CHAPTER 1

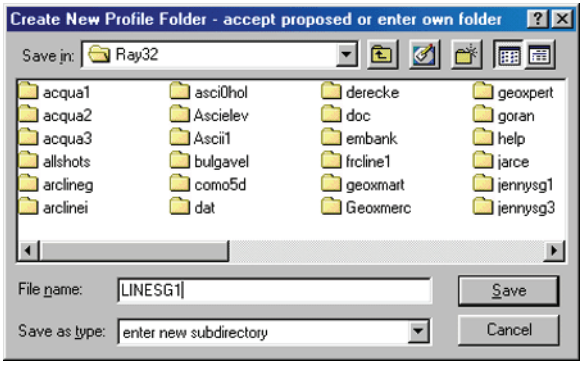
Tutorial

This chapter gives a short overview of the interpretation of seismic refraction traveltime data with Rayfract™. For more detailed instructions, please refer to the online help and tutorials as available on our web site.

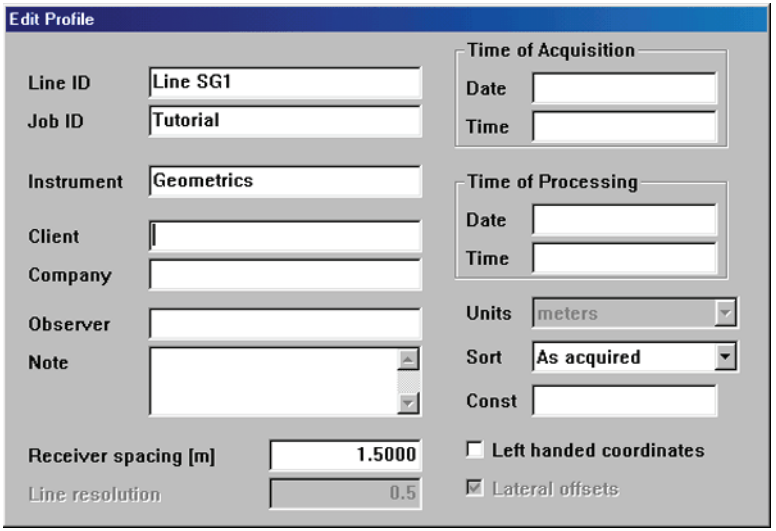
CHAPTER 1 *Tutorial*

1.1 Create new profile

1. Select File|New Profile... .
2. Set *file name* to LINESG1 and click on *Save*.



3. Select Header|Profile.

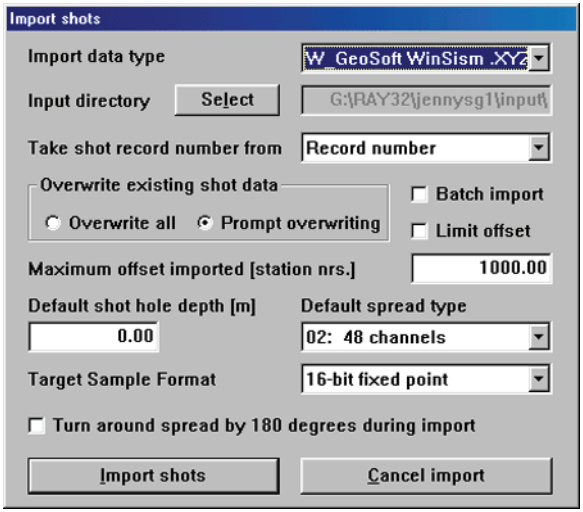


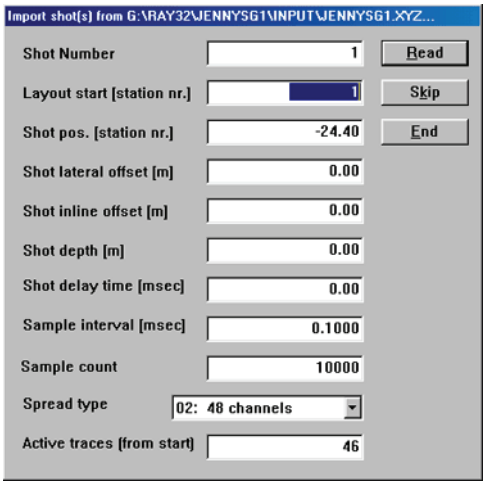
4. Set *Line ID* to Line SG1 and *Job ID* to Tutorial.
5. Set *Instrument* to Geometrics, *Receiver spacing* to 1.5 metres.
6. Hit RETURN, and confirm the prompt.

1.2 Seismic data import

Your software supports the import of both binary trace data and ASCII formatted files with first breaks and recording geometry, as generated with popular third-party packages. We use the sample W_GeoSoft WinSism file JENNYSG1.XYZ to get you started.

1 Download http://rayfract.com/samples/JENNYSG1.ZIP into a temporary directory.
2 Copy JENNYSG1.ZIP into directory \RAY32\JENNYSG1\INUT and unzip it.
3 Select File|Import Data to obtain a dialog as shown here :

