

# Main news of the REFLEXW version 4.0 (10.01.2006)

## 0. general:

### 1. plotoptions

**Fill** for **wigglemode** extended to pos./neg.. If activated both the positive and negative wiggles are filled using the actual fill color.

new option **man.** which allows to enable the manual subdivision of the axis (option dx, dy and dz) independently from the option manual scaling which now only activates the manual min./max. axis scaling.

The **color amplitude assignment** is now controlled either by the new options **min. value** and **max. value** or by the old option Amplitudescale.

New option **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.

New option **grid color** which defines the color of the grid.

### 2. global parameters

**Max. scans** within each profile increased to 1 million (1024\*1024, previous value was 256000). This is also the upper boundary for the total number of traces for a 3D-datafile.

# I. 2D-dataanalysis

## 1. display

**Wigglewindow:** new option Tracenormalize - if activated a normalization to the max. value of the actual trace is used for the display.

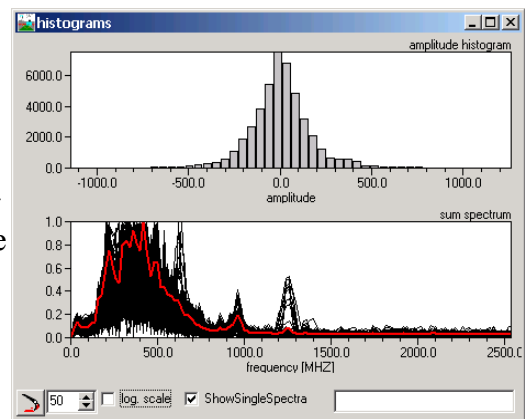
View **TraceHeader axis** -new suboptions at the top, at the bottom and at min.distance which define the positions of the traceheader coordinates. With at the top activated the traceheader coordinates are displayed at the distance labels within the upper range of the profile below the distance axis using 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).

Now the option will also be considered for the bitmap export.

View **profile histograms** - new option: activating the option opens a new window which shows the amplitude histogram of the primary profile (upper panel) as well as the sum spectrum over all traces of the profile (lower panel).

It is possible to select the number of subdivisions for the histogram. The default value is 50. Activating the option log.scale enables a logarithmic scale for the amplitudes.

With the option ShowSingleSpectra activated the spectra of the single traces are plotted in addition to the sum spectrum.



Double clicking on the histogram or the spectrum copies the corresponding chart to the clipboard for a succeeding import into any document.

File/Interactive choice option view **background bitmap** (Btm) - by default the bitmap is plotted filling out the complete coordinate range under the assumption that the coordinate origin is located on the lower left corner (flipped y-axis). Now a new option named FlipYAxis allows to deactivate the bitmap flipping in y-direction.

## 2. dataimport:

**ASCII-MATRIX:** The options file header and trace header now allow to enter a number of comment lines at the beginning of the file (option file header) and the number of comment lines at the beginning of each trace line (option trace header). All comment lines are only read in and not interpreted.

**3D-Radar:** new input format - imports the data from the 3D-Radar system (default extension 3dr). The data are 3-dimensional data either in the time- or frequency domain. If the data are in the frequency domain an automatic transformation into the time domain is done. In this case the max. timerange is asked for.

By default the conversion sequence is set to "3D-file equidistant". In this case a 3D-Reflexw file is generated.

With the conversion sequence set to "parallel lines" the 3D-Radar file is automatically subdivided into different 2D-Reflexw files. If the filename has been set to "original name"

the program automatically adds the number of the 2D-lines to the output filenames - example: the 3D-radar file testa.3dr contains 20 different 2D-lines - the Reflexw files will have the names testa000.dat, testa001.dat,..., testa020.dat.

**RADAN:** GPS-tmf file is now supported. A tmf-datafile is created when using the SIR-3000 together with a GPS-system. The tmf-datafile is a binary file and it contains:

1. the start and end GPS-positions (in degree) and the UTC-time
2. the timing of each marked scan

The UTC-times and the times of each marked scan are stored within the Reflexw traceheader on TimeCollect in secs after midnight. Based on these times it is possible to input GPS-data from an external ASCII-file using the type GPS-times within the traceheader menu. The format of this ASCII-file must be

longitude	latitude	height	GPS-date	GPS-time
638434.601	7215215.236	143.227	19.05.02	07:32:12

Longitude and latitude can also be exchanged. The GPS-date must be present but it will not be used for the matching. Only the GPS-times are used.

