis**. The velocity can be calculated using the option under **Tool > Hyperbola Velocity Calibration**.

7) **Processing Parameters:** Indicates if the Dewow filter is on (see See **View > Settings > Gain/ Filter Tab > Dewow**). Also lists the Gain Type and gain parameters applied to the cross-section images (see **View > Settings > Gain/Filter Tab > Gain Type**).

8) **Sensitivity and Contrast:** (S) in percent listed under **View > Settings > Color Palette Tab > Sensitivity** and (C) in percent listed under **View > Settings > Color Palette Tab > Contrast**.

9) **Color Bar**: displays a graphic image of the color bar used for the data image and listed under **View > Settings > Color Palette Tab > Color Palette**.

10) **Palette**: the name of the Color palette used for the data image and listed under **View > Settings > Color Palette Tab > Color Palette**.

11) **GPS**: if the data file contains GPS information, this option displays the GPS start and end positions. The format is set by pressing the **GPS Configuration** from the **Legend Tab**.

7.11.1 GPS Configuration

If the GPR data file contains GPS data (added using the EKKO_View Deluxe, IcePicker or another program), the **GPS Configuration** dialog box is available.

7.11.1.1 Latitude/Longitude

If Latitude/Longitude is selected with the checkbox, the display options are:

1) **Degrees Minutes Seconds**

2) **Decimal Degrees**

The options for the Hemisphere are:

1) **Do not show**

2) Show as a **plus or minus sign**. A plus (+) sign if Latitude is in the Northern hemisphere or Longitude is in the Eastern Hemisphere and a minus (-) sign if Latitude is in the Southern hemisphere or Longitude is in the Western Hemisphere.

3) **Letter:** For latitude, “N” for North or “S” for South. For Longitude, “E” for East or “W” for West.

4) **Word**: For latitude, “North” or “South”. For Longitude, “East” or “West”.

A sample of the current GPS output is shown at the bottom of the dialog box.

7.11.1.2 UTM

If UTM is selected with the checkbox, the **Reference Ellipsoid** can be selected from the drop-down list. The default is **WGS-84**.

To display the **UTM Zone Number** and/or the **UTM Letter Designator**, select those options.

A sample of the current GPS output is shown at the bottom of the dialog box.

8 View Menu

The **View** menu option allows the user to change various aspects of the images including increasing and decreasing gain, sensitivity, contrast, zoom, pan, link views, change units, font and showing or hiding color scale images, wiggle traces, fiducials, skipped traces, axes, grid lines, the legend, toolbars and status bar.

8.1 Settings

The View > Settings options are described in the **View Settings Menu** section of this document.

8.2 Gain/Filter Settings

The **View > Gain/Filter Settings** menu option provides a shortcut to the **View > Settings > Gain/Filter Tab**.

8.3 Color Palette Settings

The **View > Color Palette Settings** menu option provides a shortcut to the **View > Settings > Color Palette Tab**.

8.4 GPR Line Properties

The **View > GPR Line Properties** option displays the header (.HD) file for the GPR data line displayed in the current **Active Window**. This is a text file saved with data (.DT1) file when data are collected. It contains survey parameter information as well as details of any editing or post-processing performed on the data file. An example is shown in **Figure 8-1**.

Figure 8-1: Header (.HD) file display.

This header file can also be printed from this dialog box by pressing the **Print** button.

8.5 Gain Increase / Decrease

Gain is described in detail under **View > Settings > Gain/Filter Tab > Gain Type**.

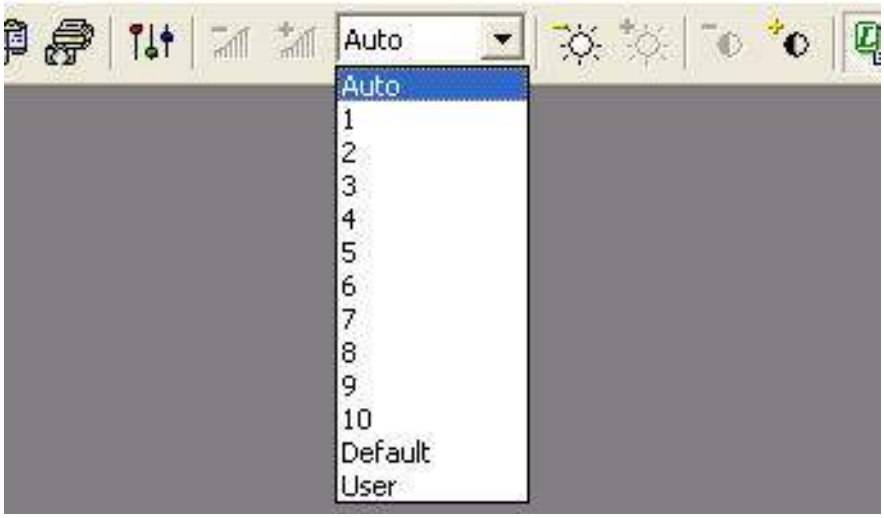
The options in the View menu are shortcuts for quickly changing the Gain **Level**.

The gain level is increased by selecting **View > Gain Increase** or clicking the following button on the **View Toolbar**:

The gain level is decreased by selecting **View > Gain Decrease** or clicking the following button on the **View Toolbar**:

These buttons will be disabled if the Gain Level is set to Auto, Default or User. To enable them, set the Gain Level to a numbered value.

The Gain Level can also changed using the Gain Level dropdown list on the **View Toolbar**:



The possible options are: Numbered Level, Default, User and Auto.

The Level Gain can also be increased by pressing the “+” key and decreased by pressing the “-” key on the numeric key pad on standard keyboards.

8.6 Contrast & Sensitivity

Contrast and Sensitivity are described in detail under **View > Settings > Color Palette Tab**.

The options in the View menu are shortcuts for quickly changing the Contrast and Sensitivity values using the menus.

The Contrast and Sensitivity values can also be changed using the buttons on the toolbar or pressing keys on the keyboard.

8.6.1 Sensitivity Decrease / Increase

Sensitivity is increased by 5% by selecting the **View > Contrast & Sensitivity > Sensitivity Increase** option.

Sensitivity is decreased by 5% by selecting the **View > Contrast & Sensitivity > Sensitivity Decrease** option.

If the **Ctrl** key is pressed at the same time, the value changes by 1%.

If the **Shift** key is pressed at the same time, the value changes by 10%.

8.6.2 Contrast Decrease / Increase

Contrast is increased by 5% by selecting the **View > Contrast & Sensitivity > Contrast Increase** option.

Contrast is decreased by 5% by selecting the **View > Contrast & Sensitivity > Contrast Decrease** option.

If the **Ctrl** key is pressed at the same time, the value changes by 1%.

If the **Shift** key is pressed at the same time, the value changes by 10%.

8.6.3 Apply Normal Settings to Contrast & Sensitivity

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

8.7 Zoom

The Zoom options zoom in and out of the cross-section image in the position direction.

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

There are 4 ways of using the Zoom option:

1) Zoom in to an area 50% of the current image size by selecting **View > Zoom > In** or by pressing the **Insert** key or the following button on the **View Toolbar**:

Zoom in only applies to the position direction. It does not apply to the time or depth direction.

2) Zoom out to an area 200% of the current image size by selecting **View > Zoom > Out** or by pressing the **Delete** key or the following button on the **View Toolbar**:

Zoom out only applies to the position direction. It does not apply to the time or depth direction.

3) Draw a box around the area to zoom to by selecting **View > Zoom > Select Area** or by pressing the following button on the **View 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 window size by pressing the **Home** key or by selecting **View > Zoom > Fit to Window** or by pressing the following button on the **View Toolbar**:

This option is usually selected to quickly return to the full image view (as determined by the data limits in the **Limits Tab**) after zooming in.

After zooming into an image, use the scroll bars to move around 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.

When zoomed in on an image, the **Page Up** and **Left Arrow** keys scroll to the left and **Page Down** and **Right Arrow** keys scroll to the right.

Page Up and **Page Down** moves one whole screen to the left and right respectively while the **Left Arrow** and **Right Arrow** scrolls the image a little bit to the left or right.

If your mouse has a wheel, the image can be scrolled left or right using the wheel.

The **Up Arrow** key scrolls the image up and the **Down Arrow** key scrolls the image down.

A zoomed in image will still display the position, depth and time scales.

If you scroll beyond the limits of the data into an area with no data, press the **Fit to Window** button to return to the data view.

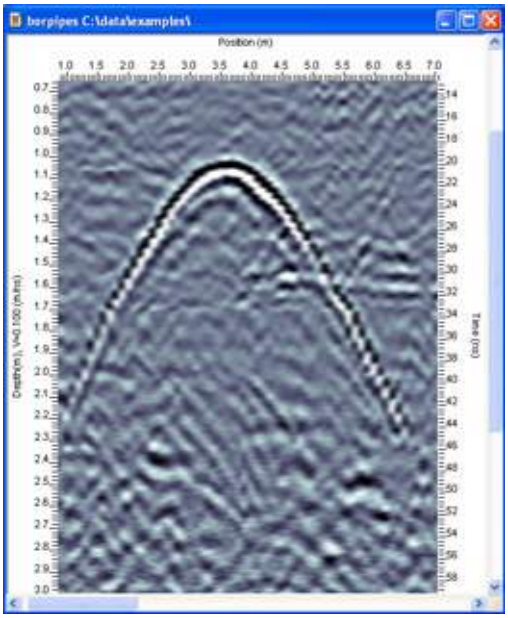


Figure 8-2: Zoomed image.Use the scroll bars on the right and bottom to move the zoomed area around the image.

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.

8.8 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 **View Toolbar**:

Once in Pan mode, click and drag the data image to a new location.

To exit from Pan mode, select the option again under **View > Pan** or depress the same button on the Toolbar.

8.9 Link View Position Range

Two or more data images can be linked together and scrolled together horizontally in the position direction. This option is very handy for comparing parallel lines.

The **Link View Position Range** option is most useful when the data files were collected with different frequencies so that you want to scroll the positions but keep the depth range for each window different (see **Figure 8-3**).

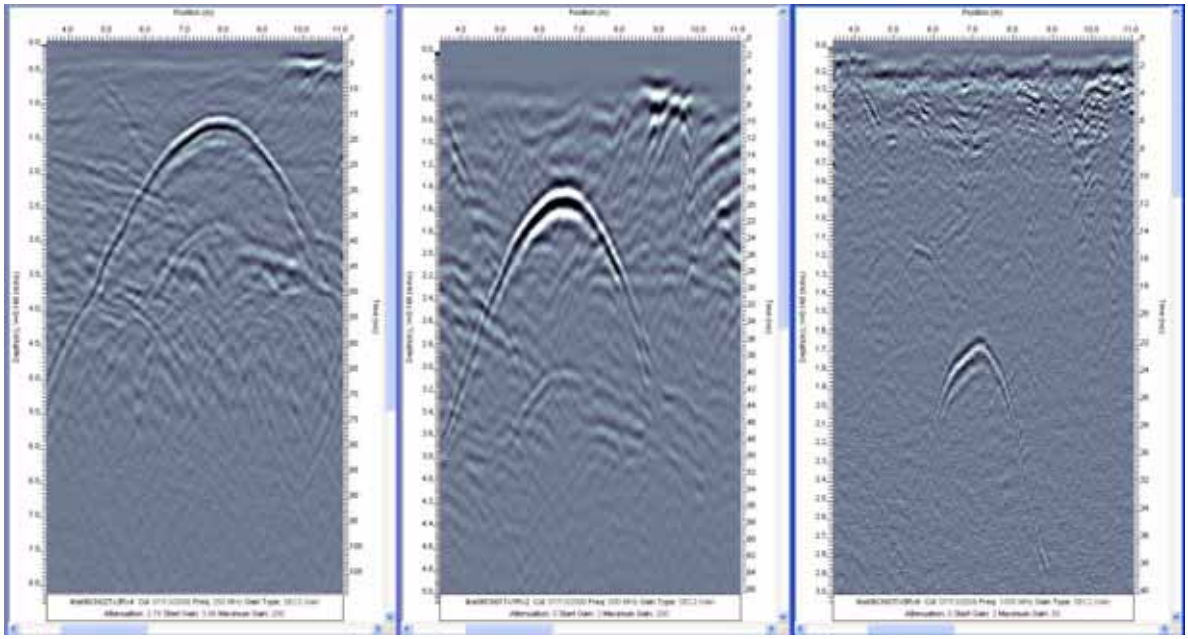


Figure 8-3: 250, Parallel lines linked by positions and scrolled together. Note that since only the positions are linked, the vertical time/depth scales can be different.

8.10 Link View Position and Time/Depth Range

All open data images can be linked together and scrolled together horizontally in the position direction and vertically in the time/depth direction. This option is very handy for comparing parallel lines.

The **Link View Position and Time/Depth Range** option is most useful when the data files were collected with the same or similar frequencies so that you want to be able to scroll horizontally in the position direction and also vertically in the time/depth direction (**Figure 8-4**).