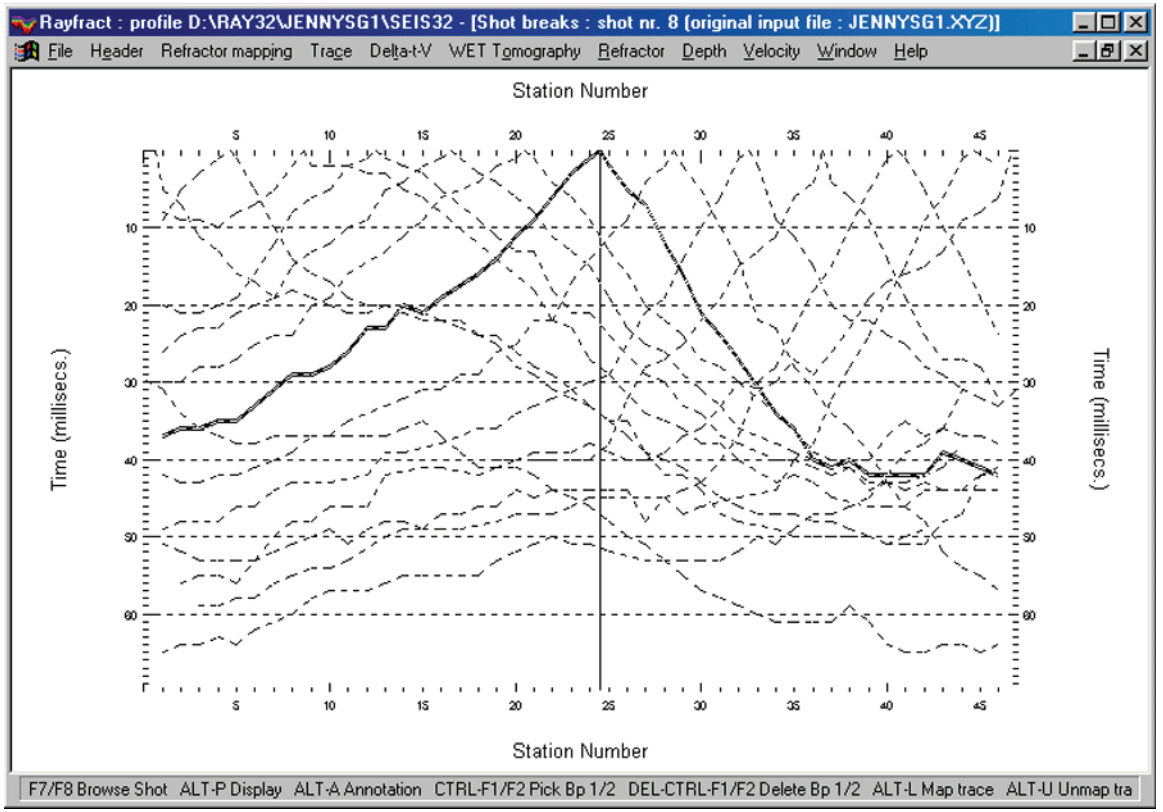




4 Set *Import data type* to W_GeoSoft WinSism .XYZ.
5 Click *Select*, select file JENNYSG1.XYZ in \RAY32\JENNYSG1\INPUT, click *Open*.
6 Set *Default shot hole depth* to 0.5 metres.
7 Set *Default spread type* to 02: 48 channels.
8 Click on *Import shots*, and confirm the prompt.
9 If required, edit *Shot pos.*, *Layout start* etc. in the following dialog. See above at right.
10 Click on *Read* for all shots as displayed in that dialog, once you have edited these values.
11 Click on *Skip* for shots which you do not want to import at this time, in the same dialog.

1.3 Review first breaks

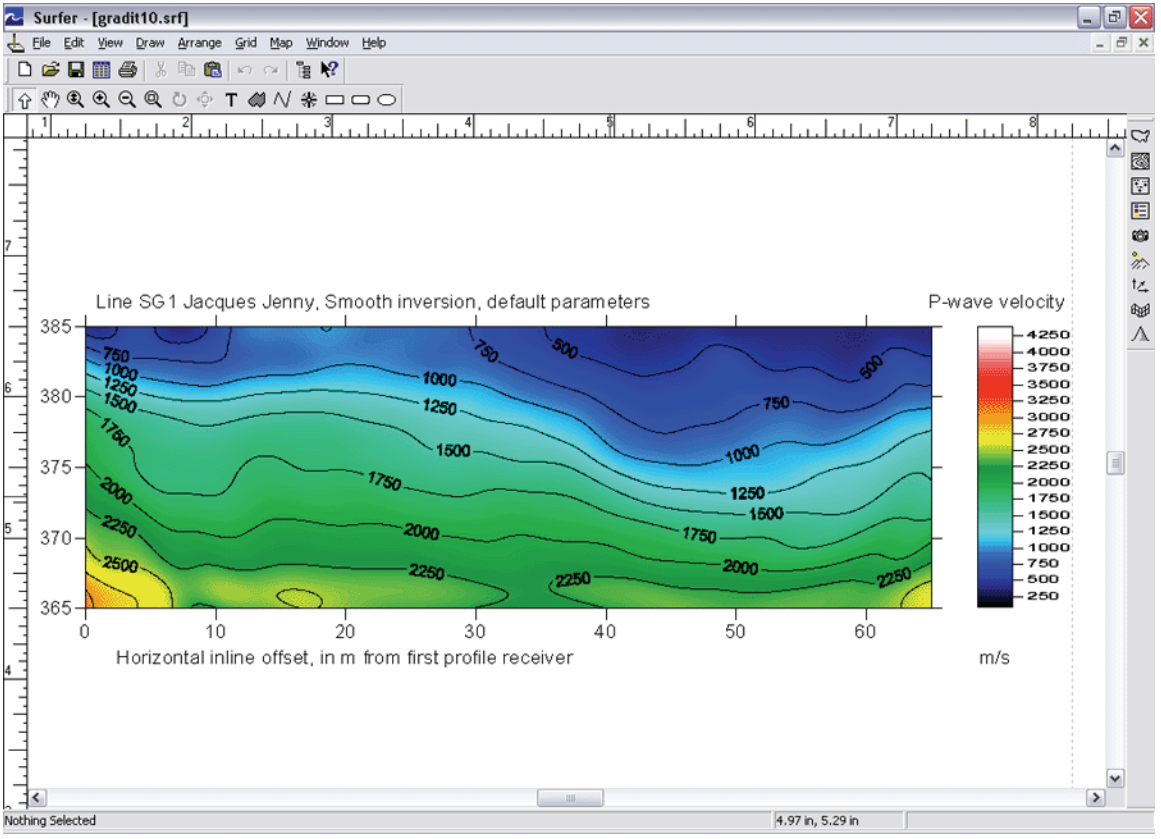
1. Select Refractor|Shot breaks to obtain a display as shown below.
2. Press ALT-P to show the *Display parameters* dialog.
3. Set *Minimum station number* to 0, and *Maximum station number* to 47.
4. Set *Maximum time* to 70 msecs. and hit RETURN.
5. Browse shot sorted traveltime curves with F7 / F8.
6. Verify that the minimum time of each inline shot curve coincides with the shot location.
7. If not, reimport the shot, with the corrected *Shot pos*. Skip all other shots. See section 1.2.



1.4 Smooth inversion

Please note that our Smooth inversion method requires 10 or more shots per profile and a close shot point spacing (ideally one shot point at every 3rd receiver; at least one shot point at every 6th receiver) for reliable results.

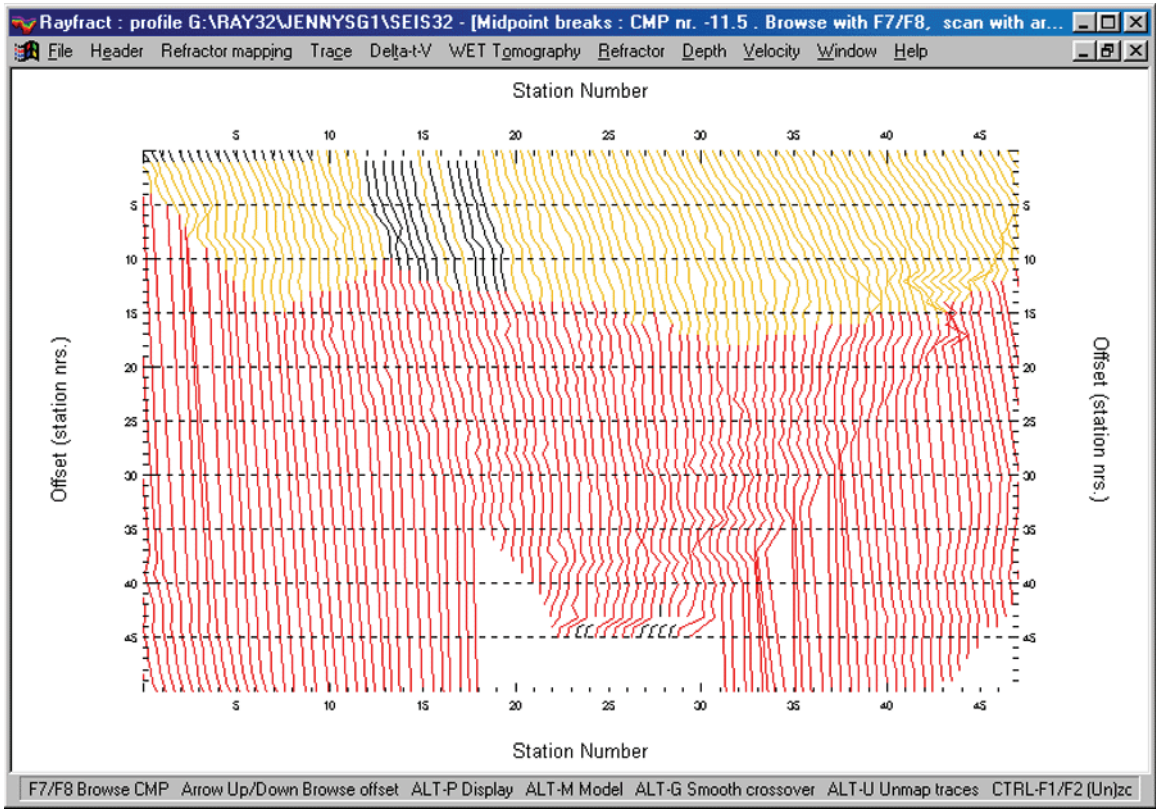
1. Select Smooth inversion|WET with 1D gradient initial model.
2. Once the 1D gradient model is shown in Surfer™, click on the Rayfract™ icon to continue.
3. Confirm the following prompts.
4. Size the resulting plot and add text within Surfer™ ; see below.