In order to use this option the following actualization must be done within the traceheader menu:

1. interpolation 0-data
2. gps-times
3. optional UTM-conversion if necessary
4. optional calculate distancies

To be considered: during the RADAN-dataimport the GPS-start and end coordinates given within the tmf-file are also stored within the traceheader of the 1. and the last trace respectively. These coordinates will be overwritten when using the option actualize based on gps-times. The coordinates are written out for completeness and may be used when no external ASCII gps-file is present.

It is possible to ignore the timing of each marked scan. For this purpose you must deactivate the option GPS mark/times within the import menu.

**KGS:** new input format of the Kansas Geological Survey

### **3. processing**

new option for **rescaling** the primary and filter trace within the processing menus:

In addition to the zooming arrows there exist an equivalent spin button which allows to move the starting point of the primary and filtered traces as well as of the corresponding spectra.

**Yo-Yo section:** new option under processing/sorting for downhole-crosshole data (source and receiver hole). The option allows the separate presentation of the data coming from below and from above a predefined depthpoint. Only those shot-receiver combinations are sorted out which direct wave is going through a choosable depth midpoint resulting in a so called Yo-Yo section. In constant velocity media Yo-Yo reflections from an interface have constant path lengths. Therefore any horizontally layered reflector will appear on a Yo-Yo section as a flat one.

The dataset must consist of different shots each containing the same number of equidistant traces (receivers). The total number of traces within the dataset is the number of shots multiplied with the number of receivers. The receivers as well as the shots must be sorted with increasing depths. The shot and receiver coordinates must be defined within the traceheader. First the data are automatically separated into two datasets one containing the upward travelling waves and the other one containing the downward travelling waves. For that purpose a fk-filtering is used. The filtering is done for each shot independently. For that purpose the complete dataset is subdivided into n different subsets each containing equal number of receiver traces (option trace number). Afterwards the data are sorted around the chosen midpoint.

The option needs the following inputs:

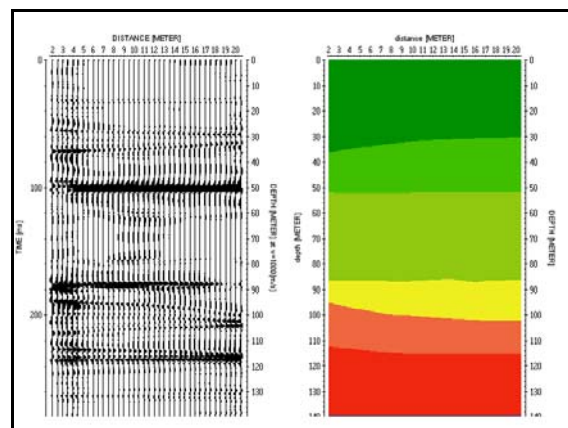
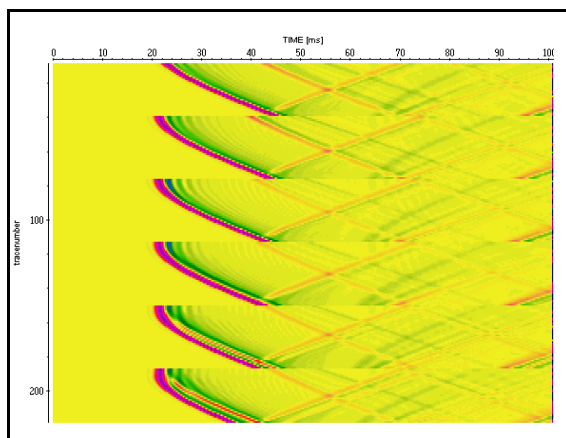
midpoint: defines the midpoint depthpoint for creating the Yo-Yo section. Only these shot-receiver combinations are taken into account which direct wave is going through this midpoint. (within the range of the chosen binsize).

binsize: defines the range for cutting the midpoint (see above). A value not equal 0 is necessary if source and receiver coordinates do not exactly match.

trace number: enter the number of traces per shot. The input is necessary for the fk-filtering of the individual shots.

velocity: enter the velocity which is used for calculating the travelttime of the direct wave from the shot to the receiver. This travelttime is subtracted from the travelttime of each trace.

The following pictures show an example with 41 shots between 50 and 90 m and 37 receivers between 52 and 88 m (picture on the left shows part of the original crosshole data - 6 shots). The Yo-Yo section has been created around the midpoint 70 m with a binsize of 0.5 m, 37 number of traces and a velocity of 1000 m/s.