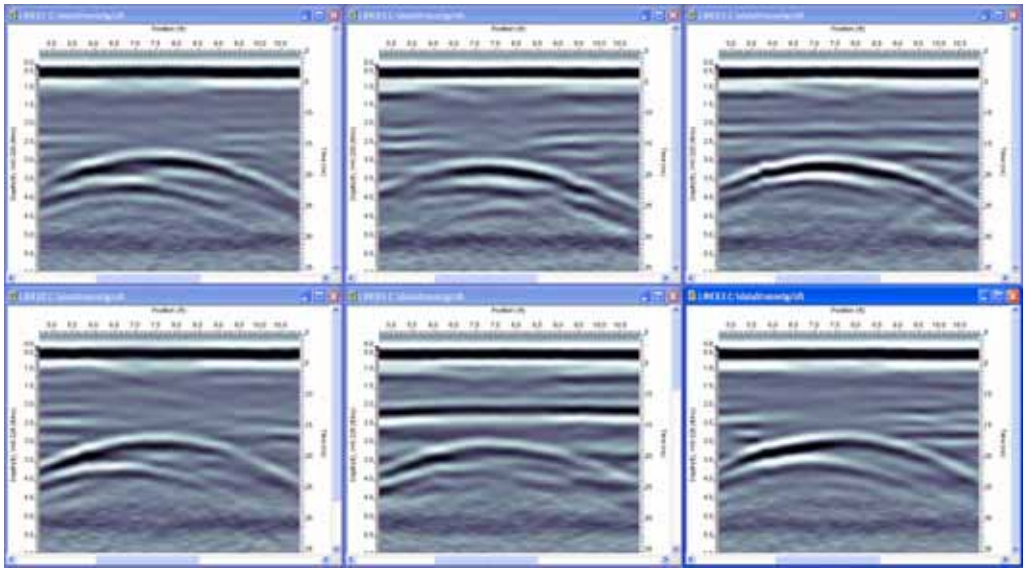


Figure 8-4: Six 250 MHz parallel lines linked by positions and scrolled together.

If the data files are different frequencies, i.e. 100 MHz and 1000 MHz, all cross-section images are plotted with the same vertical scale so the shallower, high frequency image may be difficult to see (**Figure 8-5**).

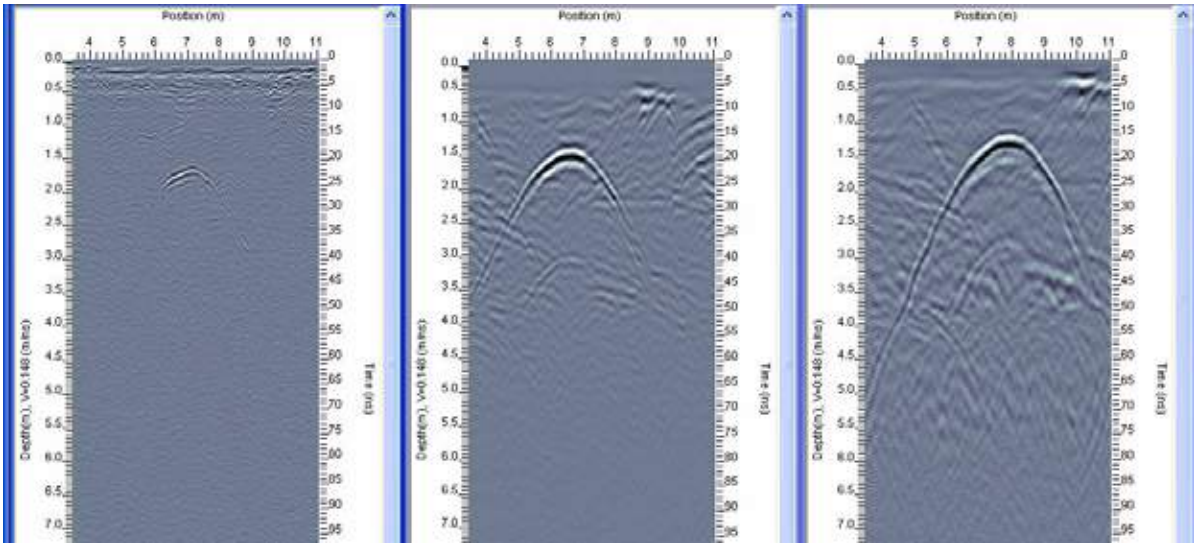


Figure 8-5: 1000, 500 and 250 MHz parallel lines linked by position and time/depth and scrolled together. Note that since both position and time/depth are linked, the vertical scales for each data image is identical. This has resulted in the higher frequency data on the left being concentrated at the top of the image compared to the low frequency data on the right.

8.11 Units

The units of the position and depth axes can be set to meters or feet. Select **View > Units > Feet** or **View > Units > Meters**.

The units can also be changed using the buttons on the **View Toolbar**:

Note that the option selected in the **View** menu changes the option under **View > Settings > Axes > Display Units**.

8.12 Font

The Font option is described in more detail under **View > Settings > General Tab > Font**.

The **View > Font** option is a shortcut to the font dialog used for the position, depth and time axes as well as the text in the Legend.

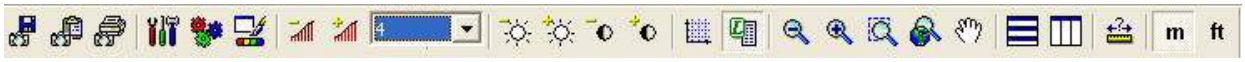
8.13 Show/Hide

8.13.1 Toolbar

The **View > Show/Hide > Toolbars** allows the user to show or hide the toolbars.

8.13.1.1 View

If **View > Show/Hide > Toolbar > View** is checked, the **View Toolbar** appears below the menu bar (**Figure 3-1**).



8.13.1.2 Velocity

If **View > Show/Hide > Toolbar > Velocity** is checked, the **Velocity Toolbar** appears at the top of the EKKO_Interp Window (**Figure 3-1**).

8.13.1.3 Interpretation

If the **View > Show/Hide > Toolbar > Interpretation** is checked, the **Interpretation Toolbar** appears at the top of the EKKO_Interp Window (**Figure 3-1**).

8.13.2 Status Bar

If **View > Show/Hide > Status Bar** is checked, the **Status Bar** appears along the bottom of the EKKO_Interp Window (**Figure 3-1**).

The information text that appears on the right side of the Status Bar corresponds to the mouse cursor position within the data image (**Figure 3-1**). This text information can be copied to the **Clipboard** by pressing the F8 key. For more details see **Status Bar**.

8.13.3 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 other Sensors & Software software.

If the DT1 file contains Fiducials, they are displayed on the data image if the **View > Show/Hide > Fiducials** option is checked.

The fiducials will appear as colored triangles on the bottom of the cross-section (see **Figure 3-1**). The color of the fiducial can be changed in **View > Settings > Marker Color**.

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

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

8.13.4 Fiducial Text

If **Fiducials** is enabled, the **View > Show/Hide > Fiducial Text** option is accessible. This option displays the text associated with the fiducials (see **Figure 3-1**).

The font size of the Fiducial Text is the same as the Axis and is changed in **View > Font** or **View > Settings > General Tab > Font**.

If the DT1 file does not contain any fiducials, this option is greyed out and not accessible.

8.13.5 Color Scale / Wiggle Trace

Data images are displayed as a Color Scale image (see **Figure 7-4**), a Wiggle Trace image (see **Figure 7-6**), both (see **Figure 7-7**) or none.

If the **View > Show/Hide > Color Scale Image** option is checked, the Color Scale image is displayed in the **Active Window**.

If the **View > Show/Hide > Wiggle Trace** option is checked, it shows the Wiggle Trace image in the **Active Window**.

If both the **Show Color Scale Image** and the **Show Wiggle Trace** options are checked, both images are displayed in the **Active Window**.

If neither the **Show Color Scale Image** or the **Show Wiggle Trace** options are checked, no cross-section image is displayed in the **Active Window**. This option is useful to show **Interpretation**s with a white background and no GPR data image (see **Figure 7-8**).

For more details, see **Color Scale** and **Wiggle Trace**.

These options are tied to the associated checkboxes in the **General Tab**. To change the data image display for multiple GPR lines, use the **Apply to All** option.

8.13.6 Skipped Traces

If the data file contains positions where traces were skipped during data collection, this can be indicated on the data image by selecting **View > Show/Hide > Skipped Traces**.

Skipped traces appear as colored rectangles on the bottom of the cross-section (see **Figure 3-1**). The color of the skipped traces can be changed in **View > Settings > Marker Color**.

Skipped traces are filled in with interpolated or repeated traces.

8.13.7 Axes

Checking the **View > Show/Hide > Axes** option displays axes around the data image (see **Figure 3-1**).

The depth scale is displayed on the left side of the image, the 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 Axes option, make sure that the image you want to display or hide the axes is in the **Active Window**.

This options is tied to the associated checkboxes in the **Axes Tab**. To change the axes display for multiple GPR lines, use the **Apply to All** option.

8.13.8 Grid Lines

Checking the **View > Show/Hide > Grid Lines** option superimposes a grid of dashed lines onto the cross-section image (see **Figure 3-1**).

Horizontal grid lines appear at time or depth label increments and/or vertical grid lines positions label increments.

Show Grid Lines is greyed out and not available unless grid lines are selected under **View > Settings > Axes Tab**.

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

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

This option is tied to the associated checkboxes in the **Axes Tab**. To change the Grid Lines for multiple GPR lines, use the **Apply to All** option.

The grid color can be changed under **View > Settings > General Tab > Grid Color**.

8.13.9 Legend

Checking the **Show Legend** option adds a legend to the cross-section image (see **Figure 3-1**).

The **Legend** appears as lines of text below the cross-section image. It contains user-defined information about the cross-section including the line name, velocity, data processing, gain, color palette, contrast and sensitivity, etc. (see **View > Settings > Legend Tab**).

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

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

This option is tied to the associated checkboxes in the **Legend Tab**. To change the Legend for multiple GPR lines, use the **Apply to All** option.

8.13.10 Inactive Interpretations

The **View > Show/Hide > Inactive Interpretations** menu option shows or hides the Inactive Interpretations. Inactive Interpretations are all the interpretations other than the **Active Interpretation**.

The purpose of this option is to allow the user to quickly hide or show all the Inactive Interpretations on the GPR cross-section in a Project.

The Show/Hide Inactive Interpretations option is also available by clicking the **Show/Hide Inactive Interpretations** button on the **Interpretation Toolbar**:

When the button is not pressed, Inactive Interpretations are hidden (default). When the button is pressed in, Inactive Interpretations are shown.

If the Active Interpretation is set to **None** and Inactive Interpretations are set to **Hide**, all Interpretations can be quickly removed using the this button.

8.13.11 Hidden Interpretations

The **View > Show/Hide > Hidden Interpretations** menu option shows or hides Interpretations with the **Hide** Property set to on.

If Hidden Interpretations is checked, Interpretations are displayed even if the Hide Property is on.

If Hidden Interpretations is not checked, Interpretations with the Hide Property on are not displayed.

The purpose of this option is to allow the user to quickly hide or show all the Hidden Interpretations in a Project without having to change the **Hide** property for each one.

8.13.12 Annotations

The **View > Show/Hide > Annotations** menu option shows or hides the **Annotations**.

The default setting is to show the annotations. If Annotations is set to Hide, annotations are not displayed unless it is the **Active Interpretation**.

The purpose of this option is to allow the user to quickly remove all the Annotations in a Project which may clutter up an interpretation display without having to change the **Hide** property for each one.

9 Interpretation

An interpretation is one or more observations drawn on the GPR data image or images using the mouse cursor and a specific drawing tool (points, polylines, boxes or annotations).

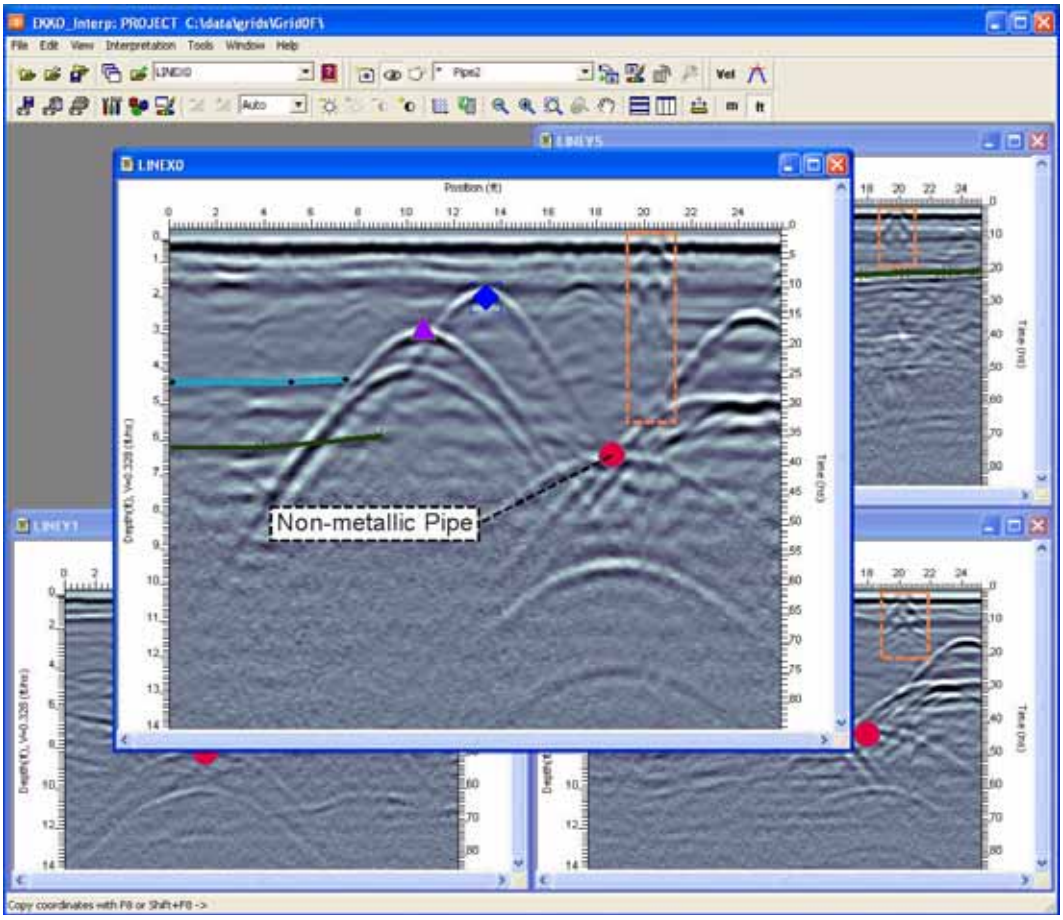


Figure 9-1: Interpretations

The **Interpretation** menu has options to create new interpretations, pick the active interpretation, add or delete observations, change the properties of an existing interpretation and edit interpretation templates.

