

Seismic crosshole testing

The program **seismic crosshole testing** has been designed for a fast interpretation of crosshole test data.

1. Original data

A crosshole test requires that s-wave source and receivers are placed always on the same depths/elevation during recording. In order to benefit from the polarisation characteristics of the s-wave the excitation is performed in two directions (later called plus and minus directions).

The acquisition software should be able to generate one (stacked) data file per depth and excitation direction stored using the SEG-2 format.

The channels of a multi-directional receiver are connected in a fixed order to the seismograph. Geophones of Geotomographie GmbH have always the following arrangement:

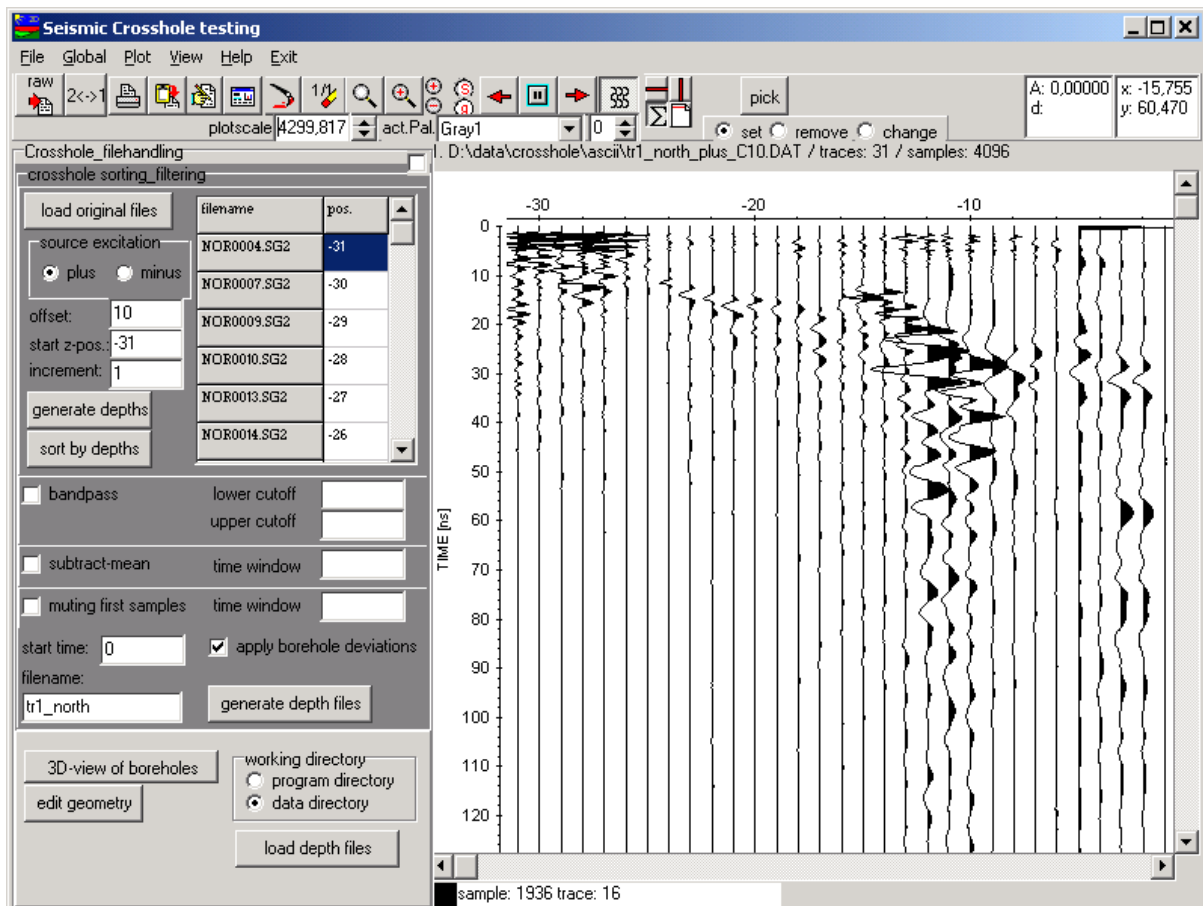
Channel 1 - vertical component

Channel 2 - horizontal component agreeing with the azimuth reading of integrated compass

Channel 3..n - remaining horizontal components

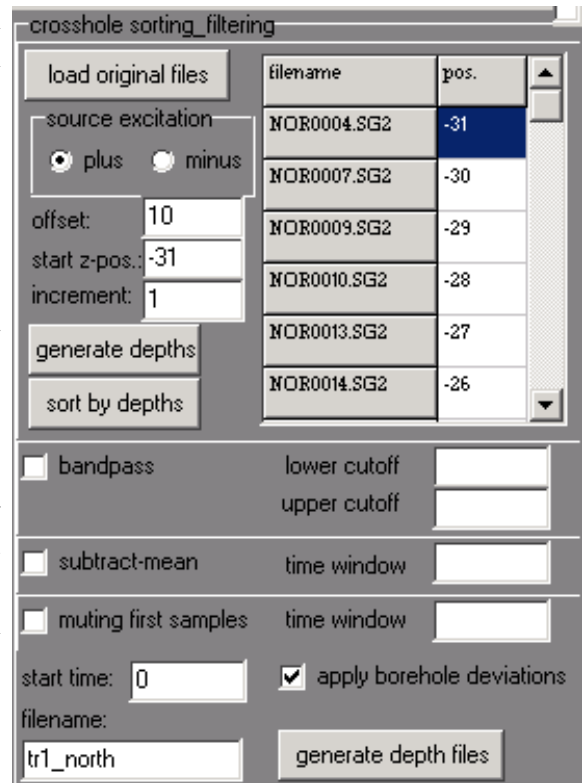
Collect all gathered seismic records in a single directory. Each record should contain the seismic signals recorded at a single depth, with a single excitation direction. The filenames should contain a record number and must be in SEG-2 format.

2. Channel sorting and filtering within seismic crosshole testing

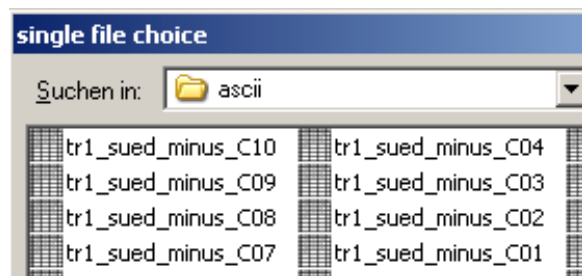


The first step is to assign a depth for each file, slit up the seismic record sorted by channel and generate seismic files sorted by depth:

- ! load the original records of one excitation direction. Make use of the multiple selection feature of the dialog window. One can select more than one file by pressing the < Control > - key together with the mouse button.
- ! Assign a z-position for each file, filling in the table by hand or using the standard assignment (option generate depths) with predefined default parameters (start z-pos. and increment). If a borehole deviation shall be applied afterwards the values must be negative (e.g. -2 to -20) which means that the first position is 2 m below the top of the borehole.
- ! Make sure that the list is ordered correctly by depth using the option sort by depths if the depths have been entered or changed manually.
- ! enter the correction source excitation (minus in this example) and the offset between the two boreholes (in this example 10 m). Enter the start time if a pretrigger has been used (start time must be negative for a pretrigger).
- ! Enter any filter option bandpass, subtract-mean or muting first samples and generate new seismic files sorted by depth using the option generate depth files based on the entered filename.
- ! Optionally activate the option apply borehole deviations in order to apply the borehole coordinates which must have been stored within 2 different ASCII-files. This correction can also be done afterwards (see chap. 3). Each line of the ASCII-file contains the XYZ-coordinates in meter. The Z values must be given as above sea level. The first line corresponds to the borehole top level. The original z-positions (see item 2 above) are assumed to be relative to this top level and must be negative. After having pressed the button generate depth files the program asks the two borehole filenames (multiple filechoice). It is assumed that the entered z-positions have been measured along the boreholes. The program recalculates these positions both for the shots and the receivers based on the given borehole data. A linear interpolation is done between the individual borehole coordinates.



Using the option **generate depth files** for each excitation direction and each receiver channel (corresponds to the component) a new Reflexw file has been generated. The channel number and the excitation direction are part of the new filename, for instance: tr1_sued_minus_C05.dat



The data will be stored either under the program directory or under the original data directory (option data directory activated).

The option load depth files allows to load up to 4 different files using the the multiple file choice.