On the right panel the model is shown.

literature: Whiteley, R.J., Holmes W.H. and R.D. Dowle, 1990. A New Method of Downhole-Crosshole Seismics for Geotechnical Investigation, Exploration Geophysics, 21, 83-89.

**Suppress multiples:** The option allows to suppress multiple reflections from the surface. For that purpose each wanted multiple reflection is first flattened based on the picked primary reflection and then the subtracting average filter is applied within a choosable time range around the flattened multiple.

The picks of the primary reflection must be saved under the same filename as the actual profile filename (option use filename automatic name within the save pick menu activated).

The following inputs are necessary:

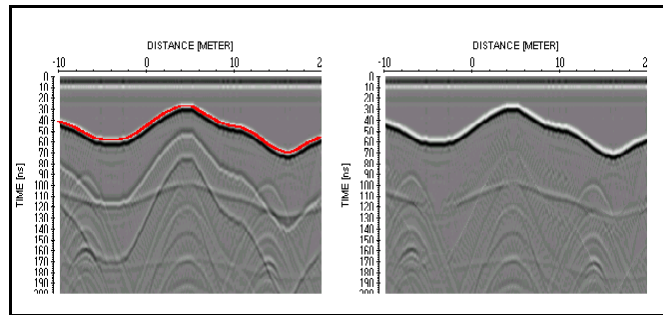
time range: specifies the time range for applying the subtracting average around the flattened multiple reflection. The range should be greater or equal the signal length.

time lag: enter a lag for shifting the time range to smaller times. Such a lag is necessary if you did not pick the very first arrival of the primary reflection. A default value is about a quarter of the signal length if the first maximum has been picked.

nr. of multiples: enter the number of multiple reflections to be suppressed.

nr. of traces: enter the number of traces for the subtracting average filter. The smaller this value the larger is the effect of the subtracting average filter (see also processing step subtracting average).

The picture on the right shows an example of the suppress multiples filter. The left panel shows the original data together with the picks of the primary reflection, the right panel shows the filtered data (time range: 20 ns, time lag: 10 ns, nr. of multiples: 3, nr. of traces: 20).



**Markerinterpol:** new parameter first trace marker - if activated a marker will be included automatically for the first trace.

New parameter view only - if activated the markers from the ASCII-file (option load) are only displayed with red symbols. It is possible to enter a shift value for the position of the first marker relative to the actual profile. This option might be useful to control the actual marker positions with an external relocation file in order to check if some markers are missing or false. The file must have the extension MAR and the following format (one line equals one marker position) is used:

*tracenummer markerincrement comentstring (optional)*

The tracenummer will be ignored. Therefore any value may be entered there. The comentstring is optional and might be used for redefining the comment markers within a separate step. For that purpose you must enter the edit comment marker option for the processed file, activate the option create and choose the ASCII-relocation file.

**Fk-filter:** new options neg.kx and pos.kx for an easy definition of a filter range for only negative or positive kx-values.

**remove zero traces:** new option - allows to automatically remove all traces with zero amplitude values. The traceincrement as well as the startcoordinate will be kept. The endcoordinate is updated based on the new number of traces.

**Fix profile length:** new option - allows to fix the profile length to a given value. The filter parameter profile length specified the new length of the profile in the given distance dimension. If the original length is greater than this value the corresponding traces will be omitted. In case of a smaller original profile length traces with zero amplitude values will be added.

## **5. Edit comment markers**

new option **batch create:** allows to create comment markers for a choosable number of datafiles within one step.

Option **create** with the format **ASCII-distance:** now 3 different formats are supported:

1. If the chosen ASCII-file has the extension TAB another format is used which corresponds to the format for saving the comment marker tabella on an ASCII-file (see also option save table):

*tracenummer distance markerincrement comentstring*

The tracenummer as well as the markerincrement are ignored. Use this possibility for example if you have acquired parallel lines with a multichannel system where the antenna have different start positions and therefore the comment markers are only correctly positioned for some files. Save the commentmarkers of the correct file on the tab-file using the option save table and load the other files, reset the existing comment markers if necessary and create the comment markers using this option.

