Import aggregated SEG-2 .SG2 & Update header data & WET for VSP profile TTBM4 v. 5.01 :

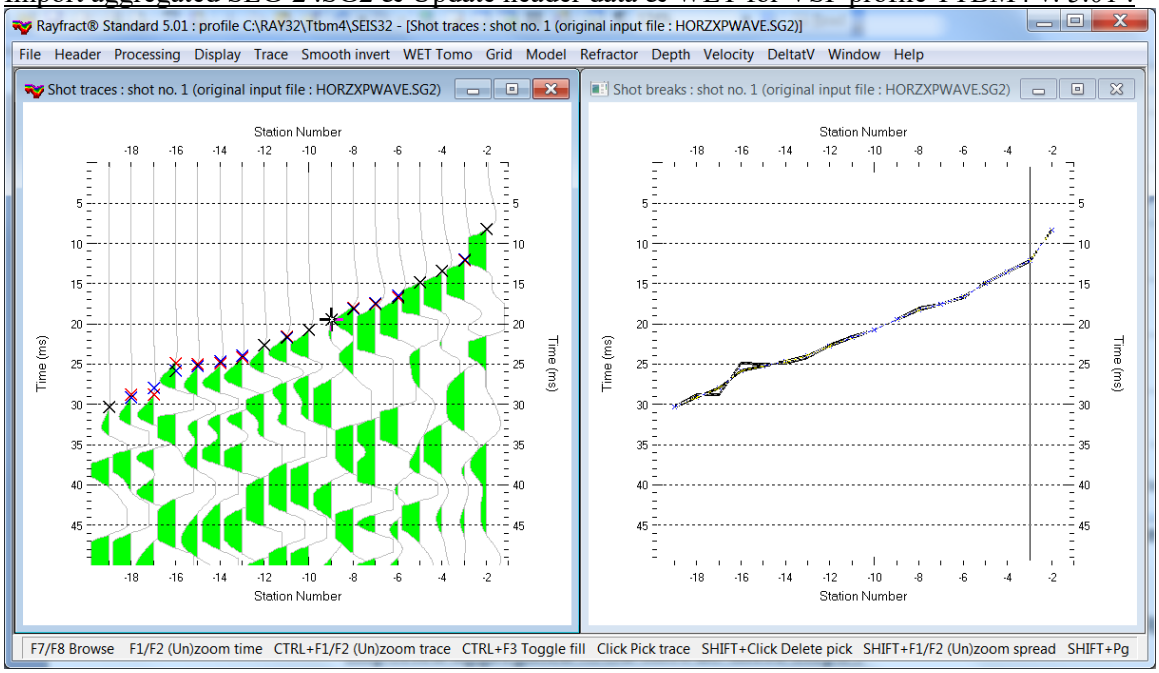


Fig. 1 : Left : *Trace|Shot gather*, right : *Refractor|Shot breaks*. Shows fit between picked times (solid curve, red crosses) and modeled times (dashed blue curve, blue crosses).

To create the profile database, aggregate the SEG-2 channels, import the aggregated .SG2 and view the imported aggregated .SG2 shot do these steps :