3. Apply borehole deviations and edit geometry

The option edit geometry within the crosshole_filehandling panel allows to edit the shot and receiver coordinates of the actually loaded depth file, e.g. apply the borehole deviations.

After having activated the option the menu edit trace header coordinates opens together with a table containing the traceheader coordinates and the traceheader gain. The table shows the traceheader coordinates (distance and the x, y, z-coordinates of the receivers and the shots), the time delay, the gain and the time collect. These values can be manually changed. The following options are available:

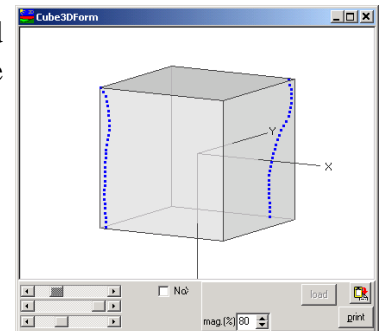
The option **apply borehole deviations** allows to apply the borehole coordinates which must have been stored within 2 different ASCII-files. Each line of the ASCII-file contains the XYZ-coordinates in meter. The Z values must be given as above sea level. The first line corresponds to the borehole top level. The original z-positions (see also chap. 2) are assumed to be relative to this top level and must be negative. The original xy shot and receiver coordinates will be ignored. After having pressed the button generate depth files the program asks the two borehole filenames (multiple filechoice). It is assumed that the original z-positions have been measured along the boreholes. The program recalculates these positions both for the shots (corresponds to borehole 1) and the receivers (corresponds to borehole 2) based on the given borehole data. A linear interpolation is done between the individual borehole coordinates. The following table shows the file structure of 2 borehole data and the pictures show the coordinates before and after the borehole correction. To be considered: The first receiver within the example corresponds to the greatest depth.

The screenshot displays the 'edit trace header coordinates' application. It features two overlapping windows. The top window shows a table with columns: trace-nr., distance, shot-x, shot-y, shot-z, rec.-x, rec.-y, rec.-z, time delay, gain, and time collect. The bottom window shows the same table but with numerical values for each cell, and includes a control panel with buttons like 'apply borehole deviations', '3D-view of boreholes', and various input fields for time and frequency.

trace-nr.	distance	shot-x	shot-y	shot-z	rec.-x	rec.-y	rec.-z	time delay	gain	time collect
1	0	0	0	-31	10	0	-31	0	1	0
2	0	0	0	-30	10	0	-30	0	1	0
3	0	0	0	-29	10	0	-29	0	1	0
4	0	0	0	-28	10	0	-28	0	1	0
5	0	0	0	-27	10	0	-27	0	1	0
6	0	0	0	-26	10	0	-26	0	1	0
7	0	0	0	-25	10	0	-25	0	1	0
8	0	0	0	-24	10	0	-24	0	1	0
9	0	0	0	-23	10	0	-23	0	1	0
10	0	0	0							
11	0	0	0							
12	0	0	0							

50000.0 45300.0 110.0	50005.0 45304.0 110.0
50000.1 45300.1 108.5	50005.1 45304.1 106.5
50000.2 45300.2 106.5	50005.0 45304.2 102.5
50000.3 45300.2 102.5	50004.9 45304.2 100.5
50000.4 45300.1 100.5	50004.7 45304.1 98.5
50000.3 45300.0 95.5	50004.4 45304.0 92.5
50000.2 45300.1 90.5	50004.2 45304.1 88.5
50000.1 45300.2 85.5	50004.1 45304.2 84.5
50000.1 45300.3 80.5	50004.1 45304.3 81.5

The option **3D-view of boreholes** allows a 3D-view of the shot and receiver xyz-coordinates. The cube may be interactively rotated using the left mouse key.



nominal frequency: enter the nominal frequency of the antenna (GPR-data) or seismic source (seismic data) used. Enter the value in MHz with `timedimension` set to `ns`, KHz with `timedimension` set to `µs` or Hz with `timedimension` set to `ms`. The option `get` allows to automatically determine the nominal frequency from the data.

start time: specification of the start time for sample 1 in the given time dimension.

TimeDimension: Specification of the time dimension. Possible inputs are `ms` and `ns`.

The option **save changes** saves the manual changes within the traceheaders of the current file.

The option **reload from file** reloads the coordinates from the traceheaders of the current file. Possible manual changes will be lost.

The option **save on AsciiFile** stores the traceheader coordinates on an ASCII-file with the extension `dst`. Each line of the ASCII file contains the following 8 informations:
tracenumber distance Shot-X-Pos Shot-Y-Pos receiver-X-Pos receiver-Y-Pos Shot Z receiver Z

The option **load from AsciiFile** allows to load the traceheader coordinates from an ASCII-file with the extension `dst`. Each line of the ASCII file contains the following 8 informations:
tracenumber distance Shot-X-Pos Shot-Y-Pos receiver-X-Pos receiver-Y-Pos Shot Z receiver Z
An automatic interpolation is done if for various traces no coordinate data are present within the ASCII-file.

If all distances within the ASCII-file are zero (2.colum) the distances will be calculated from the total difference between each shot and receiver positions (x,y and z-coordinate are taken into account).

The option **interpolate** allows to interpolate between two given coordinates. The interpolation is only possible for one single traceheader coordinate group (for example only `rec-z`). There are two ways how to proceed:

- a. activate the option interpolate, then click on the wanted first coordinate and then on the second one. Inbetween a linear interpolation will be done.
- b. If you have changed manually any coordinate click on interpolate and then on the second coordinate. Again the linear interpolation will be performed.

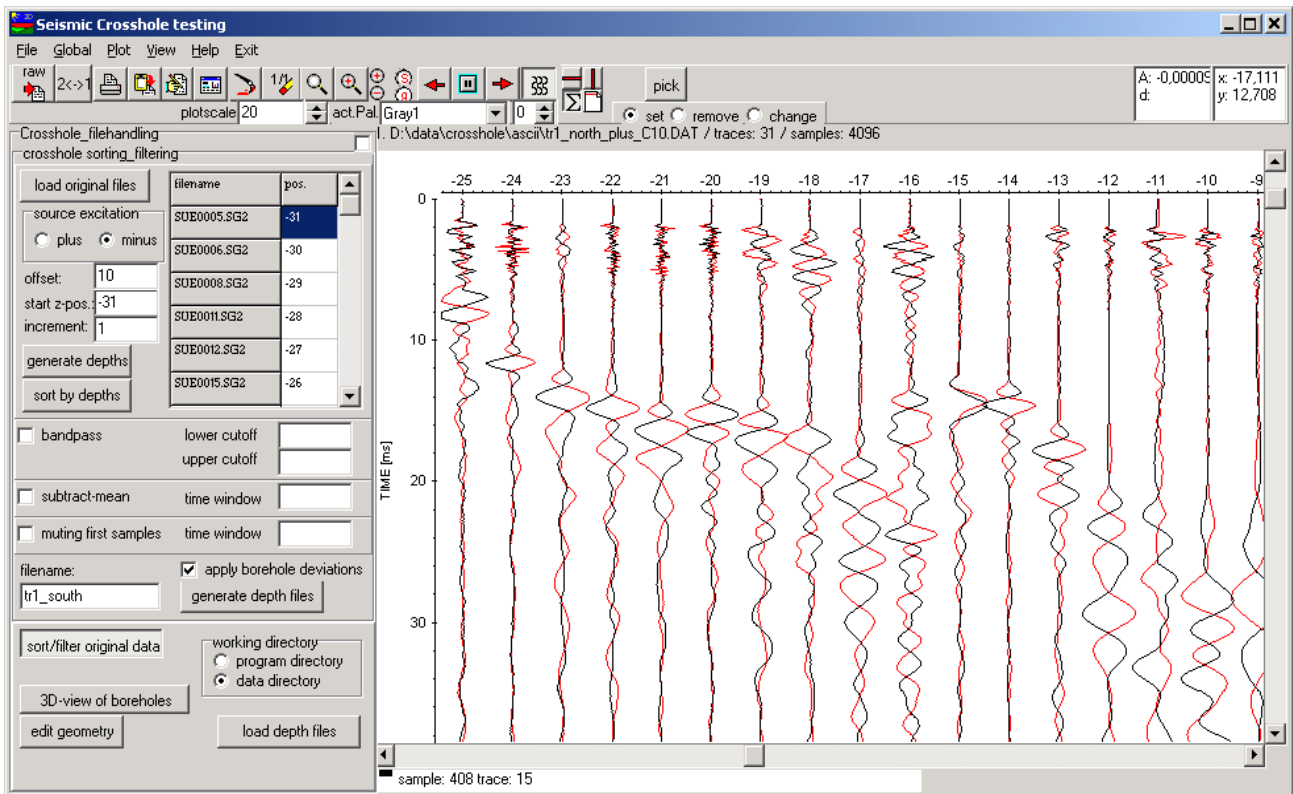
The option **source <-> rec.** allows to exchange the shot and receiver coordinates. The option might be useful if the shot position has been continuously changed with a fixed receiver. Such a geometry should be exchanged because the following interpretation methods all base on a fix shot position and changing receiver positions.

