Use of GPS-coordinates (georeferencing) within REFLEXW

REFLEXW allows to handle so called traceheader coordinates which are stored within the header of each trace. Therefore it is possible to use GPS-coordinates for a special analysis.

GPS coordinates may be used within Reflexw for may different applications:

- view the profile line within Google Maps for a check of the surrounding conditions.

- use the coordinates for the interpretation, e.g. picking the onsets and exporting those to ASCII or DXF for a further CAD interpretation

- rescaling the distancies (trace relocation) based on the gps-coordinates

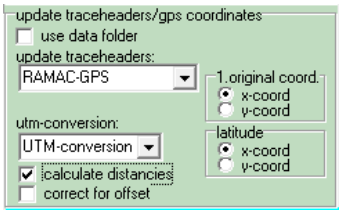
- 3D-data block generation based on gps coordinates

- seismic refraction interpretation including tomography using gps based data

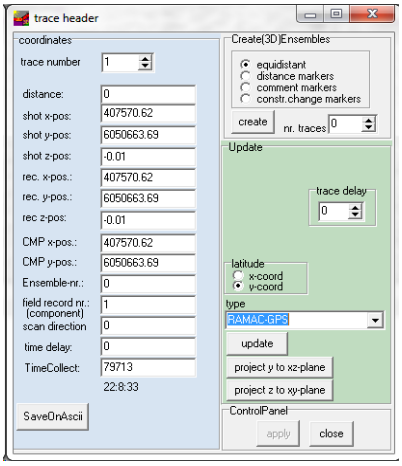
1. Import/Generate the GPS-coordinates

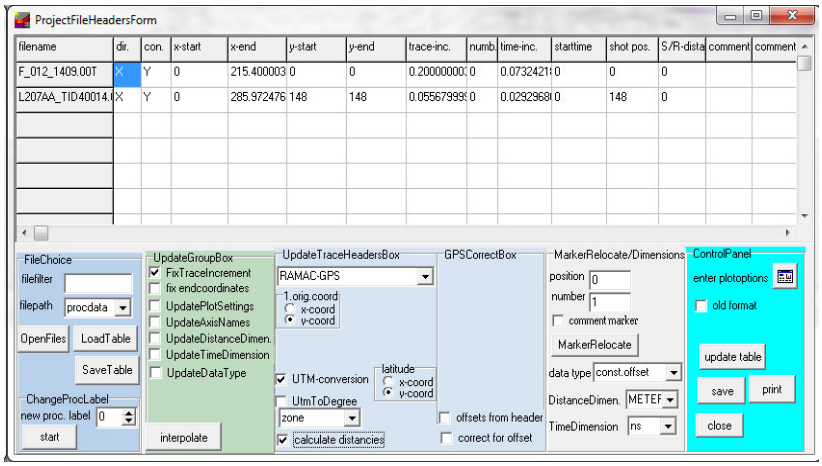
1.1 Import the GPS-coordinates

If GPS-data are simultaneously acquired it is possible to synchronize the GPR- or seismic data with the GPS-coordinates. The original GPR data may either be time based or based on a wheel. The different GPR-systems use different synchronization types. Mala, Utsi, IDS or PulseEkko for example generate a gps-file which contains both the tracenumber of the GPR-file and the GPS-coordinates.