5. Select Refractor|Shot breaks to display picked and synthesized (blue) first breaks together.

1.5 Automatic refractor mapping

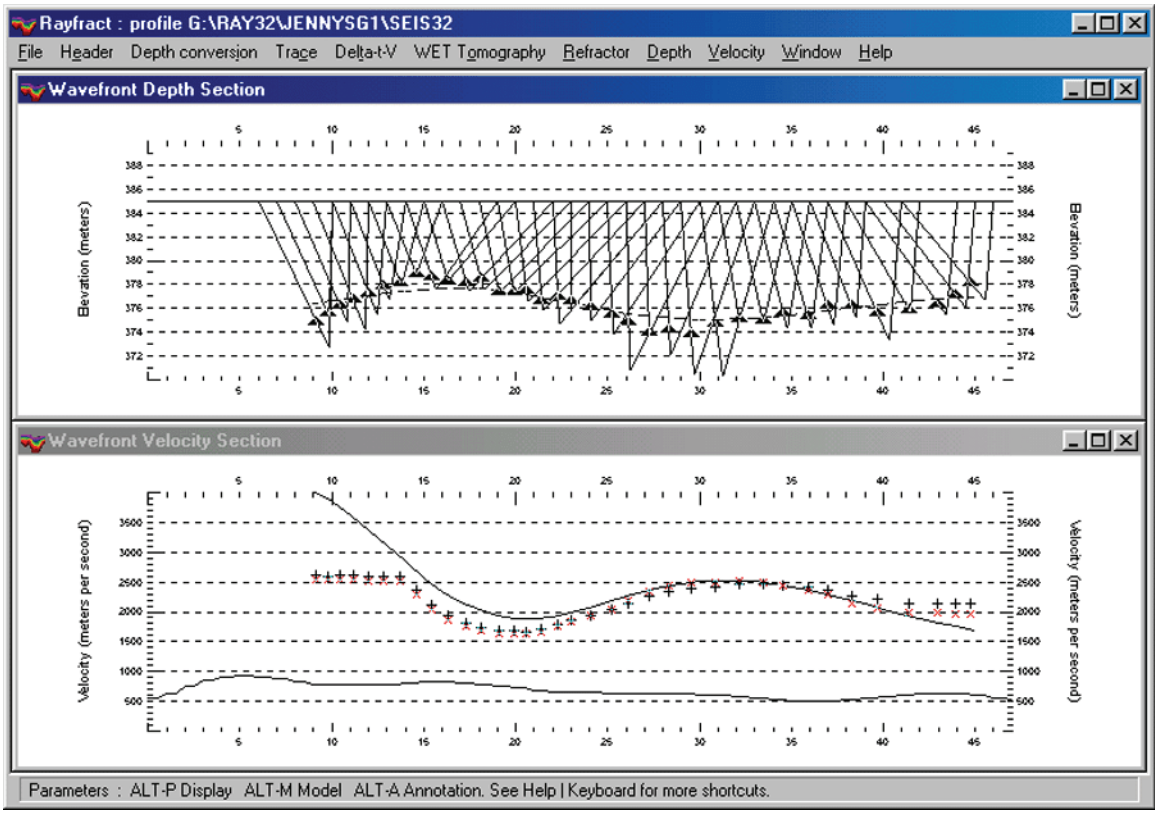
1. Select Refractors|Midpoint breaks and zoom time axis with CTRL-F1.
2. Display the *Refractor mapping* dialog with ALT-M.
3. Now set *Refractor count* to 1 and hit RETURN.
4. Press ALT-G to display the *Crossover distance* dialog.
5. Set *Overburden filter* to 10, and *Basement filter* to 20.
6. Hit RETURN to obtain a display as shown below.



7. Select Header|Station to display the *Station editor*, and click on button *v0 from CMP*.
8. Confirm the prompt and then hit ESC to leave the dialog.