The option **x <-> y** allows to exchange the x- and y-coordinates of the sources and the receivers.

The option **check rec.coordinates** checks the receiver coordinates for breakouts and interpolates these. For that purpose the two x and y mean absolute differences between successive xy-receiver positions are calculated. If the absolute difference between two successive xy-receivers positions multiplied by the value of the option factor f.check exceeds one of the two mean difference value an interpolation for both the xy-shot and receiver coordinates is done for this xy-position.

The option **smooth rec. xy-coord.** allows to perform a running smooth of the xy-receiver coordinates over an adjustable range of traces. The option might be useful for GPS-data especially if the option update distances (see below) shall be used afterwards.


4. Control and plot options





Use the lower panel for a speed access to different options:

2<>1 button: Use this option if you want the secondary file to be the primary file and the primary to be the secondary

1


 caption raw: open REFLEX raw data (see also option load depth files or file menuitem/load)
caption proc: open REFLEX processed data (see also File MenuItem)


 print the current data files (see also Print Menu). Depending on the current settings either only the primary file or the primary and secondary file are printed based on the current splitting parameters. With the option showmarker activated (see PlotOption) the markers are printed in addition. The size of the markers are taken from the size defined within the symbol font (see FontSettings).


 copy to clipboard

 enter geometry menu (seeh also option edit geometry)

 enter PlotOptions

 scroll to the left

 stop scrolling

 scroll to the right

The spin button located beneath the autoscroll options defines a delay factor in order to slow down the scrolling. Value 0 no delay - value 50 max. delay.

 allows to easily switch between pointmode and wigglemode



allows to directly change the display split - ver. split, hor. split, overlay and no split



replot current line with current zoom parameters



resets the x- and y-scale values (zoomvalues) to 1 and replots the current line



enable magnifying glass function



enable manual zoom - With the option ZOOM an arbitrary area of the data set can be selected and plotted in full screen size. If the screen is split in order to show two data sets, this option can be applied to each data set, but not across the separating line of the two data sets. With split screen the ZOOM option automatically acts on both data sets.

The area to be enlarged, a rectangle, has to lie within a data set. Pressing the left mouse button you determine a corner of this rectangle and by moving the mouse with pressed button the desired area is opened.

The zoom range may be changed step by step using the small + or - buttons on the right side. Clicking on the + button increases the zoom by 10 %, clicking on the - button decreases the zoom by 10 %, this means the x-y-range to be shown will be larger.

The current zoom may be stored using the small "s" button and may be restored using the small "g" button.

pick button: enters the Pick MenuItem

act.palette: load the wanted color palette from the stored palettes (see also PlotOptions menu).

plotscale: enter multiplication factor for the color-amplitude assignment or enter multiplication factor for the wiggle size.

5. Arrival time picking

The last step consists in the picking of the first arrivals.

The Reflexw files which are sorted by depths are loaded using the option load depth files. Up to 4 different files can be loaded using the multiple file choice.

Theoretical Considerations

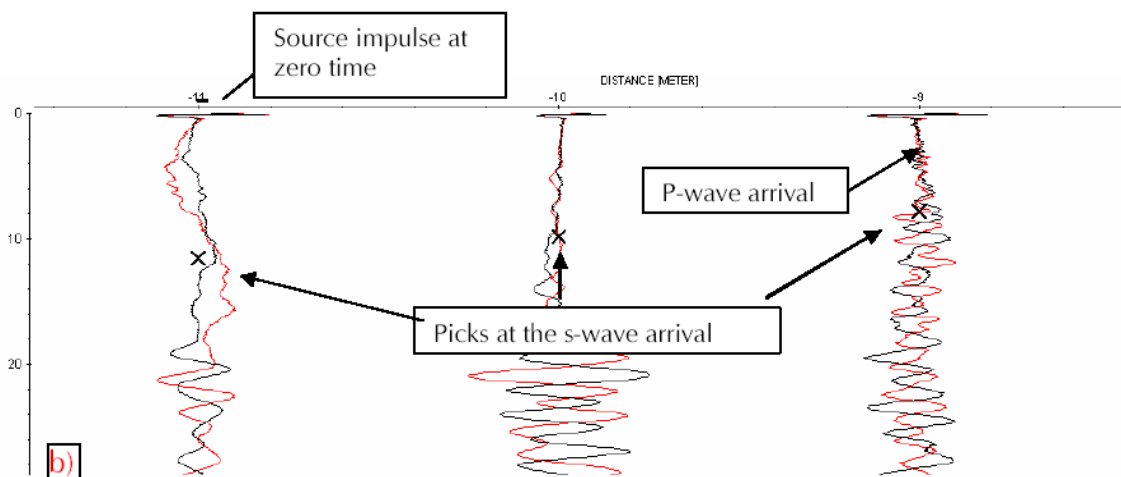
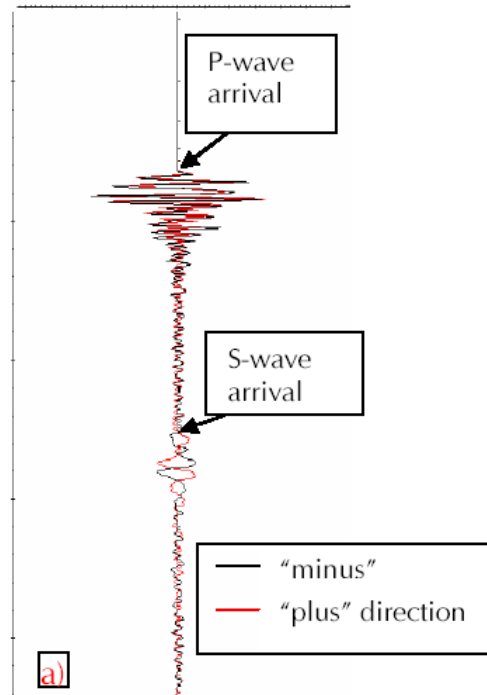
Primary (P-) and Secondary (S-) waves are different types of body waves. The p-wave is in principle at least 1.4 times faster than the s-wave. The ratio can go up to about 7 or even 12 in case of loose saturated sediments.

The direction of the particle motion caused by a p-wave (as a compressional wave) does in general not depend on the direction of the excitation whereas the direction of particle motion caused by a swave does. Therefore if the signals of the two opposite excitation directions are overlaid the wavelets of the p-wave will show the same polarization direction whereas the signals at the time of s-wave arrival will split up leading to a phase inversion between the two s-wave wavelets.

Figure a) gives an example of seismic signals of an extraordinary good quality. These signals were recorded in clay. The figure shows also that the wavelet of the p-wave has a high frequency in comparison to the s-wave wavelet.

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Figure b) shows that the electrical impulse used to drive the borehole source can be seen in the recorded signals under certain conditions. This is caused by cable cross-talk and cannot be eliminated completely. Please don't mistake this pulse for the p-wave arrival. Due to the nature of the crosshole test only the horizontal channels of the geophone are relevant, both for p- and s-wave arrival identification. Since the orientation of the geophone is not controlled during the test it is in the beginning unknown which of the horizontal channels is most appropriate for the arrival time picking. Therefore it is good practice to select at first a channel where most signals have a reasonable data quality, perform the picking and adjust the picks afterwards using the remaining horizontal channels.

