RAYFRACT Tutorial specific to INEMA line 2 :

Creating a new Rayfract profile, importing the SEG-2 trace files :

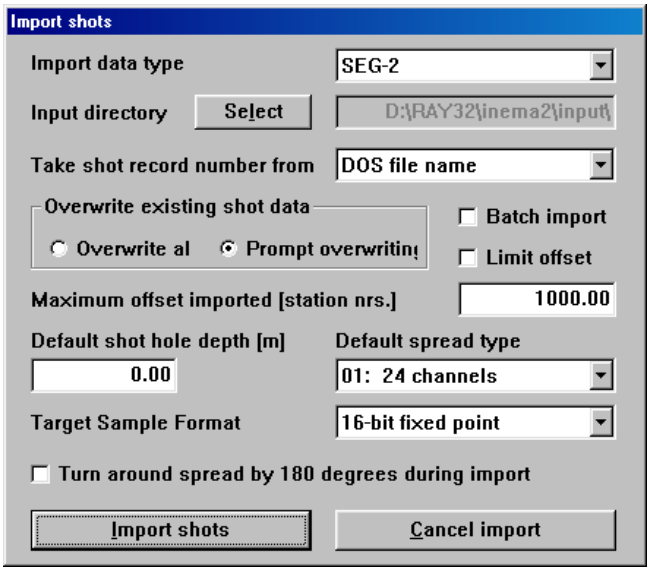
This tutorial describes how to import and process Geometrics SmartSeis SEG-2 formatted shot files 5920.dat, 5922.dat, 5924.dat, 5926.dat, 5928,dat, 5930.dat, 5932.dat and 5934.dat. Please note that we recommend to record at least 10 or more shots per profile, to obtain reliable interpretations with our Delta-t-V and WET inversion methods. The shorthand notation File|New Profile means : select item „New Profile“ in menu „File“.

Start up Rayfract and select File|New Profile. Be sure that the current directory as displayed above the directory selection box is your \RAY32 root directory. Now enter „INEMA2“ or similar in the top left text field labeled „File name“. Then hit RETURN.

Now select Header|Profile. Enter text strings into the three top left edit fields labeled „Line ID“, „Job ID“ and „Instrument“. Then enter the profile spacing of 5 (distance between adjacent receiver stations, in meters) into the text field labeled „Receiver spacing“. Now hit RETURN. Confirm the prompt as now displayed with RETURN.

Now create a subdirectory named „INPUT“ or similar, in directory \RAY32\INEMA2. Do this from within your Windows Explorer or in a DOS box. To start up Windows Explorer, select item „Windows Explorer“ in menu „Programs“ as displayed when clicking on the Windows 95 „Start“ button. To open a DOS box, select item „MS-DOS Prompt“ in the menu displayed when clicking on the Windows 95 „Start“ button. Copy the eight .dat input files 5920.dat etc. into this new subdirectory

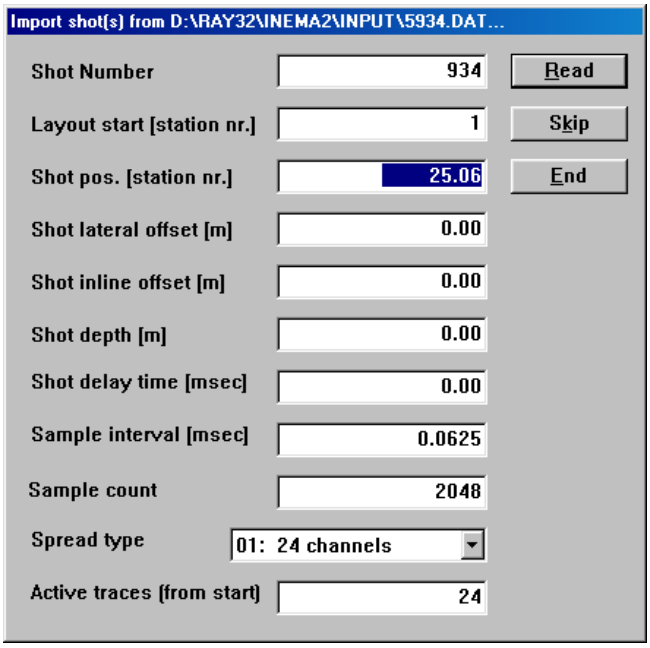
Now select item „Import data...“ in menu „File“. Rayfract will display the „Import shots“ dialog as imaged below. Be sure to adjust the edit fields as displayed.