- ***File|New Profile***..., set *File name* to **`TTBM4`** and click *Save button*
- in the prompt shown next (Fig. 4) click ***No*** button .
- in ***Header|Profile***... set *Line type* to **`Borehole spread/line`** . Set *Station spacing* to 2.0m. See Fig. 2.
- unzip archive **`https://rayfract.com/tutorials/TTBM4 INPUT.zip`** with **`SEG-2 .SG2`** shot files & files **`COORDS.COR & SHOTPTS.SHO & BREAKS.LST`** in directory **`C:\RAY32\TTBM4\INPUT`**
- download installer **`https://rayfract.com/tools/SEG2Aggregate.exe`** and run on your PC where you are running our Rayfract®
- open SEG2 Aggreg 5.01 program via desktop icon. See Fig. 5.
- click on file icon besides uppermost field ***Select one SEG-2 file in INPUT directory***
- navigate into folder **`C:\RAY32\TTBM4\INPUT`**. At right bottom of dialog select **`ABEM files (*.SG2)`**.
- click on one file e.g. **`DAT_5731.SG2`** and click *Open* button.
- tab to field ***Deepest receiver depth below topo [m]*** and enter value 38.
- for next field ***Receiver spacing [m]*** enter 2.
- in frame ***Determine DDS geophone positions*** click radio button ***Pull up from hole bottom by 2m then 2m etc. Skip RX2 channel***. See Fig. 5.
- in frame ***Determine source position : horizontal and vertical offset from top of hole*** set ***Source x offset from top-of-hole [m]*** to 2.4. Leave ***Source depth below top-of-hole [m]*** at 0.0.
- click button ***Setup output directory*** to set field *Select output directory* to **`C:\RAY32\TTBM4\INPUT2`**.
- click button ***Aggregate SEG-2 files***. Confirm prompts **`Successfully run batch file`** (Fig. 6).
- 9 aggregated SEG-2 files are written into folder **`C:\RAY32\TTBM4\INPUT2`**.
- click on title bar of our opened Rayfract® 5.01
- select import option *File|SEG-2 import settings and commands|**Receiver coordinates specified***
- select ***File|Import Data***...
- set *Import data type* to **`SEG-2`**. See Fig. 3.
- click *Select button* and navigate into **`C:\RAY32\TTBM4\INPUT2`**
- set *Files of type* to **`ABEM files (*.SG2)`** and select a file e.g. **`HORZXPWAVE.SG2`** & click *Open*

- leave *Default spread type* at **`10: 360 channels.`** Click *radio button* ***Overwrite all.***
- click ***Import shots button*** and confirm prompt
- in Fig. 7 dialog with title **`Import C:\RAY32\TTBM4\INPUT2\HORZXPWAVE.SG2`**… click *Read* button
- skip all other aggregated .SG2 by next clicking *End* button
- select *File|Update header data|Update First Breaks*. Select file **`BREAKS.LST`** & click *Open*.
- select *Trace|Shot gather* and *Window|Tile* to obtain Fig. 1
- click on title bar of *Refractor|Shot breaks* window (Fig. 1 right) and press ALT+P. Edit *Maximum time* to 50 ms & press ENTER key to redisplay. Do the same for *Trace|Shot gather* window (Fig. 1 left).
- click on title bar of *Trace|Shot gather* window and press CTRL+F1 to zoom trace amplitude
- press CTRL+F3 to toggle trace wiggle display mode in *Trace|Shot gather* window.
- press SHIFT+Q and edit *band pass filter* as in Fig. 8 . Click *Filter* button.
- press ALT+M and edit *Trace processing parameters* as in Fig. 9 . Click *Filter* button.