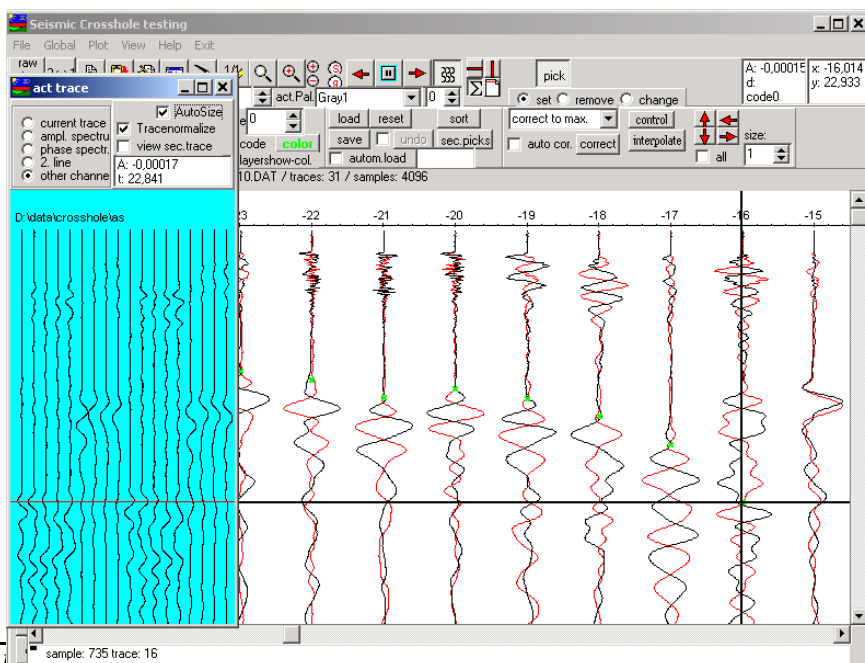
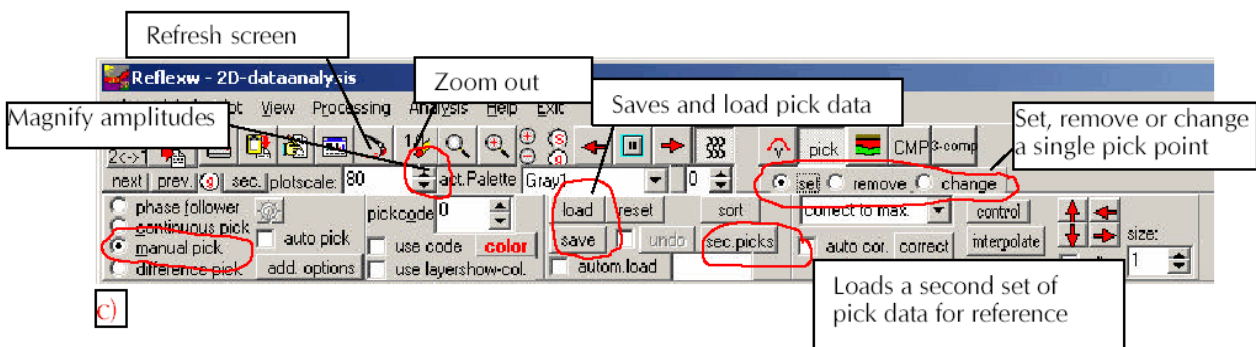


Technical Considerations

Technically the arrival picking means to set one pick point indicated as “x” to each signal. In the beginning only the buttons and control elements indicated in Figure c) are needed. Manual picking is in almost all cases required, since the automated algorithm (“phase follower” control) does not work very well on crosshole data. Please experiment yourself, most is self-explanatory. You can call the help system of seismic crosshole testing for additional advice by pressing the “F1” key.

But please consider the following:

- Pick P-wave and S-wave arrival separately.
- Be careful not to set more than one pick on each trace.
- If you are unsure about where to set a pick on a trace just leave it blank. It is usual in crosshole testing that at certain depths no reliable velocity can be determined.
- Make use of the “sec.picks” button if you are unsure about the arrival times. If you save different picking versions you can use this button to load an alternative picking scenario in the background for comparison.
- Optionally you can use the view/wiggle window with activated option **other channels** which allows the plotting of the actual trace (depth) of all other channels within the actual project. The program searches all files within the actual directory which has the same filename except the excitation direction (plus or minus) and the channel number (C??). The current trace of all these files will be plotted within the wiggle window together with a straight line indicating the timebase of the cursor position. This option may help to determine the correct onset if it es better visuale in ayn other channel.
- Save the picks occasionally and at the end of picking according to the procedure described later.



Saving of pick data

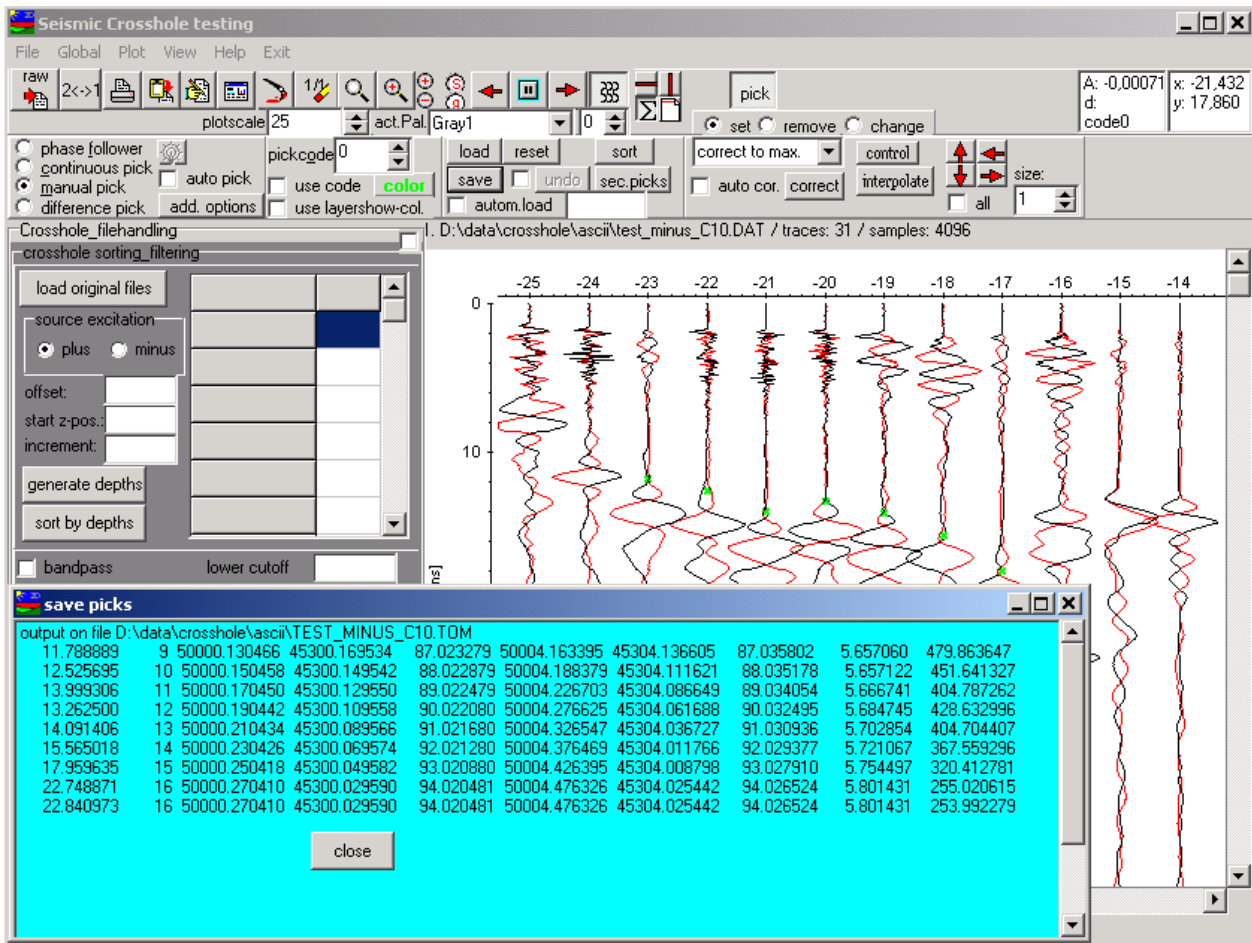
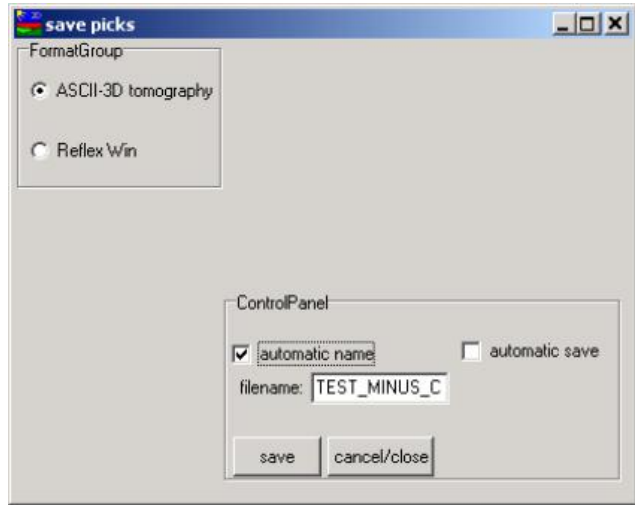
Push save button to save the pick data set.