Specify the correct Rayfract input directory by clicking on button „Select“. Then navigate to your \RAY32\INEMA2\INPUT directory, specify file type .DAT, select one .DAT file and hit RETURN. Be sure that the list box displayed to the right of label „Take shot record number from“ is set to entry „DOS file name“. This should happen automatically once you select Import data typ SEG-2.

Now click on the list box below label „Default spread type“, and select the entry „01: 24 channels“. This spread type defines an equidistant receiver spread type (all receivers are separated from each other by the same receiver spacing distance interval). If you need to define your own spread type, please refer to the online help.

Now start the import of the SEG-2 trace files by clicking on button „Import shots“ or hitting RETURN. In the following, the „Import shot“ dialog will be displayed as imaged below, once for each shot record to be imported.



The default station number value for the first receiver station as displayed in text field „Layout start“ is 1. Shot positions as specified in the SEG-2 trace header are transformed into station numbers relative to the layout start of the spread automatically. The „Receiver spacing“ as specified above will be used for this transformation.

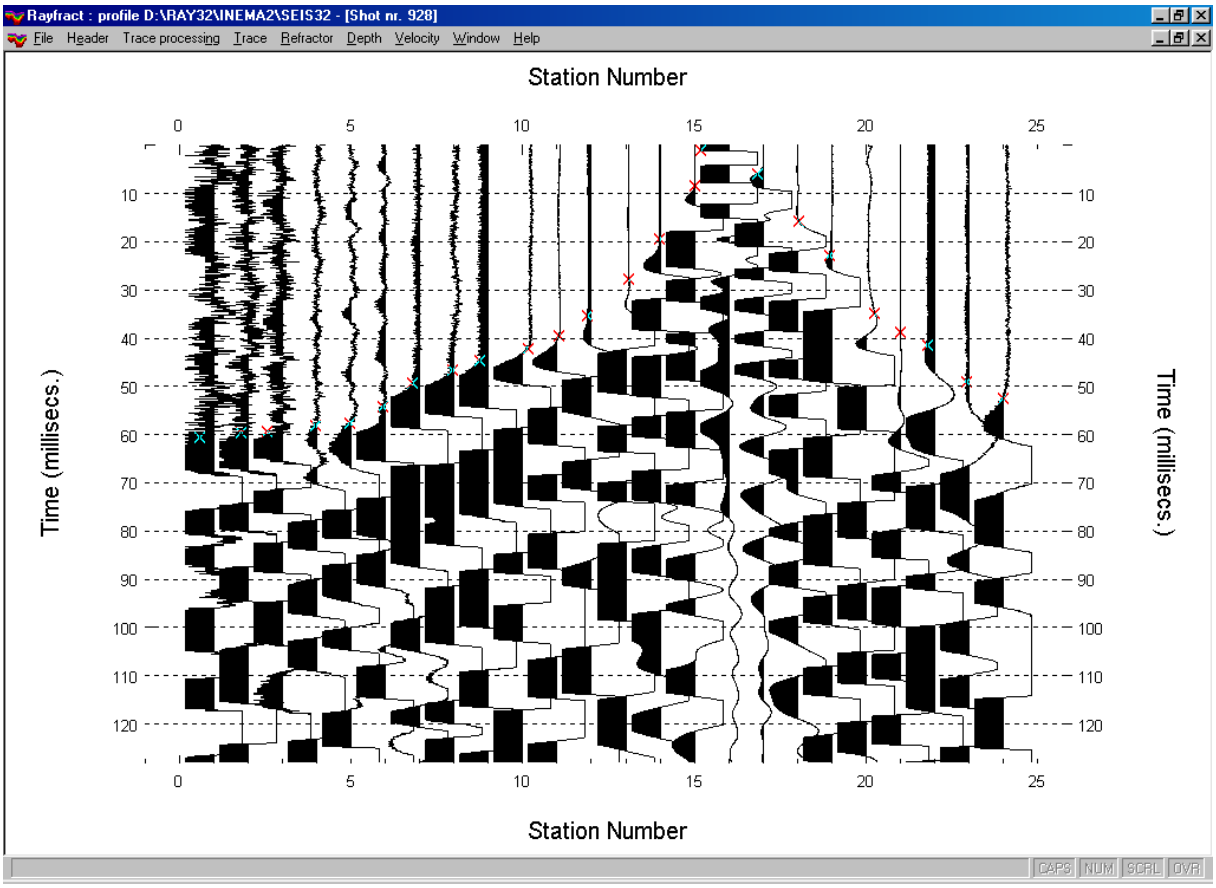
So shot position 120.30 for shot file 5934.dat for the receiver spread starting at position 0.0 (both positions in meters) is transformed into the station number 25.06, based on the receiver spacing of 5 meters as specified above.