9.1 Create New Interpretation

There are several ways to create a new interpretation:

1) Select **Interpretation > Create New Interpretation** from the menu,

2) Select the **New Interpretation** button from the **Interpretation Toolbar**:

3) Select **<New>** from the **Active Interpretation** dropdown list on the **Interpretation Toolbar**.

The **Create New Interpretation** dialog is shown in **Figure 9-2**.

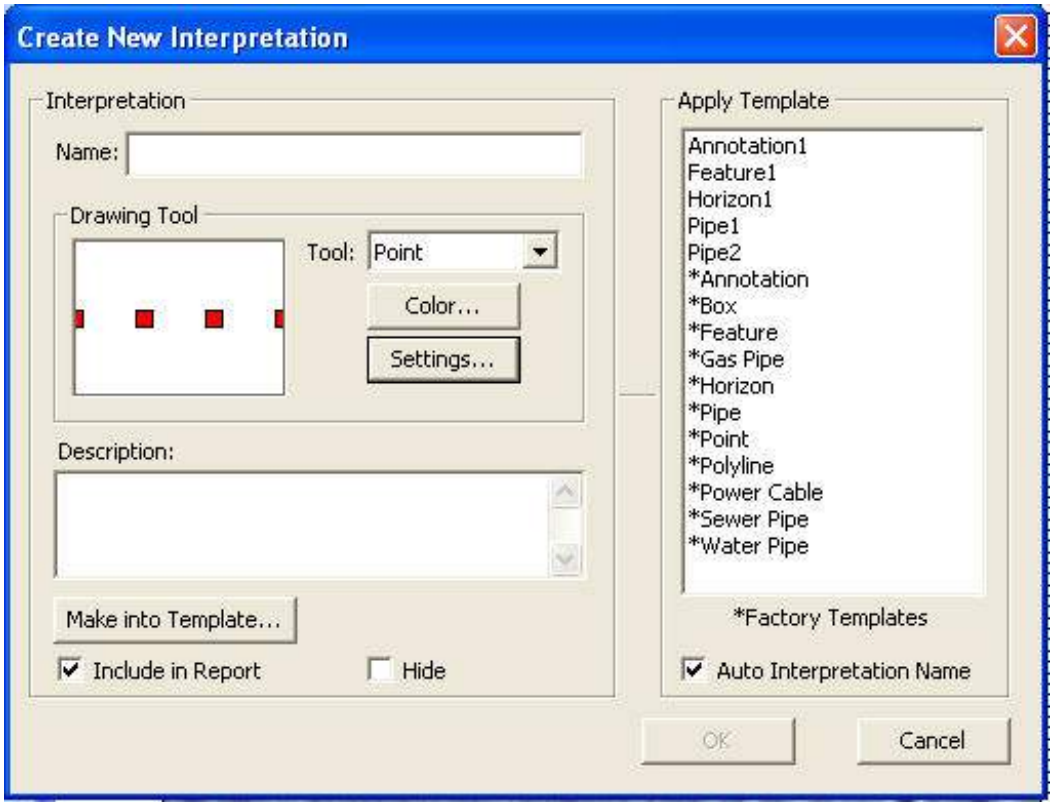


Figure 9-2: Create New Interpretation dialog

The user creates a new interpretation by setting the Name, Drawing Tool, etc. properties on the left side of the dialog. To quickly create a new interpretation with automatically generated properties, select a template from the **Apply Template** list on the right side of the dialog.

Pressing the OK button automatically puts EKKO_Interp into **Add** mode (the Add Observations button on the **Interpretation Toolbar** is pressed) allowing the user to immediately start adding observations on the GPR cross-section image.

9.1.1 Name

When creating a new interpretation, enter a name in the Name field. This name will appear in the **Active Interpretation** dropdown list on the **Interpretation Toolbar** and in the **Interpretation Report**.

If a template is selected for a new interpretation, the name is automatically generated if **Auto Interpretation Name** is enabled.

9.1.2 Drawing Tool

Under Drawing Tool, select the Tool for drawing the interpretation. The options available from the dropdown list are point, polyline, box or annotation.

9.1.2.1 Point

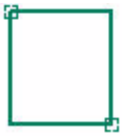
The Point tool draws one or more points on the GPR Line image.

9.1.2.2 Polyline

The Polyline tool draws a line consisting of one or more points.

9.1.2.3 Box

The Box tool draws a rectangular box.



9.1.2.4 Annotation

The Annotation tool writes text in a box. The box includes a line to connect the text to a specific location within the GPR data or interpretation image.

Figure 9-3: Annotations consist of two parts: the annotation box containing the text and the annotation line that connects the annotation box to a point in the data image.

9.1.2.5 Color

The color option is used as a quick way of setting the color of the interpretation. When selected, the standard Windows color selection dialog opens and the user selects a color.

Unlike the **Settings** option, which allows different colors for marker borders, marker fill and lines, the Color option sets all these to the same color.

9.1.2.6 Settings

The Settings option edits the Interpretation Properties including the marker style, marker border color, marker fill color, marker size, line style, line color, line weight and text font.

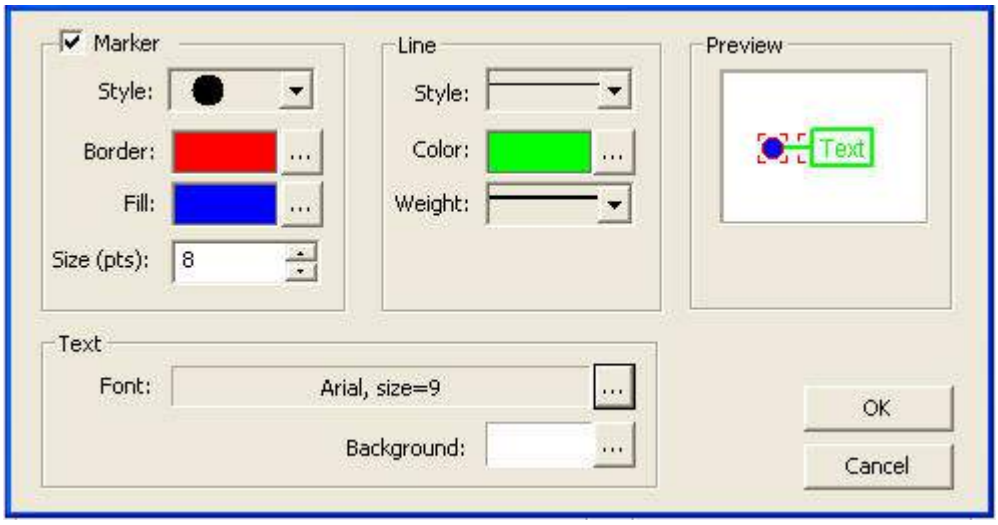


Figure 9-4: Interpretation Settings

All interpretations use the same Settings dialog to set Marker, Line and Text but not all settings are available for all interpretations. For example, the Line settings are not accessible for Point Interpretation and Marker settings are not accessible for the Box Interpretation. However, Markers are optional for Polyline interpretations. The details of what settings are available for each type of interpretation is summarized in the table below.

Interpretation	Marker	Line	Text
Point	Yes	No	No
Polyline	Optional	Yes	No
Box	No	Yes	No
Annotation	Optional	Yes	Yes

Markers: Markers are used for points and are optional for Polylines and Annotations. There are several options for Marker styles including squares, circles, diamonds and crosses. Sizes vary from 1 to 20 points. Solid marker styles like squares have a Border color and Fill color while other marker styles like crosses and X's only use the Border color.

Lines: Lines are used for Polylines, Boxes and Annotations. There are several options for Line styles including solid and various dashed lines. The Line Color can be selected from the color list. There are 20 different weights (thicknesses) for the line.

Text: Text is only used for Annotations. The font, font size and font color are selected from the standard Windows font dialog. The Background Color can be selected from the color list.

Preview Box: As the interpretation settings are edited, the Preview box displays a graphic of the current interpretation settings.

9.1.3 Description

The description provides space for the user to add text describing the Interpretation. The Description text is written to the **Interpretation Report**.

9.1.4 Apply Template

The user can quickly create a new interpretation with automatically generated properties by selecting a template from the Template list on the right side of the dialog (**Figure 9-2**).

The properties of interpretations, including those created from templates, can be edited by selecting the **Settings** button.

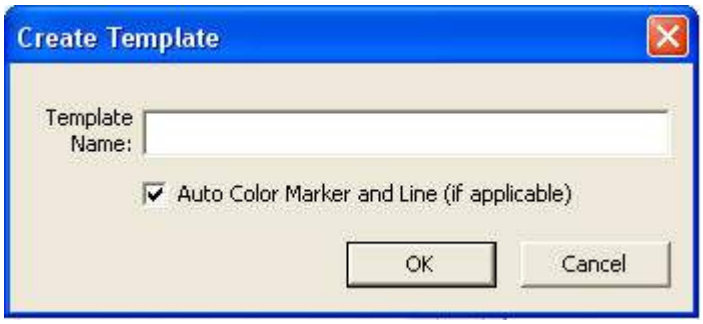
9.1.4.1 Auto Interpretation Name

If **Auto Interpretation Name** is enabled, when a template is selected for a new interpretation, the name is automatically generated. The name can be edited, if desired.

9.1.5 Make into Template

The current interpretation and its properties can be made into a template to be used in the future by selecting the **Make into Template** button.

If selected, the user is prompted to enter a name for the template. This name will appear in the **Apply Template** list.



A check box allows the user to decide whether the template properties are fixed with the current properties or will automatically change whenever the template is selected (the default).

9.1.6 Include in Report

The **Include in Report** checkbox allows the user to decide if the interpretation values are included in the **Interpretation Report**.

This option allows the user to quickly remove the results of an interpretation from the Interpretation Report without having to delete the whole interpretation.

9.1.7 Hide

The Hide checkbox allows the user to hide the interpretation so it is not displayed, unless it is the Active Interpretation. The Active Interpretation overrides any setting to hide the interpretation.

Hidden Interpretations are also displayed if the **View > Show/Hide > Hidden Interpretations** option is set to Show.

9.2 Pick Active Interpretation

9.2.1 Active Interpretation

The Active Interpretation is the only interpretation that can be edited to **Move**, **Add** or **Delete** observations.

The Active Interpretation is selected in one of two ways:

1) Selecting the interpretation name from the interpretation drop-down list on the **Interpretation Toolbar**, or

2) Using the **Pick Active Interpretation** button on the **Interpretation Toolbar**:

After clicking the button, the mouse cursor, when it is over the data image, turns into a hand with a pointing finger and a dot. Move the mouse cursor and position the dot on any observation and the dot turns red. Clicking will make the interpretation associated with that observation the Active Interpretation.

Picking the Active Interpretation lists the name of that interpretation to the Active Interpretation list on the **Interpretation Toolbar**.

It also depresses the Pick Active Interpretation button. To select another Active Interpretation, the Pick Active Interpretation button must be pressed again.

The Pick Active Interpretation button is handy when there are numerous interpretations and you have forgotten the name of the interpretation you want to select but recognize it from the data image.

The Active Interpretation is indicated by corner handles around the markers (**Figure 9-5**):

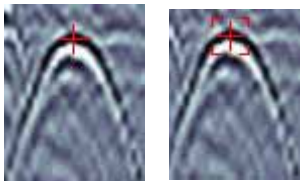


Figure 9-5: Interpretation Markers, in this case, a cross (left), have corner handles added when they are the Active Interpretation (right).

Using the interpretation drop-down list on the **Interpretation Toolbar**, the Active Interpretation can be set to “None”. This displays all the interpretations without the corner handles. Setting the Active Interpretation to None is desirable before saving the image to the Clipboard (see **Copy Image to Clipboard**) or saving the image to a graphics file (see **Export Image**) so the interpretations in the data image do not have corner handles.

Active Interpretations are ALWAYS displayed, even if the **Hide** attribute of the interpretation is on. The Active Interpretation overrides any setting to hide the interpretation.

To hide all interpretations, use the interpretation drop-down list on the to set the Active Interpretation to None and then Hide the Inactive Interpretations using the **View > Show/Hide > Inactive Interpretations** menu option or by pressing the Hide Inactive Interpretations button on the **Interpretation Toolbar**.

9.2.2 Selected Observations

Single observations from the Active Interpretation are selected by clicking on them.

Selected Observations are indicated by two concentric solid squares around them (**Figure 9-6**).