Chose a filename for each set, e.g. “p-wave” or “s-wave”.

Tow different formats are available:

ASCII-3D tomography: this is the standard ASCII-format. The ASCII-file contains the traveltimes, the tracenumber and the XYZ-coordinates of the shot and the receiver as well as the distance between shot and receiver distance and the velocity (last column) calculated from this distance and the traveltimes (see picture below).

Reflex Win: binary format for the interchange with the Reflexw program format and if the option sec.picks is used.



6. View MenuItem

ColorBars: activate this option for displaying the current color amplitude assignment bar at the right of the window.

Amplitudes: activate this option if you want the current amplitudes to be displayed in the status panel on the top (A:) when moving the mouse.

FileInfo: activate this option if you want the label infos about the loaded files shall be visible.

act sample informations: if active a window opens near the actual cursor position showing the actual trace and sample number, the amplitude, the distance and the time.

WiggleWindow: This option allows the additional plotting of the current trace or of the trace spectrum or of a second profile or of the other channels into freely movable and scalable window. The y-axis corresponds to that of the primary profile. After activating the option you may choose between **current trace**, **ampl. spectrum**, **phase spectr.** or **2. line**.

After activating **current trace** the current trace (only visible part) is plotted in the wiggle-mode using the current Plotsettings. Activating the option **Tracenormalize** enables a normalization to the max. value of the current trace. With the option **view sec.trace** activated the corresponding trace from the secondary profile will be plotted in addition using a gray color.

After activating the option **ampl. spectrum** the frequency amplitude spectrum of the current trace is shown. Only the visible part of the current trace (e.g. if zoomed) will be taken into account for the spectrum calculation.

After activating the option **phase spectr.** the frequency phase spectrum of the current trace is shown. Only the visible part of the current trace (e.g. if zoomed) will be taken into account for the spectrum calculation. The calculated phase is restricted to the range between 0 and 2 pi.

Activating the option **2. line** allows the plotting of a second profile in the wiggle-mode. Open the wanted line using the option open. All traces of the profiles are shown.

Activating the option **other channels** allows the plotting of the actual trace (depth) of all other channels within the actual project. The program searches all files within the actual directory which has the same filename except the excitation direction (plus or minus) and the channel number (C??). The current trace of all these files will be plotted within the wiggle window.

The current parameters time and amplitude are shown if the mouse cursor is inside the wiggle window.

TraceHeader axis: if activated the xy-receiver traceheadercoordinates are displayed along the distance axis in addition. The option is only available for the primary profile and with deactivated plotoptions Rotate90degree and FlipXAxis. The number font is used. The number of places and the number of decimal places may be entered within the global settings menu within the pick parameters panel. The option transp.comm.marker within the global settings menu controls if the text will be transparent or if a white box will be underlied.

The suboptions at the top, at the bottom and at min.distance define the positions of the traceheader coordinates. With at the top activated the traceheader coordinates are displayed at the distance labels within the upper range of the profile below the distance axis using a 90 degree rotated font. With at the bottom activated the coordinates are displayed within the lower range of the profile again using a 90 degree rotated font. With at min.distance activated only the traceheader coordinate for the min. coordinate will be displayed above this min. coordinate. If enough space above the min. coordinate is available the x- and y-traceheader coordinates will be separately plotted, otherwise they will be combined separated by the “/” character (according to the options at the top and at the bottom).

show xyz-traceheader coordinates: shows the actual x-, y- and z-traceheader coordinates (xc, yc and

zc) within a new listbox on the upper right corner.

show cursor in 2. window: shows the actual cursor position within the secondary profiles using the settings of the symbol font.

7. Plotoptions menu

Within this menu you may change the current plot settings.

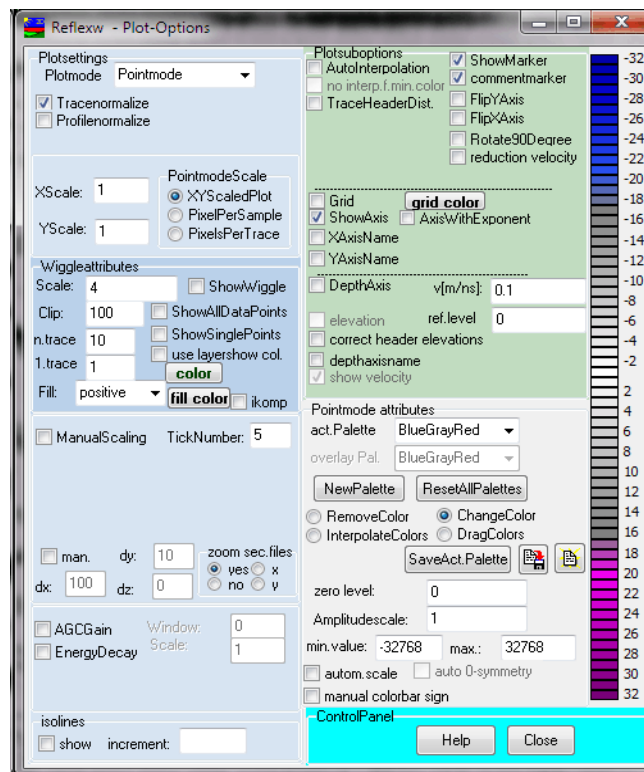
7.1 Plotsettings

Plotmode: The option allows the specification of the plotype. You may choose between pointmode and wigglemode.

Pointmode means that the data are plotted with colored pixels according to the predefined color-amplitude configuration (see also pointmodeattributes).

Wigglemode means that each trace of the profile is plotted as a polygonal line. The size of the deflections of each wiggle is controlled by the parameter scale (see also Wiggleattributes).

The two modes might be used together if the pointmode is chosen together with the activated option **ShowWiggle**.



Three different scale modes are incorporated:

XYScaledPlot: Activating this option means that the data are completely plotted into the current window provided that the two scale options **XSCALE** and **YSCALE** are set to 1. Increasing the number of the scale options means a zooming up, decreasing means a zooming down.

PixelsPerSample: Activating this option means that the plotting size of each data point is given in screen pixels. The size in x-(distance) direction and y-direction can be changed using the option **XSCALE** and **YSCALE** respectively.

PixelsPerTrace: Activating this option means that the distance between successive traces is given in screen pixels (option **XSCALE**). In every case the complete time series of each trace is plotted corresponding to the size of the current window. This means no zooming possibilities in y-(normally time-)direction are given for that scale mode.

XScale: enter a value for the window scaling in x-(normally distance-)direction. If PixelsPerTrace or PixelPerSample is activated, the parameter gives the distance between successive traces in pixels. If XYScaledPlot is activated, the parameter gives the x-zooming value corresponding to the current profile window (e.g. a value of 2 means that half of the traces are plotted into the current window).

YScale: enter a value for the window scaling in y-(normally time-)direction. If PixelPerSample is activated, the parameter gives the range between successive points in pixels. If

PixelsPerTrace is activated, the parameter has no meaning. If XYScaledPlot is activated, the parameter gives the y-zooming value corresponding to the current profile window (e.g. a value of 2 means that half of each trace length is plotted into the current window).

Tracenormalize: Activate this option if you wish the data to be plotted amplitude normalized for each trace. With the option profilenormalize deactivated (see below) the maximum amplitude of each visible trace is normalized to 1. Like that a plotting is guaranteed, where all traces are well visible. Deactivate this option if you want to plot the data with real amplitudes. For the **wigglemode** the size of the individual deflections is controlled by the parameter Scale (tracenormalize: Scale = Size in Pixels, no tracenormalize: current amplitude * Scale = Size in Pixels). For the **pointmode** the parameter Amplitude scale controls the amplitude color assignment.

Profilenormalize: with this option activated the normalization is not done based on the max. amplitudevalue of each trace but on the mean amplitudevalue of the complete profile. Thereby amplitude variations from trace to trace within one profile will remain but it is possible to compare profiles with different value scales. The option is only available with the option tracenormalize activated. To be considered for

Wigglemode: The entered wiggle size corresponds to the mean amplitude. Therefore you must enter a clip value greater than 100 for the greater amplitudes. Otherwise these amplitudes will be clipped. By default a clip value of 200 is set.

