Import SEG-2 & WET S-Wave VSP BOATSH26 AMBROGEO Twin borehole geophone 5.02 :

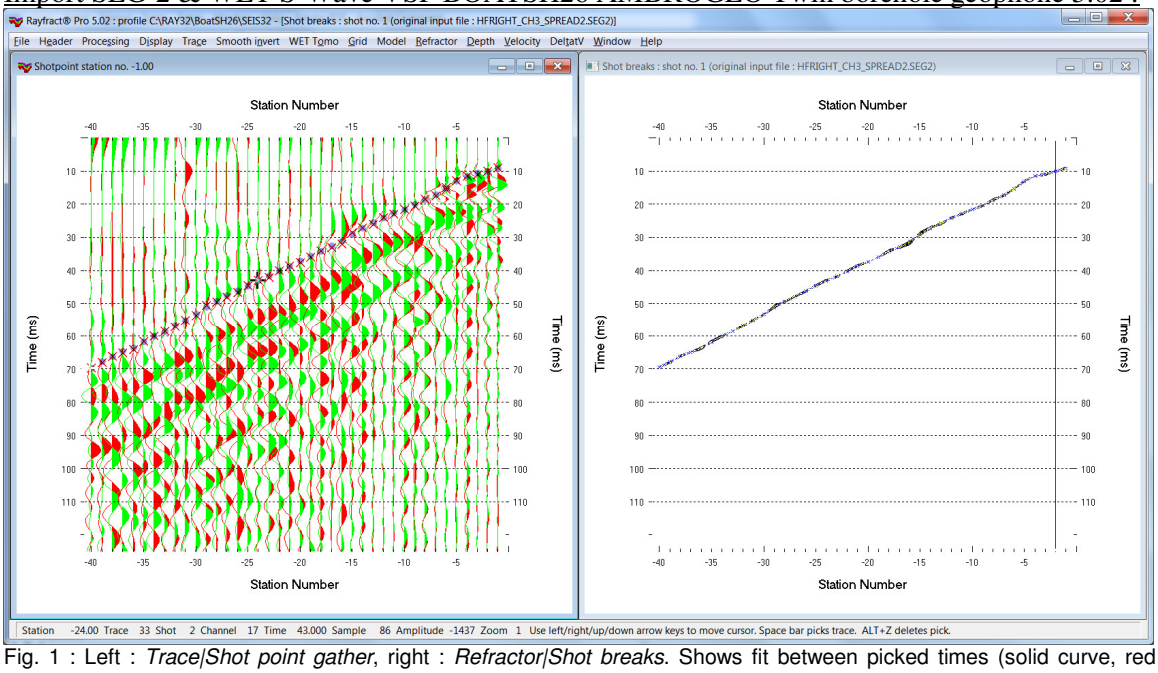


Fig. 1 : Left : *Trace|Shot point gather*, right : *Refractor|Shot breaks*. Shows fit between picked times (solid curve, red crosses) and modeled times (dashed blue curve, blue dots).

To create the profile database, aggregate the SEG-2 channels, import the aggregated .SEG2 and view the two imported aggregated .SEG2 shear-wave shots do these steps :

1. ***File|New Profile***…, set *File name* to **`BOATSH26`** and click *Save*
2. in the prompt shown next (Fig. 4) click ***No*** button .
3. in ***Header|Profile***… set *Line type* to **`Borehole spread/line`** . Set *Station spacing* to 1.0m. See Fig. 2.
4. unzip archive **`https://rayfract.com/tutorials/BOATSH26.zip`** with **`SEG-2 .SEG2`** receiver channel files & files **`COORDS.COR & SHOTPTS.SHO & BREAKS.LST`** in profile directory **`C:\RAY32\BOATSH26`**
5. download installer **`https://rayfract.com/tools/SEG2HoleMerge.exe`** and run on your PC where you are running our Rayfract® 5.01 or 5.02 Standard or Pro software.
6. open SEG2 HoleMerge 5.02 program via desktop icon. See Fig. 5 .
7. click on file icon besides uppermost field ***Select one SEG-2 file in INPUT directory***
8. navigate into **`C:\RAY32\BOATSH26\INPUT`**. At right bottom of dialog select **`DMT files (*.SEG2)`**.
9. click **`2HFRight.SEG2`** (receiver channels for elevation -2.0, right shear-wave) and click *Open* button
10. in frame ***Determine geophone channel number to be merged*** click radio button ***S-wave recorded with third horizontal y channel***. See Fig. 5.
11. in frame ***Determine distance unit : meters or feet*** click radio button ***Meters***
12. click radio button ***Do extract 3 channels for 2nd receiver into separate SEG-2 channel file***. See Fig. 5.
13. set ***Double geophone receiver separation [m]*** to 1. See Fig 5.
14. in frame ***Determine aggregated receiver geometry for vertical borehole*** set ***Deepest receiver depth below topo [m]*** to 40. Set next field ***Receiver spacing [m]*** to 1. See Fig. 5.
15. in frame ***Determine source position : horizontal and vertical offset from top of hole*** set ***Source x offset from top-of-hole [m]*** to 3. Leave ***Source depth below top-of-hole [m]*** at 0.0.
16. click button ***Setup output directory*** to set frame *Select output directory* to **`C:\RAY32\BOATSH26\INPUT2.`**
17. click button ***Aggregate SEG-2 files***. Confirm prompts (Fig. 6). Click ***Close*** button.
18. the aggregated SEG-2 receiver spread file **`HFRight_ch3_Spread2.SEG2`** is written into folder **`C:\RAY32\BOATSH26\INPUT2.`**
19. repeat steps 6. to 18. for **`C:\RAY32\BOATSH26\INPUT\2HFLeft.SEG2`**. See Fig. 9. In step 9. select **`2HFLeft.SEG2`**. In step 10. click radio button ***S-wave recorded with third horizontal y channel***. See Fig. 9. In step 18. the aggregated SEG-2 file **`HFLeft_ch3_Spread2.SEG2`** is written into folder **`C:\RAY32\BOATSH26\INPUT2.`**
20. click on title bar of our opened Rayfract® 5.02
21. select import option *File|SEG-2 import settings and commands|**Receiver coordinates specified***