2. If the chosen ASCII-file has the extension MAR the format for saving the marker increments for the processingstep “marker interpol” is used:  
*tracenummer markerincrement comentstring*  
The first marker is positioned on the first trace. The positions of the following markers are calculated from this position and the entered markerincrements.
3. In all other cases the following format is used:  
*distance commentstring*

## **6. Pick**

option **load**: new format ASCII-columns - corresponds to the ASCII-columns format within the picksave menu with activated options xy-coordinates, depths and codes. Each line contains the following informations:

*distance offset(profileconstant) x-shot y-shot x-rec y-rec travelttime depth amplitude code*

**autopick**: option now available for first arrivals (e.g. seismic refraction).

## **7. layershow**

**create velocity - option core data/1D-models**: with activated option construction change no interpolation will be done within the area bordered by the construction changes unless two or more coredata are located within this area.

## II. 3D-datainterpretation

**Rescaling or subdivision** for 3D-dataset:

The max. number of points in each direction is restricted to 1024. If the points in one or more direction exceed this boundary Reflexw offers two possibilities rescale and subdivide which can be selected in a separate window.

The option **rescale** automatically calculates rescaling factors in all directions where the number of points exceed the 1024 boundary. Example: 2400 points in line direction and 1200 points in time direction. The data are automatically rescaled by a factor of 3 and 2 resulting in 800 points in line direction and 600 points in time direction.

The option **subdivide** will only be enabled if only the number of points in line direction exceeds the 1024 boundary. Activating this option generates a number of subdatasets of the complete 3D-dataset in this direction. Two new options next and prev. control the access to the different subdatasets. An example shall illustrate the option:

3D-dataset with 6000 points in line direction, 100 points perpendicular to the line direction and 256 points in time direction. The option subdivision generates 6 different subdatasets each with 1000 points in line direction. The first subdataset is displayed after having activated the option. The option next loads the next subdataset from trace nr. 1001 to 2000 in line direction.

New option **ASCII export** within the options menu - allows to export the actual cut to ASCII GRD-format (see also Dataexport). The option is only enabled within the scroll mode. The ASCII-filename is automatically determined from the 3D-datafilename and the actual cut.

**Cube-display:** if a cube **cutting** is defined the cutted area will be surrounded by black lines.

### III. Modelling

#### 1. general:

New option **modelparameters** under view. With this option activated the physical parameters (one single set of parameters) are displayed below the defined model points. The program controls if identical physical parameters for subsequent layerpoints are present and only displays the middle one. Analogous to the option fill or interpolated physical parameters you may determine within the model generation “input of model parameters menu” which physical parameter is used. Click on the wanted parameter in the upper right corner table. By default the first parameter is set (marked by a x).

New option **export data traveltimes to ASCII** under file: allows to save the actually loaded data traveltimes into an ASCII-format needed by the tomography.

**Distance dimension** meter and foot enabled. The dimension is specified within the global settings menu.

New option **RandomLayer** within the model input menu. Activating the option allows to specify statistic parameters for a random perturbation of the physical parameters of the individual layer. It is possible to choose between fluctuations (see picture on the right - 2. layer) and discontinuous perturbations (see picture - 1.layer). Different spatial distributions as well as different statistic distributions for the physical parameters are available.

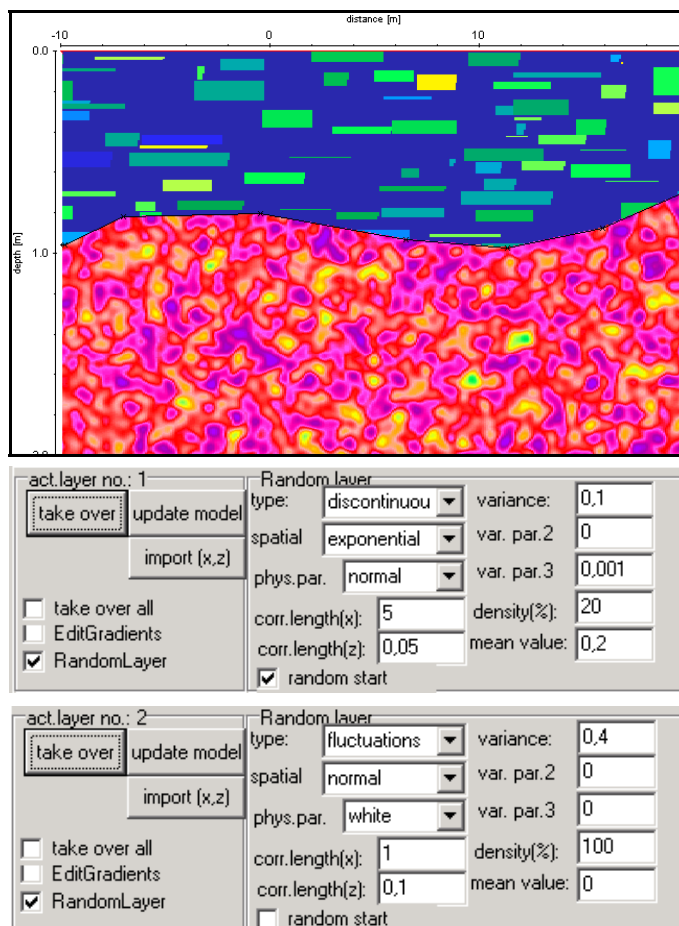
The correlation lengths in x- and z-direction define the average size of the inhomogeneities.

