RAYFRACT Tutorial specific to N.I.R.M. test profile / shots 74 to 78 :

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

This tutorial describes how to import and process ABEM Terraloc Mk6 SEG-2 trace data files 000074.SG2 to 000078.SG2. These files are available on our web site :

http://rayfract.com/tutorials/nirmseg2.zip . Download the .zip archive. Uncompress it with PKUNZIP.EXE or similar in a temporary directory e.g. C:\TEMP .

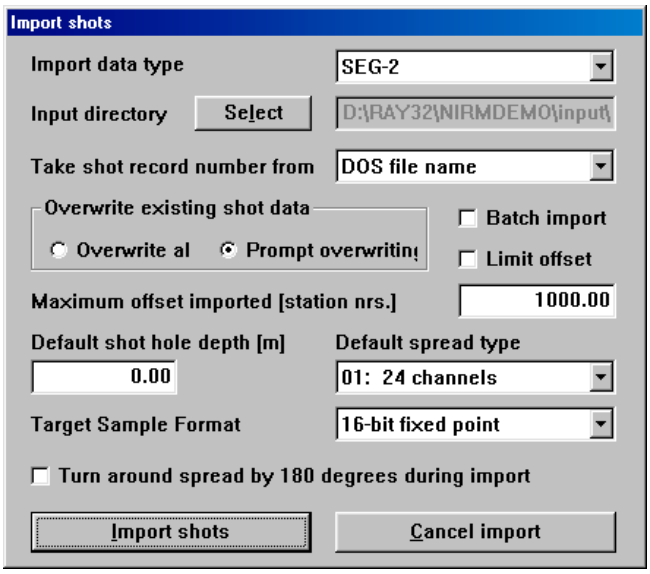
In the following, the shorthand notation File|New Profile means : select menu item „New Profile“ in menu „File“.

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 „NIRMDEMO“ or similar in the text field labeled „File name“. Then hit RETURN.

Now select Header|Profile. Enter text strings „N.I.R.M. shots 74 to 78“, „Test profile“ and „ABEM Terraloc Mk 6“ into the three top left edit fields labeled „Line ID“, „Job ID“ and „Instrument“. Enter the profile receiver spacing of 5.0 (minimum distance between adjacent receiver stations, in meters) ino the edit field labeled „Receiver spacing“. Now hit RETURN. Confirm the prompt „Is new profile spacing valid ?“ with RETURN.

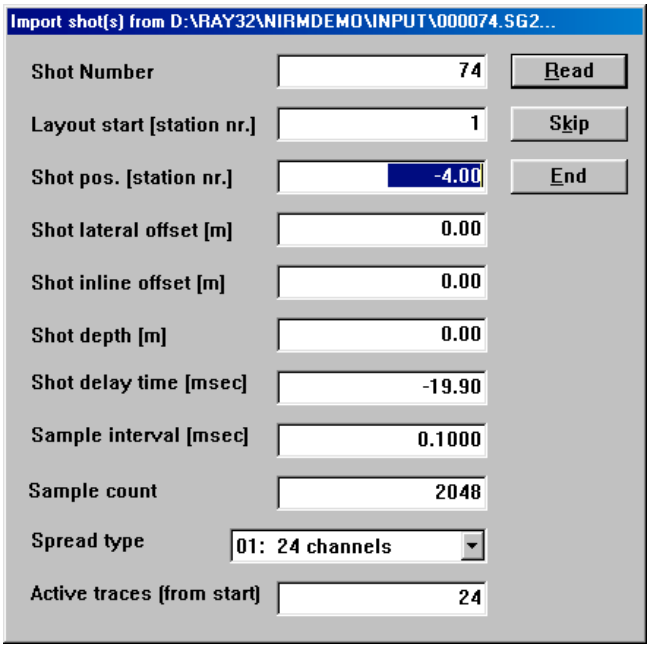
Now create a subdirectory named „INPUT“ or similar, in directory \RAY32\NIRMDEMO. Do this from within your Windows Explorer or in a DOS box. To start up Windows Explorer, select item „Windows Explorer“ in menu „Programs“ as displayed when clicking on the Windows 98 „Start“ button. To open a DOS box, select item „MS-DOS Prompt“ in the same menu. Copy the five .SG2 trace data files into this new subdirectory. See your Windows documentation and online help for information on how to create subdirectories and copy files.