Pointmode: by default the amplitudescale is set to 0.5 - this means that the color amplitude assignment includes all amplitude values until twice the mean amplitude. Higher amplitude values are assigned to the max. color(s).

Manual scaling: Activate this option if you wish to manually input the min. and max. axis lengths in x- and y- (time-) direction (see also chap. 3.4 Manual scaling and incrementation). Deactivate this option if you wish the program to automatically determine the axis lengths.

Man.: if activated the manual subdivision of the axis (options dx, dy and dz, see also chap. 3.4 Manual scaling and incrementation) will be enabled - if deactivated the program automatically chooses a suitable incrementation.

TickNumber: Enter the number of ticks between the axis marks.

zoom sec. lines: the zoom for the secondary lines can be deactivated using the following suboptions no, x or y. With **no** activated no zoom will be done for both axis, with **x** activated no zoom will be done for the x(distance)-axis and with **y** activated no zoom will be done for the y(time)-axis.

Isolines: This option allows to plot isolines in addition (option **show** active). The option is only available for the pointmode. The **increment** together with min. value and max. value of the amplitude range of the pointmode attributes (see also chap. 3.2) control the number of the isolines:

1. isoline: min.value+increment
2. isoline: min.value+2*increment

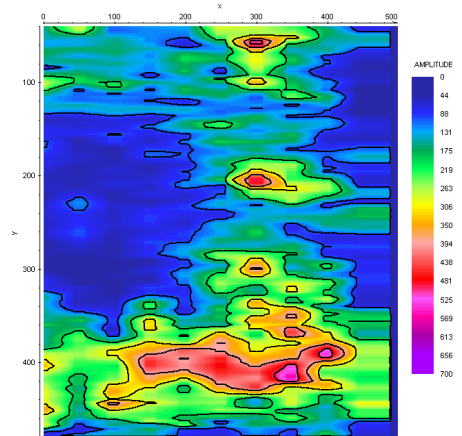
...

last isoline: max.value-increment

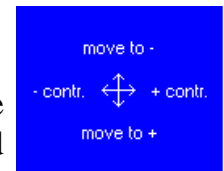
The color and the line thickness of the isolines are controlled by the settings of the symbol font.

The option is available within the 2D-dataanalysis, the 3D-datainterpretation and the modelling module. The CPU-time for plotting significantly increases if the option will be activated.

For the example on the right an increment of 100 and bold black symbol font was used. The min./max amplitude values were fixed to 0 and 700 respectively.



7.2 Pointmodeattributes



This group box controls the attributes for the pointmode. The color amplitude assignment consists of 128 different colors which are linearly distributed between a minimum and maximum amplitude value. The minimum and maximum amplitude values are controlled by the multiplication factor **Amplitude scale**. With a value of 1 for Amplitude scale the amplitudes range from -2048 to 2048 for unnormalized data and from -1 to 1 for tracenormalized data. With a Value of 0.0625 the amplitudes range from -32768 to 32768.

act.palette: load the wanted color palette from the stored palettes. The following palettes are predefined: Rainbow1, Rainbow2, Gray1, Gray2, Gray3, BlueGrayRed. You may add any changed or created palette by activating the option **SaveActPalette**.

overlay Pal.: load the wanted color palette for overlaying a second profile. In order to overlay the 2 profiles you must deactivate the options hor. and ver.split and activate the option ShowSecondLine. To be considered: by default the option ShowSecondLince is automatically deactivated when deactivating both the options hor. and ver.split for the pointmode. One example might be overlying a profile with the underground velocity distribution e.g. taken from a seismic refraction analysis. In this case it might be useful to activate the plotoption always each file because of the different amplitude distribution.

NewPalette: enter this option for defining a new palette. Please choose 16 different colors from the color dialogue menu. Between these 16 colors a linear interpolation is automatically done in order to define the 128 different colors. The new color palette is shown in the color bar on the right-hand side.

ResetAllPalettes: this option resets all palettes to the default ones.

SaveAct.Palette: this option allows to save the current palette on disk with a freely choosable name.



loads a new **palette file** from disk



saves the actual palette file on disk using any name.

RemoveColor: with this option activated you may remove any color from the color bar on the right-hand side by clicking on the corresponding color using the left mouse key.

ChangeColor: with this option activated you may change any color from the color bar on the right-hand side by clicking on the corresponding color using the left mouse key. The new color must be defined in the opened color dialogue menu.

InterpolateColor: with this option activated you may interpolate the colors between two choosable colors. Click on the two colors in the color bar using the left mouse key. After having chosen the second color, the in-between colors are linearly interpolated.

DragColor: two possibilities to interactively drag the colors are given
- a blue panel opens (see picture on the right) which allows to interactively change the colors

when moving the mouse with pressed left mouse key within the panel. Starting from the midpoint increases the contrast to the right and decreases it to the left. The color table is moved to the colors which are assigned to negative amplitude values when moving to the top and vice versa when moving to the bottom. The changes are instantaneously shown within the loaded profile.

- you may continuously move a linearly interpolated color range. After having activated this option, please click on two different colors. In-between these colors a linear interpolation is done. The trackbar below may be used in order to increase or to decrease this color range. The wanted color palette must be saved for a later use. Otherwise the original palette will be reloaded whenever you are entering the profile.

Zero level: enter a zero amplitude level for the color-amplitude assignment. The mean level of the color amplitude assignment is shifted by this given level. Thereby the color amplitude assignment is defined by this parameters and the value given for the Amplitude scale. A value 0 for zero level is useful for “normal” seismic or GPR-data. A value different from 0 is useful e.g. for displaying data with only positive or negative amplitude values (e.g. timeslices calculated on the base of absolute or envelope data).

Amplitude scale: The minimum and maximum amplitude values are controlled by the multiplication factor Amplitude scale. With a value of 1 for Amplitude scale the amplitudes range from -2048 to 2048 for unnormalized data and from -1 to 1 for tracenormalized data. With a Value of 0.0625 the amplitudes range from -32768 to 32768 provided the value of zero level is set to 0. The min. and max. Amplitude values are shown within the options **min. value** and **max. value** which also may be used for defining the amplitude scale. If new values will be entered here both the amplitude scale and the zero level will be updated accordingly.

autom.scale: the option allows to automatically define the min./max. amplitude range for the color/amplitude assignment. If activated the program extracts the min. and max. amplitudes from the actual profile or slice and uses these values for setting the color palette. The amplitude scale cannot be changed in this case any more.

Manual colorbar sign: if activated a manual name for the colorbar sign may be entered. Activate this option if the sign does not fit correctly.

auto 0-symmetry: If the option autom.scale is activated the 0-level of the color palette may be different from profile (slice) to profile (slice) as the min./max. values may vary. The option auto 0-symmetry overcomes this problem. If activated the absolute max. value will be determined from the min./max. values and either the min. or the max. value will be set to the absolute max. value with the corresponding sign. Activating this option might be useful if “normal” profiles are displayed with positive and negative amplitudes whereas deactivating this option might be a good choice for plotting slices showing the envelope.

7.3 Wiggleattributes

Scale: enter a value for the size of the individual wiggle deflections. The size is calculated by: current amplitude * Scale = Size in Pixels. If the option Tracenormalize is activated, the current amplitude must be replaced by the value 1 - therefore the size directly corresponds to the wiggle size in pixels of the max. or mean (profilenormalize activated) amplitude.

ShowWiggle: activate this option if you want to display the polygonal line.

With the pointmode selected this option controls if the data are plotted in pointmode together with the wiggles or not.

With the Wigglemode selected the option controls if the polygonal line is plotted or not. With this option deactivated only the filled part is plotted in this case (see below).

ShowAllDataPoints: activate this option if you want to display all data points of the trace even if the number of data points per trace is larger than the pixel number of the current window. Deactivating the option means that every trace is resampled based on the current screen points. If the number of samples to be displayed is much larger than the screen point number aliasing may occur. In this case the option should be activated. This means that every data point is plotted.

ShowSinglePoints: if activated the datapoints are marked by a cross symbol in addition.

n.trace: only every n.trace is plotted in wiggle-mode. This option is for example useful if you want to plot a large data file in point mode together with the wiggles.