22. select ***File|Import Data***… . Set *Import data type* to **`SEG-2`**. See Fig. 3.
23. click *Select button* and navigate into **`C:\RAY32\BOATSH26\INPUT2`**
24. set *Files of type* to **`DMT files (*.SEG2)`** and select file **`HFRight_ch3_Spread2.SEG2`** & click *Open*
25. set *Take shot record number from* to **`Job number`**
26. leave *Default spread type* at **`10: 360 channels.`** Click *radio button* ***Overwrite all.***
27. click ***Import shots button*** and confirm prompt
28. in Fig. 7 with title **`Import C:\RAY32\BOATSH26\INPUT2\HFLeft_ch3_Spread2.SEG2 …`** set *Shot Number* to 2 and click *Read* button. Click *Skip* button to skip other aggregated .SEG2 files.
29. with updated title **`Import C:\RAY32\BOATSH26\INPUT2\HFRight_ch3_Spread2.SEG2…`** set *Shot Number* to 1 and click *Read* button. Click *Skip* or *End* button to skip all other aggregated .SEG2 files.
30. select *File|Update header data|Update First Breaks*. Select file **`BREAKS.LST`** & click *Open*.
31. select *Trace|Shot point gather* and *Refractor|Shot breaks* and *Window|Tile* to obtain Fig. 1
32. click on title bar of *Refractor|Shot breaks* window (Fig. 1 right). Press ALT+P. Edit *Maximum time* to 125 ms. Press **`ENTER`** key to redisplay. Do the same for *Trace|Shot point gather* window (Fig. 1 left).
33. click on title bar of *Trace|Shot point gather* window and press CTRL+F1 to zoom trace amplitude
34. press CTRL+F3 to toggle trace wiggle display mode. Uncheck *Display|Color trace outline*.
35. press SHIFT+Q and edit *band pass filter* as in Fig. 8 . Click *Filter* button.
36. select *Processing|Pick all shots, in shot point gather*. Select *Display|Show picks on time axis.*