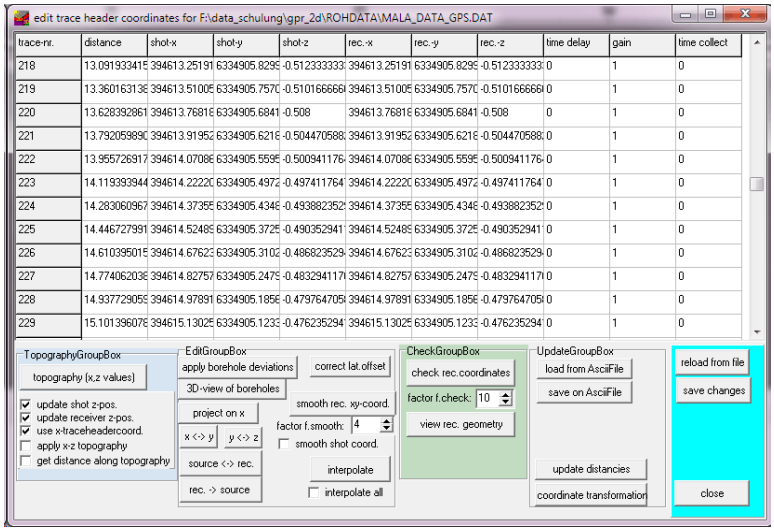


For most data acquisitions systems it is possible to automatically import the gps-data into the Reflexw file during the **import** and to perform a subsequent UTM-conversion (optionally). The options 1. original coord. and latitude allow to store the latitudes and longitudes on different items within the traceheaders. Here a suitable parameter choice must be found for the individual ASCII-files because these use different sortings. The two parameters allow the same storing order within the traceheaders for different original data formats.
In addition the gps coordinates may be imported at a later stage within the **edit trace header menu** or **edit several fileheader menu**.





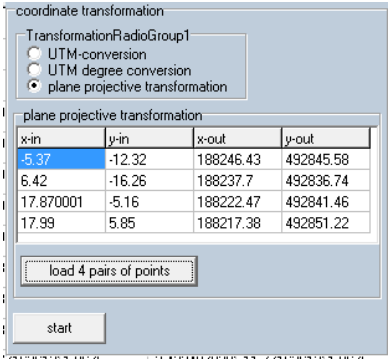
A **linear interpolation** will be automatically done where no GPS-data are present. The option **calculate distancies** sums up the distance along the gps-line (utm-conversion assumed) and stores it into the Reflexw traceheader. The GPS-coordinates may be controlled and edited within the edit **traceheader tabella**. Here many different smoothing and editing possibilities are available.

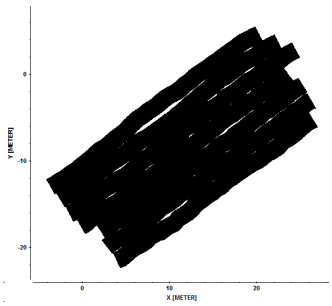


To be considered: The traceheader coordinates are stored using a 64 bit double precision format (Reflexw formats new 16 bit integer and new 32 bit floating point) - see also guide GPR_Import_Display or the specification within the manual concerning the Import format specification (chap. 1.5.4). The old formats with only 32 bit floating point precision is only supported by older Reflexw versions. If the coordinates have very high values with small changes, the data representation of the 32 bit floating format may not be good enough. In this case the Reflexw new format with the 64 bit double precision format must be used when importing the original data or a constant offset should be subtracted from the coordinates before storing them into the traceheaders.

1.2 Generate/transform the GPS-coordinates

The gps-coordinates may be transformed in utm-coordinates and vice versa and into different national coordinate systems. The transformation may be done for example within the edit traceheader menu or within the edit traceheader tabella.
The **plane projective transformation** within the **coordinate transformation** box within the edit traceheader tabella allows the transformation of the original coordinates into another coordinate system using four pairs of transformation coordinates. This transformation allows you for example to use a local coordinate system and to transform these coordinates into UTM-coordinates (example shows data from a 24 channel GPR antenna array - in total 7 different arrays).