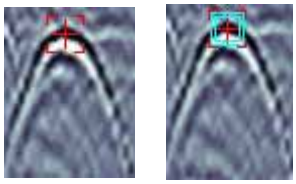


Figure 9-6: Markers for the Active Interpretation (left) are highlighted by concentric squares when selected. Selected observations can be moved or deleted.

Multiple observations are selected by clicking on them while pressing the Control (Ctrl) on the computer keyboard.

Multiple observations can also be selected by clicking and dragging a box around one or more observations (**Figure 9-7**).

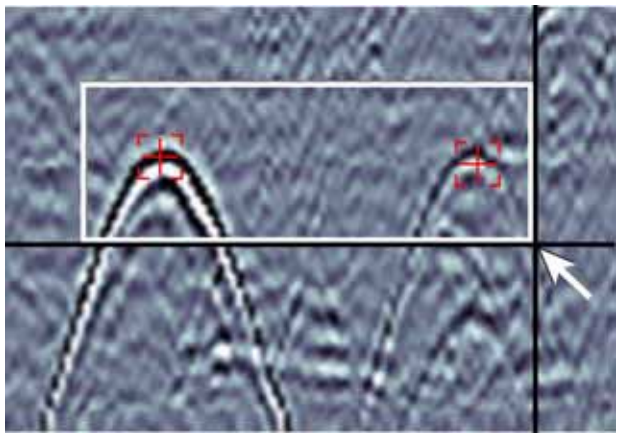


Figure 9-7: Multiple observations are selected by dragging and dropping a box around them. Selected observations can be moved or deleted.

9.2.2.1 Delete

Pressing the Delete key on the computer keyboard deletes the selected observations.

9.2.2.2 Move

A selected observation is moved by using the mouse cursor and dragging it to a new location. Ensure that you are NOT in **Add**, **Delete** or **Join Polylines** mode when moving an observation.

Moving a Box

There are two ways of moving an Box:

1) Resize the box by clicking and dragging one of the handles on the box. Note that the other handle stays fixed while the box resizes.

2) Move the entire box by clicking and dragging anywhere in the middle of the box.

Moving Annotations

Annotations consist of two parts: the annotation box containing the text and the annotation line that connects the annotation box to a point in the data image (**Figure 9-3**).

There are three ways of moving an Annotation:

1) Move just the annotation box by clicking and dragging the the end point of the annotation line where it attaches to the annotation box. Note that the end-point of the annotation line stays fixed while the annotation line stretches to stay attached to the box.

2) Move just the end-point of the annotation line by clicking and dragging the end point of the annotation line. Note that the annotation box stays fixed while the line stretches.

3) Move the entire annotation including the box containing the text and the annotation line by clicking and dragging the middle of the annotation line or the middle of the annotation box.

9.3 Observation

Observations are the “building blocks” of an interpretation. For example, a Point Interpretation consists of one or more point observations at specific positions on the data image.

The **Interpretation > Observation** menu option allows the user to add and delete observations and, in the case of polyline interpretations, insert points or join two polylines together.

9.3.1 Add

The **Interpretation > Observation > Add** menu option is used to add new observations to the current **Active Interpretation**.

Add observation mode can also be accessed by selecting the **Add Observations** button on the **Interpretation Toolbar**:

When selected, the mouse cursor turns into cross-hairs when over the data image. Add observations by clicking the mouse at the desired positions. For higher precision when adding observations, use **Zoom**.

Interpretations are not restricted to a single cross-section image. Observations for the same interpretation can be added to more than one cross-section, for example, to interprete the same pipe or the same horizon on several images (**Figure 9-1**).

When finished adding observations, exit Add mode by:

1) depressing the **Add Observations** button,

2) pressing the **Esc** key on the keyboard or

3) selecting the **Interpretation > Observation > Add** menu option again.

Note that when a new interpretation is created (**Create New Interpretation**), EKKO_Interp automatically enters Add mode to allow the user to quickly start adding observations for the new interpretation without having to press the **Add Observations** button first.

9.3.1.1 Point

Points are added by simply clicking at the desired cross-hair positions.

See **Move** for moving a point.

9.3.1.2 Polylines

Polylines are added by clicking the mouse at the desired cross-hair positions to create one or more points linked by a line (**Figure 3-2**). End a polyline by double-clicking on the end point.

Start a new polyline (of the same Interpretation) by clicking at a new cross-hair position. A new line can be started by right-clicking and selecting **Insert New Line** from the menu.

Polylines cannot form closed loops.

See **Move** for moving a point in a polyline.

9.3.1.3 Box

Boxes are added by clicking at one corner of the box position and dragging the mouse cursor to the opposite corner. A “ghosted” box will appear and turn permanent when the mouse cursor is dropped.

See **Moving a Box** to move a box.

9.3.1.4 Annotation

Annotations are added by clicking at the desired cross-hair position. A dialog box opens to enter text. Clicking OK creates the annotation box containing the text with the end-point of the annotation line at the original cross-hair position.

If you click and drag, the end of the annotation line is placed at the original cross-hair position and the annotation box is placed at the final drag position.

See **Moving Annotations** to move the annotation, the annotation box or the annotation line.

9.3.2 Delete

The **Interpretation > Observation > Delete** menu option is used to delete observations from the current **Active Interpretation**.

Delete mode can also be accessed by selecting the **Delete Observations** button on the **Interpretation Toolbar**:

When selected, the mouse cursor turns into a garbage can with small dot. When the dot in the mouse cursor is close to an observation from the Active Interpretation, it turns red and the garbage can lid opens, indicating that the observation will be deleted by clicking the mouse or pressing the **Delete** key on the computer keyboard.

When in Delete mode, Points, boxes annotations and points in a polyline are deleted by clicking on them.

The line between markers in a polyline can also be deleted. When a polyline is the **Active Interpretation**, garbage can cursor turns into scissors when moved over the line between polyline markers. Clicking the mouse will delete the line and separate the polyline into two segments (Figure 9-8).

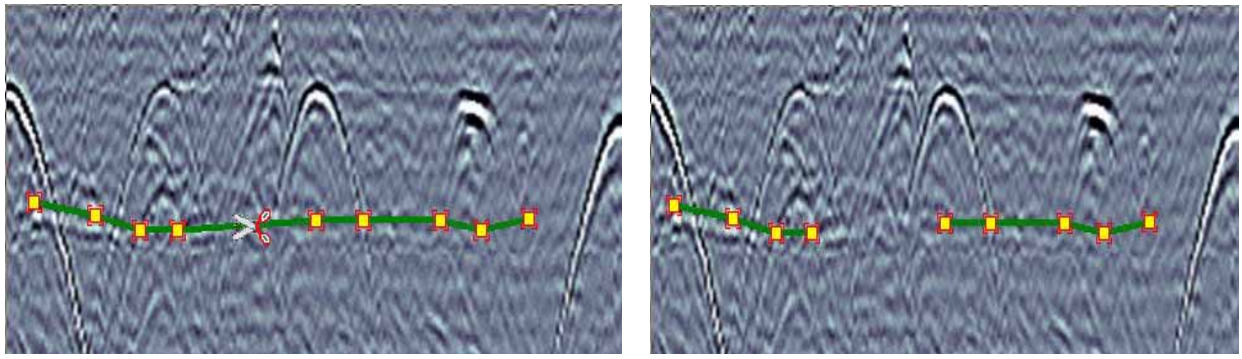


Figure 9-8: When in Delete mode, the mouse cursor is a pair of scissors when it is over the line between 2 points of a polyline (left). Clicking deletes the line and cuts the polyline into two segments (right).

To delete more than one observation:

1) Click and drag a box to select one or more observations (**Figure 9-7**) and then press the Delete key on the computer keyboard.

2) Select the **Delete Observations** button on the **Interpretation Toolbar**. Then click and drag a box around the observations.

When finished deleting observations, exit Delete mode by:

1) depressing the **Delete Observations** button,

2) pressing the **Esc** key on the keyboard or

3) selecting the **Interpretation > Observation > Delete** menu option again.

Even when NOT in Delete mode, any observation from the **Active Interpretation** can be deleted by selecting it with the mouse cursor and then pressing the Delete key on the computer keyboard.

9.3.3 Join Polylines

If the current **Active Interpretation** consists of two or more separate polylines, the **Join Polylines** option is used to join two polylines together into one continuous polyline.

Select Join polylines by either:

1) The **Interpretation > Observation > Join Polylines** menu option,
2) Right-clicking and selecting **Join Polylines** from the menu, or
3) Selecting the **Join Polylines** button on the **Interpretation Toolbar**:

When selected, the mouse cursor, when located on the data image, turns into a glue bottle. When the tip of the glue bottle is over an end-point of a polyline that could be joined to another end-point, the glue bottle turns red. Click and drag the glue bottle from one end-point to the other one to join to and drop the mouse cursor (**Figure 9-9**). This will join the two ends of the polyline together.

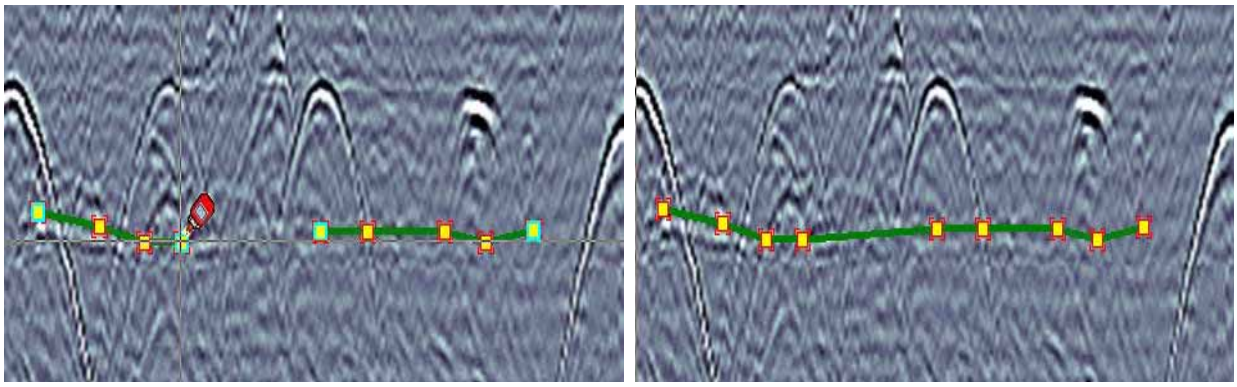


Figure 9-9: When Joining Polylines, the mouse cursor is a glue bottle that turns red when over the end point of a polyline (left). Clicking and dragging to another end point joins the two polylines into one polyline (right).

Polylines cannot form closed loops so the two end points from a polyline cannot be joined together.

The Join Polylines option CANNOT be used to join polylines from different polyline interpretations together; the polylines joined together MUST be from the same interpretation.

When finished joining polylines, exit Join Polyline mode by:

1) depressing the **Join Polylines** button,
2) pressing the **Esc** key on the keyboard,
3) selecting the **Interpretation > Observation > Join Polylines** menu option or
4) right-clicking and selecting **Join Polylines**.

Join Polyline mode is automatically exited when the polyline consists of one segment.

9.3.4 Insert Point in Polyline

The **Interpretation > Observation > Insert Point in Polyline** menu option is used to insert new points between existing points or on the ends of a polyline that is the current **Active Interpretation** (**Figure 9-10)**.

Enter **Insert Mode** by either:

1) Right-clicking and selecting **Insert** from the menu or

2) Pressing the **Insert** key on the computer keyboard.

The mouse cursor turns into a small cross-hair with the “Insert” to indicate Insert mode. Move the cross-hair to the position between points in the polyline where a new point is desired and click the mouse.

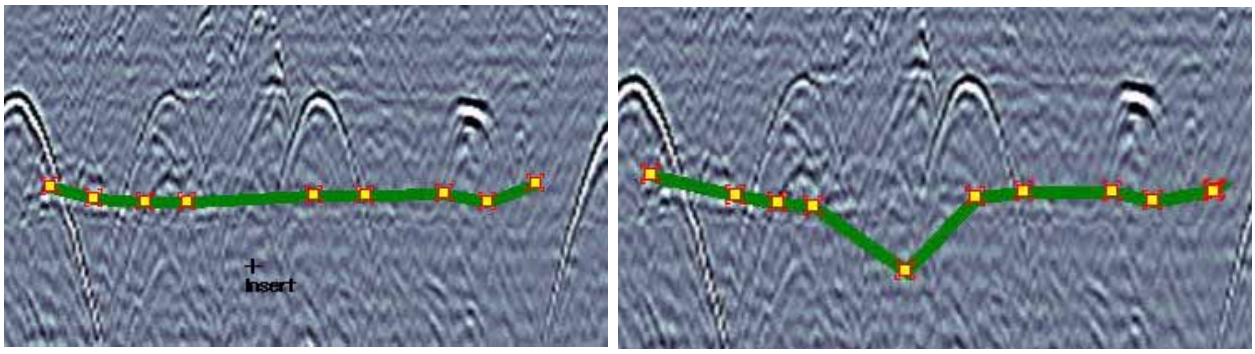


Figure 9-10: Insert mode is used to insert points in a polyline. Insert mode can also be used to add points to the ends of a polyline.

Note that new points are added between the CLOSEST two points in the polyline. There may be times when other points in a polyline are closer than the intended points. In this case it will be necessary to insert a point between the intended points and then **Move** that point to the desired position.

Insert Mode can also be used to add new points to the ends of the polyline.