Just hit RETURN or click on the „Read“ button once for every shot header displayed.

Displaying the shot records imported and picking the first breaks

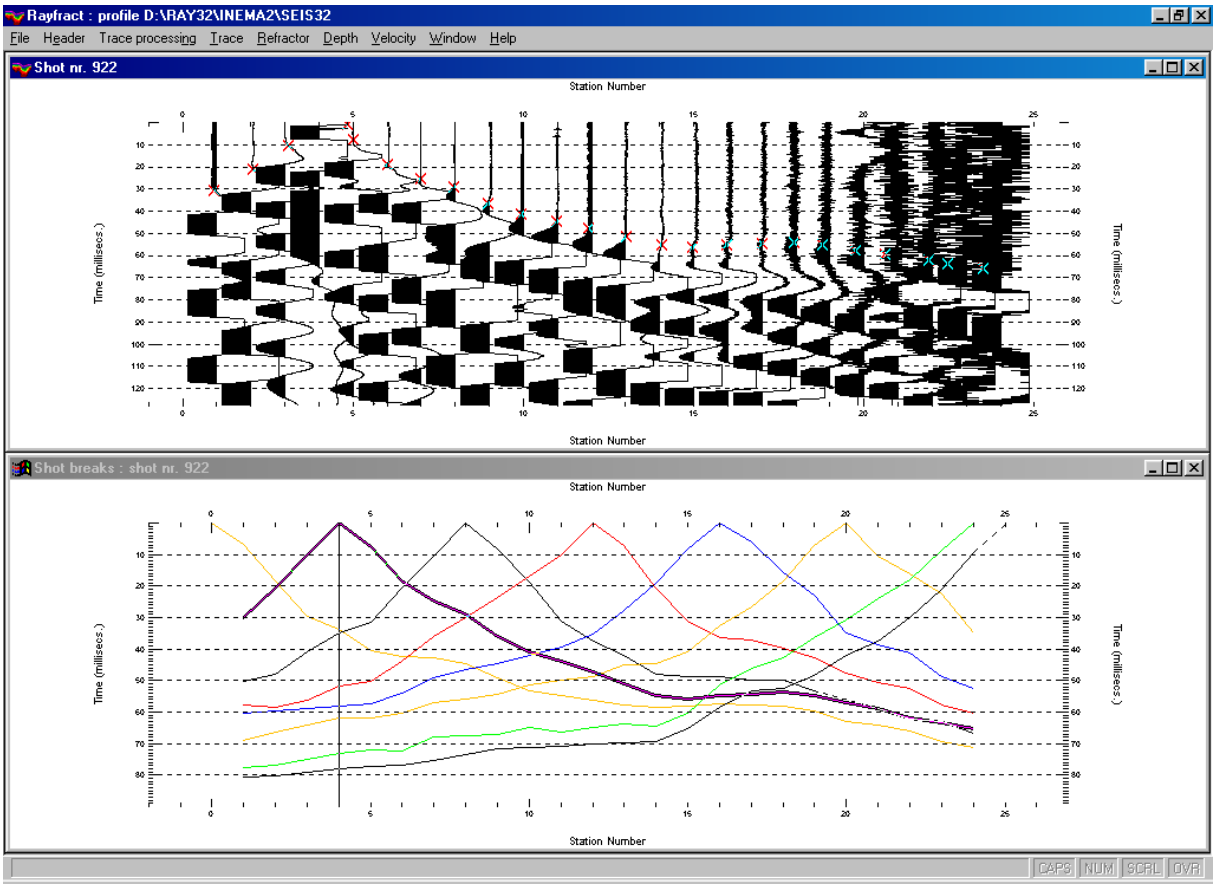
Since no .BPK Geometrics first breaks files were supplied with the .dat shot files, you need to pick the first breaks interactively from within Rayfract. Select item „Shot gather“ in menu „Trace“. Now select an appropriate trace display mode by pressing CTRL-F3 repeatedly. Finally, you may zoom the horizontal trace signal amplitude using CTRL-F1.