Select File|Import Data.... Your Rayfract software will display the „Import shots“ dialog as imaged below. Be sure to adjust edit fields to values as displayed.



Specify the correct Rayfract input directory by clicking on button „Select“. Then nagivate to your \RAY32\NIRMDEMO\INPUT directory, select one of the .SG2 files and hit RETURN.

Now start the import of the SEG-2 trace files by clicking on button „Import shots“. Confirm the prompt „Reset model and geometry data ?“ with RETURN. In the following, the „Import shot“ dialog will be displayed as shown below, once for each shot record to be imported.



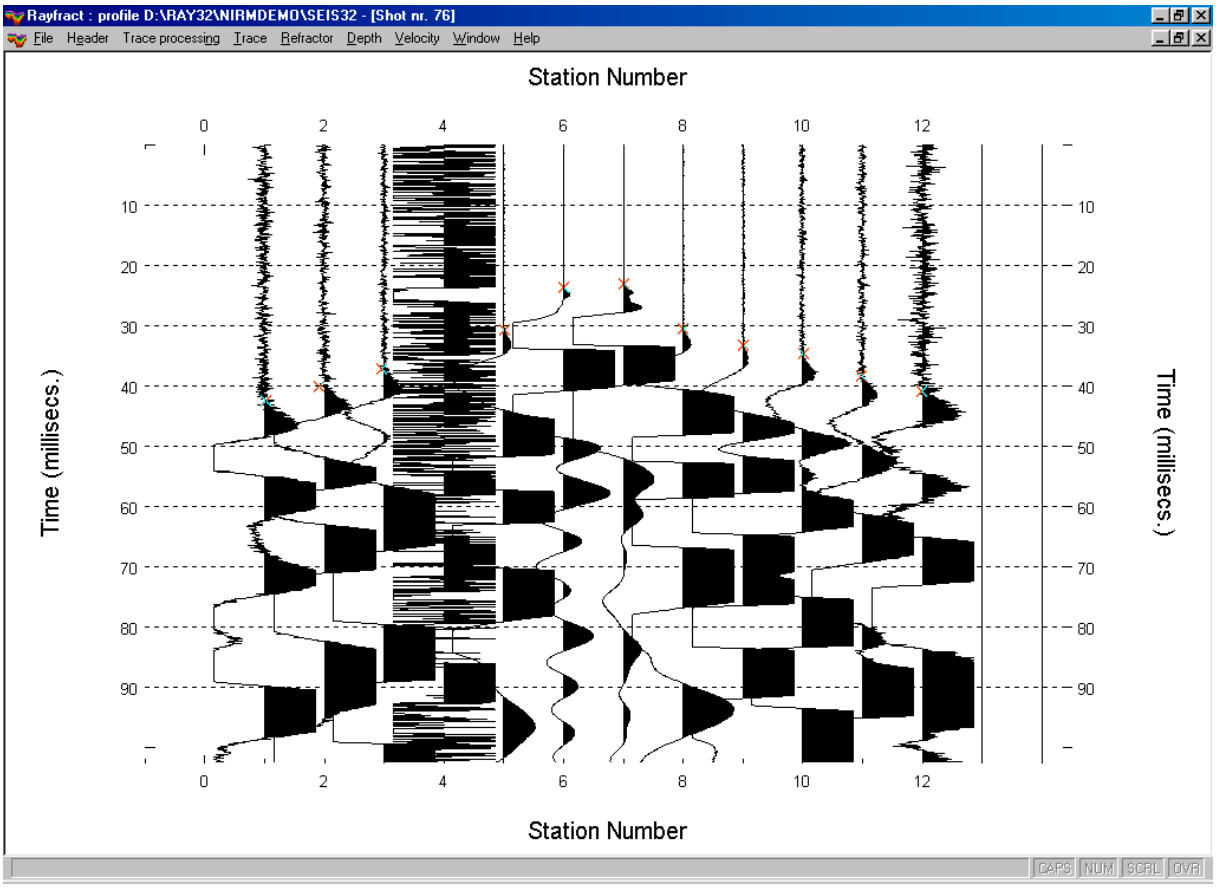
Correct the „Shot pos. [station nr.]“ field value for the first shot nr. 74 (as shown at left) to –4.0. Then hit RETURN or click on „Read“ button once for every shot header displayed. Correct „Shot pos.“ for shot nr. 77 to 17.0, and for shot nr. 78 to 13.0. Shot positions for the other two shots are specified correctly in the .SG2 input files.