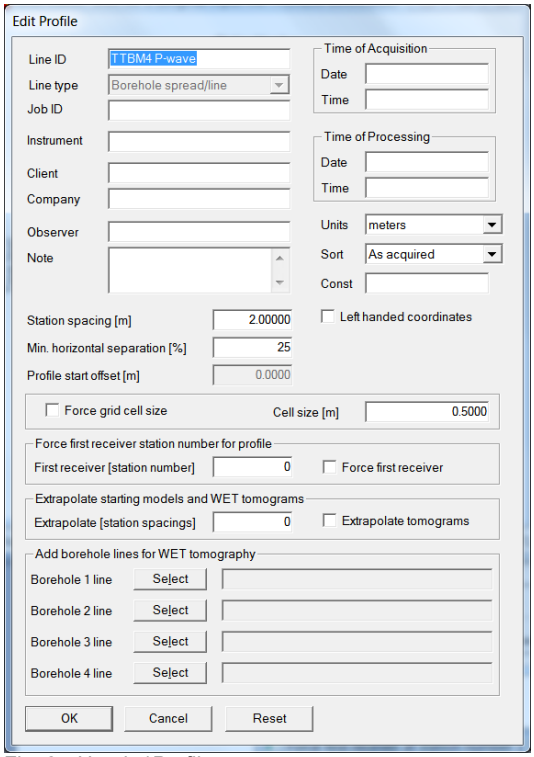


Fig. 2 : *Header|Profile*

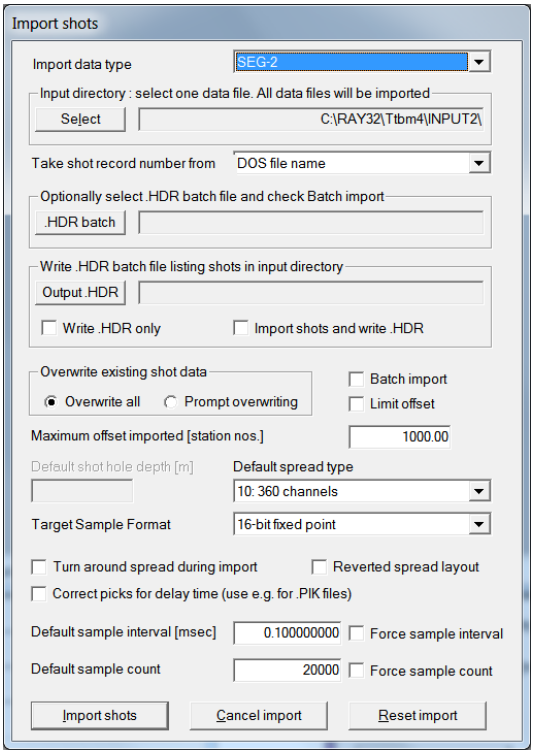


Fig. 3 : *File|Import Data*

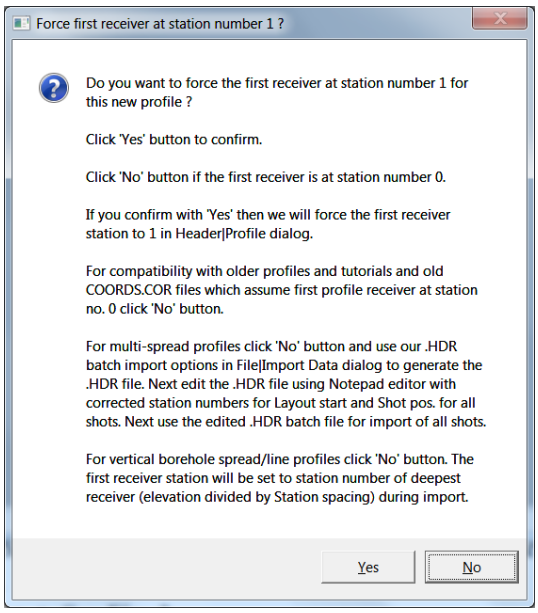


Fig. 4 : click *No* button.

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.

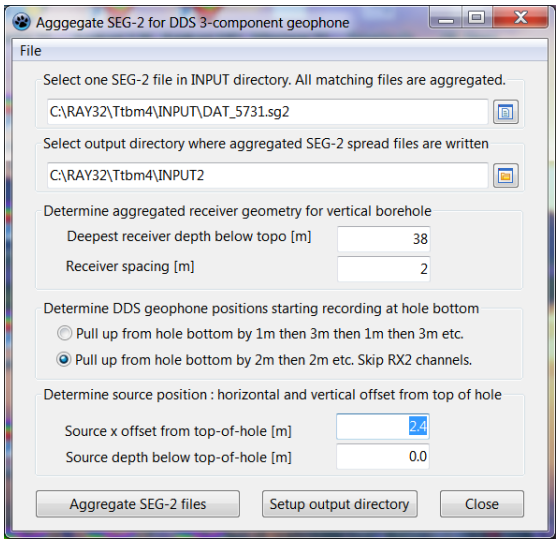
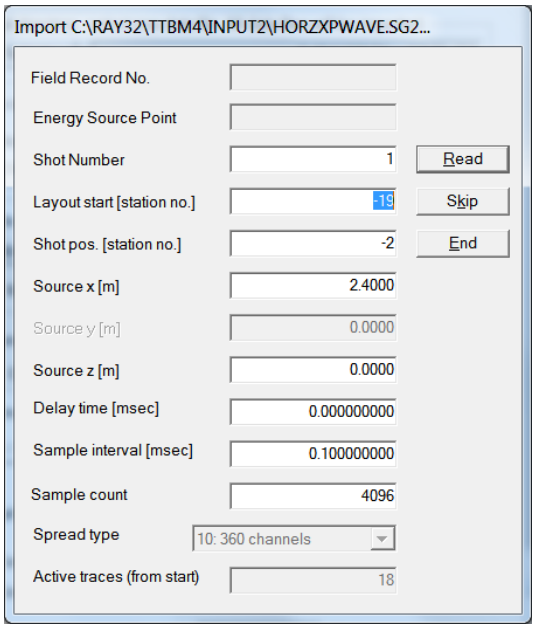


Fig. 5 : click SEG2 Aggreg 5.01 icon. Edit as shown. Click *Setup output directory* / ***Aggregate SEG-2 files***.