Pick the first breaks by moving the mouse cursor onto the trace and to the assumed first break location, and then clicking the left mouse key. Picks are visualized with a red cross. To delete a first break, press the SHIFT key and then click at the trace with the left mouse key.



Page through all shot records with function keys F7 and F8. Once you have picked first breaks for all traces and shots, you may initiate the Delta-t-V time-to-depth inversion of your data set. But first you have to specify the profile topography for all stations. Do this by selecting item „Station...“ in menu „Header“. Then enter the value „0.0“ in the edit field labeled „z“ and hit RETURN. The software will then extrapolate the elevation of 0 meters for all profile stations automatically.

You may want to repick first breaks such that traveltime curves are parallel / show the same features below the same station number, for different shot numbers / shot positions. To do this, select Window|Close All and then Trace|Shot gather. In the display as shown below, you may repick first breaks in the upper half, as before. Page through the traveltime curves and shots with F7/F8. Refresh the lower half „Shot breaks“ display to show the updated first break picks and traveltime curves by pressing ALT-Y whenever you have repicked one or more traces in the upper window.



Delta-t-V inversion of the first breaks

First make sure that Depth|Output Horizontal Offset of CMP pos. in meters is checked. If not so, select that menu item to check it. Now make sure that Depth|Output Measured CMP Velocity is unchecked. Then select Depth|CMP Velocity vs. Depth (Delta-t-V). When the „Parameters for Delta-t-V method“ dialog is displayed, just hit RETURN once to accept the default parameter values.