Displaying the shot records imported and picking the first breaks

Since no .FIR ABEM first breaks files were supplied with the .SG2 shot files, you need to pick the first breaks interactively from within Rayfract. Select Trace|Shot gather. Zoom the horizontal station number axis once with SHIFT-F1. Zoom the vertical time axis by pressing function key F1 once. Now select an appropriate trace display mode by pressing CTRL-F3 repeatedly. Finally, you may zoom the horizontal trace signal amplitude using CTRL-F1 to obtain a display similar to the one as shown on the next page.

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. You may delete a pick by pressing the SHIFT key and then clicking on 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. Confirm the prompt „Changed station coordinates : confirm processing ?“ with RETURN. The software will then extrapolate the elevation of 0.0 meters for all profile stations automatically.



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. Then select Depth|Delta-t-V method(CMP Velocity vs. Depth)... . When the „Parameters for Delta-t-V method“ dialog is displayed, just hit RETURN once to accept the default parameter values. Confirm the dialog „Save Delta-t-V output - accept proposed or enter own file name“ with RETURN. Accept the message entitled „Match of Delta-t-V inverted to measured CMP layer bottom velocities“ with RETURN.

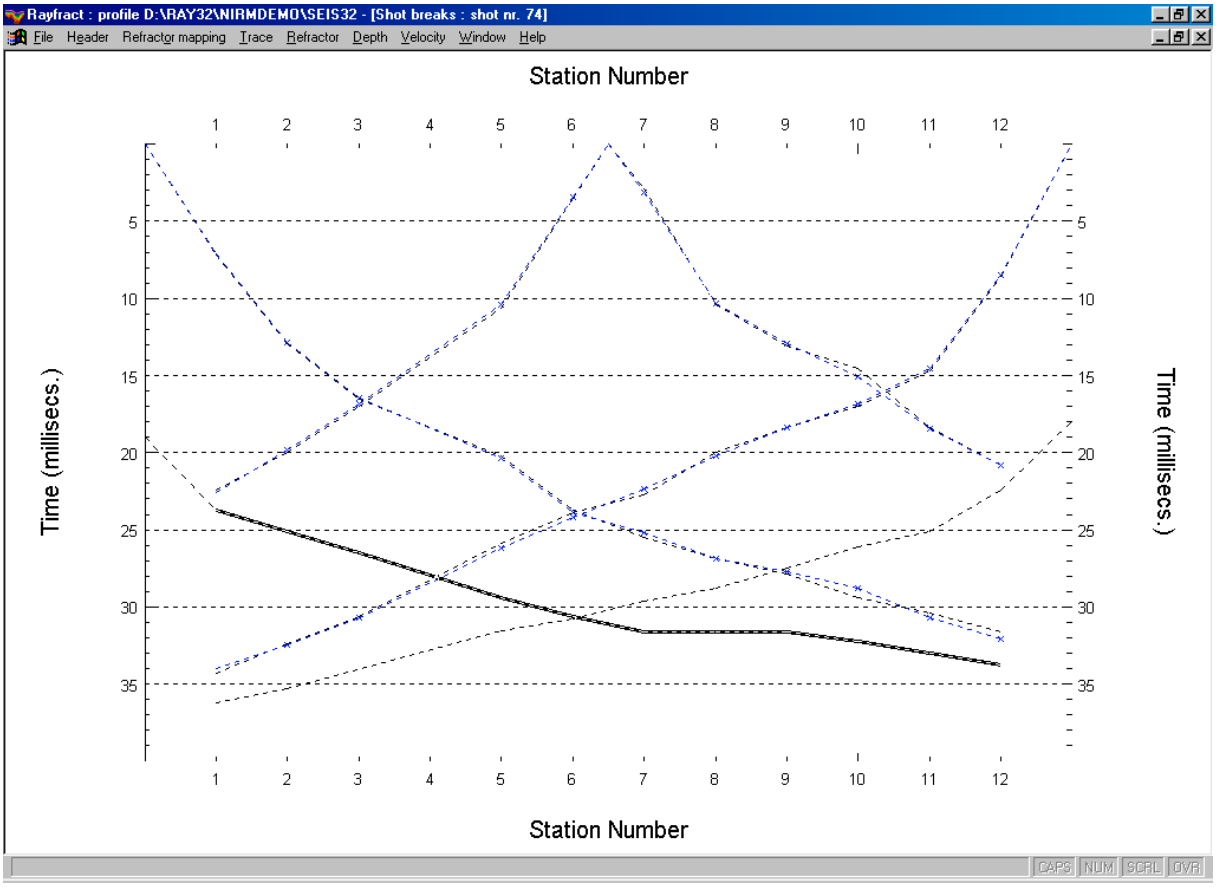
Once the inversion has been carried out, Rayfract will store the results into a comma-separated value file named DELTATV.CSV and into directory \RAY32\NIRMDEMO. Grid the horizontal inline offset-depth-velocity triples contained in this file with Surfer. See chapter „Delta-t-V Inversion“ of your Rayfract online help (rightmost Rayfract menu „Help“, item „Contents“) for details, or follow these instructions (assuming you are using Surfer version 7) :