1.trace: specifies the first trace within each block to be plotted if n.trace is greater than 1. The value of 1.trace must be between 1 and n.trace.

Color: choose the color for the polygonal line of the wiggles.

Use layershow colors: if activated the layershow colors are used for plotting and filling the wiggles. Each trace has a different color (max. 100). The layershow colors can be defined within the layershow menu (see chap. 1.12.3, option colors).

Fill: controls the filling of the polygonal lines.

Entering **no**, means no filling.

Entering **positive**, means only the positive amplitudes are filled with the chosen FillColor.

negative means only the negative amplitudes are filled with the chosen FillColor.

colors means that the wiggles (positive and negative amplitudes) are filled with the current color amplitude assignment. In this representation correlated signal arrivals are very well recognizable.

Pos./neg. means that both the positive and negative wiggles are filled using the current fill color.

Clip: With the parameter clip all amplitudes, exceeding the value of clip in pixels, can be cut. A large value for width and a small value for clip thus facilitates to recognize signal arrivals of small amplitudes otherwise covered by phases with large amplitudes.

FillColor: choose the color for the filled areas of the polygonal lines. The Fill option must be set to positive or negative.

ikomp: if activated the secondary color will be used for traces with $ikomp = 2$.

7.4 Manual scaling and incrementation

xmin: enter a value for the minimal x-(normally distance-) value of the line to be plotted

ymin: enter a value for the minimal y-(normally time-) value of the line to be plotted
enter a value for the maximal axis value in x-direction

xmax: enter a value for the maximal x-(normally distance-) value of the line to be plotted

ymax: enter a value for the maximal y-(normally time-) value of the line to be plotted
enter a value for the maximal axis value in x-direction

dx: enter a value for the subdivision of the x-axis

dy: enter a value for the subdivision of the y-axis

dz: enter a value for the subdivision of the optional depth axis. If set to 0 the subdivision is automatically determined from dy.

7.5 PlotGain/Filter

This group box allows to specify a gain or filter function for the plotting of the data.

AGCGain: if activated an AGC (AutomaticGainControl) with the given **Window** value (enter the wanted window length in the current time dimension) is applied for plotting the data. AGC facilitates the creation of equally distributed amplitudes in y-direction (normally time axis) within a predefinable window. This option serves for emphasizing of low amplitude ranges against ranges with high amplitudes. The information of the true amplitude is lost, of course. The program calculates at first an average amplitude over the total time range for each trace. After that the program scales each amplitude value in that way that the mean amplitude has the same value for each selected window around the current value within a trace. The size of the window determines the kind of amplitude equality distribution. A window size of only one sample increment means that each time sample within one trace receives the same amplitude value (no reasonable choice), a window size of the whole trace length causes no modification of the amplitude. Small window sizes cause a strong equality distribution, large windows a weak. Often it is necessary to apply a scaling factor (parameter **Scale** with which the data are multiplied after the application of the AGCGain) smaller than one because after the application of the AGCgain some amplitude values will exceed the maximum amplitude of the original profile. The optimal choice of this scaling factor enables that all amplitude values will not exceed the limit of 16 bit.

EnergyDecay: if activated the energy decay curve is applied for plotting the data. By activating this option a gaincurve in y-(time-)direction is applied on the complete profile based on the mean amplitude decay curve. First a mean decay curve is determined from all existing traces. After the application of a median filter on this curve every data point of each trace is divided by the values of the decay curve. Often it is necessary to apply a scaling factor (parameter **Scale** with which the data are multiplied after the application of the EnergyDecay curve) smaller than one because after the application of the gain some amplitude values will exceed the maximum amplitude of the original profile. The optimal choice of this scaling factor enables that all amplitude values will not exceed the limit of 16 bit.

7.6 Plotsuboptions

This group box controls the main plot settings.

ShowMarker: if activated the distance markers are shown as white rectangles.

Commentmarker: if activated the comment markers are shown as yellow rectangles together with the comment.

TraceHeaderDistancies: if activated the profile is plotted based on the individual distancies stored in the single traceheaders and not based on the equal trace increment of the fileheader. The option is available both for the wiggle and point plotmode. With activated option the following restrictions for the pointmode hold true:

- Printing is not possible
- the actual setting of the parameter n.trace is also valid for the pointmode
- for the filling a mean fill size will be determined automatically. In case of strong variations of the trace positions gaps may occur. The same holds true for the scrolling. Please use after scrolling the repaint button.

The actual setting of the TraceHeaderDistancies will be kept after leaving the program if the wigglemode has been chosen. In case of the pointmode the default deactivated setting will be used.

A repositioning of the data into equidistant traces instead of the TraceHeaderDistancies is recommended if you are using filters which require equidistant data (e.g. migration or fk-filter). The processing step "make equidist.traces" (chap. 1.11.6.3) under processing/trace interpolation performs this repositioning.

AutoInterpolation: if activated an autointerpolation in x- and y-direction is done for the pointmode. Activate this option if your data density is smaller than the plotting area (for example when you did a large zooming). Plotting takes more CPU time when this option is activated.

no interp.f.min.color: if activated no interpolation will be done for amplitude values lying within the min. color range. This might be useful for example for plotting a tomographic inversion result which has been restricted to the covered area. Then the border of the area will not be interpolated. The option is only enabled if AutoInterpolation has been activated.

ShowSecondLine: if activated the second line is plotted (option is not available for REFLEXW DataView).

Rotate90Degree: if activated the profile is rotated by 90 degrees.

FlipYAxis: activate this option if you want that the y-axis starts at the bottom.

FlipXAxis: activate this option if you want that the x-axis starts at the right. With this option activated it is not possible to do some analysis steps like picking.

ShowAxis: if activated the x- and y-axis are plotted.

Grid: if activated a grid is plotted. The option grid color specifies the color of the grid.

XAxisName: activate this option for a manual labelling of the x-axis. This manual labelling is stored in the INI file after terminating the program and is loaded when starting the program. If the option is deactivated, the x-axis name string stored in the fileheader of the current line is used for the labelling.

YAxisName: activate this option for a manual labelling of the y-axis. This manual labelling is stored in the INI file after terminating the program and is loaded when starting the program. If the option is deactivated, the y-axis name string stored in the fileheader of the current line is used for the labelling.

AxisWithExponent: if activated the axis labelling is done with exponential representation if the labelling values exceed some predefined values (e.g. values between 10000 and 30000 are displayed as $100 \cdot 10^{**2}$ and $300 \cdot 10^{**2}$).

If activated and no manual axis labelling (options XaxisName and YaxisName deactivated) is entered the following holds true in addition:

timeaxis: automatic display in μ s instead of ns and ms instead of μ s and s instead of ms if the timerange is bigger than 10000.

distanceaxis: automatic display in KM instead of METER if the distancerange is bigger than 10000.

DepthAxis: if activated an additional depth axis is plotted. The depth axis is calculated from the timeaxis and the given velocity (see below).

reduction velocity: if activated the traces are plotted with a timeshift calculated from the trace-distance and the entered velocity. The option is useful for e.g. displaying refraction data.

v[m/ns]: enter a value for the velocity for the calculation of the depth axis.

Elevation: With the option elevation activated the depth axis on the right hand side is replaced by an elevation axis showing the elevations based on the entered ref. level. The current elevation is calculated from: reference level - current depth value.

correct header elevations: if activated the traces are shifted based on the receiver and the shot elevation values stored within the traceheader of each trace and the entered elevation level. The shift levels are calculated from the difference of the entered elevation level and the individual traceheader elevation values. Based on the current velocity the travelttime shift value is calculated from the sum of the shot and the receiver elevation differences.

The correct header elevations plot option is comparable with the processing option correct3Dtopography in the processing menu StaticCorrection/muting, if the static correction is done based on the shot and receiver elevations stored within the traceheaders. But in contrast to that processing option the range of the timeaxis will not be changed using this plot option. Therefore it can happen, that - depending on the chosen elevation level - information of some traces is not plotted because it is shifted to times outside of the time range.

depthaxisname: activate this option for a manual labelling of the depth-axis. This manual labelling is stored in the INI file after terminating the program and is loaded when starting the program. If the option is deactivated, the y-axis name string stored in the fileheader of the current line is used for the labelling.

showvelocity: if activated the depth axis labelling contains the velocity or the velocity file which are the base for time-depth conversion.

8. Print Menu

This menu allows you to setup the parameters for printing a profile. In every case the complete profile is printed according to the chosen minimum and maximum border values (either automatically determined or entered manually - see also manual scaling).