The variance defines the strength of the perturbation for the first physical parameter (either p-velocity or epsilon). The parameters var. par. 2 and var. par. 3 define the strength for the 2 other parameters (s-velocity or : and density or sigma) respectively. The distribution functions are the same for all physical parameters.

The parameter density(%) allows you to restrict the density of the

perturbations (density must be greater than 0 and smaller/equal 100). The parameter does not exactly represent the resulting density of the perturbations especially for small correlation lengths and for the type discontinuous. Therefore it might be necessary to change this value by trial and error if the resulting density does not fit the wanted needs. With the type discontinuous the single perturbations do not overlap for densities smaller than/equal 75 %. For greater densities an overlapping is allowed.

The parameter mean value defines a static level for the perturbations which will be add to all perturbation values. It is possible to define a positive or negative mean value.





By deactivating the option random start the random function repetitively generates the same specific sequence of random numbers if the other parameters and the discretization interval do not change. Activating the option random start always generates a new sequence of random numbers.

## **2. tomography:**

If no model has been specified a start model will be generated automatically when starting the tomography. For that purpose a mean velocity as well as the min./max. coordinates are calculated from the loaded traveltimes.

The max. number of receivers has been increased to 50000.

## **3. FD-modelling:**

Different **signal types** are now available: Kuepper, sine, Ricker, digitized signal, Kuepper 4 Extr. damped, and Kuepper 6 Extr. damped.

The digitized signal is taken from the first trace of a Reflexw formatted datafile. A possibly existing starttime within the Reflexw file will not be considered. The critical values for DeltaX and DeltaT are still be calculated from the manually entered frequency which should be the dominant frequency of the digitized signal.

The Kuepper 4 and 6 Extr. damped types may be used in order to simulate a longer reverberating signal. The first 2 extrema remain undamped and then a cos-taper is used in order to damp the following 2 or 4 extrema.

## **4. raytracing:**

**3D-ray:** new option - allows a 3-dimensional raytracing based on the network raytracing. The parameters ymin and ymax defines the model range in y-direction. The rasterincrement DeltaX also holds true for the y-direction. The parameter source y and receiv. y define the source and receiver positions in y-direction. Restriction: the receivers may only be located along one constant y-position.

The 3D-model is built up from different 2D-cuts lying within the xz-plane. The parameter ycoord defines the location of each cut in the y-direction. The option load allows you to define the wanted 2D-model cuts.

The source and receiver **z-positions** now may be located on any interface. On the right hand side of the “source z” option you may define if this value shall be taken or if the source shall be located on the 1. layer (topogr.) or on the 2.-5. layer. Equally the option next to the “rec z-start” and “z-end” options allows you to define the receiver line according to the entered values or to the chosen interface (1.layer(topogr.) or on the 2.-5. layer). Depending on the setting of the option topography “value” (not activated topography) or “topogr.” is highlighted by default both for the source and the receiver line.

## IV. travelttime analysis

### 1. general:

**Distance dimension** meter and foot enabled. The dimension is specified within the global settings menu.

### 2. time term analysis:

The timeterm analysis (new option under Analyse) allows the reconstruction of a 3D-refractor from xy-traveltime data. The timeterm analysis has been described by Willmore and Bancroft (1960). The essential feature of the method is that each traveltime  $t_{ij}$  may be written in the form  $t_{ij} = a_i + b_j + \sqrt{d_{ij}^2 + h^2}/v$ , where  $a_i$  and  $b_j$  are timeterms which are characteristic of the shot- and receiver point respectively,  $d_{ij}$  is the distance between shot and receiver and  $v$  is the refractor velocity. Under special conditions it is possible to derive  $a_i$ ,  $b_j$  and  $v$  which give the best fit to the observed traveltimes  $t_{ij}$ . The preconditions are:

- the velocity of the overburden varies only with depth within the critical refracted ray cone under the shot or receiver
- the refractor velocity is assumed to be constant
- slope and curvature of the refractor is small
- the model consists of one layer and a half space

If the actual layernumber (option layer nr.) is set to 0 all traveltime data above the min. traveltime are taken into account. If the actual layernumber is unequal 0 only the traveltimes which have been assigned to that layer before are taken into account. After having activated the option Time Term interpretation under Analyse the wanted traveltime data are queried.