Start up Surfer and select Grid|Data. Then select file \RAY32\NIRMDEMO\DELTATV.CSV. Change values for the two edit field in column „# of Lines“ for rows „X Direction“ and „Y Direction“ to 600 and 202, respectively. 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. This will ensure that grid cells are small and about quadratic, a prerequisite for raytracing and tomography processing. Now click on the OK button, of the „Scattered Data Interpolation“ dialog. Surfer 7 will do the kriging and gridding and generate a disk grid file named DELTATV.GRD.

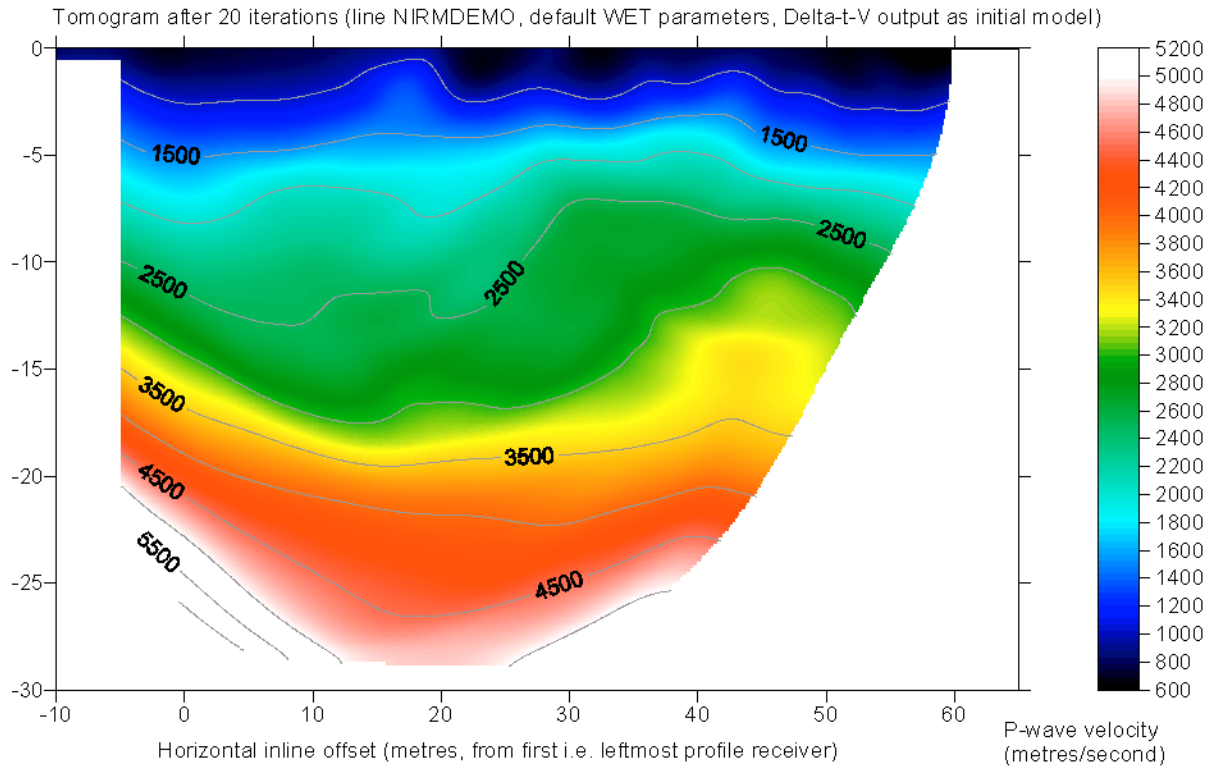
Refining Delta-t-V velocity model with tomography processing