When finished inserting points in a polyline, exit **Insert Mode** by either:

1) Right-clicking and selecting **Insert** from the menu,

2) Pressing the **Insert** or **Esc** key on the computer keyboard or

3) selecting the **Interpretation > Observation > Insert Point in Polyline** menu option.

9.4 Properties

The properties of the **Active Interpretation** are accessible by:

1) Selecting the using the **Interpretation > Properties** menu item or by

2) Selecting the Properties button on the **Interpretation Toolbar**:

3) Right-clicking on the data image and selecting **Properties** from the menu.

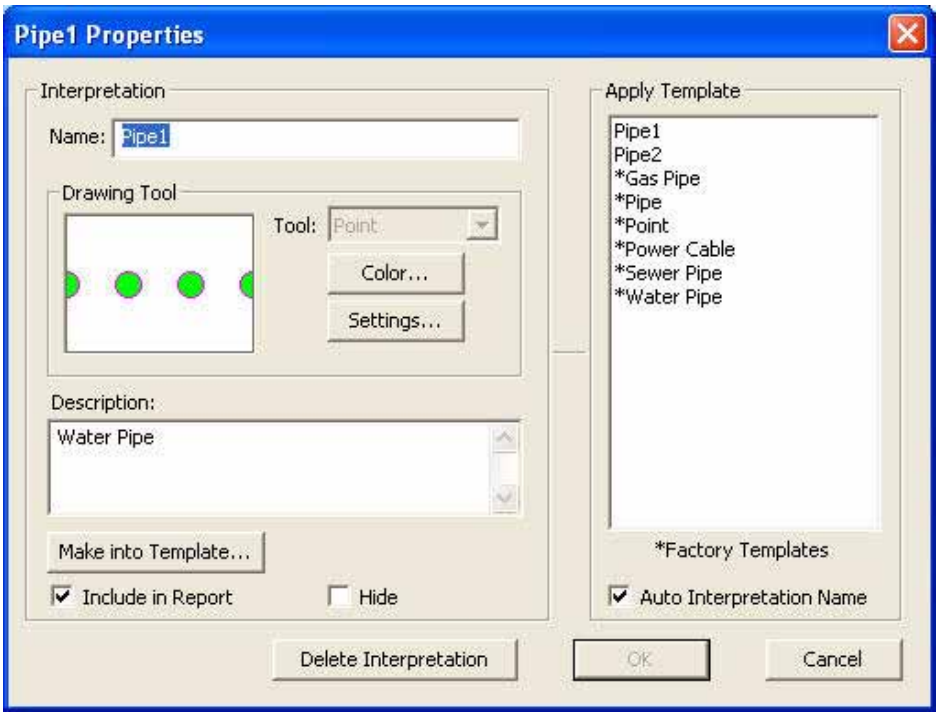


Figure 9-11: The Properties dialog is used to modify the interpretation.

The Interpretation Properties dialog has most of the same options as the **Create New Interpretation** dialog (**Figure 9-2**) except the option to select a different **Drawing Tool** or a Template based on a different Drawing Tool. These properties are not available when editing the Properties of an existing Interpretation.

The Properties dialog has a Delete button to delete the interpretation. Selecting Delete will delete the interpretation from the **Active Interpretation** dropdown list on the **Interpretation Toolbar** and delete all observations using this interpretation in the GPR project. The user is asked to confirm the deletion of the interpretation.

9.5 Templates

The **Interpretation > Templates** menu option manages the current templates.

A list of the all the current interpretation templates is displayed (**Figure 9-12**). The user can delete or rename a custom template or reset the templates list back to the factory default templates.

For more details about creating a custom template, see **Make into Template**.

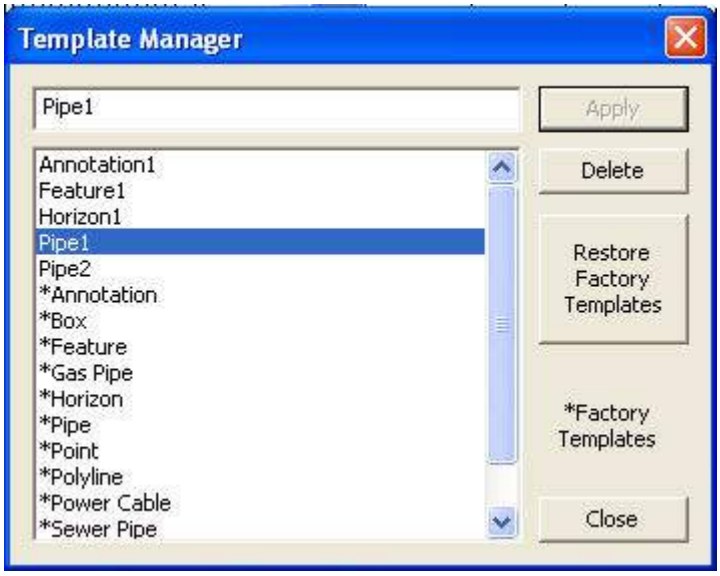


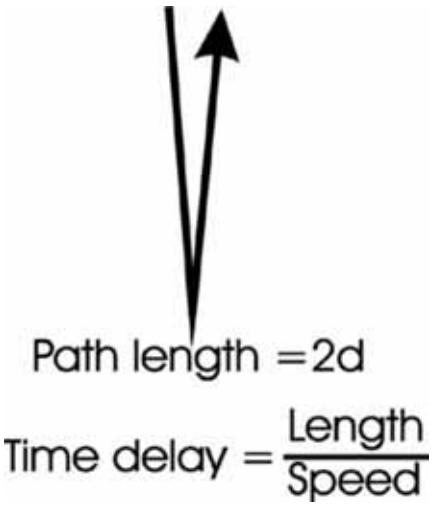
Figure 9-12: Use the Template Manager to delete or change names of custom templates. Factory templates, indicated by a star (*) can be deleted from the list but cannot be renamed.

10 Tools Menu

The **Tools** menu has tools to calibrate GPR velocity and measure distances on the cross-section image.

10.1 How Depth is Determined

Ground penetrating radar systems record the time for a radio wave to travel to a target and back. The depth to that target is calculated based on the velocity at which the wave travels to the target and back.



In simple terms, it is calculated as:

$$D = V \times T/2$$

where: D is Depth (meters or feet)

V is Velocity (meters/nanosecond or feet/nanosecond)

T is Two-way travel time (nanoseconds)

The finite separation between antennas complicates this calculation, especially for shallow depths. Correcting for the antenna separation is why the depth axis appears non-linear at the top (see **Depth Axis**).

To calculate the depth to a target, it is critical that the velocity of the material be known.

Velocity can be measured using the **Velocity Calibration for Depth Determination** described below but if depth data is desired but radar velocity cannot be measured, it must be estimated. The table below gives typical radar velocities for many common materials. If the material is unknown, a good average velocity to use for geological materials is 0.10 m/ns or 0.328 ft/ns.

10.1.1 Typical GPR Velocities of Common Materials

Material	Velocity (m/ns)	Velocity (ft/ns)
Air	0.30	0.98
Ice	0.16	0.53
Dry Soil	0.15	0.49
Granite	0.13	0.49
Dry Salt	0.13	0.43
Dry Rock	0.12	0.39
Limestone	0.12	0.39
Wet Rock	0.10	0.33
Concrete	0.08-0.12	0.26-0.39
Pavement	0.10	0.33
Shale	0.09	0.30
Silt	0.07	0.23
Wet Soil	0.06	0.20
Clay	0.06	0.20
Fresh Water	0.033	0.11

A velocity can be input in the **View > Settings > Axes Tab > Depth Axis** velocity field or selected from the Velocity Table (**Figure 7-24**) accessed by clicking on the ".." button

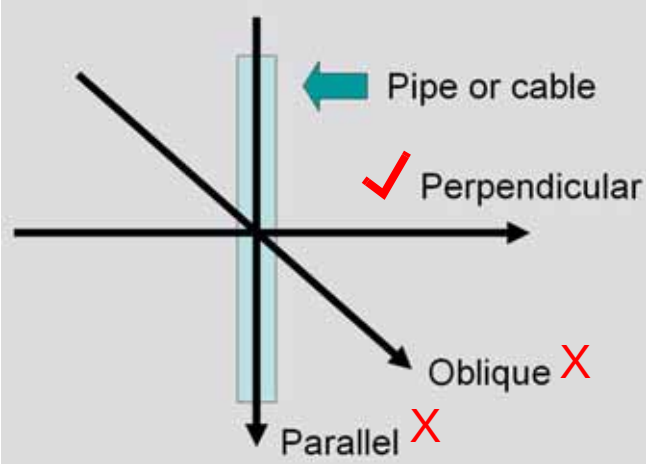
10.2 Velocity Calibration for Depth Determination

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

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

Velocity can be determined by calibrating to a hyperbola in the cross-section data. This method requires the user to fit a typical response curve (a hyperbola) to the raw data to extract the velocity.

Select the **Tool > Hyperbola Velocity Calibration** from the menu or the **Hyperbola Velocity Calibration** button from the **View Toolbar**:



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 and inaccurate depth measurements.

When Hyperbola Velocity Calibration is selected, a hyperbola is superimposed on the current cross-section image. The details of fitting the hyperbola to the data are described below.

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

10.2.1 Hyperbola Velocity Calibration

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 top edge of a 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.

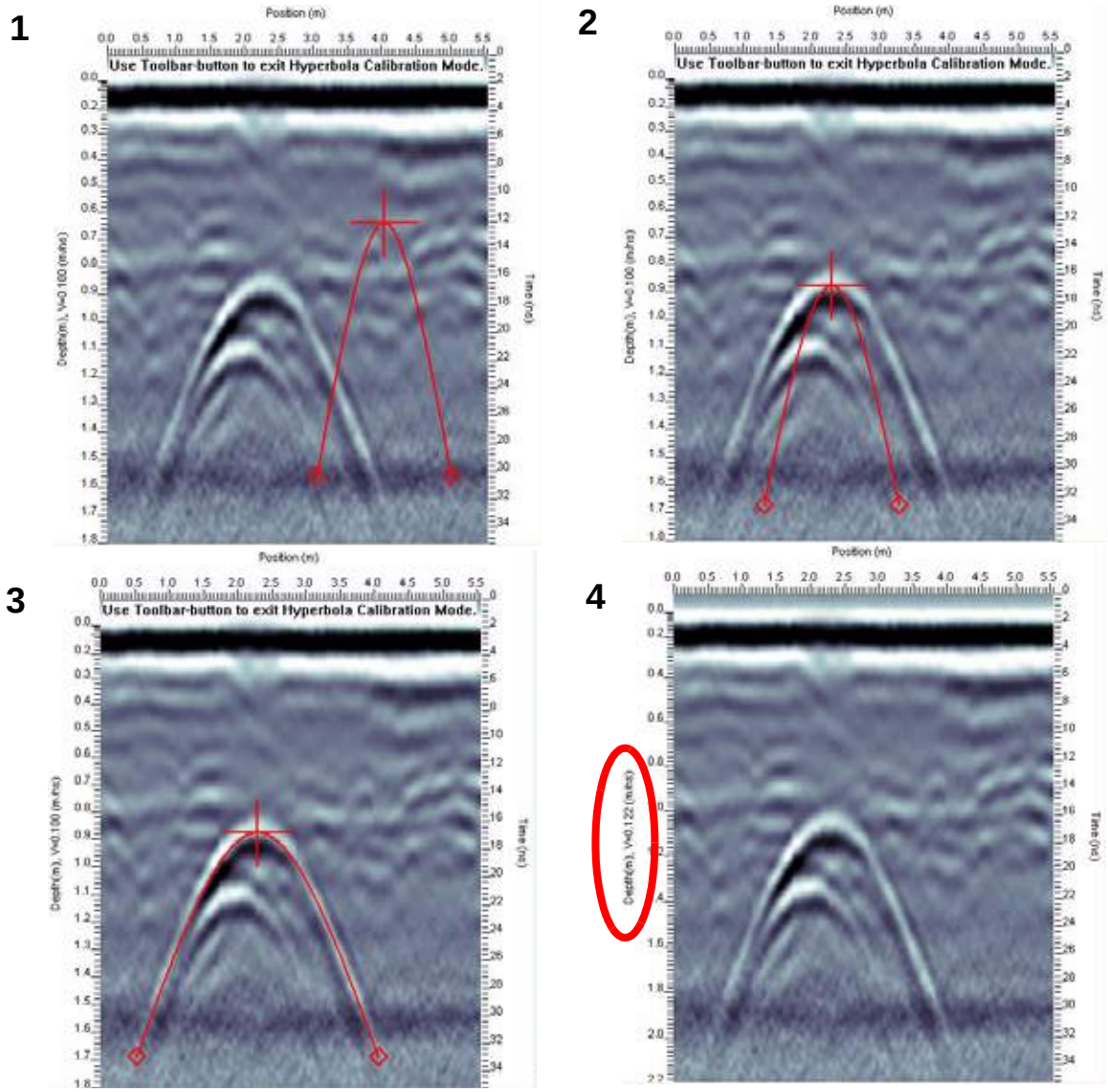


Figure 10-1: Hyperbola-fitting (1) is done by first clicking or dragging the superimposed hyperbola onto one of the colored bands on the hyperbola in the data (2). Choose the top edge of a band that has long tails. This is not necessarily the top band. Then, click and drag one of the diamond-shaped handles on the ends of the hyperbola until the shape matches (3). During this process, the velocity, depth and time are displayed on the Status Bar on the bottom of the screen. After the process is complete, the depth axis is updated using the new velocity value (4).