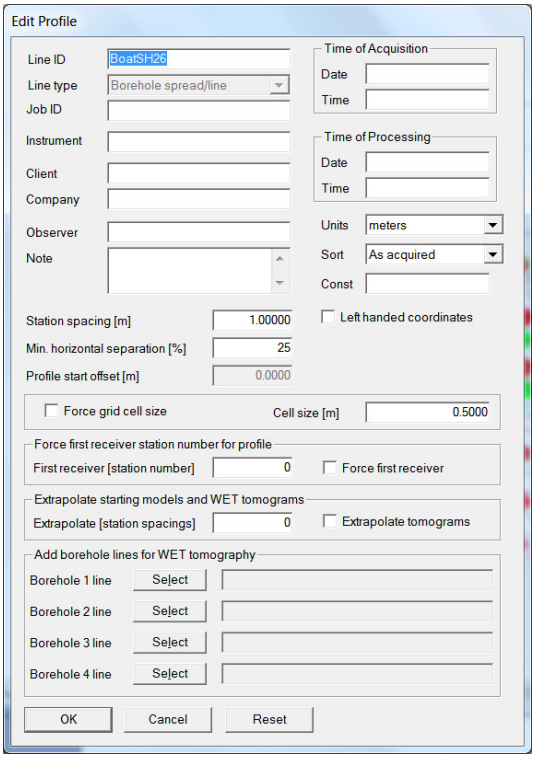


Fig. 2 : *Header|Profile*

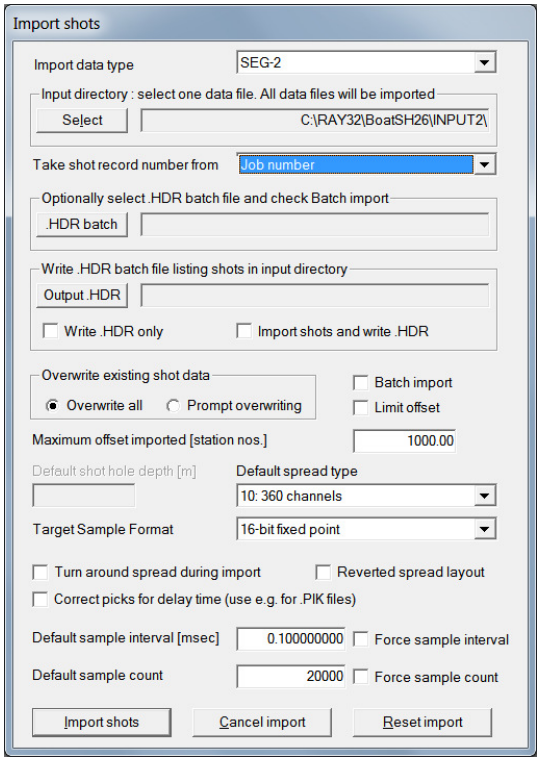
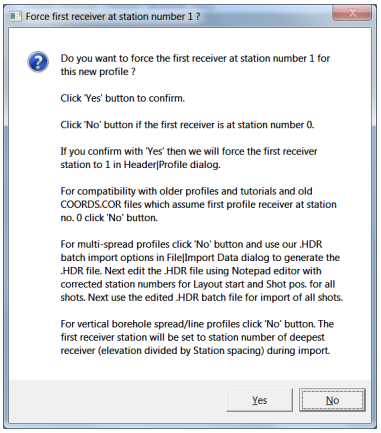


Fig. 3 : *File|Import Data*

Fig. 4 : in prompt ***Force first receiver at station number 1 ?*** click *No button*. For vertical borehole/spread line profiles click *No button*. The first receiver station will be set to station number of deepest receiver (elevation divided by *Station spacing*) during import.



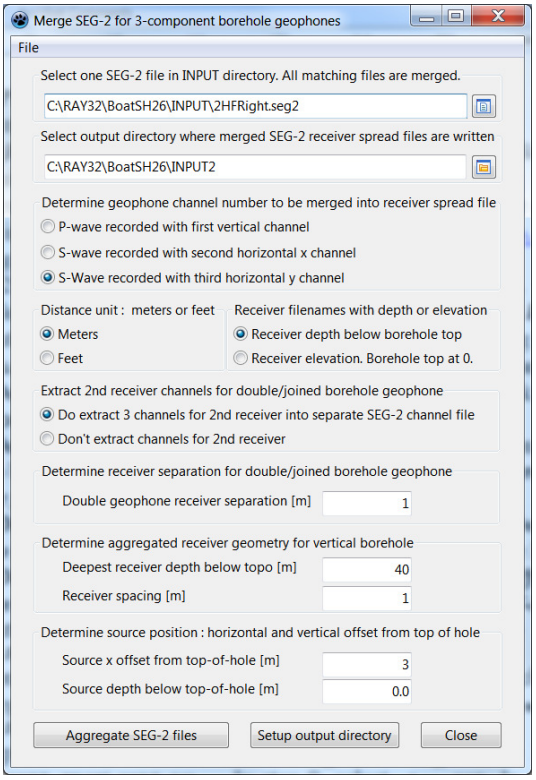


Fig. 5 : click SEG2 HoleMerge 5.02 icon. Edit as shown. Click buttons *Setup output directory* and ***Aggregate SEG-2 files***.

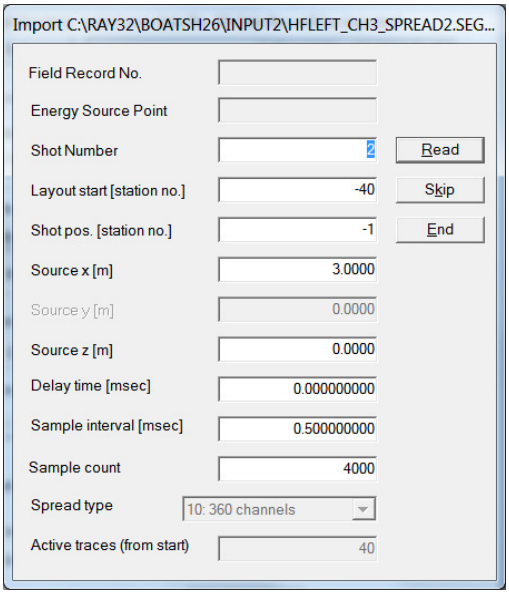


Fig. 7 : click *Read* button to import the two aggregated .SEG2 borehole receiver spreads. Click *Skip* button to skip all other .SEG2 spread files.