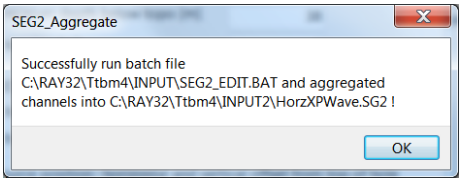


Fig. 6 : prompt shown after click on Aggregate SEG-2 files button. Click OK to dismiss prompt.

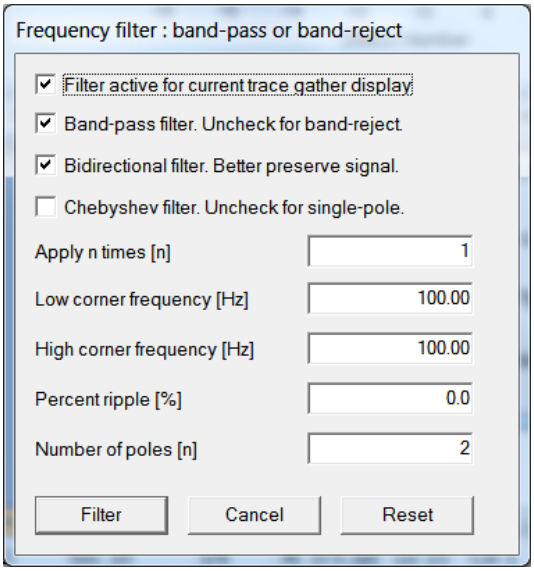


Fig. 8 (top) : Band-pass filter dialog shown with SHIFT+Q. Edit as shown and click *Filter* button.

Fig. 7 (left) : Import shot dialog. Click *Read* button. Then click *End* to skip all other aggregated .SG2.

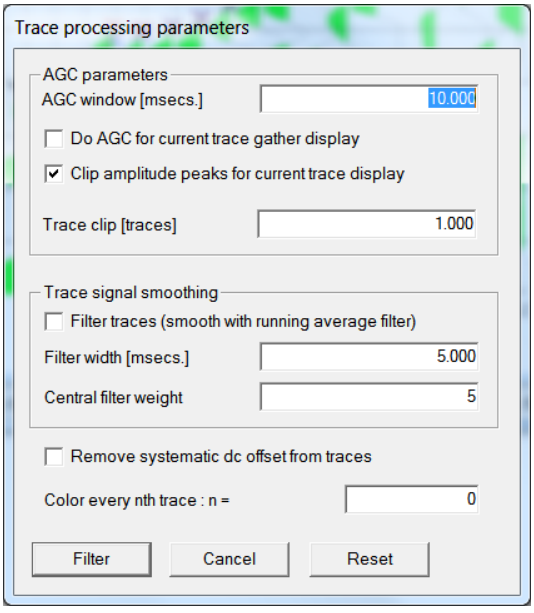


Fig. 9 : Trace processing parameters shown with ALT+M. Edit as shown and click *Filter* button.

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

- select option *Grid|Vertical plot title*
- edit *Grid|Surfer plot Limits* as in Fig. 10
- 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 button *Edit velocity smoothing*. Edit as in Fig. 12 right. Click button *Accept parameters*.
- click button *Start tomography processing* and confirm prompts to obtain Fig. 13 (center and right)