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.

After the calibration is complete, press the Hyperbola Velocity Calibration button again to exit from velocity calibration mode.

The message "**Use Toolbar button to exit Hyperbola Calibration Mode**" appears on the upper left of the image to remind the user.

After exiting from Hyperbola calibration Mode, if the velocity value has changed, the user is prompted to answer Yes or No to changing the velocity value and updating the depth axis.

During the hyperbola velocity calibration, the **Status Bar** along the bottom of the EKKO_Interp screen displays information including the velocity, depth and time of the hyperbola. As the hyperbola shape is changed, the velocity and depth also change.

10.2.2 Target of Known Depth

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

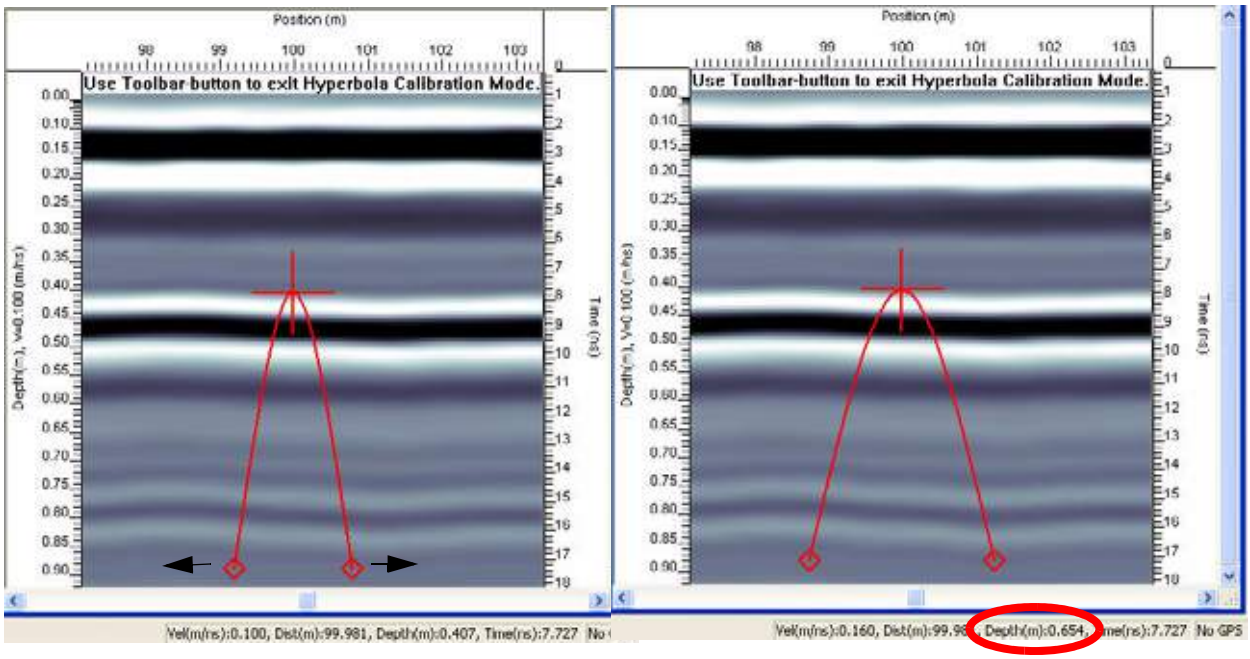


Figure 10-2: For a target at a known depth, like in this case the known thickness of ice, the apex of the hyperbola is placed on the reflection of the target (left) and the velocity adjusted by dragging the hyperbola handles until the depth value listed at the bottom of the screen matches the known depth. The velocity will then be listed on the bottom of the screen as well.

For example, if the reflection from the bottom of the ice is visible in the cross-section image and the depth of the ice is known, the apex of the hyperbola can be positioned on that reflection and the velocity changed until the depth value displayed on the status bar at the bottom of the window matches the known depth.

Target depth should be measured at the top of the highest band in the GPR response.

10.2.3 CMP/WARR Velocity Calibration

Common Mid Point (CMP) and Wide Angle Reflection and Refraction (WARR) are different types of GPR surveys compared to reflection mode surveys typically plotted with EKKO_Interp.

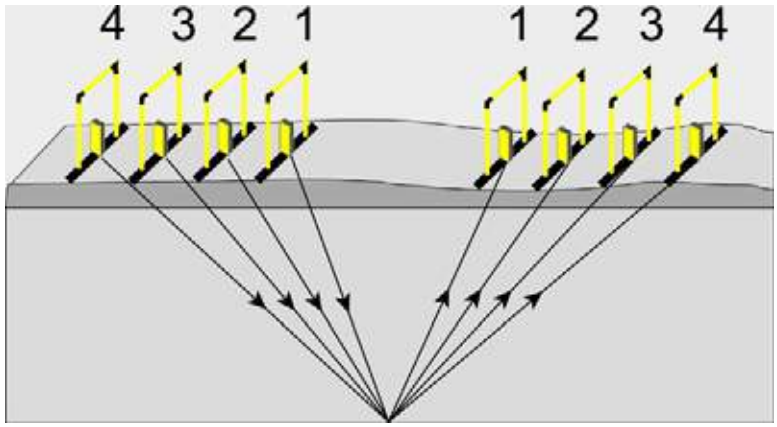


Figure 10-3: CMP data collection method.

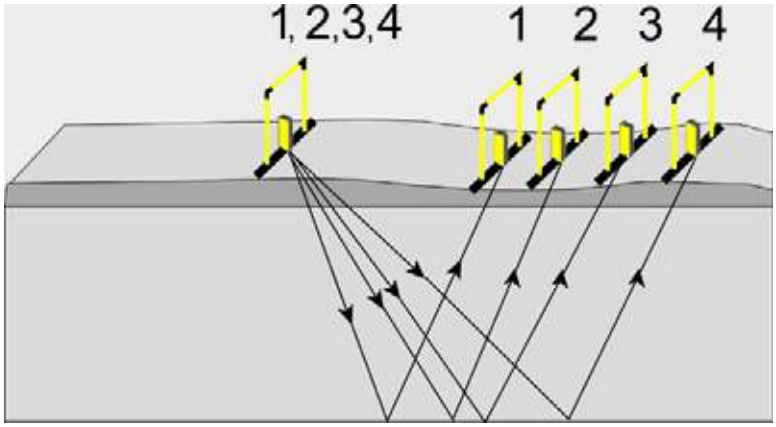


Figure 10-4: WARR data collection method.

The data can only be collected with fully bi-static GPR systems like the pulseEKKO and is used for subsurface velocity determinations. For more information on CMP or WARR data collection, see the pulseEKKO PRO User's Guide.

When **Hyperbola Velocity Calibration** is selected for a CMP/WARR file, the superimposed hyperbola can be moved to the top of one of the data hyperbolas at the approximate zero antenna separation point at the edge of the image (for data with a relatively large starting separation, it may be necessary to scroll the image slightly to the right to see the zero antenna separation point). The shape of the hyperbola can then 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 (**Figure 10-5**).

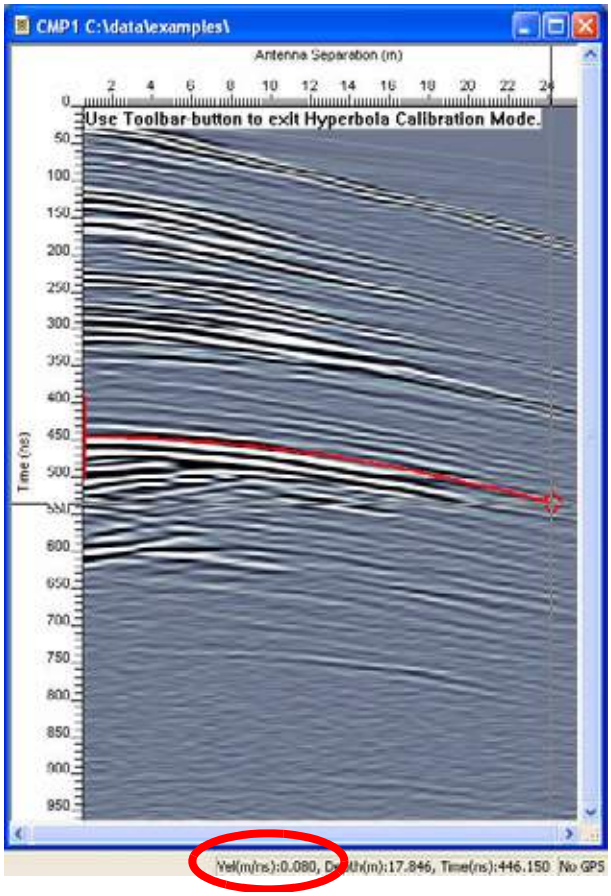


Figure 10-5: When determining velocity from a Common Mid Point (CMP) data file, move the superimposed hyperbola to the zero antenna separation point near the edge of the screen so only half is visible. Click and drag the diamond-shaped handle until it fits the curve in the data image. The average velocity for all the material above that reflector is displayed on the Status Bar at the bottom of the screen.

During the hyperbola velocity calibration, the **Status Bar** along the bottom of the EKKO_Interp screen displays the velocity of the hyperbola. As the hyperbola shape is changed, the velocity also change.

After the calibration is complete, press the Hyperbola Velocity Calibration button again to exit from velocity calibration mode.

The message "**Use Toolbar button to exit Hyperbola Calibration Mode**" appears on the upper left of the image to remind the user.

The velocity extracted from a CMP/WARR file can then be used as the velocity for reflection mode survey lines collected in the same area as the CMP/WARR data (see **Depth Axis**).

10.2.4 Determining Target Depth

After measuring the GPR velocity using the Hyperbola Velocity calibration described above, the depth axis, depth grid lines and mouse cross-hairs can be used to determine the depths of targets in the cross-section image.

It is important to understand that the depth of the target should always be measured from the highest band in the GPR response from that target; not necessarily the strongest band.

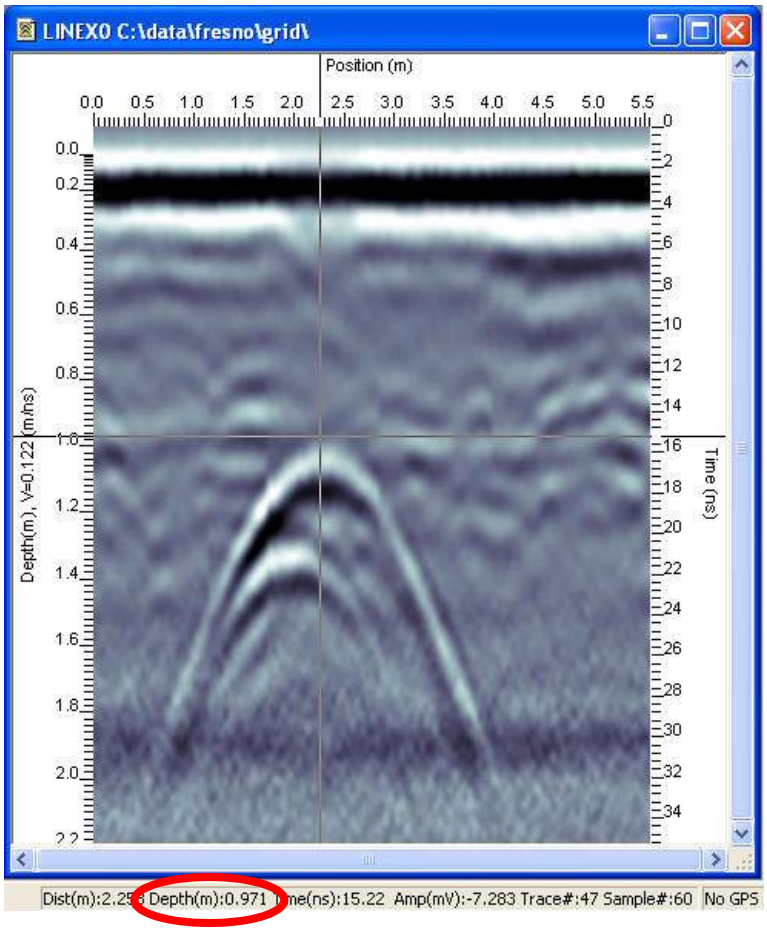


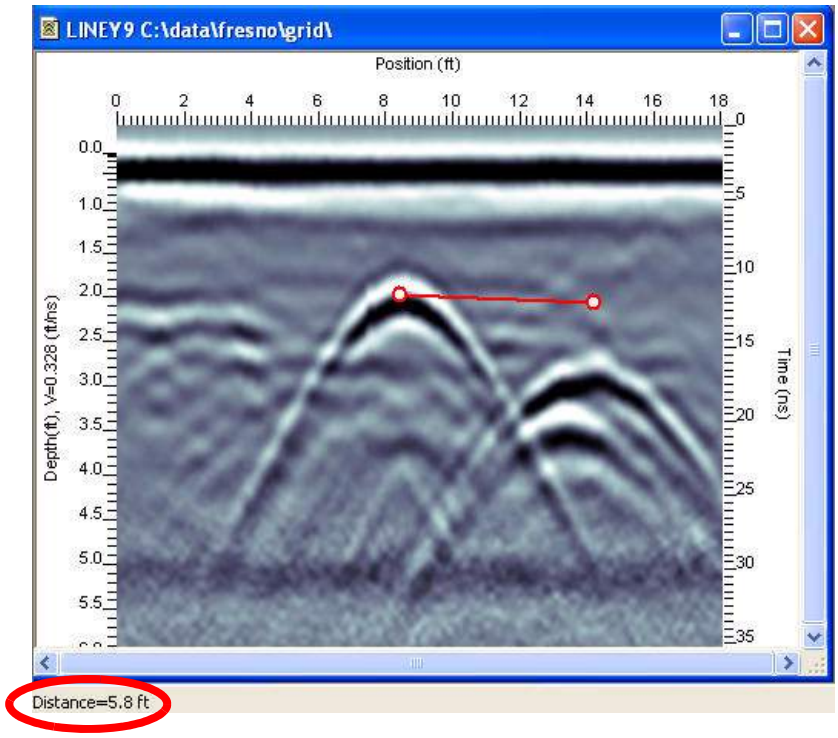
Figure 10-6: The depth to a target should always be measured from the highest band in the GPR response from the target. This band may not necessarily be the strongest. In this case, the depth of the pipe is determined by placing the mouse cross-hairs on the top of the white band.