Fig. 9 (right) : click SEG2 HoleMerge 5.02 icon. Edit as shown. Click buttons *Setup output directory* and ***Aggregate SEG-2 files***.

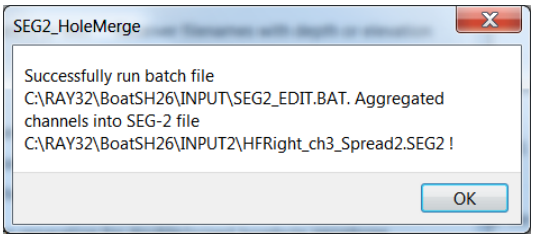


Fig. 6 : click *OK button* to dismiss success prompt.

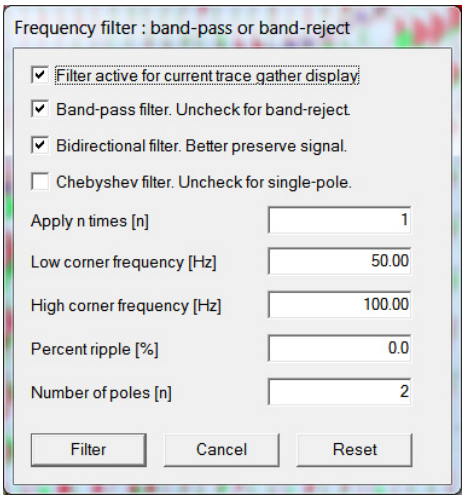
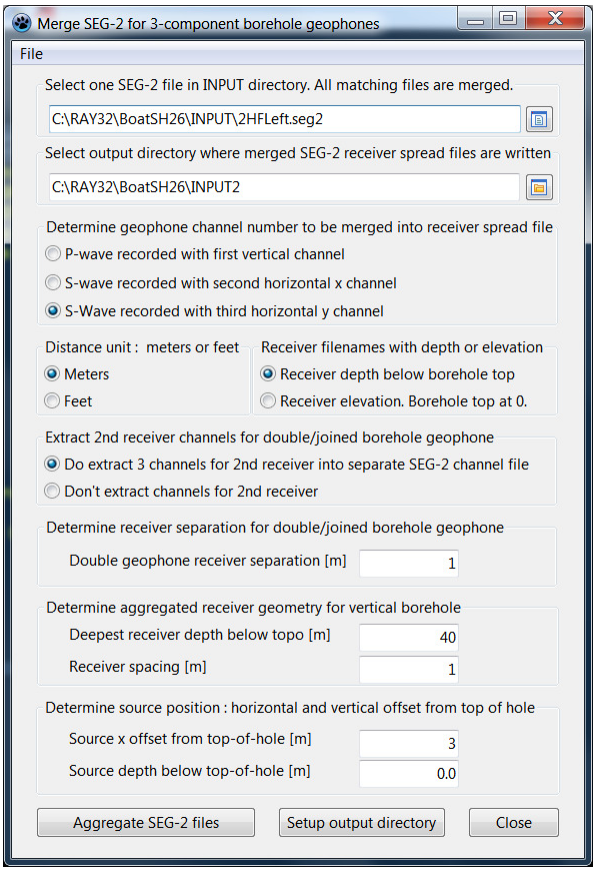


Fig. 8 : Band-pass filter dialog shown with SHIFT+Q. Edit as shown and click *Filter* button.



Configure and obtain constant-velocity starting model and run interactive WET inversion :

- edit *Grid|Surfer plot Limits* as in Fig. 10
- check *Grid|Vertical plot title*. Check *Grid|GS CENTERED FONT* to fix Surfer 11 plot display.
- select ***Smooth invert|WET with constant-velocity initial model***
- wait for the constant-velocity starting model to show as in Fig. 13 (left)
- in prompt to continue with WET inversion click *No* button
- uncheck all blanking options in *WET Tomo|WET tomography Settings|Blank* menu
- select *Model|WDVS Smoothing*. Click radio button ***discard WET smoothing*** (Fig. 11). Click *OK*.
- check option *WET Tomo|WET tomography Settings|**Scale wavepath width***
- check option *WET Tomo|WET tomography Settings|**Scale WET filter height***
- select *WET Tomo|**Interactive WET***. Edit main dialog as in Fig. 12 left.
- click *Select* button. Navigate into folder **`C:\Ray32\BOATSH26\HOLETOMO`**. Select **`CONSTVEL.GRD`** starting model grid.
- click button *Edit velocity smoothing*. Edit as in Fig. 12 right. Click button *Accept parameters*.
- click button *Edit grid file generation*. Edit as in Fig. 15. Click button *Accept parameters*.
- click button *Start tomography processing* and confirm prompts to obtain Fig. 13 (center and right)
- select *Grid|Export grid file to ASCII.TXT*. Edit dialog as in Fig. 17 and click button *Export to .TXT* .
- open **`C:\Ray32\BOATSH26\HOLETOMO\VELOIT999.TXT`** in Microsoft Notepad editor as in Fig. 18