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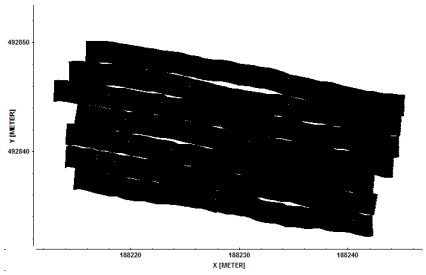
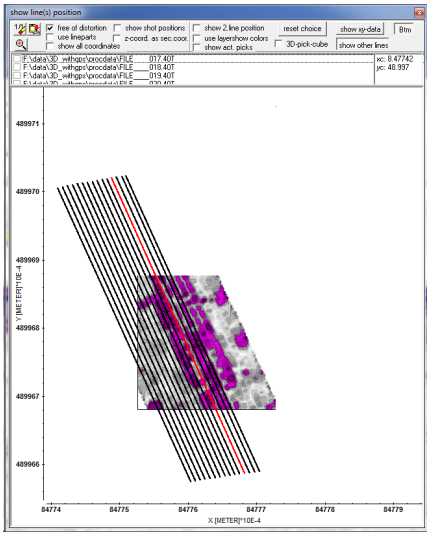


Another application is to convert a data field recorded using parallel equidistant lines into a georeferenced coordinate system. For that purpose the traceheader coordinates must be updated first based on the individual fileheaders and then the plane projecive transformation may be applied using the 4 corner points coordinate pairs.

2. Viewing possibilities using the gps coordinates

Within the 2D-dataanalysis module there exist different **viewing options** of the **traceheader xy-coordinates**.



First using the option **profile line (trace header coord.)** the profile location based on the traceheader coordinates is shown in an additional window (any curvature of the line coordinates is displayed). When moving the mouse cursor within the data window the actual xy-position of the mouse cursor is also shown.
Second with the option **TraceHeader axis** activated the xy-receiver traceheadercoordinates are displayed along the distance axis in addition.

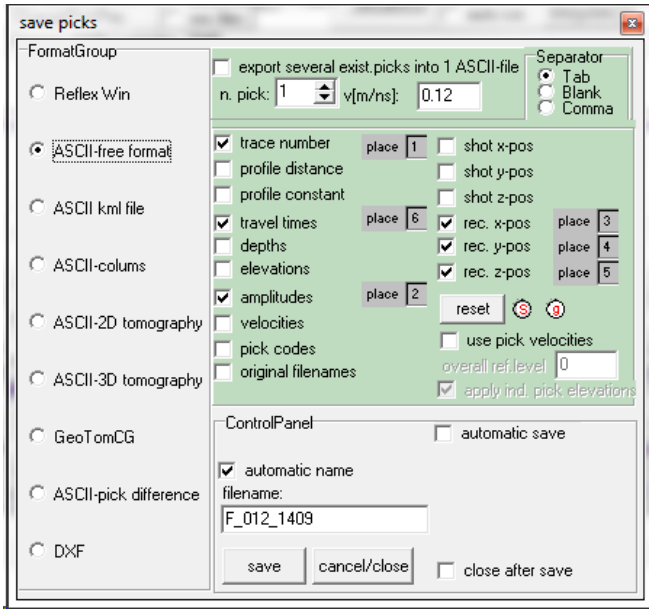
Third the option **Gps map** allows to view the profile lines within a Google Map. Activating the option **show line position** allows to continously show the actual mouse postion by a red circle when dragging over the line. The option **show 2. line position** displays the xy-position of the secondary file using the same distance coordinate. The option **show other lines** allows to show the xy-locations of other profiles.

The **traceheader z-coordinates** are used for the plotoption **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 actual velocity the traveltime shift value is calculated from the sum of the shot and the receiver elevation differences. The option is only enabled if the option elevation is activated.

The plotoption **TraceHeaderDistancies** allows to plot the profile 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.

3. picking:

The traceheader coordinates can be used for **exporting picked data** to an ASCII-file. Use for example the format ASCII free format which allows to export different picked attributes as well as the xyz-coordinates.
Another useful export format is DXF for a direct import into any CAD program.



If using the option **view/gps map** it is also possible to display the picks using a red-green-blue color scheme for the icons with red corresponding to the smallest traveltime values and blue to the largest traveltime values.