Now select Depth|Tomography processing of traveltimes ... . Then click on button „Select“ and specify the DELTATV.GRD file as generated above. Click on button „Accept parameters“. Then change parameter „Number of WET tomography iterations“ to 20. 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 20 iterations and about seven 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 :



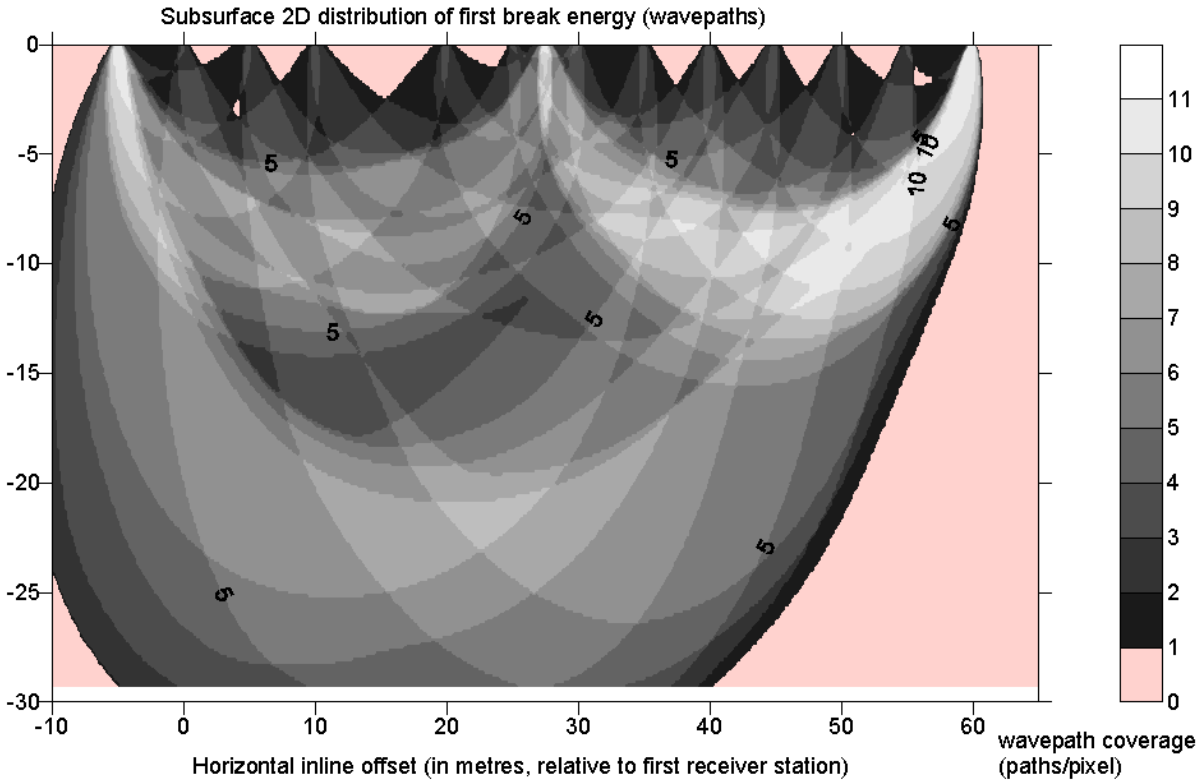
Now contour the output of the final tomography iteration as stored in file VELOIT20.GRD (as described e.g. in tutorial line14.pdf) :



Possible explanations for a gradual increase of accoustic i.e. p-wave propagation velocity with depth are :

- systematically increasing pressure on the rock, with increasing burial depth and as exercised by the geological sequences lying above it.
- the topmost regions of most geological units / strata may have been directly exposed to the atmosphere at some time in the geological past and may have undergone significant weathering and fracturing as a consequence.

To obtain a 2D vertical subsurface section showing the coverage of each 2D pixel with ray paths, just contour the file COVERG20.GRD. In the Surfer 7 Contour Map Properties dialog (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 1. 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“. Limit the data range displayed and scale the plot as described e.g. in tutorial line14.pdf, to obtain a composite image of all wave paths as shown below (brighter color means higher coverage with first break energy) :



For theoretical background information on 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) .

For more information regarding our Rayfract™ software, please go to our web site

http://rayfract.com .