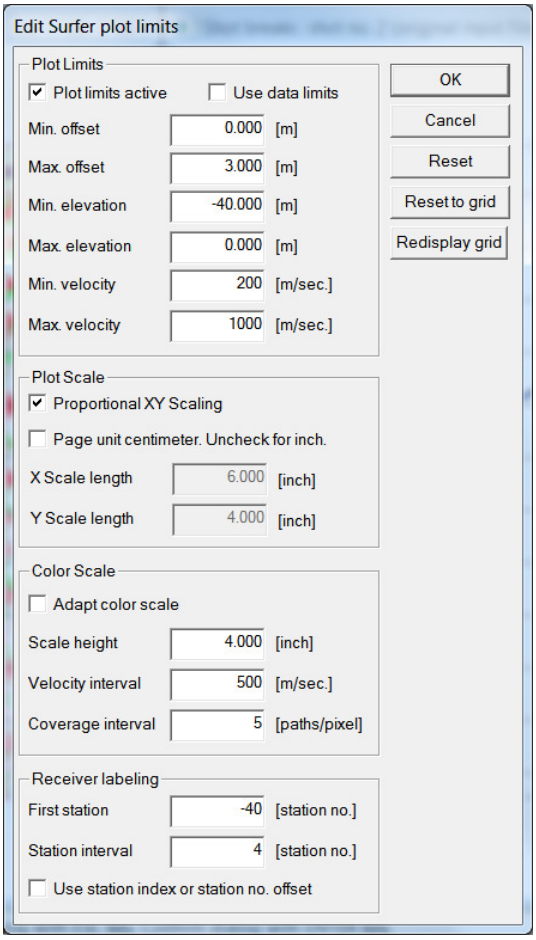


Fig. 10 : *Grid|Surfer plot Limits* dialog. Check box ***Limits active*** and ***Proportional XY scaling***. Edit as shown. Click OK button.

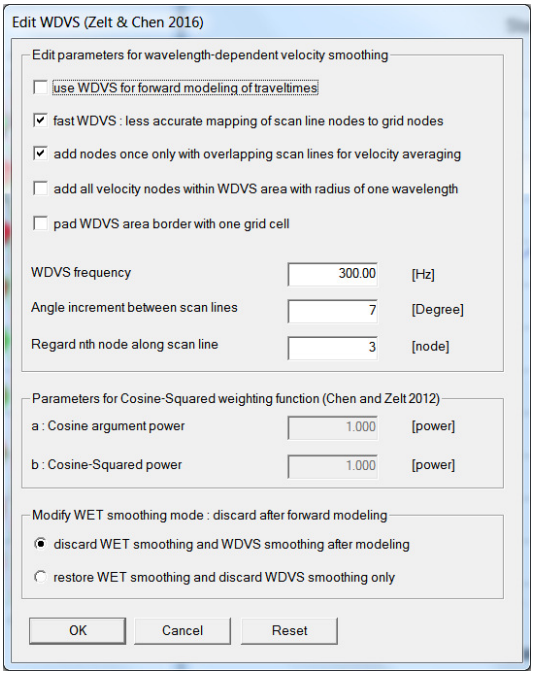


Fig. 11 : *Model|WDVS Smoothing* dialog. Click option ***discard WET smoothing and WDVS smoothing after modeling***. Click OK.