4. processing options

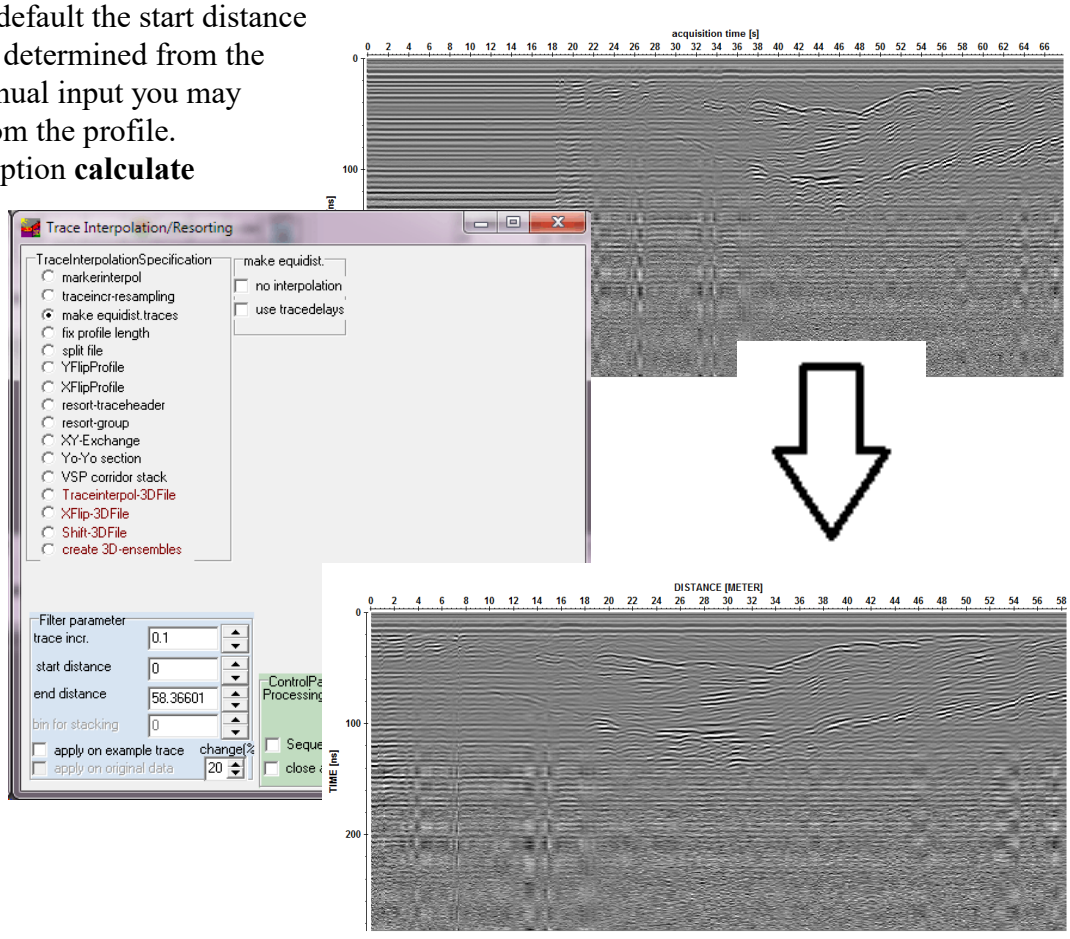
There exist several processing options which allow the use of the traceheader-coordinates. For example:

4.1 correct 3D-topography

With the suboption z-tracecoord activated the static correction is based on the shot and the receiver elevations stored within the traceheader of each trace.

4.2 make equidist. traces

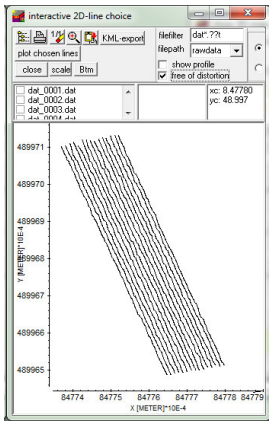
A subsequent processing step named **make equidist.traces** under processing/ TraceInterpolation/ Resorting allows to interpolate the non-equidistant data in such a way that the resulting data are equidistant. The non-equidistant data are resampled in x-direction based on the filter parameter trace incr. and the distance values stored in the individual trace headers of each trace. In addition the start distance and the end distance (starting and ending position of the new profile) have to be specified in the given distance dimension. By default the start distance and the end distance are determined from the traceheaders. By the manual input you may extract a distinct part from the profile. Precdontion is that the option **calculate distancies** which sums up the distance along the gps-line (utm-conversion assumed) and stores it into the Reflexw traceheader has been applied before..