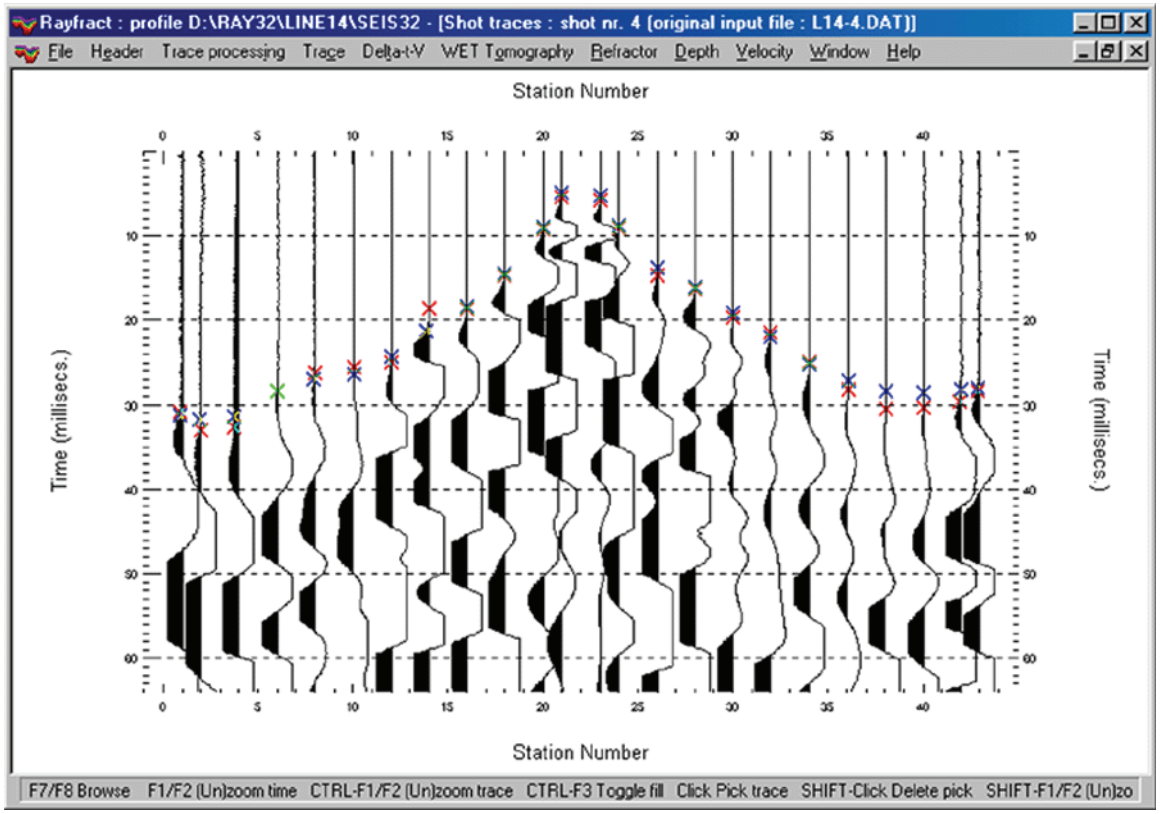
1.6 Wavefront method

1. Select Window|Close All and then Depth|Wavefront.
2. Confirm the following prompts.
3. Select Depth conversion|Display Wavefront rays.
4. Press ALT-P to show the *Display parameters* dialog.
5. Set *Minimum station number* to 0, and *Maximum station number* to 47. Hit RETURN.
6. Select Velocity|Wavefront. Scale the plot as in previous two steps.
7. Select Window|Tile horizontal to obtain a display as shown here :



1.7 Automatic picking

1. Select File|Open Profile... . Double click on folder LINE14, and click on file SEIS32.DBD.
2. Click on *Open*. Select File|Export header data|Export First Breaks and hit ENTER.
3. Select Trace|Shot gather. Browse to shot nr. 4 by pressing F8 five times.

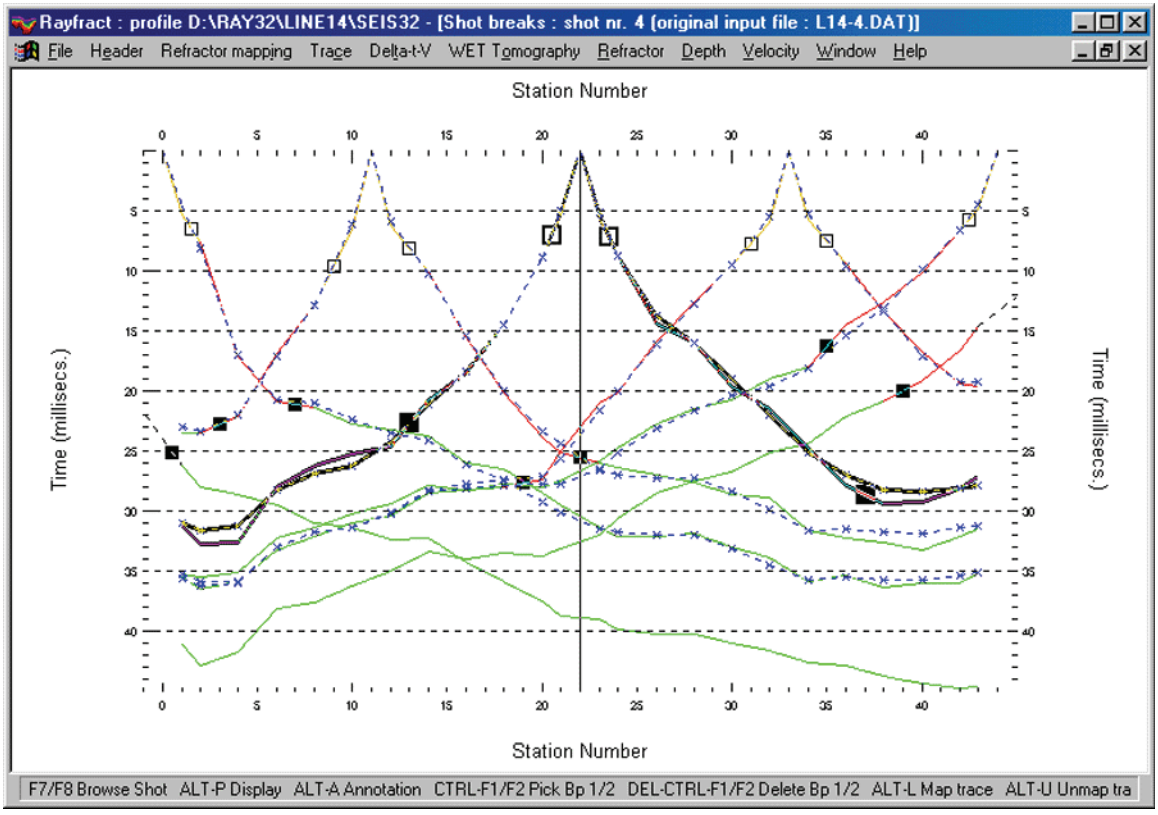


4. Maximize the shot gather window by double clicking on its title bar.
5. Zoom up time by pressing F1 once. Adapt the trace fill mode by pressing CTRL-F3 twice.
6. Zoom up the trace signal amplitude by pressing CTRL-F1 three times.
7. Press ALT-B to show the *Automatic first break picking parameters* dialog.
8. Set the *First break envelope length* to 50 msecs. and hit RETURN.
9. Select File|Update header data|Update first breaks, click on BREAKS.LST and click *Open*.