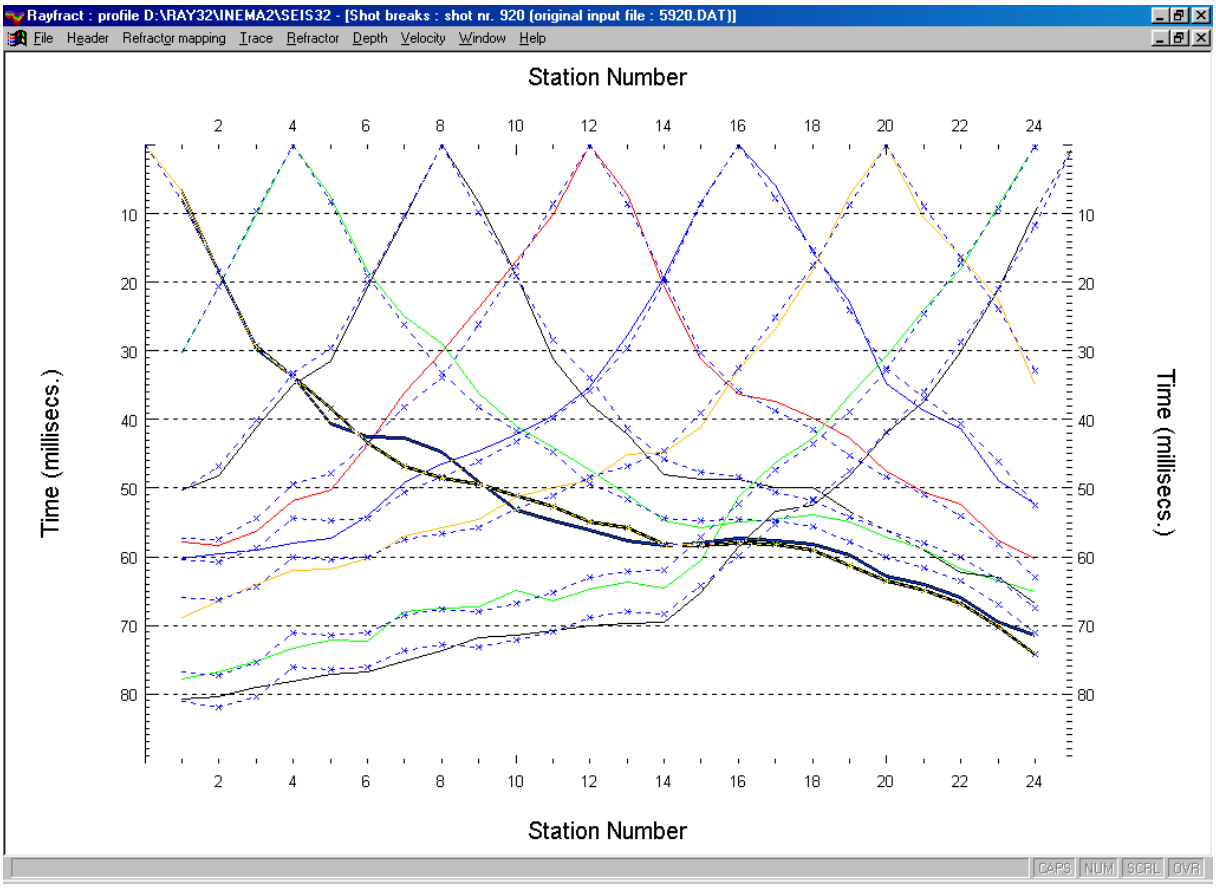
Once the inversion has been carried out, Rayfract will store the results into a comma-separated value file named DELTATV.CSV into directory \RAY32\INEMA2. You may grid and contour the station nr.-depth-velocity triples contained in this file with Surfer or a similar scientific data plotting package. See chapter „Delta-t-V Inversion“ of your Rayfract online help (rightmost Rayfract menu „Help“, item „Contents“) for details, or follow these instructions (assuming that you use Surfer version 7) :

Start up Surfer and select Grid|Data. Then select file \RAY32\INEMA2\DELTATV.CSV. Change values for the two edit fields in column „# of Lines“ for rows „X Direction“ and „Y Direction“ to 400 and 152, respectively. This will ensure that grid cells are small and about quadratic, a prerequisite for raytracing and tomography processing. Adjust Y Dir. # of Lines until the Y Dir. size of the cell (row spacing, as indicated in the previous column) optimally matches the X Dir. size of the cell i.e. column spacing. Now click on the OK button, of the „Scattered Data Interpolation“ dialog.