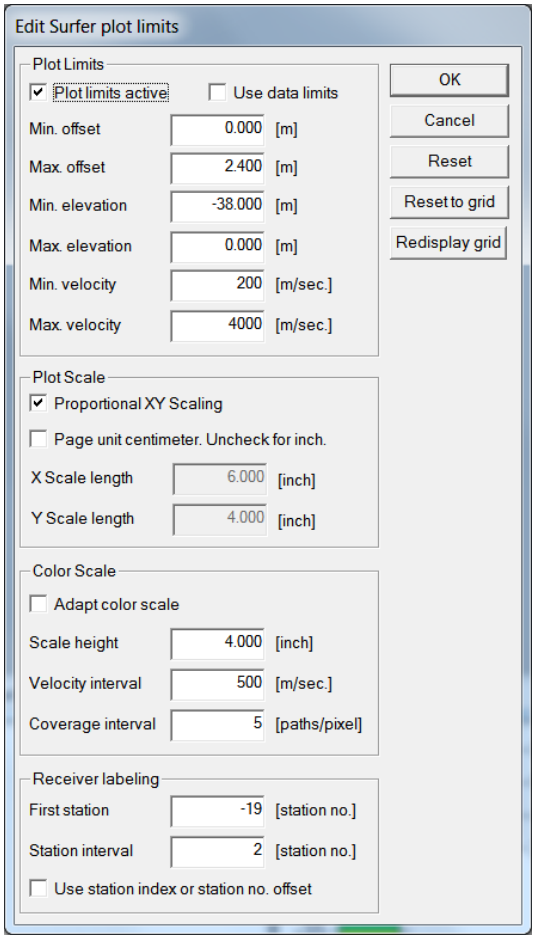


Fig. 10 : Grid|Surfer plot Limits dialog. Check box ***Limits active*** and ***Proportional XY scaling***. Edit as shown. Click OK button.

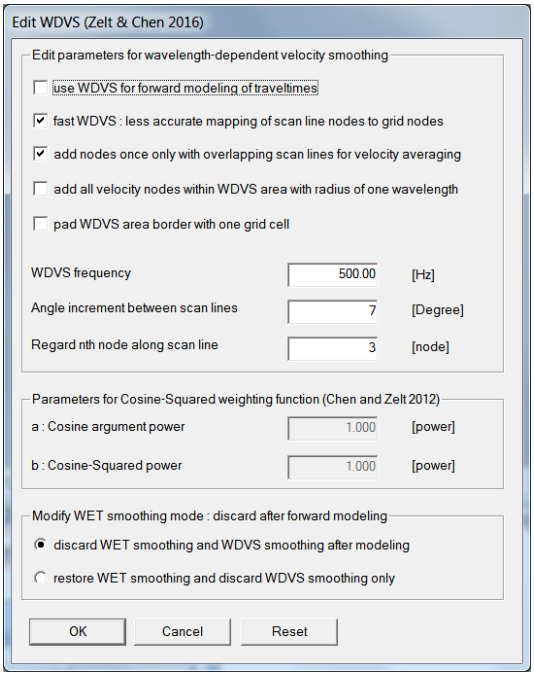


Fig. 11 : Model|WDVS Smoothing dialog. Click option ***discard WET smoothing and WDVS smoothing after modeling***. Click OK.