1.8 Manual refractor mapping

1 Select Window|Close All and then Refractor|Shot breaks.

2 Browse to shot nr. 4 by pressing F8 five times to obtain the following display :



3 Press the left arrow key a few times to move the vertical pick bar to station nr. 19.

4 Press CTRL-F1 to move branch point 1 for reverse shot nr. 4 to station nr. 19.

5 Press the right arrow key a few times to move the pick bar between station nrs. 20 and 21.

6 Press CTRL-F1 again to move branch point 1 to the more realistic station nr. 20.5.

7 Press ALT-L to confirm, validate and store the new trace to refractor mapping.

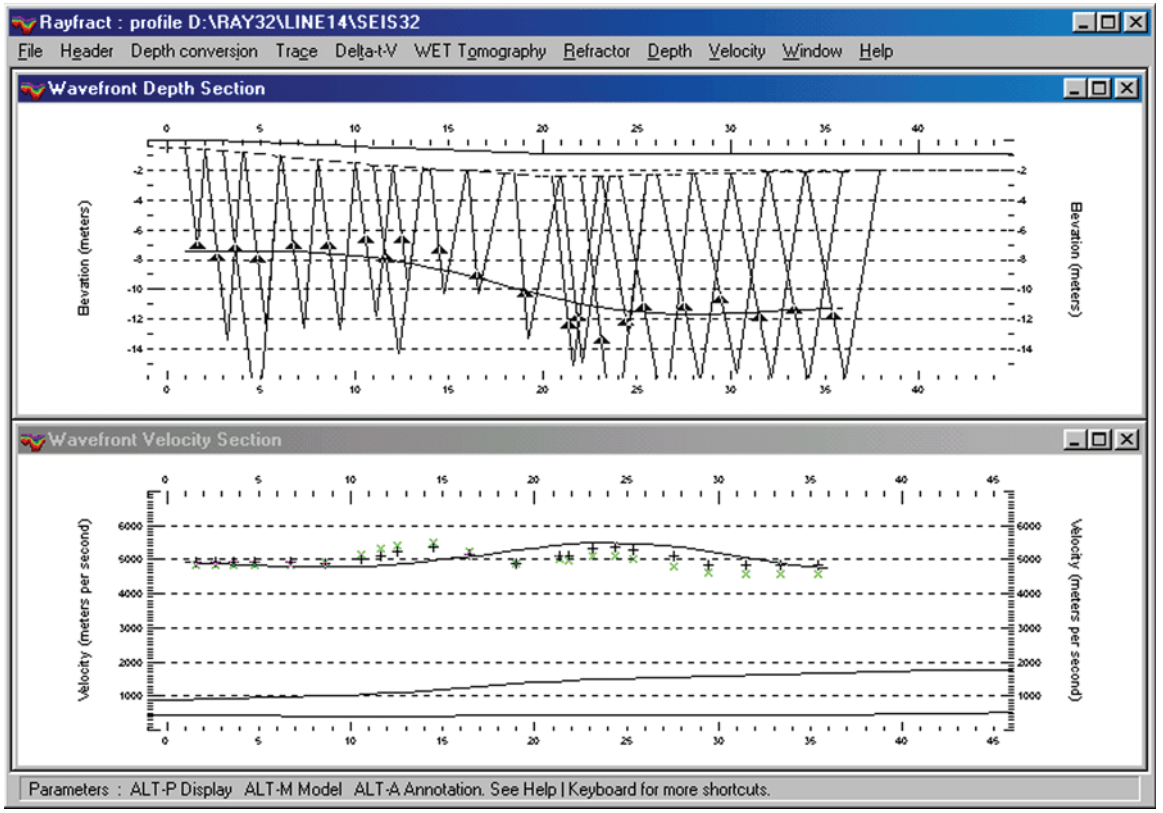
8 Press the left arrow key until the branch point pick bar is located at station nr. 11.

9 Press CTRL-F2 to move branch point 2 for reverse shot nr. 4 to station nr. 11.

10 Press ALT-L again to confirm and store the updated trace to refractor mapping.

1.9 Wavefront LINE14

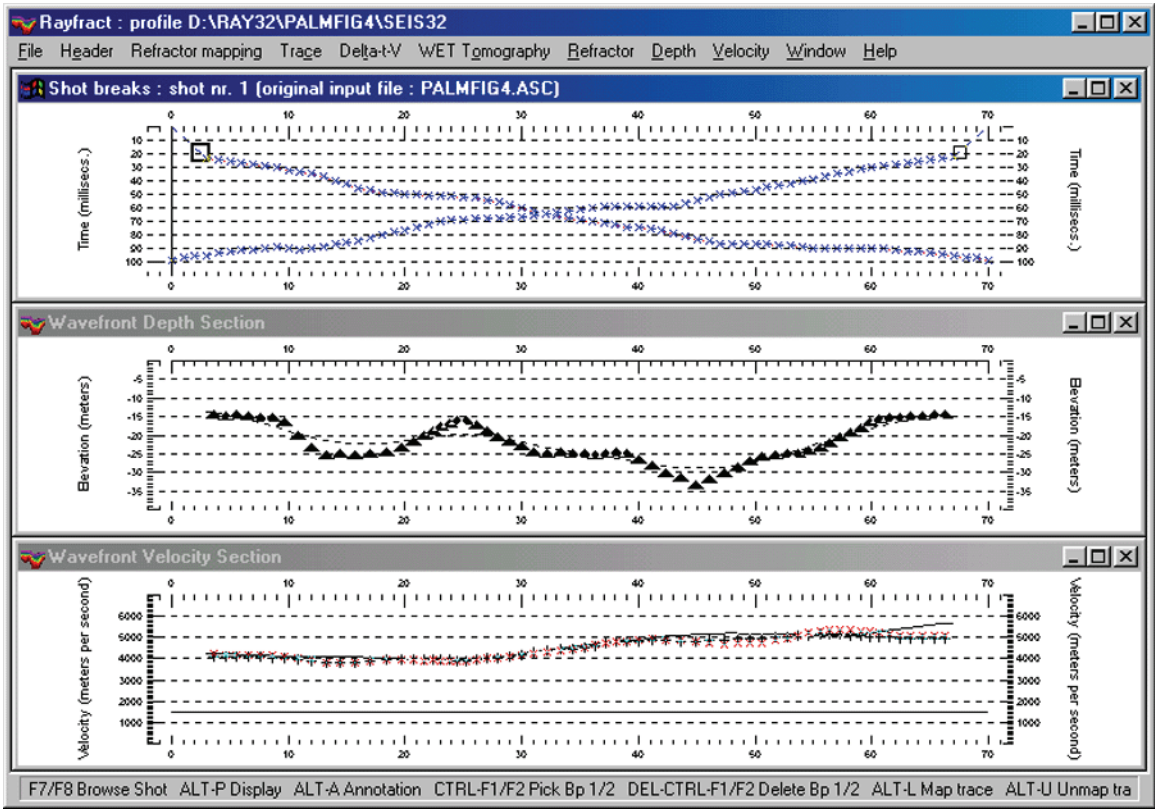
1. Select Header|Station to display the *Station editor*, and click on button *v0 from Shots*.
2. Confirm the prompt and then hit ESC to leave the dialog.
3. Select Window|Close All and then Depth|Wavefront. Confirm the following prompts.
4. Select Depth conversion|Display Wavefront rays.
5. Scale the *Wavefront depth* and *Wavefront velocity* sections as described in section 1.6.
6. Select Window|Tile horizontal to obtain a display as shown here :



Our Wavefront method is a ray inversion method based on publications by E. Brueckl 1987, and Glyn M. Jones and D. B. Jovanovich 1985. We support modeling of one or two refractors.