10.3 Measure

The measure tool allows the user to measure the straight-line distance between any two points on a 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 vertical 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 **View Toolbar**.

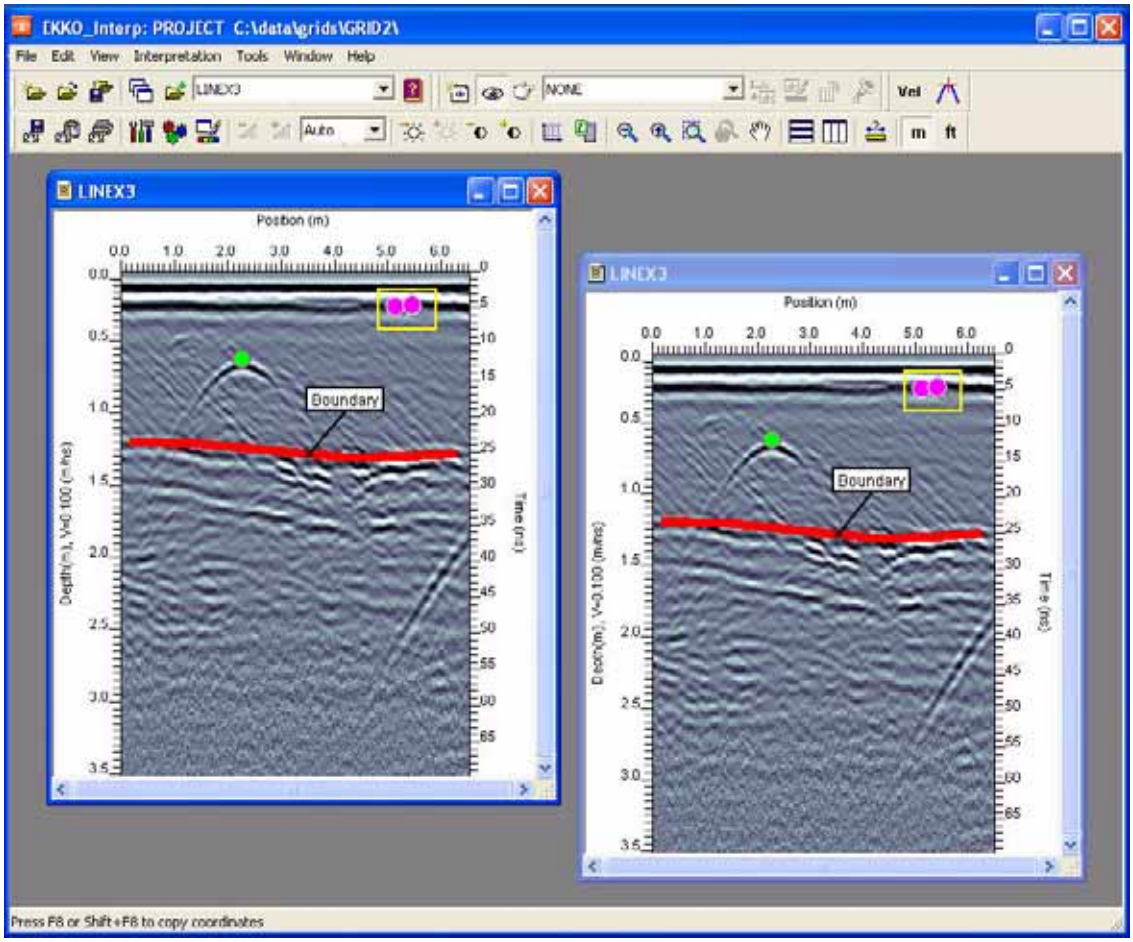
The color of the Measure tool is set under the **View > Settings > General Tab > Marker Color**.

11 Window

11.1 New Window

Selecting **Window > New Window** opens another cross-section window for the current DT1 data file.

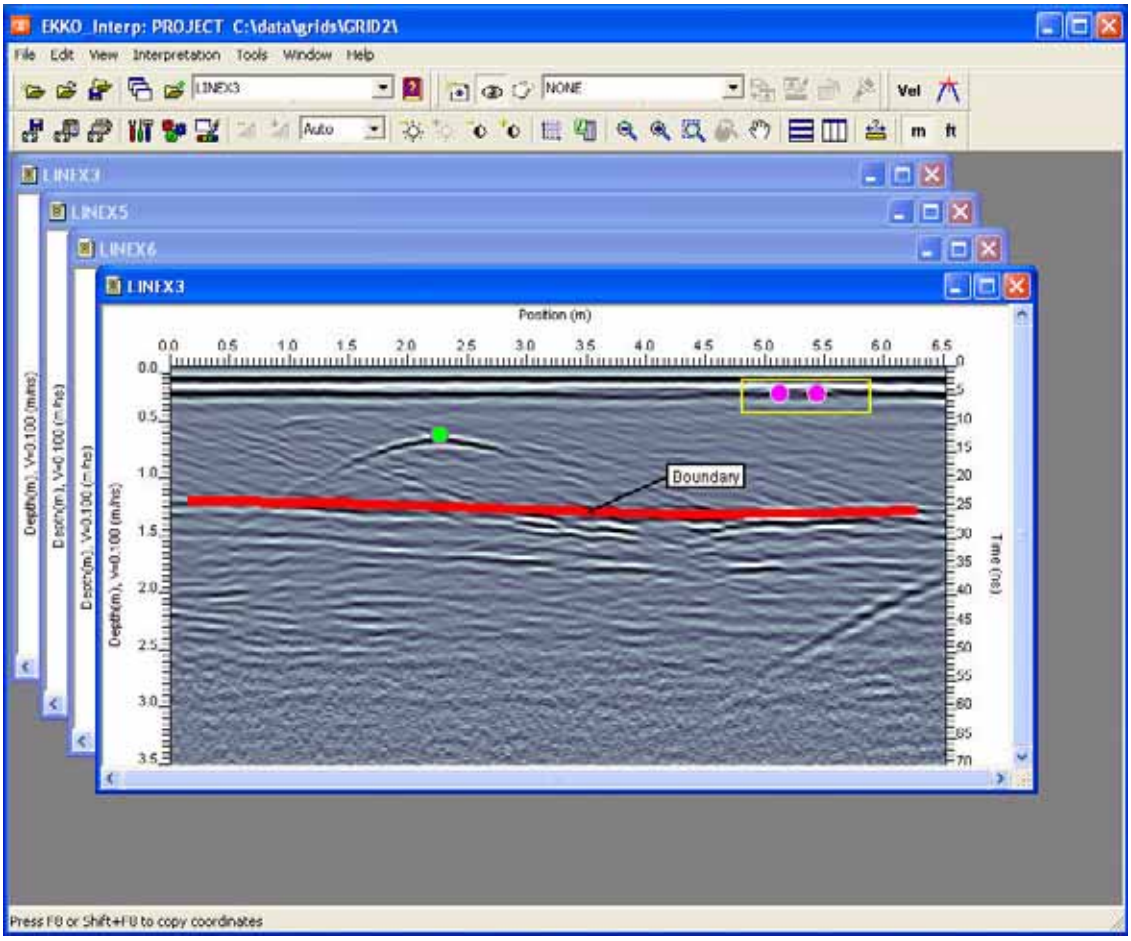
This is especially useful for looking at the same cross-section in different windows with different processing to see differences.



When there are multiple cross-section windows on the screen, only one is active at a time. Changing display settings under View > Settings only applies to the current **Active Window** unless the **Apply to All** button is selected.

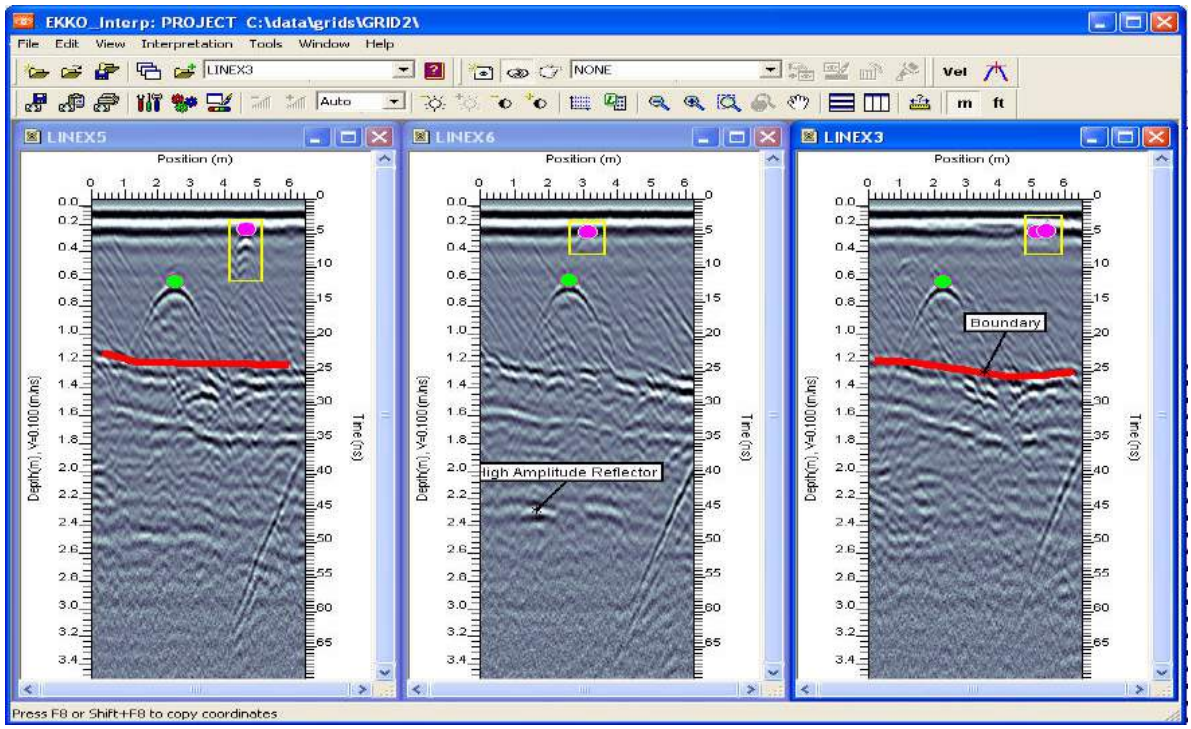
11.2 Window Cascade

Selecting **Window > Window Cascade** will rearrange open windows 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.



11.3 Tile Vertically

Selecting **Window > Tile Vertically** 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.