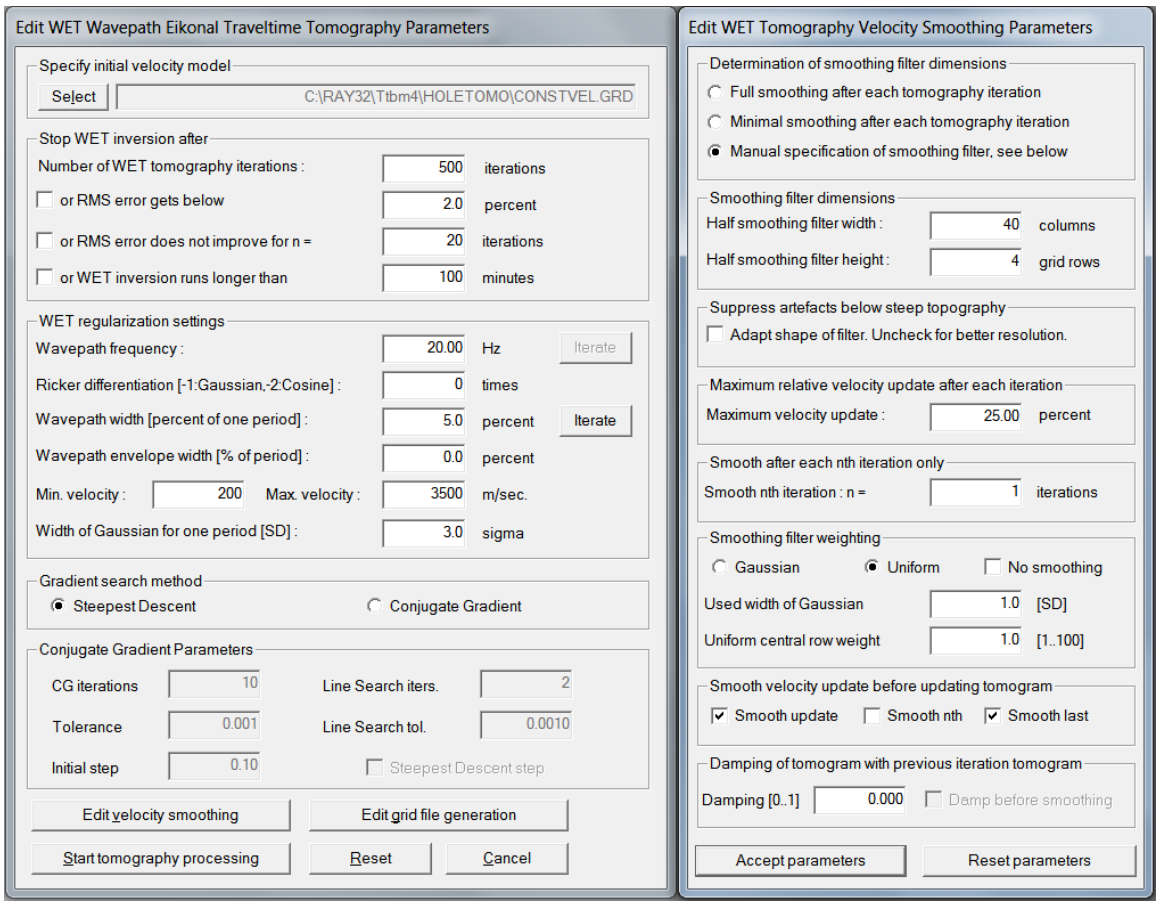


Fig. 12 : WET Tomo|Interactive WET main dialog (left). Edit velocity smoothing (right).

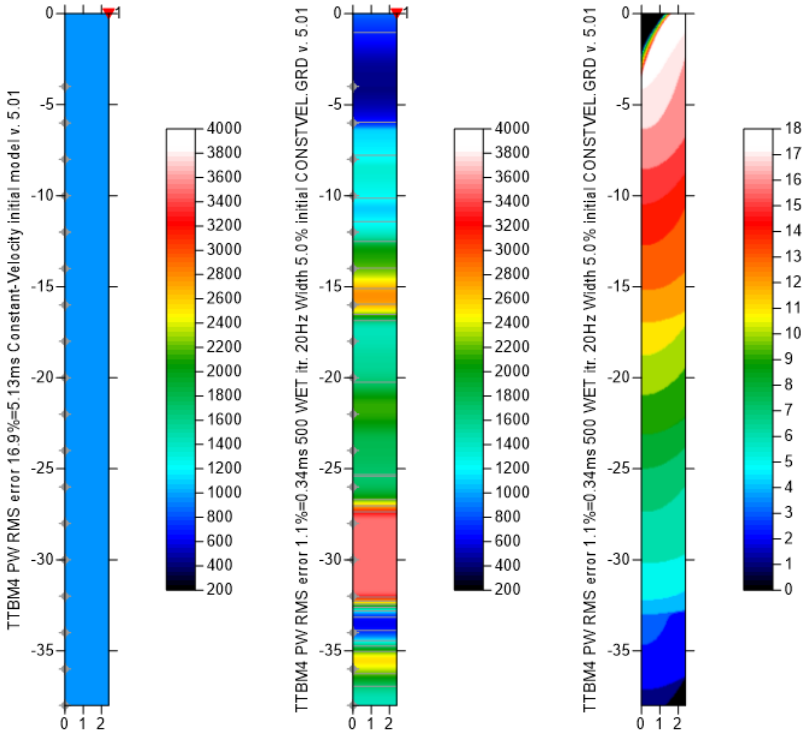


Fig. 13 : constant-velocity initial model (left). Steepest-Descent WET inversion after 500 iterations (center) with ***discard WET smoothing*** checked in *Model|WDVS Smoothing* (Fig. 11).

We set WET ***wavepath frequency*** to 20Hz and WET ***wavepath width*** to 5 percent (Fig. 12 left).

We use a ***Ricker wavelet*** for WET update weighting across the wavepath (***Ricker differentiation*** 0 in Fig. 12 left) and ***manual WET smoothing*** (Fig. 12 right) with smoothing filter ***half-width*** 40 grid columns and ***half-height*** 4 grid rows. We uncheck option ***Adapt shape of filter***. This manual 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 pixel.