1.10 Wavefront PALMFIG4

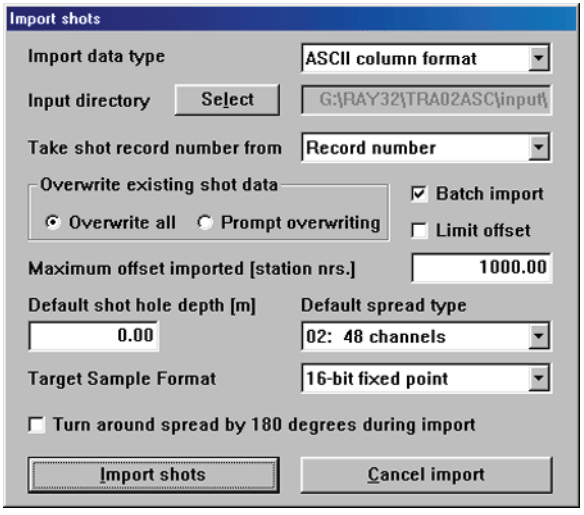
1. Create a subdirectory PALMFIG4 with Windows Explorer, in your \RAY32 directory.
2. Download http://rayfract.com/samples/PALMFIG4.ZIP into a temporary directory.
3. Copy PALMFIG4.ZIP into \RAY32\PALMFIG4 and unzip it.
4. Select File|Open Profile... . Double click folder PALMFIG4, and open file SEIS32.DBD.
5. Select Velocity|Wavefront, Depth|Wavefront and Refractor|Shot breaks.
6. Select Window|Tile horizontal to obtain a display as shown here :



Above two traveltime curves are the synthetic first breaks for model “Flat topography irregular refractor” as listed on page 90-91 of Derecke Palmer 1980. The Generalized Reciprocal Method Of Seismic Refraction Interpretation. Society of Exploration Geophysicists, Tulsa. ISBN 0-931830-14-1. See also Fig. 4 on page 17 and Fig. 5 on page 18, same reference.

1.11 ASCII data import

1 Create a new profile named TRA02ASC, as shown in section 1.1. Select Header|Profile.
2 Set *Line ID* to TRA9002, *Job ID* to ASCII Import, and *Receiver spacing* to 5 metres.
3 Set *Instrument* to BISON, hit RETURN and confirm the prompt.
4 Download http://rayfract.com/samples/TRA02ASC.ZIP into a temporary directory.
5 Copy TRA02ASC.ZIP into \RAY32\TRA02ASC\INPUT and unzip it.
6 Select File|Import Data... and set *Import data type* to ASCII column format.
7 Click *Select,* select file TRA9002.ASC in \RAY32\TRA02ASC\INPUT, click *Open*.

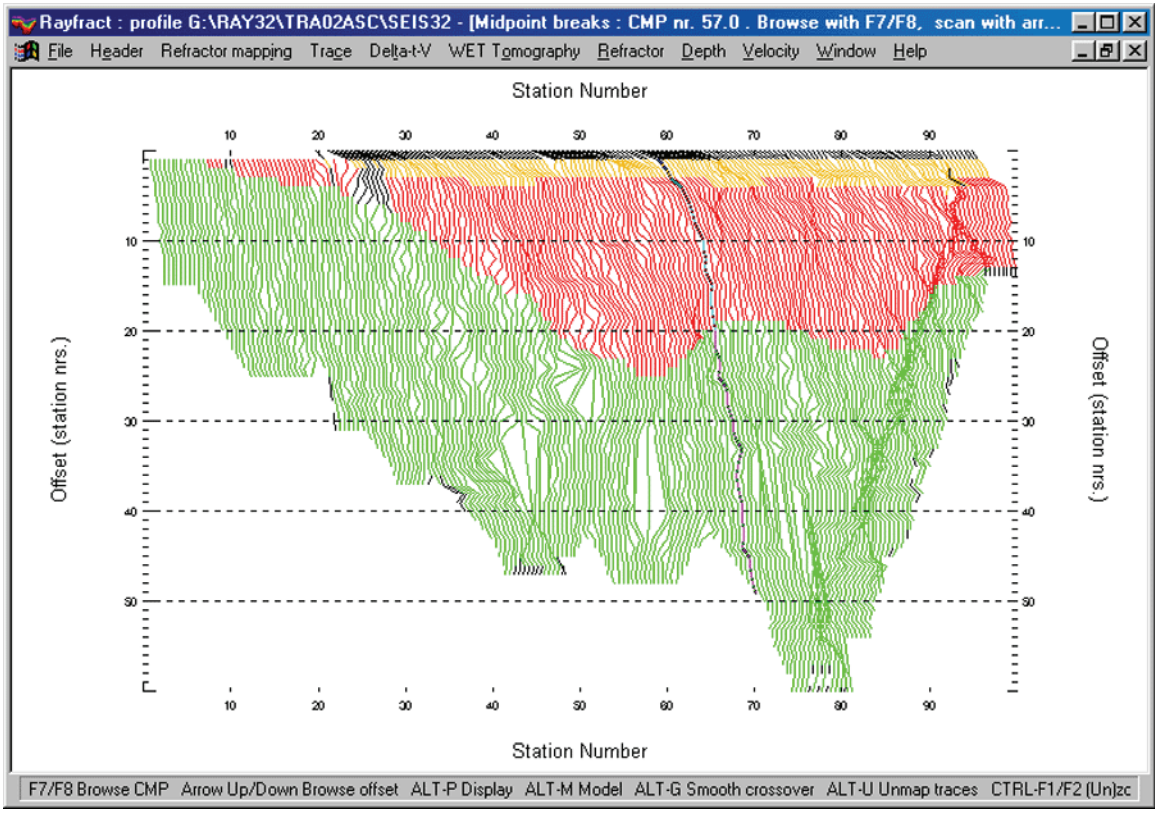


8 Check *Batch import* and set *Default spread type* to 02: 48 channels.
9 Set *Default shot hole depth* to 0.0 metres, click *Import shots*, confirm prompt.
10 Select File|Update header data|Update Station Coordinates. Click on *Select*.
11 Select file \RAY32\TRA02ASC\INPUT\TRA9002.COR, click *Open*, *Import file*.
12 Confirm prompt and select Header|Station. Browse with F7/F8. Leave with ESC.

For fully automated WET tomography processing, please skip the following and go to section 1.14. For “conventional” processing with our Wavefront ray inversion method, see below.