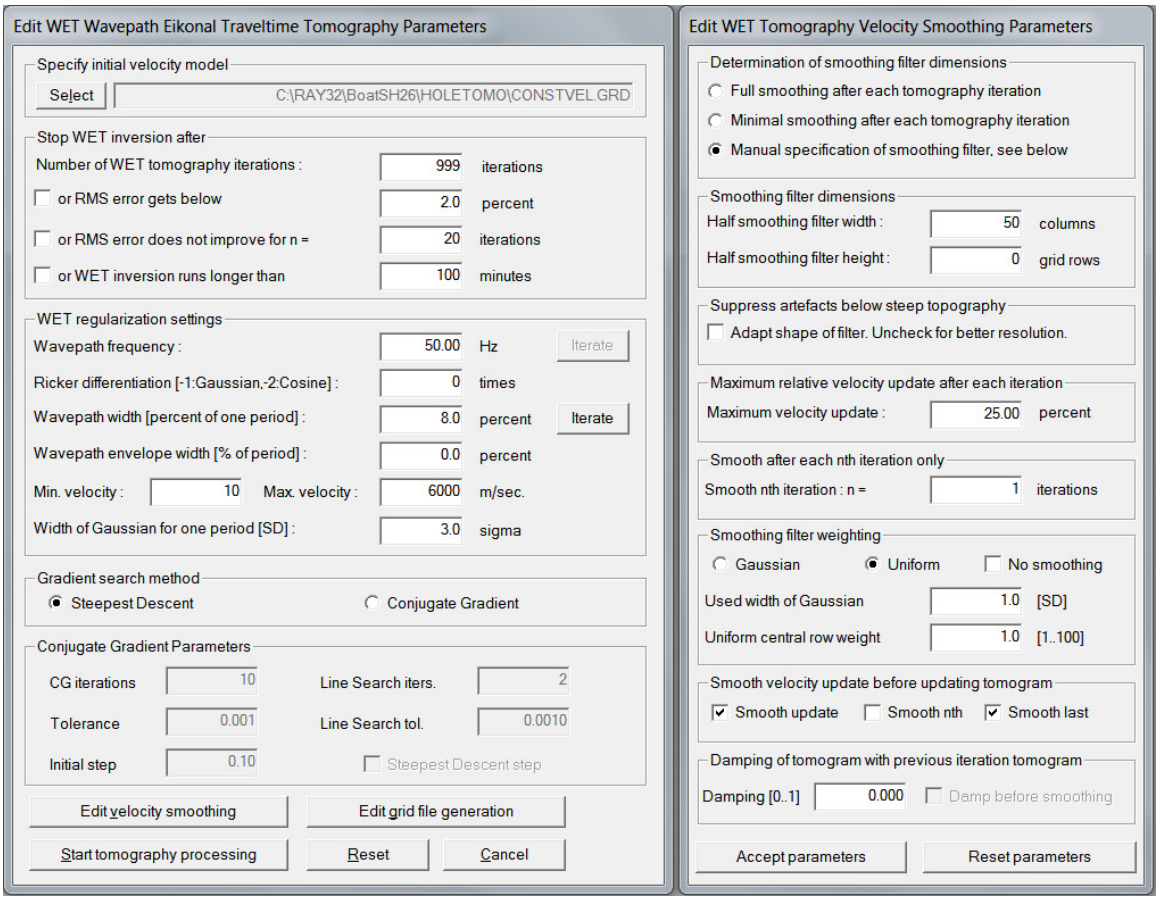


Fig. 12 : *WET Tomo*|*Interactive WET* main dialog (left). Click *Select* button. Navigate into folder C:\Ray32\BOATSH26\HOLETOMO. Select CONSTVEL.GRD starting model grid. Edit velocity smoothing (right).

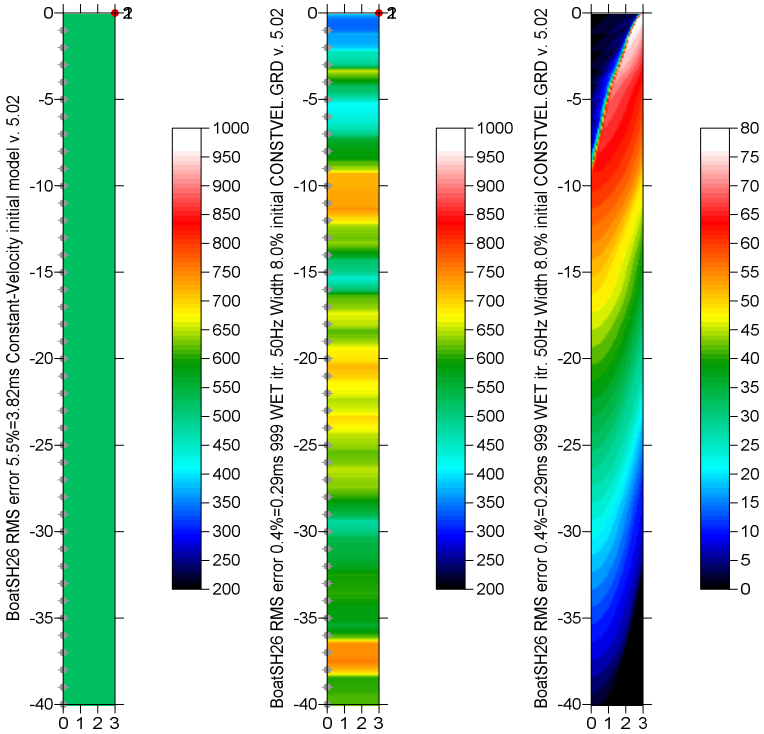


Fig. 13 : constant-velocity initial model (left). Steepest-Descent WET inversion after 999 iterations (center) with ***discard WET smoothing*** checked in *Model*|*WDVS Smoothing* (Fig. 11).

We left WET ***wavepath frequency*** at 50Hz and left WET ***wavepath width*** at 8 percent (Fig. 12 left). We increased ***Number of WET iterations*** to 999 from default 20 iterations. We left the ***Max. WET velocity*** at 6,000 m/s.