5. 3D-datainterpretation

5.1 data acquisition:

Mala data 15 lines using gps.

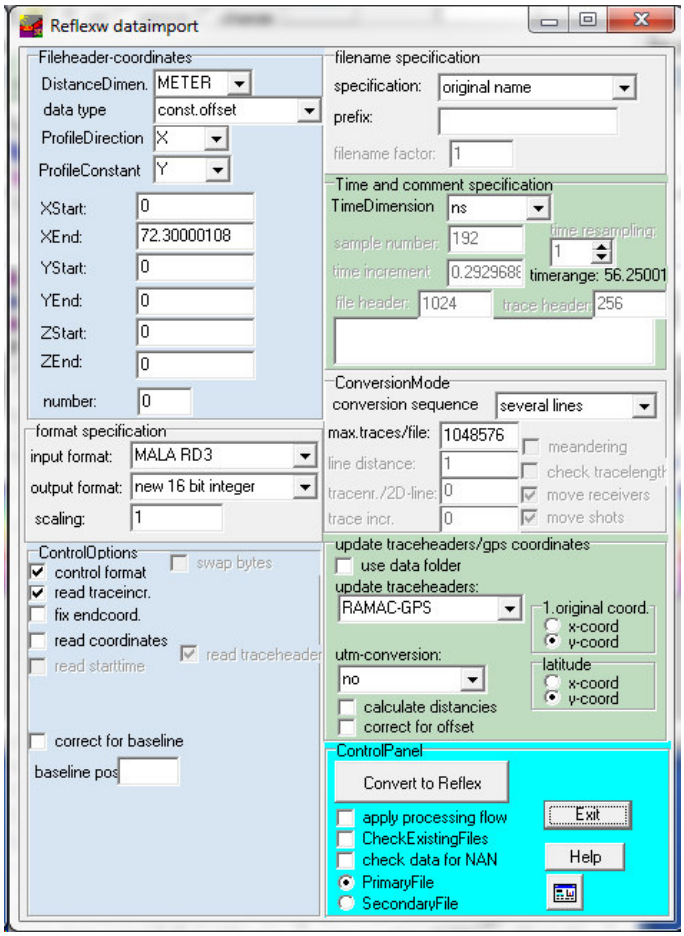


5.2 Import:

parameters: MALA RD3, read traceincr., several lines, datatype to const.offset

update traceheaders set to RAMAC-GPS: the corresponding cor-file which contain the gps-coordinates will be imported automatically into the traceheaders.

If meter coordinates are wished the utm-conversion may be activated.