1.12 Refractor mapping TRA02ASC

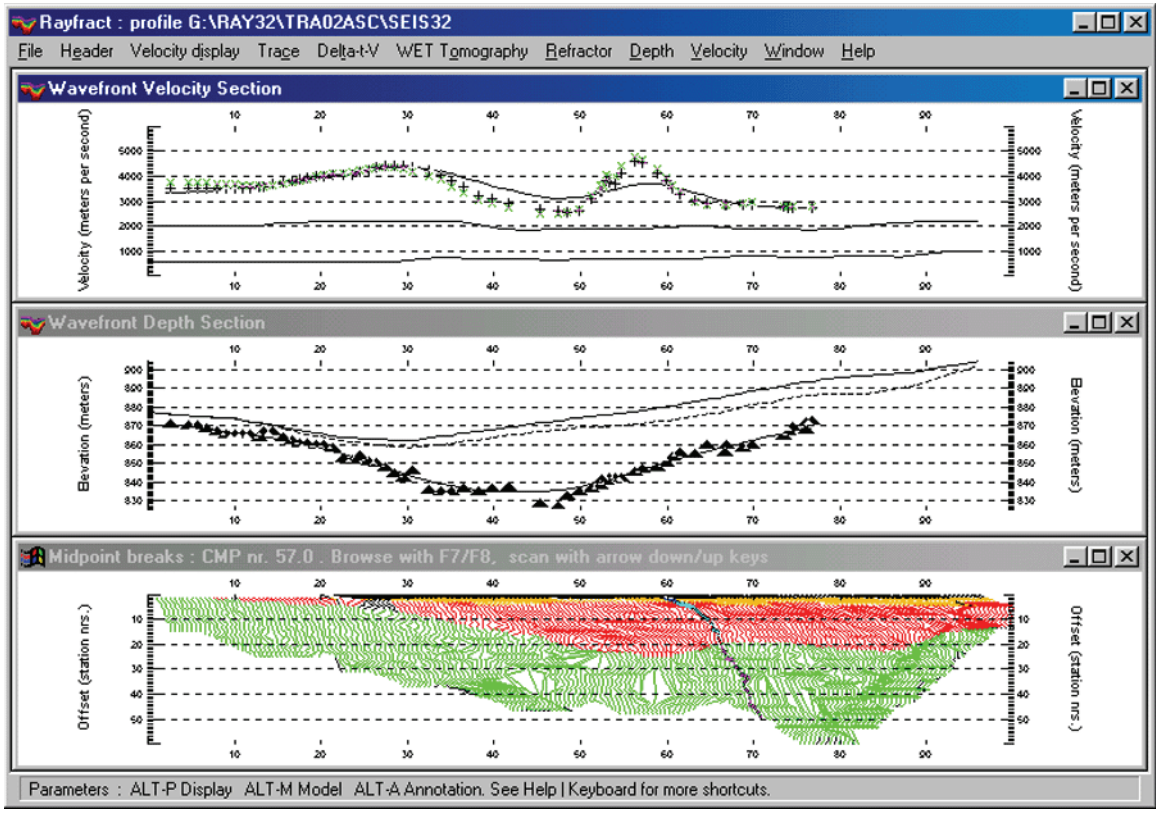
1. Select Refractor|Shot breaks. Press ALT-P and set *Minimum station number* to 0.
2. Set *Maximum station number* to 100, and *Maximum time* to 130 msecs.
3. Hit RETURN. and select Refractor|Midpoint breaks. Zoom time with CTRL-F1.
4. Press ALT-M to bring up *Trace to refractor mapping* dialog and hit RETURN.
5. Confirm prompt, then press ALT-G to show the *Crossover distance processing* dialog.



6. Set *Overburden filter* to 5, *Basement filter* to 10 and hit RETURN to obtain above display.
7. Press F8 and hold it down until the CMP traveltime curve for CMP nr. 57 is highlighted.
8. Select Header|Station to bring up the *Station editor* dialog again.
9. Click on *v0 from CMP*. Confirm prompt. Leave with ESC.

1.13 Wavefront TRA02ASC

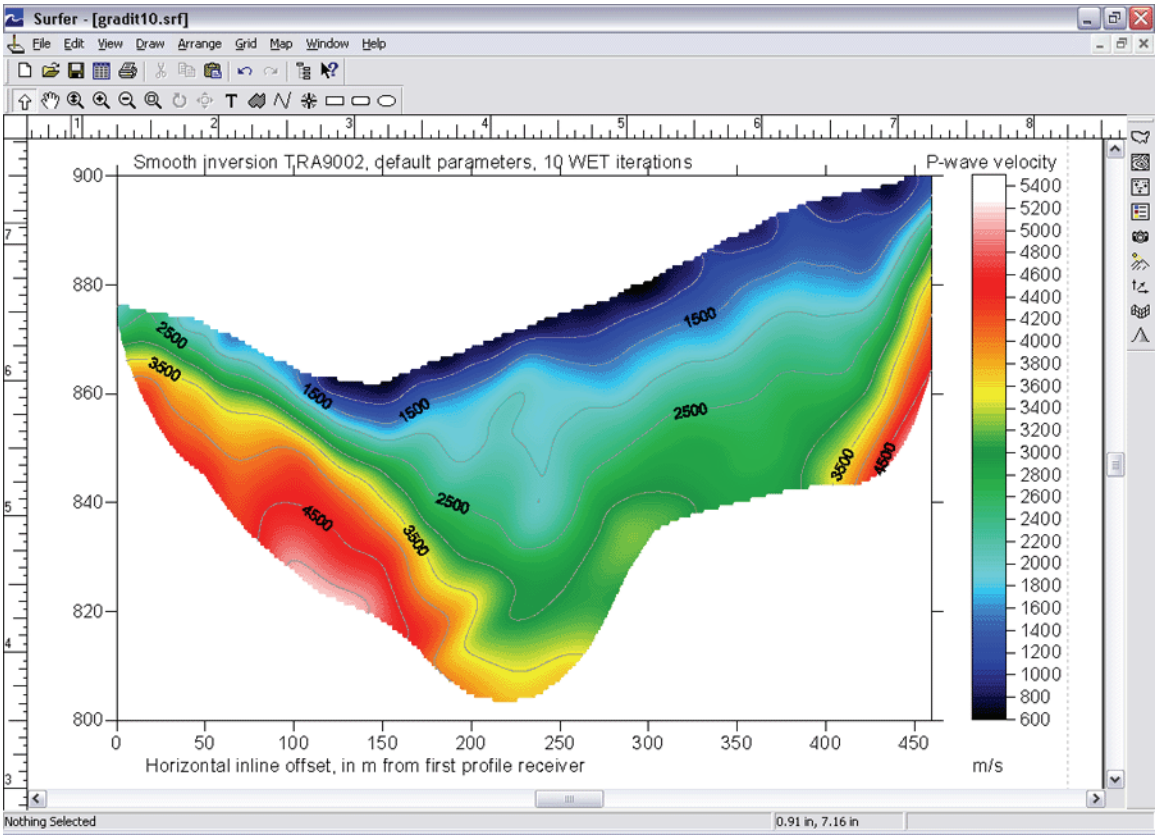
1. Select Depth|Wavefront. Confirm prompts, press ALT-P to show *display parameters*.
2. Set *Minimum station number* to 0, *Maximum station number* to 100.
3. Set *Minimum elevation* to 825. Set *Maximum elevation* to 905. Hit RETURN.
4. Select Velocity|Wavefront. Press ALT-P and set *Maximum velocity* to 6000 m/sec.
5. Set *Minimum station number* to 0, *Maximum station number* to 100. Hit RETURN.
6. Select Window|Tile horizontal to obtain a display as shown below :



Note how the high velocity anomaly at station nr. 57 in the *Wavefront velocity section* (top) correlates with the basement hump as indicated by the boundary between red and green CMP traveltime curve sections in the *Midpoint breaks section* (bottom), around CMP nr. 57 to CMP nr. 64.