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

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

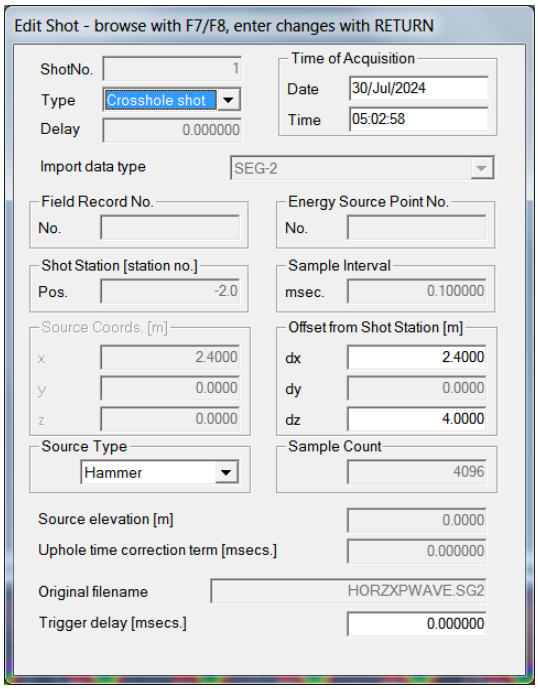


Fig.14 : *Header|Shot*. Check if fields x and z in frame *Source Coords. [m]* match the *Source x-offset from top-of-hole* and *Source depth below top-of-hole* as specified in SEG2_Aggregate program (Fig. 5).

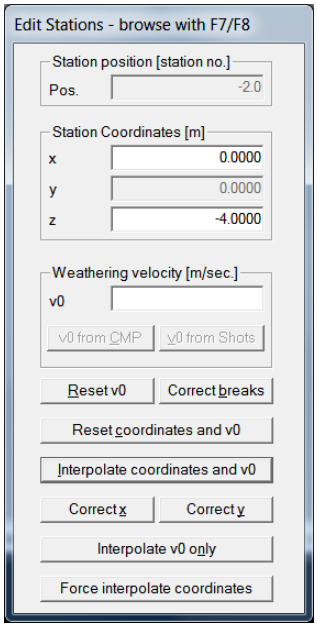


Fig. 15 : *Header|Station*. Use F7/F8 keys to browse to *Station position [station no.]* -1.0 as referenced in *Header|Shot* (Fig. 14).

Click here for the .rar archive of the profile folder obtained with above processing.

See also our updated 2024 manual

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

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

Our new SEG2_Aggregate program is described in above rayfract.pdf paragraph ***Aggregate Geotomographie DDS borehole geophone traces into SEG-2 borehole spread files***.

See also our twin tutorial https://rayfract.com/tutorials/TTBM6.pdf and our earlier 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 .

- for the Geotomographie GmbH DDS borehole geophone manual see https://geotomographie.de/assets/equipment/Manual2023-DDS.pdf
- the Geotomographie GmbH test data set is available in archive https://geotomographie.de/exchange/DDS_Example_SEG2_Files.zip . Download and unzip in above input directory.
- for a description of the SEG-2 file set format of the above test data showing the VSP recording geometry see https://rayfract.com/tools/Downhole_Test_DDS_Example_SEG2_Files.pdf
- Doug Crice describes cross-hole and down-hole shear wave recording geometry in his paper http://geostuff.com/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 https://rayfract.com/help/rayfract.pdf chapter ***Shear wave picking*** .

Discussion

We show aggregation of DDS recorded SEG-2 channels into SEG-2 receiver spread files. Then we import the aggregated SEG-2 files into a Rayfract(R) borehole profile database. Next we apply frequency filtering and pick the P-wave first breaks. Finally we run our WET inversion using 500 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 Rajko Vasić at Jaroslav Cerni Water Institute 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 write our new SEG2_Aggregate program and for his feedback regarding interpretation of this borehole VSP data set with our latest version 5.01 software. Rajko Vasić describes the geological subsurface setting as “all the boreholes go through quaternary sedimentary dusty clays, clays, marly clays alternating with marls, loams and sometimes marls and limestones that appear only in a few boreholes mainly at the bottom of the borehole. This project is tied to TBM (Tunnel boring machine) which will go through marly clayey sediments and “soft” rocks (marls and limestones rocks)”. See also Wikipedia.

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