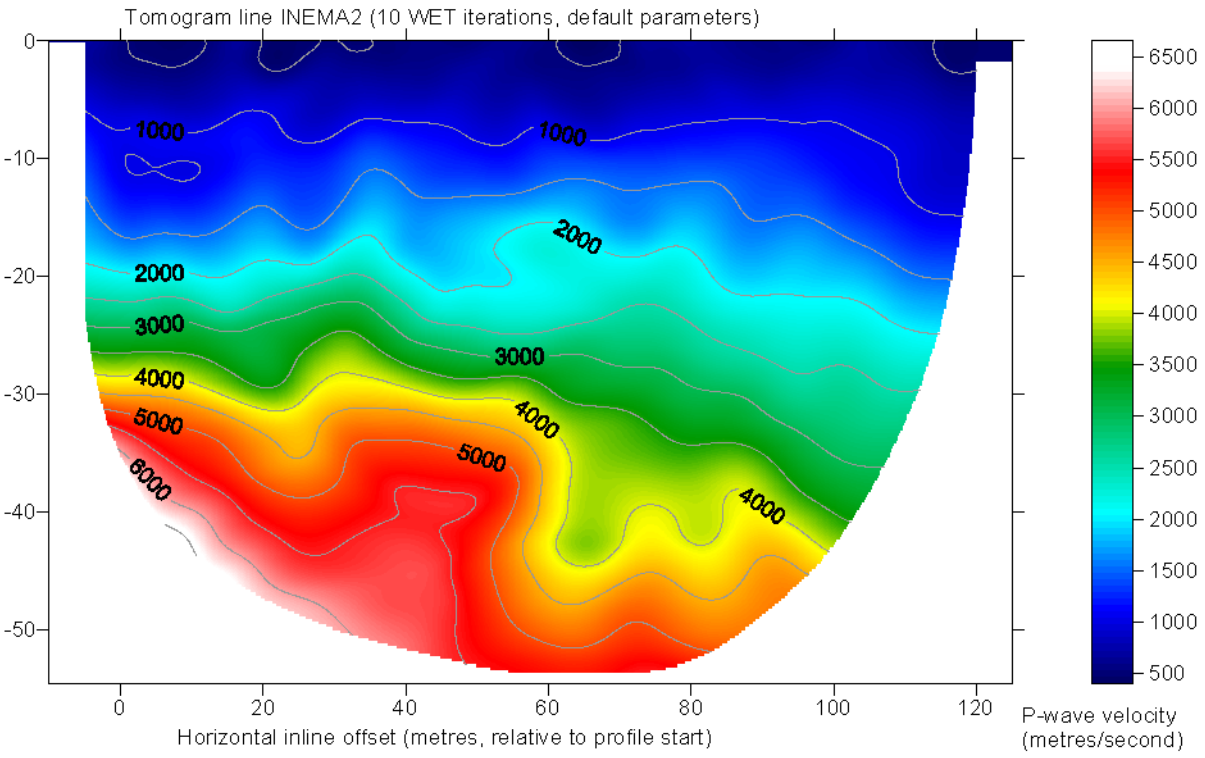
Refining Delta-t-V velocity model with tomography processing

Now select Depth|Tomography processing of traveltimes ... . Then click on button „Select“ and specify the DELTATV.GRD file as generated above. Leave all other processing parameters at their default values. To generate subsurface coverage maps showing the number of ray paths going through each 2D section pixel, click on button „Edit grid file generation“ and enable option „Write section coverage grids after each iteration“. Click on „Accept parameters“. Now click on button „Start tomography processing“.