1.14 Smooth inversion TRA02ASC

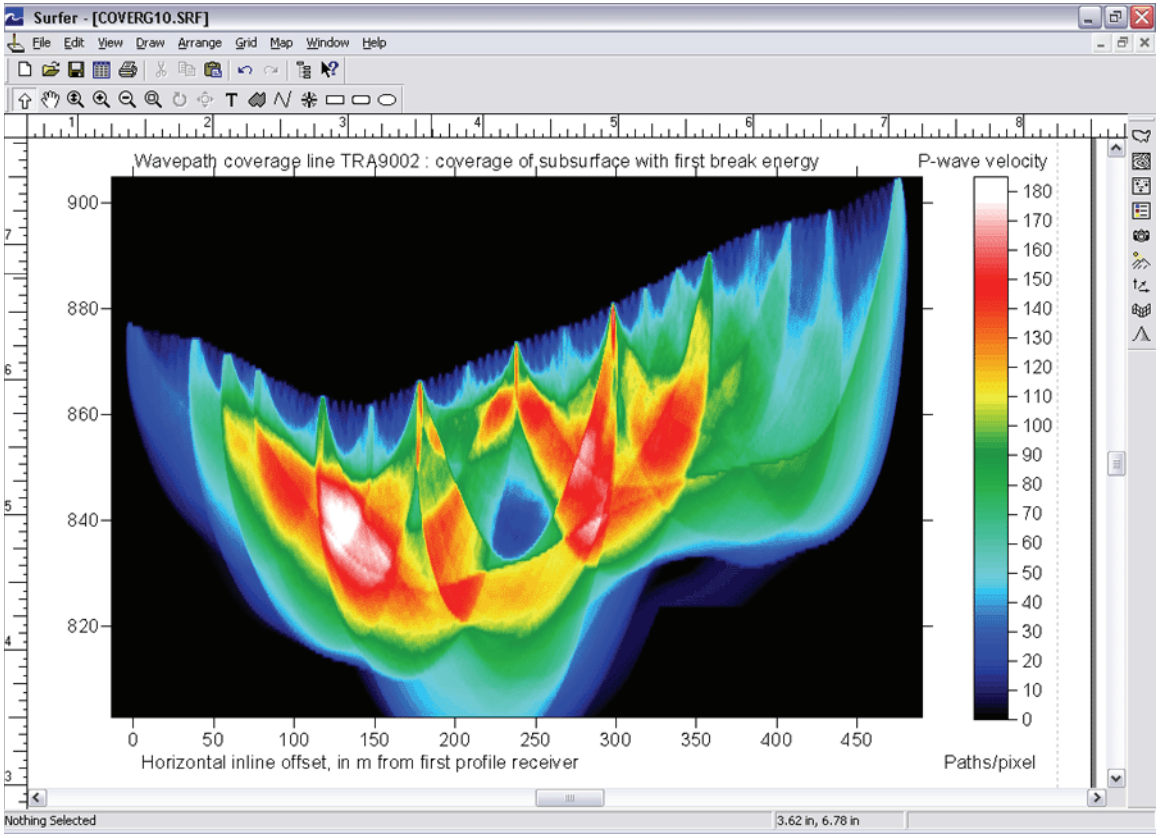
1. Select Smooth inversion|WET with 1D gradient initial model.
2. Once the 1D gradient model is shown in Surfer™, click on the Rayfract™ icon to continue.
3. Confirm the following prompts.
4. Size the resulting plot and add text legends within Surfer™ to obtain such a display :



Note the good correlation between the high velocity anomaly as imaged at horizontal inline offset of 300 metres and elevation of 840 metres, and the high velocity “basement hump” as identified earlier by the Wavefront interpretation in section 1.13, at station nrs. 57 - 64. Station nr. 60 corresponds to about horizontal inline offset 300 metres, at spacing of 5 metres.

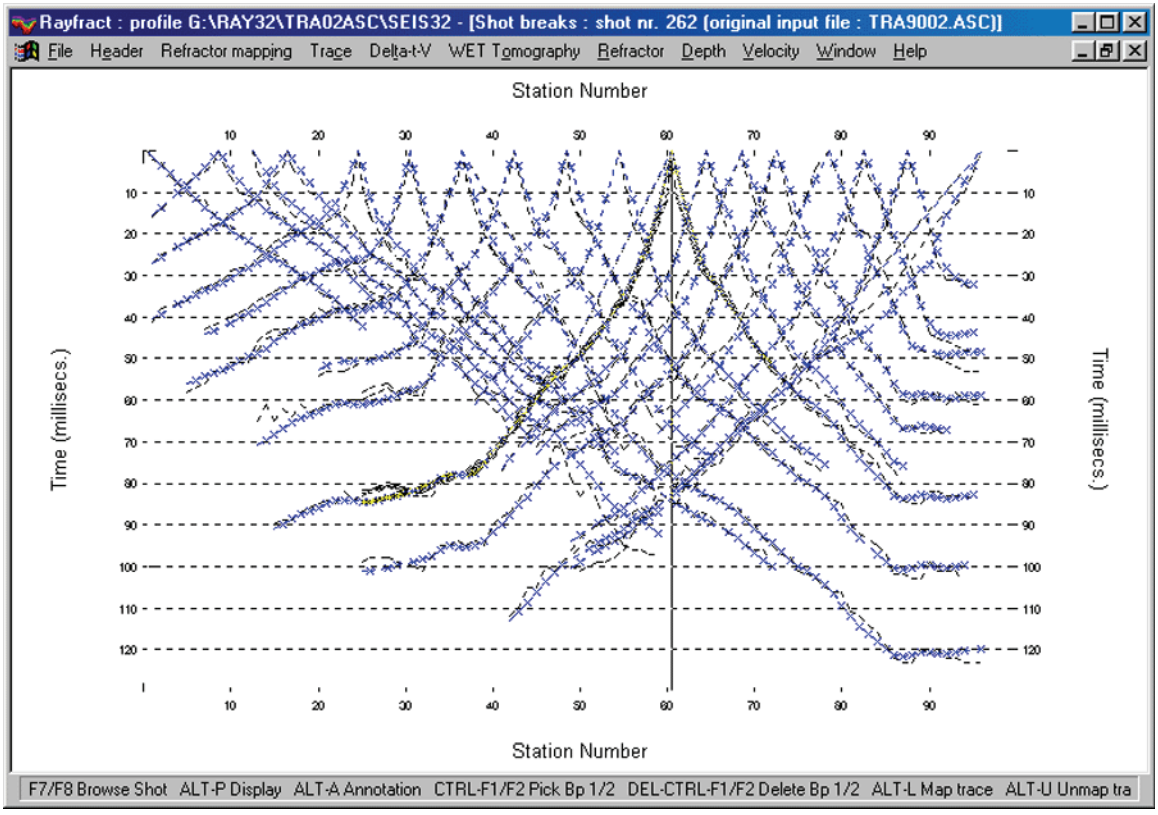
1.15 Wavepath coverage

1. Click on Surfer™ icon shown on your task bar, as started up automatically in section 1.14.
2. Use CTRL-TAB to cycle between WET and 1D gradient model and WET coverage plot.
3. Size the resulting coverage plot and add text legends to obtain a display as shown here :



1.16 Forward model first breaks

1. Select WET Tomography|Forward model traveltimes... .
2. Select model file \RAY32\TRA02ASC\VELOIT5.GRD. Click *Open*. Confirm prompt.
3. Select Refractor|Shot breaks to display both picked and modeled (blue) traveltimes.
4. Press ALT-P and set *Minimum station number* to 0. Set *Maximum station number* to 100.
5. Set *Maximum time* to 130 msecs. Hit RETURN.
6. Repeat steps 1 to 3 for file \RAY32\TRA02ASC\VELOIT10.GRD to obtain this display :



7. Press ALT-U to undo shot offset traveltime corrections, of earlier refractor mapping.