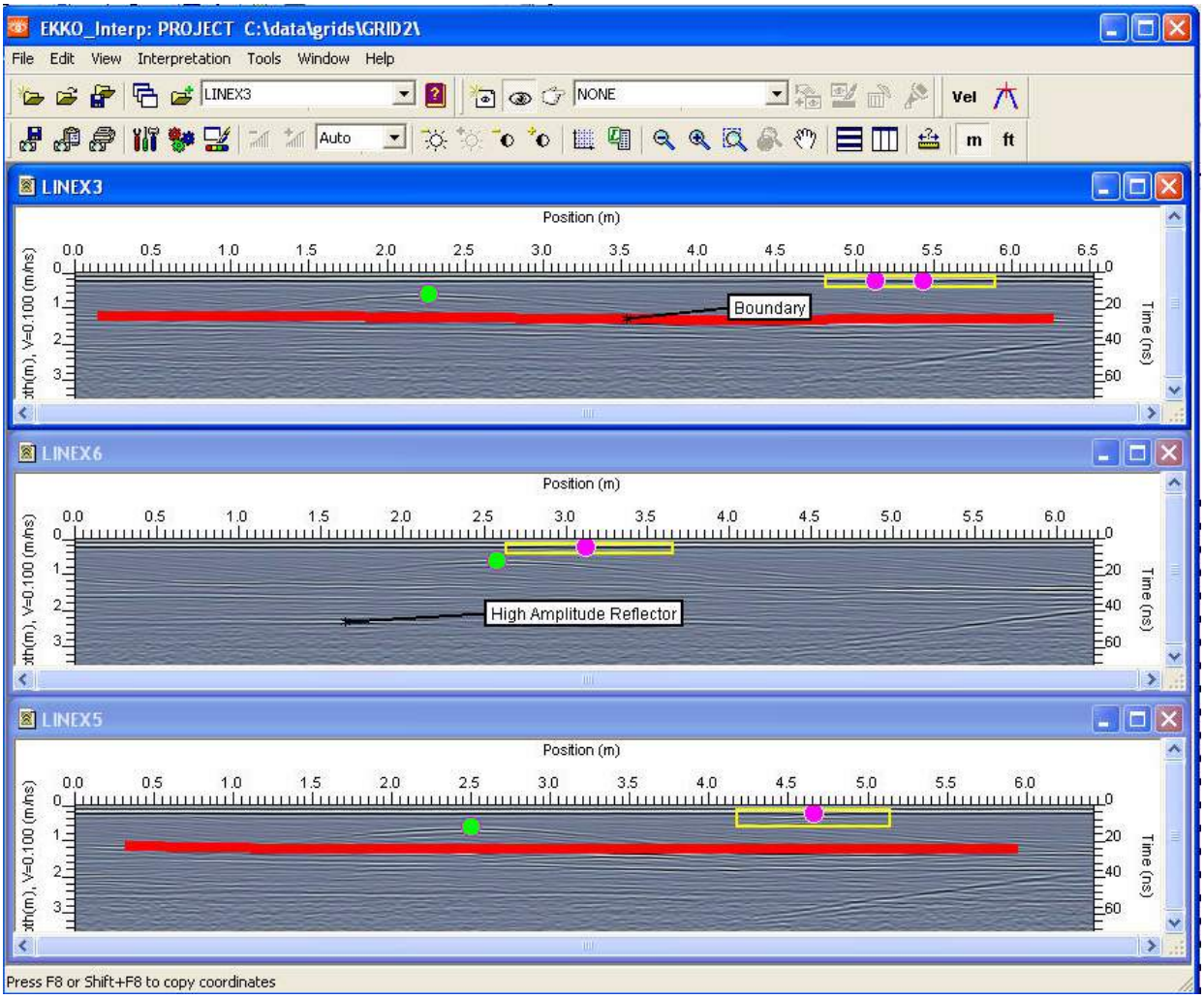


The **Tile Vertically** option can also be accessed by clicking the following button on the **View Toolbar**:

If there are many windows, this option may tile them in multiple rows rather than just one row.

11.4 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.

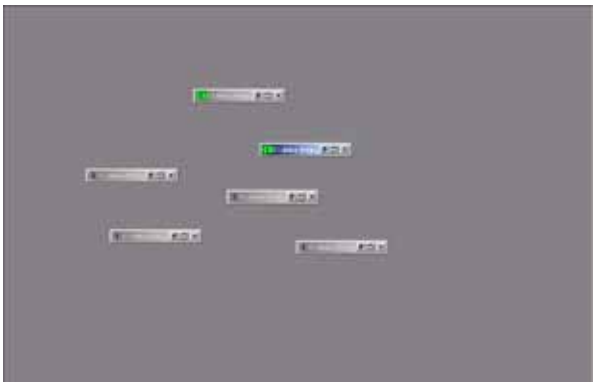


The **Tile Horizontally** option can also be accessed by clicking the following button on the **View Toolbar**:

If there are many windows, this option may tile them in multiple columns rather than just one column.

11.5 Arrange Icons

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



11.6 Open All GPR Lines

The **Open All GPR Lines** option opens all the GPR data (DT1) files in the Project (GPZ) file for display; each DT1 file in a separate window.

This provides a quick way of displaying all the GPR lines without having to open them up one at a time.

The **File > GPR Line(s) > Open All GPR Lines** option can also be accessed by clicking on the **Open All Lines in Project** button on the **Project Toolbar**:

11.7 Close Current GPR Line

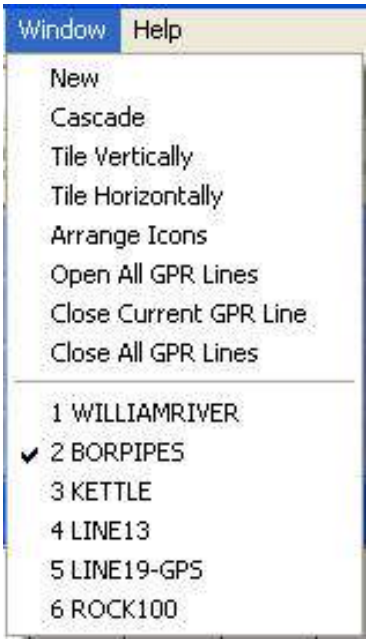
Selecting **Window > Close Current GPR Line** will close the current **Active Window**.

11.8 Close All GPR Lines

Selecting **Window > Close All GPR Lines** will close all currently opened windows, whether they have been minimized or not.

11.9 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.


Window
Help
New
Cascade
Tile Vertically
Tile Horizontally
Arrange Icons
Open All GPR Lines
Close Current GPR Line
Close All GPR Lines
1 WILLIAMRIVER
2 BORPIPES
3 KETTLE
4 LINE13
5 LINE19-GPS
6 ROCK100

12 Help

12.1 Help Topics

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.

12.2 Sensors & Software Contact Information

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

12.3 About EKKO_Interp

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

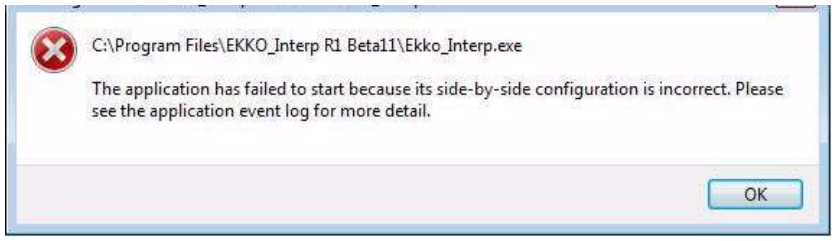
12.4 Registration

See **Software Registration**.

13 Troubleshooting

13.1 Program Fails to Launch

If you receive either of the following error messages:



it is necessary to manually run the application “vcredist_x86.exe”. This application is in the EKKO_Interp installation folder on the Software installation CD or in the folder downloaded from Sensors & Software. Look for it in the vcredist_x86 sub-folder.

13.2 Out of Memory - Too Many Files Open

If so many DT1 files have been opened that the computer memory has been exceeded, the user will see the following warning:

Some files need to be closed before others can be opened.

13.3 Opening Corrupted Data Files

Sometimes with a corrupted data, the header (.HD) file lists less traces than there are in the data (.DT1) file. EKKO_Interp will display a warning message that the file is corrupt:

but will plot the number of traces listed in the header file.

If the data (.DT1) or header (.HD) file is corrupted and cannot be displayed, a message will be written to the screen and the plotting aborted.

13.4 Slow Display Response

If the data are stored on an external storage drive, the display response may be irritatingly slow when changes are made to the View Settings. To improve the response time, data files should be copied locally.

13.5 Corrupted Configuration File

When a GPR data file is opened in EKKO_Interp, a configuration (.ini) file is created to save the plotting parameters. This file is located in the same folder as the GPR data file and has the same name.

If EKKO_Interp is behaving oddly, the configuration file may have become corrupted. Using Windows Explorer, find the folder containing the GPR data file and delete the corresponding configuration (.ini) file. The next time the file is opened in EKKO_Interp, a new configuration file will be generated.

Appendix A: EKKO_Interp Glossary

GPR Data View Terms

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.

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.

Velocity: is the term used to characterize the speed at which GPR signals travel. Velocity is a critical parameter when estimating depths of targets since velocity is used to convert travel-time to depth.

Color Palette: is the term used to refer to the table that converts a data attribute like amplitude into color in the creation of cross-section images.

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.

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.

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 Pal-

ette increases the area of extremes of data signal. Given as 0-100%, with default of 0% (no added contrast)

Hyperbola Velocity Estimate A point source GPR refection 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.

GPR Interpretation Terms

Interpretation (Noun): A group of observations of a specific type used to categorize and spatially locate a set of buried objects. This allows the user to group buried objects into categories.

For example, in a cross-section image of a deck, the observed upper layer of hyperbolic features are interpreted by the user as belonging to the upper rebar mat. The user can then create an interpretation named "Upper Rebar Mat" using the point tool, select this interpretation and then click on the location of the apexes of all the corresponding hyperbolas to assign them to the interpretation "Upper Rebar Mat".

Similarly an interpretation consisting of set of polylines define a horizon and a set of boxes can outline a set of similar features.

Interpretation (verb): Process of marking the location of a feature on a GPR image (cross-section or depth slice) to determine the depth and position of the buried object. As part of this process the user categorizes the feature as belonging to an interpretation type (e.g. rebar, pipe). Note that in EKKO_Interp we use this as a noun to define a group of like observations.

Drawing Tool or Tool: The graphic object drawn on the cross-section or depth slice image to interpret and mark the location of a buried object. (e.g. point, line or box). For example, when picking the location of the bottom of an asphalt layer on a cross-section image the polyline drawing tool would be used. To mark the apexes of hyperbolas the point drawing tool would be used.

Point: A drawing object consisting of a symbol centered on defined x,y,z coordinates.

Polyline: A drawing object consisting of a set of ordered points with defined x,y,z coordinates.

Box: A drawing object consisting of 4 points with defined x,y,z coordinates joined by straight segments forming a rectangle.

Annotation: A rectangle that can be drawn on the cross-section or depth slice image that contains text and has an attached arrow. This uses the Callout type of drawing tool in Word. This tool creates a text box with an attached arrow. The point on the arrow is at the location the mouse is clicked. The text box can be changed in size and moved around on the cross-section image relative to arrow. The arrow can also be moved but is always attached to the box.

Marker: The symbol used for the point on the Point drawing tool and the points on Line and Box drawing tools.

Observation: The member of an interpretation. For example for the point tool this would an individual point, for the polyline tool this would be the set of points that define a polyline and for a box tool this would be the set of points that define the box.

Horizon: A continuous linear feature in a cross-section image that defines the surface separating two different material types in the subsurface. For example this may be different rock types in a geological section or the interface between asphalt and granular in pavement. A set of horizons provide a stratigraphic interpretation of the subsurface.

Hyperbola: A characteristic scattering response feature in a cross-section image produced by a buried object. (e.g. utility pipe, boulder). It is shaped like a an inverted "V".

Feature: Characteristic response on a cross-section (e.g. hyperbolic feature)

Object: The physical buried entity that is causing the observed feature in the cross-section.

Attributes: The properties of an observation. These would typically include the position, depth, time, amplitude, optional comment and GPS location.

Marking Locates: Process of drawing a symbol at location of scattering hyperbola features on cross-section. Used for utility locating Interp module.

Selected Observations: The group of observations or line vertices defined by the following processes: clicking on an observation, drawing a box around a group of observations or line vertices and using the 'Select All' item in the right click menu. The user can only select observations from the active interpretations. For example by selecting a group of observations the user can delete them together.

Active Interpretation: The interpretation on which operations can be performed. These operations include selecting, editing and exporting. Active interpretations are highlighted by small boxes drawn around the the points that define the interpretation. In normal use one interpretation will be made active by the user to allow them to delete, add and move observations.

X,Y,Z Coordinates: The X,Y,Z coordinates described above are the trace, sample number and line position.

General GPR Terms

Alpha exponential attenuation coefficient - normal units dB/m (see attenuation)

K relative permittivity or dielectric constant

Sigma electrical conductivity - normal units mS/m

v propagation velocity - normal units m/ns

dB/m decibels/metre, common unit for attenuation,

m/ns	metre/nanosecond, common unit of GPR velocity, v (see nanosecond)
mS/m	milli Siemens/metre, common unit for conductivity,
ns	nanosecond, normal unit of GPR time (see nanosecond)
ps	picosecond = 0.001 ns =10^{-12}s, occasion unit of GPR time
us	microsecond = 1000ns =10^{-6}s, occasion unit of GPR time
COR	common offset reflection (survey type where a constant antenna separation is maintained).
CMP	common mid-point (survey type where a transmitter and receiver antenna separation are changed but the mid point remains constant)
GPR	ground penetrating radar
EM	electromagnetic (common abbreviation)
antenna	Device used to couple electromagnetic energy into the ground. Sometimes called a transducer.
antenna separation	Spacing between transmitting and receiving antennas.
attenuation	A reduction in signal amplitude caused by energy dissipation in the transmitting media (see Alpha).
bandwidth	The range of frequencies over which a given device transmits or detects signals above a specified amplitude or power
center frequency	Middle of the frequency band defined by a device's bandwidth
conductivity	The ability of a material to conduct electrical current. In isotropic materials the reciprocal of resistivity. Sometimes called specific conductance. Units are siemen/m or S/m. (Or occasionally, mhos/m). For GPR, usually expressed as mS/m. Common symbol
cross section	Image that results from side-by-side display of a number of traces which are from adjacent spatial measurement position
gain	Process of amplifying signals to match recording device or display dynamic range
nanosecond	10^{-9}s (One Billionth of a second)
radio wave	Electromagnetic fields that travel through a material as waves and typically have oscillating frequencies in the 1 GHz to 10 GHz range
receiver (Rx)	General term for electronics devices used to detect fields and translate signals into records or displays
resolution	The minimum separation of two objects before their individual responses merge into a single response
sample point	Signal amplitude measured at specific point in time

signal amplitude	A measure of the strength of the radio wave signal
station interval	Spatial distance between observation points along a survey line
step size	See station interval
transmitter(Tx)	General term used for electronics devices used to create propagating electromagnetic fields
transducer	Name used where GPR antenna, electronics, and shield are combined into one physical unit
trace	Sequence of sample points from a single GPR channel that indicate time variation of signal amplitude