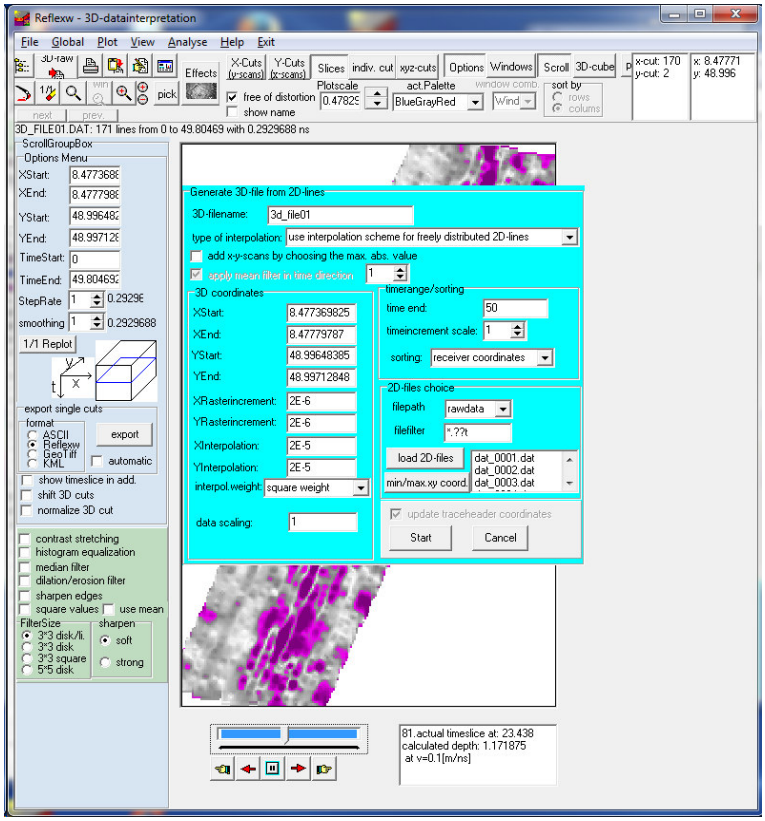


5.3 Processing:

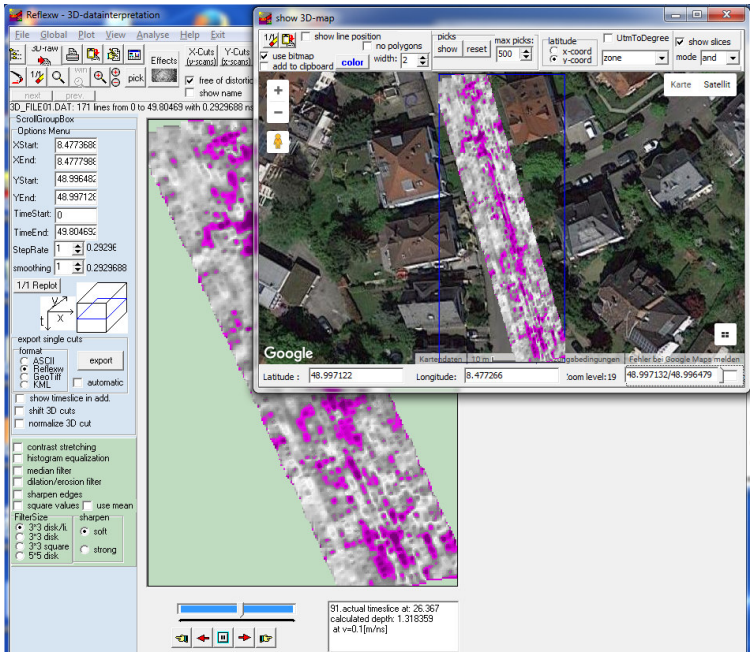
A standard processing has already been perforemd on the original data. Any additional processing is optional.

5.4 3-data generation:

The 3D-data may be generated from the 2D-lines using the option file/generate 3D-file from 2D-lines and using the type of interpolaion “use interpolation scheme for freely distributed 2D-lines”.