We use a ***Ricker wavelet*** for WET update weighting across the wavepath (***Ricker differentiation*** 0 in Fig. 12 left; Schuster 1993) and ***manual WET smoothing*** (Fig. 12 right) with smoothing filter ***half-width*** 50 grid columns and ***half-height*** 0 grid rows. We uncheck option ***Adapt shape of filter***. This manual WET smoothing filter results in horizontal layering in WET tomogram (center). Surfer plot limits as in Fig. 10.

WET wavepath coverage plot is shown at right. Unit is wavepaths per grid cell.

In menu *WET Tomo*|*WET tomography Settings* we checked the two options

- ***Scale wavepath width***
- ***Scale WET filter height***

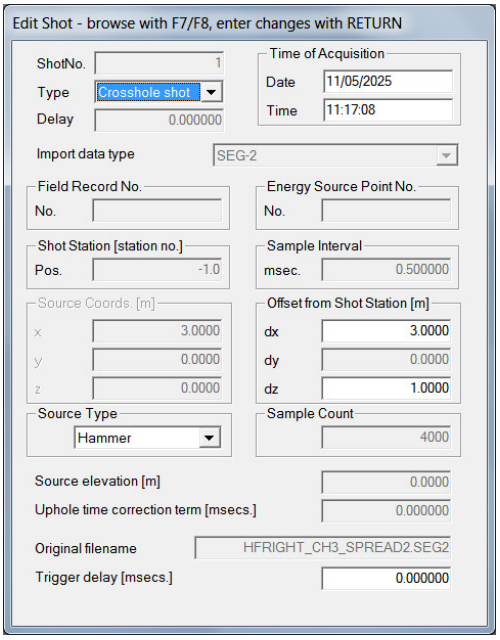


Fig. 14 (left) : *Header|Shot*. Check if fields x and z in frame *Source Coords. [m]* match the *Source x-offset from top-of-hole* and *Source depth below top-of-hole* as specified in SEG2_HoleMerge program (Fig. 5).

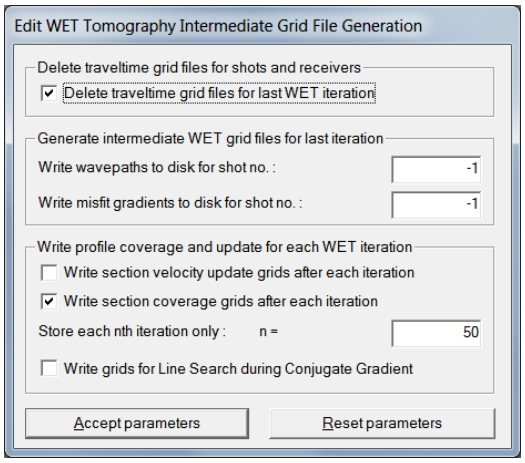


Fig. 15 (above) : *WET Tomo|Interactive WET|Edit grid file generation*. Edit as shown and click *Accept parameters* button.

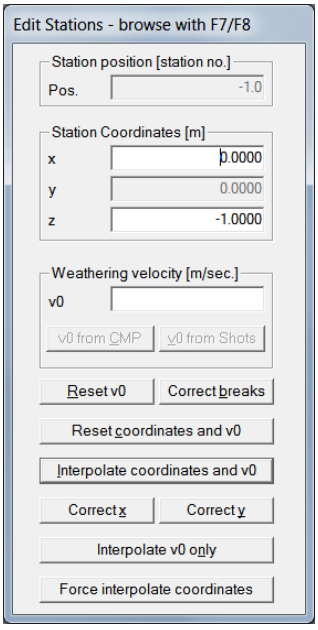


Fig. 16 (left) : *Header|Station*. Use F7/F8 keys to browse to *Station position [station no.]* -1.0 as referenced in above *Header|Shot* (Fig. 14).

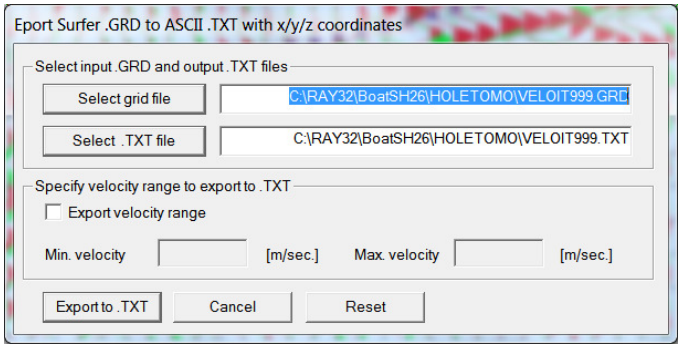


Fig. 17 (above) : select *Grid|Export grid file to ASCII.TXT* . Edit as shown and click button *Export to .TXT* . Open **`VELOIT999.TXT`** in Microsoft Notepad editor as in Fig. 18.