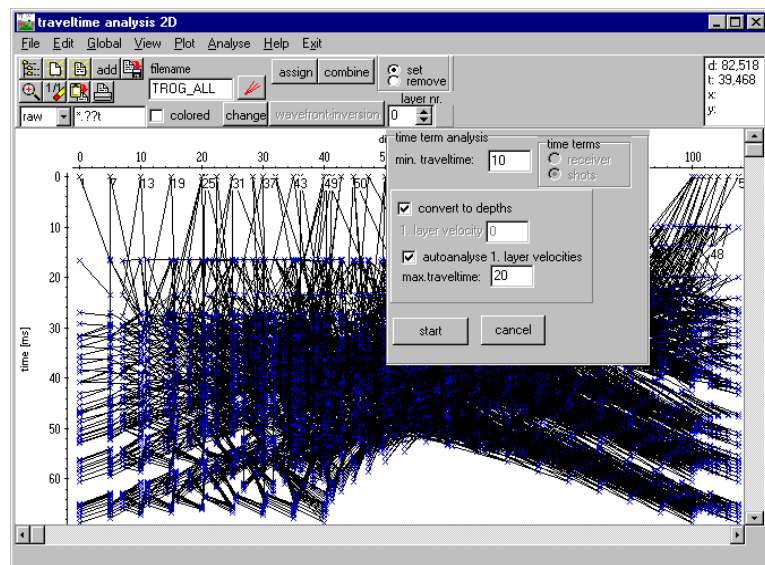
The time term analysis window opens. The following options are available:

min. traveltime: specifies the lower border for the traveltimes which are taken into account for the timeterm analysis (layer nr. = 0).

Within the time terms box you may specify if the timeterms are calculated for the different receivers or shots. With the option autoanalyse 1. layer velocities activated the timeterms are always calculated for the different shots.

convert to depths: if activated the depths are calculated in addition. For that purpose the velocity of the overburden must be entered (option 1. layer velocity).

With the option autoanalyse 1. layer velocities activated the velocities for the overburden are calculated from the given traveltimes. The option max. traveltime specifies the upper border for the traveltimes which are taken into account for this calculation.

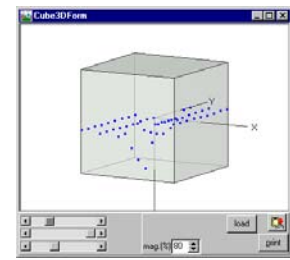


After having activated the option start the traveltimes data are sorted and analyzed. The result is plotted into the 3D-cube and is saved under an ASCII-file.

The output is an ASCII-file with the first line showing the velocity of the refractor. The following lines contain the resulting time terms and the coordinates:

```
output on file TROG_ALL.TimeTerm
2117.944655
10.57 0.00 -20.00 0.00 0.00
10.83 20.00 -20.00 300.62 3.26
10.98 40.00 -20.00 300.63 3.30
8.47 60.00 -20.00 500.80 4.24
8.31 80.00 -20.00 500.54 4.16
8.04 100.00 -20.00 500.72 4.02
10.56 0.00 -15.00 302.35 3.19
10.82 20.00 -15.00 302.03 3.22
10.97 40.00 -15.00 301.5 3.27
9.92 60.00 -15.00 501.2 4.31
8.28 80.00 -15.00 500.96 4.15
8.03 100.00 -15.00 501.18 4.03
10.60 0.00 -10.00 302.86 3.21
10.87 20.00 -10.00 302.88 3.29
13.65 40.00 -10.00 302.58 4.13
10.62 60.00 -10.00 500.97 5.32
8.29 80.00 -10.00 500.67 4.15
```

*timeterm x-coord. y-coord.  
overburdenvelocity depth*



literature: Willmore, P.L. and A.M. Bancroft ,1960. The time-term approach to refraction seismology, Geophys.J., 3, 419-43.

## V. CMP-velocity analysis

### 1. general:

The timewindow for the **semblance analysis** has been changed. Now the timewindow for the semblance analysis is centered around the actual time. The timewindow for the unnormalized correlation still starts at the actual time.