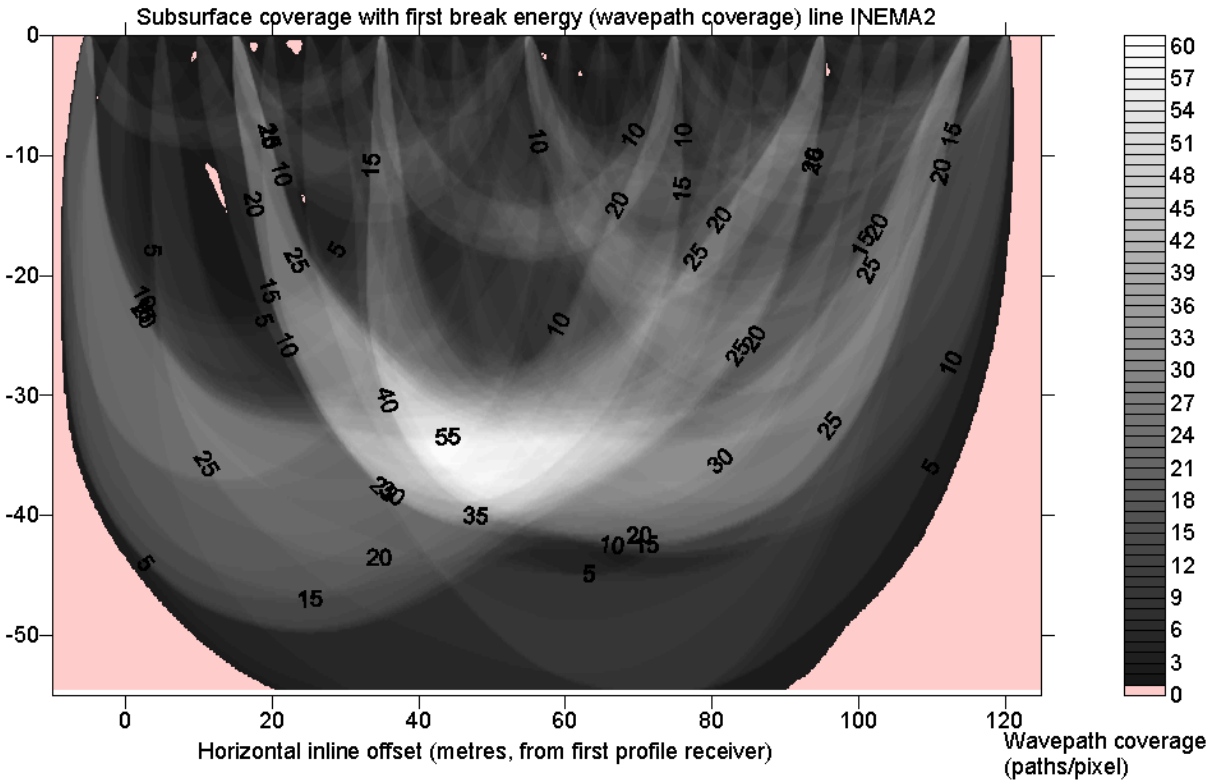
Once the tomography processing has terminated after 10 iterations and about five minutes of processing time (on Pentium III processor at 500 MHz), select Refractors|Shot breaks to display picked and synthesized traveltimes together as shown below :



To contour and display tomogram as just obtained, open Surfer 7 and select Map|Contour Map|New Contour Map... . Then specify the VELOIT10.GRD file as just generated by Rayfract. Click on check boxes „Fill Contours“, „Smooth Contours“ and „Color Scale“, in the „Contour Map Properties“ dialog. Then click on OK. Once the contour smoothing has finished and the resulting contour map is displayed, select it with the left mouse key. Now select Map|Scale and deselect the bottom left check box „Proportional XY Scaling“. Then enter a values of 6.0 in colum „Length“ of the upper row „X Scale“ and a value of 4.0 in column „Length“ for the lower row „Y Scale“. Then click on OK. Now save the Surfer plot with File|SaveAs... and specify filename \RAY32\INEMA2\VELOIT10.SRF. Then scale the output to the whole screen with View|Fit to Window. You will obtain a plot similar to the one shown here :



To obtain a 2D vertical subsurface section showing the coverage of each 2D pixel with ray paths, just contour the file COVERG10.GRD. In the Surfer 7 Contour Map Properties dialog (as displayed when double clicking on the plot), click on tab „Levels“ and then on column header „Level“. Now set parameter „Minimum“ to 0 and „Interval“ to 2. Then click on „OK“. Now double click on the topmost row of column „Fill“ (for level 0) and specify e.g. pink as foreground and background color. Click on column header „Line“ and select Style „Invisible“. Then accept all edited dialogs with „OK“. You will obtain a composite image of all wave paths as shown below (brighter color means higher coverage with first break energy) :



The Geometrics SmartSeis .DAT SEG-2 formatted input files used to import the binary trace data as described above are available on the web :

http://rayfract.com/tutorials/INEMA2.ZIP .

For theoretical background of our new tomography algorithm, see Wavepath eikonal traveltime inversion: Theory (Gerard T. Schuster and Aksel Quintus-Bosz 1993, GEOPHYSICS VOL. 58 NO. 9 September 1993, P. 1314 – 1323) as formerly available on the web :

For more information, please go to our web site

http://rayfract.com .