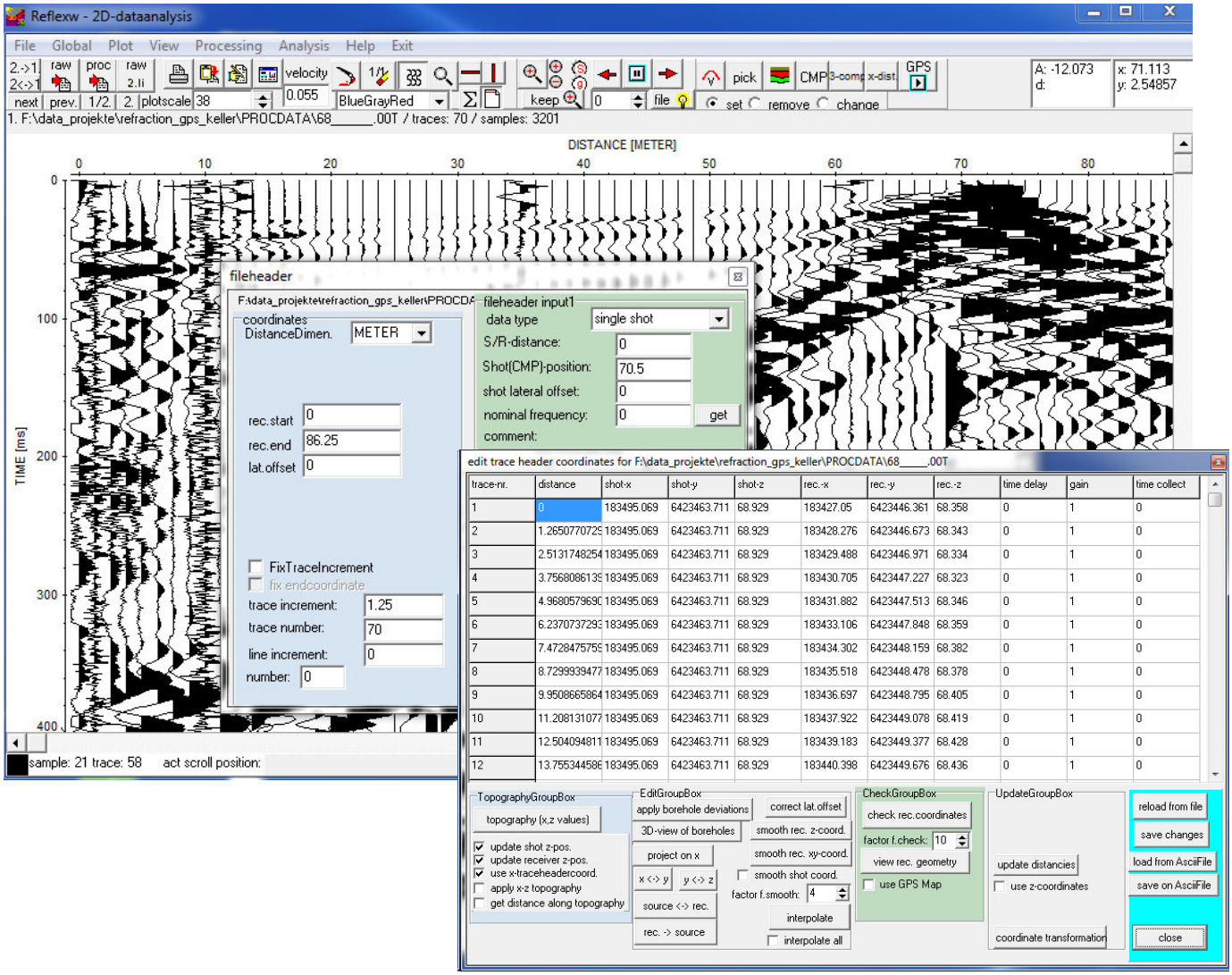
The option view/gps map allows to view the slices within the google map.



6. Use of gps-ccordinates for seismic refraction interpretation

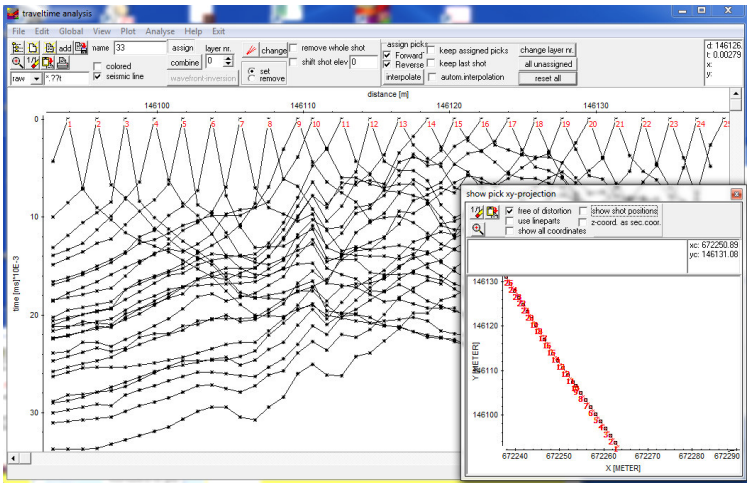
The seismic refraction interpretation is based on pure x-coordinates for both the shots and the receivers. Nevertheless it is possible to interprete refraction data which have been acquired along a nearly straight line using gps-coordinates.