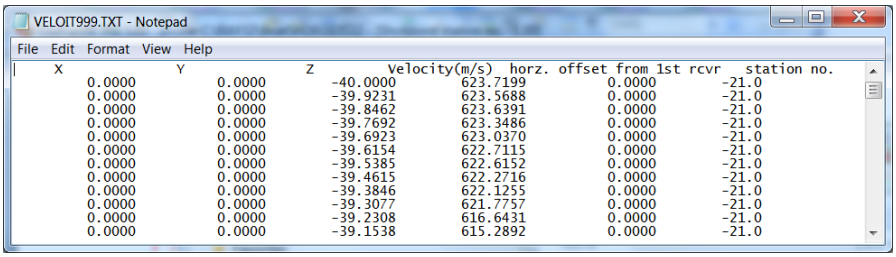


Fig. 18 : Open Windows Explorer window. Navigate into **`C:\Ray32\BOATSH26\HOLETOMO`** folder. Right-click **`VELOIT999.TXT`** and select *Open with* and Notepad.

Download the .rar archive of the profile folder obtained with above processing from DropBox link

https://www.dropbox.com/scl/fi/76lv0gp5xui4wpeb15aws/BoatSH26_Aug1_2025.rar?rlkey=yz4na9i6iq8thakwm840ms5xp&st=0e6gru4x&dl=0

See also our updated 2024 manual

https://rayfract.com/help/rayfract.pdf

chapter ***Crosshole survey interpretation*** and chapter ***Downhole VSP interpretation***.

See also our twin VSP tutorial https://rayfract.com/tutorials/SH27_Test.pdf showing S-wave VSP processing for another borehole.

See also our 2024 P-wave downhole VSP tutorials https://rayfract.com/tutorials/TTBM6.pdf and https://rayfract.com/tutorials/TTBM4.pdf and our earlier VSP tutorial https://rayfract.com/tutorials/vsp.pdf.

See also our crosshole tutorials https://rayfract.com/tutorials/MDW2011_23.pdf and https://rayfract.com/tutorials/b8b9.pdf

and our walkaway VSP tutorial https://rayfract.com/tutorials/walkaway.pdf

and our joint inversion of surface refraction spread with borehole receiver spread tutorial

https://rayfract.com/tutorials/11REFR.pdf

and our tutorial with receivers in 3 boreholes https://rayfract.com/tutorials/KING17.pdf .

- Doug Crice describes cross-hole and down-hole shear wave recording geometry in his paper https://seg.org/wp-content/uploads/2023/06/Downhole_Shearwaves.pdf
- we allow picking of shear waves on shot traces recorded with reversed shot polarity in our ***Trace\|Shot point gather*** display. See above and our manual https://rayfract.com/help/rayfract.pdf chapter ***Shear wave picking*** and our S-wave refraction tutorial https://rayfract.com/tutorials/SH_60m.pdf .

Discussion

We show gathering of SEG-2 channels recorded using AMBROGEO 3D twin/double borehole geophone and PASI seismograph into SEG-2 receiver spread files sorted by channel number and receiver elevation. ***We assume that the receiver channel files are named <receiver_depth><optional wave identifier>.DAT / .SG2 / .SEG2.*** 1.SEG2 / 1HFRight.SEG2 / 1HFLeft.SEG2 means the borehole receiver was located at elevation -1m with the borehole top at elevation 0m.

40.SEG2 / 40HFRight.SEG2 / 40HFLeft.SEG2 means the borehole receiver was positioned at elevation -40m. Rename your SEG-2 receiver channel files in Windows Explorer to match this file naming convention. For double-geophone channel files the filename should include the ***receiver_depth*** of the lower geophone of the double geophone.

Next we import the two aggregated SEG-2 borehole receiver spread files into a Rayfract(R) borehole profile database. Next we apply frequency filtering and pick the shear-wave first breaks. Finally we run our WET inversion using 999 Steepest-Descent iterations. We weight the velocity update across the wavepath using a Ricker wavelet (Schuster 1993). Also we use a custom WET smoothing filter to obtain a horizontal layering in the final WET velocity tomogram. We scale the WET wavepath width with the picked time for each trace for improved weathering resolution. Also we scale the WET smoothing filter height with the grid row depth below topography.

Acknowledgements

We thank our reseller Ing. Kofi Boateng at HGL Consult Ltd. for giving us permission to use the above SEG-2 files for this tutorial and to make them available on our website. Also we thank him for giving us the impulse to update our SEG2_HoleMerge program to support the AMBROGEO 3D twin/double borehole geophone and for his feedback regarding interpretation of this borehole VSP data set with our latest version 5.02 software.

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https://dx.doi.org/10.1190/1.1820777

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