The scale in x- and y-direction is freely choosable (see also PrinterSize). The scale is entered either by direct input of the scale or by entering the length of the individual x- and y-axis.

A page blocking option is included (see also PrinterSize and PrintOptions1).

Printing on banner paper (printing on continuous paper) is supported.

If printing a layershow you may choose between printing both the profile and the interpretation (options **print profile** and **print layershow** activated) and only the profile (option **print profile** activated) or the interpretation (only option **print layershow** activated).

8.1 PrintOptions1

This group box allows to specify some controlling options for the scale and the print view.

automatic center: if activated the profile is automatically centered on the sheet. Automatic centering is automatically disabled if printing is done in the Printing on banner paper mode (continuous paper).

X-scale output: the given scale is used for determining the x-size of the output.

Y-scale output: the given scale is used for determining the y-size of the output. With layer-show activated (see also LayerShow MenuItem) the scale is applied on the depth axis of the layer show in the lower image and not on the time axis of the 2D-profile in the upper image. With depth axis activated (see also Plotsuboptions) the scale is applied on the depth axis and not on the time axis of the profile.

page blocking: if activated only one block of the given profile length/page is printed on one page. The program automatically subdivides the profile into several parts of constant length which will be printed on individual sheets.

Page blocking is automatically disabled if printing is done in the Printing on banner paper (continuous paper).

Landscape: if activated the output is landscape. With deactivated option the output is portrait. The current settings within the printer setup for landscape or portrait are overwritten.

use current zoom: if activated the currently set zoom parameters are used for the printing. If deactivated the complete profile(s) is plotted. The option is only enabled for printing from the 2D-dataanalysis.

8.2 PrinterSize

x-axis length[cm]: enter the x-axis length of the output in cm. If page blocking is activated, this length specifies the x-axis size of one page block.

x-scale[relation-1:?]: enter the scale if the option x-scale output is activated. For example: profile length 200 m. You enter a x-scale of 1000: the output has a length of 20 cm.

y-axis length[cm]: enter the y-axis (normally timeaxis) length of the output in cm.

y-scale[relation-1:?]: enter the scale if the option y-scale output is activated (see also x-scale[relation-1:?]).

upper border[cm]: enter the upper border in cm.

left border[cm]: enter the left border in cm.

profile length/page: enter the length of the profile part to be printed on one page if the option page blocking is activated.

get total print size: allows to show the total print size in x- and y-direction.

8.3 PrintOptions2

fast print: if activated a fast algorithm is used for printing the data for the point mode. In some cases dependent from the printer this printing method fails (only the frame is printed or the colors are not correct) and you must deactivate the option in order to print out the data.

print general comment: print a general comment - this comment is printed at the upper left corner of the image.

print file comment: print the comment stored in the file header of the profile to be printed. This comment is printed at the lower left corner of each line to be printed. When printing the Windowing 3D-file the file comment is only printed when a 3D-file has been loaded.

print frame: print a frame around the output. Print frame is automatically disabled if printing is done in the banner mode (continuous paper).

print filename: print the filename on the top of each profile.

print header boxes: if activated the program asks for the header box file to be loaded after having activated the option print. For a detailed description of the header comment boxes see chap. 8.7 (print preview).

8.4 FontSettings

Text Font: enter the font for the text of the output.

Number Font: enter the font of the numbers of the output.

Symbol Font: enter the font for the symbols to be printed (e.g. picks or markers).

Please use only true type fonts because only these fonts are able to be rotated.

control fontsize: active only when printing within the windows mode of the 3D-datainterpretation. Deactivate this option if the fontsize is not correctly determined from the program. In this case the screen fontsize is used for printing. Therefore you must change the fontsize in such a way that the printer and the screen resolution match.

8.5 ControlPanel

PrinterSetup: Enter the printer-setup menu.

Partitionskans: enter the max. number contained within one single print bitmap. The program automatically subdivides the printer bitmap based on the entered number. If problems occur with the printing (e.g. something is missing) it might be helpful to decrease this number. The number does not restrict the total number of scans to be printed.

Preview: Enter the print preview menu which allows a preview of the size of the printoutput and to define text boxes (for a detailed description see chap. 1.8.7).

CANCEL: break off printing

PRINT: start printing

8.6 Printing on banner paper

Banner printing (printing on continuous paper) is supported. The following restrictions are valid for banner printing:

- no automatic center
- no page blocking
- no print frame
- the border in banner direction is always set to 0

- because banner printing is still a page based printing the following problems may occur when switching to the next page:
 - axis numbering is not correct
 - the wiggles may be disturbed at this position

8.7 Print preview

The print preview window is only available within the 2D-dataanalysis.

The print preview menu allows you to preview the size and shape of the print output and to define a **print header** consisting of up to 30 different header comment boxes containing up to 6 different comments. The print area is whitened and a simple preview of the profile(s) is shown within this area.

To be considered: The profile preview is only a simple bitmap transform from the screen and does not exactly represent the print output especially concerning the axis size. Some print options like print general comment or print file comment and print frame are also not taken into account.

If the printing is done onto **several pages** different print headers for each page may be defined (see option page (max.)). In this case the profile itself is not shown but you only may define the print headers. The option copy to all pages (see below) allows to copy the actual print header to each page.

The following general options are available:



resets the x- and y-scale values (zoomvalues) to 1 and replots the print preview replot with current zoom parameters



enable manual zoom - With the option ZOOM an arbitrary area of the print preview can be selected and plotted in full screen size. The area to be enlarged, a rectangle, has to lie within a data set. Pressing the left mouse button you determine a corner of this rectangle and by moving the mouse with pressed button the desired area is opened. Afterwards you may use the scroll buttons to scroll through the zoomed print area.

close: close the print preview window without printing.

print: does printing using the current comment box settings and closes the print preview window.

reset act: clear the current comment box.

reset all: clears all comment boxes.

load: loads an existing set of comment boxes from file.

save: saves the existing set of comment boxes on file. The file will have the extension hea and is stored under the path rohdata under the current project directory. You must store the set of comment boxes if you want to use the boxes without entering the print preview window (see option print header boxes within the PrintOptions2, chap. 1.8.3).

add: add header boxes (one additional file) to the current ones

copy to all pages: copies the actual print header to each page. The option may be used if the same or nearly same print header should be used for each print page.

page (max.): choose the wanted print page for defining the print headers

The **print header** is built up of up to **30 different header comment boxes** each containing up to **6 different comments**.

One **comment box** is characterized by the following values:

X-pos: enter the x-coordinate of the left corner in cm

Y-pos: enter the y-coordinate of the top corner in cm

width: width of the box in x-direction in cm

height: height of the box in y-direction in cm

degree°: specifies the rotation angle of the comment text - e.g. 0°: horizontal alignment, 90°: vertical alignment

pen width: specifies the width of the box frame

frame: specifies the color of the box frame

fill: specifies the fill color of the box if transparent if deactivated

transparent: if activated the box is transparent, activate this option for example if you want to place some comments within your data

bitmap-file: if activated a bitmapfile can be loaded into the box, e.g. a logo.

The **current box** is highlighted by a big frame. An existing box may be activated by pressing the left mouse button within the wanted box. With pressed left mouse button the current box may be moved to any position.

The edit option **box nr.** shows you the number of the current box. This option also allows you to choose any of the existing boxes.

A **new box** is interactively defined by spanning up the wanted area. Click on the uppermost left corner of the area to be spanned up and drag the mouse to the wanted lowermost right corner with the left mouse button pressed.

Each comment box may contain up to **6 different comments**. Each comment is defined by the following parameters:

the comment text itself

font: enter the wanted font of the comment

X-Pos.: enter the x-position in cm within the comment box. You may use the up and down arrows for a fast replacement of the comment. The option change size defines the stepwise size of each redefinition.

Y-Pos.: enter the y-position in cm within the comment box. You may use the up and down arrows for a fast replacement of the comment. The option change size defines the stepwise size of each redefinition.

To be considered: A **horizontal** or **vertical line** is easily constructed by defining a new header box with a width (vertical line) or height (horizontal line) smaller than 0.05 cm.

This menu allows you to setup the parameters for printing a profile. Batch printing is supported - see PrintOptions2. The scale in x- and y-direction is freely choosable (see also PrinterSize). The scale is entered either by direct input of the scale or by entering the length of the individual x- and y-axis. A page blocking option is included (see also PrinterSize and PrintOptions1). Printing on banner paper (printing on continuous paper) is supported.