Import the data like the standard seismic refraction data using relative coordinates for the shots and the receivers. These coordinates only serve for a simplification of the picking and using the interactive velocity tools like the intercept time method.
Update the traceheaders using the gps coordinates instead of updating them from the relative fileheader coordinates.
Perform an **UTM-conversion**

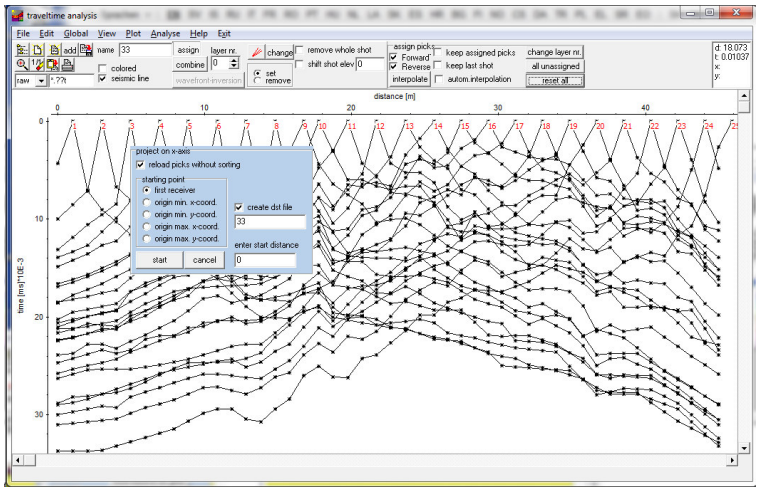


To be considered: The shots will always be displayed using the order of the geophone line. Therefore it might happen that the data will be displayed reversed in comparison to the pathway of the main coordinate direction. In this case a flipping of the profile in x-direction using the option **FlipXProfile** might be useful. The picks within the traveltime analysis module will always be displayed into the main coordinate direction.

Pick the first arrivals as usually and save them as pck-files.



Enter the **traveltime analysis module** and load all pick files. The program determines the main direction (either the x- or y- direction) and uses this coordinate as the display axis. The start coordinate is taken from the minimum coordinate and the position of the individual picks is calculated from the real distance within the xy-plane.
The option **view/showxyprojection** may be used for a a check of the pathway.



The seismic refraction interpretation is based on pure x-coordinates for both the shots and the receivers. Therefore the traveltimes must be projected onto the x-axis before using any interpretation tool (either wavefront or tomographic inversion or raytracing). This is done using the option **edit/project on x-coord.** After having performed this projection the y-coordiantes have been set to 0 and all coordinates have been projected onto the x-axis. The start distance in x-direction may be entered manually. With the option **create dst file** an ASCII dst file will be created which contains the original xy GPS coordinates together with the calculated distances along the line. This file can be used after the refraction inversion in order to reconstruct the original GPS coordinates for the inversion result (done within the traceheader menu using the type ASCII file/interpol. with activated option distances instead of tracenos). This result must represent a 2D-Reflexw file, e.g. a tomographic inversion file or when using the option fill within the modelling menu.

Now the traveltime data are ready for the interpretation and all tools may be applied.

6.1 final result

The tomopgraphic result or the filled inverted model may be loaded into the 2D-dataanalysis and the original coordinates may be imported into the traceheaders using the type **ASCII-file/interpol** with activated option **distancies instead of traceno**.