Import SEG-2 .DAT & Update header data & Smooth invert shear wave SH_60M v. 5.01 :

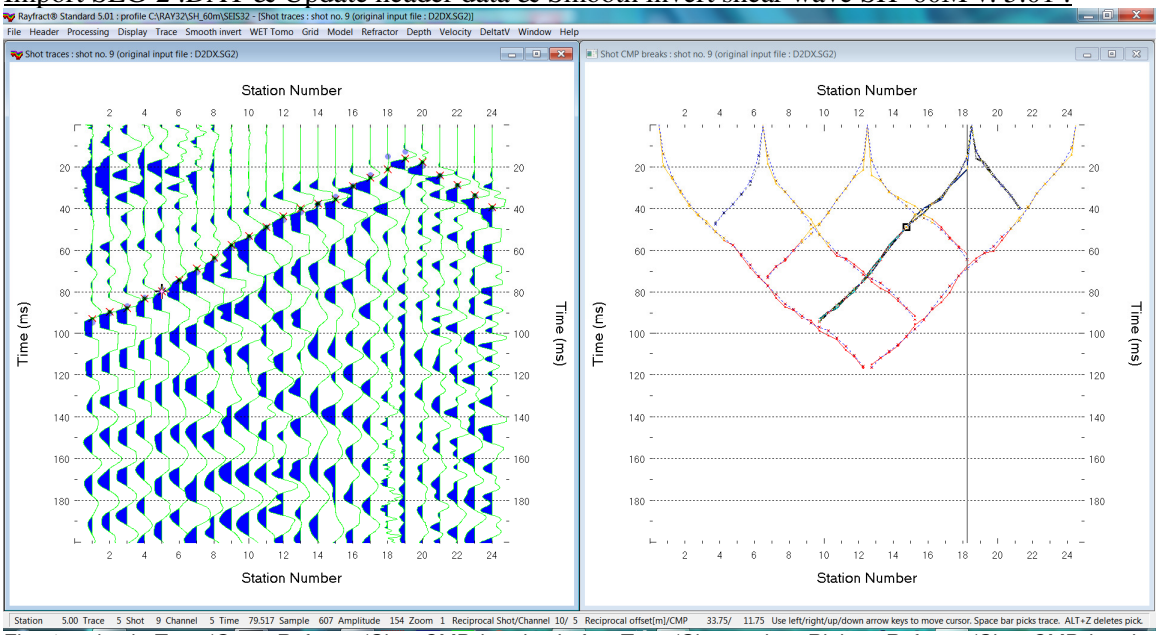

Fig. 1 : check *Trace|Open Refractor|Shot CMP breaks*. Left : *Trace|Shot gather*. Right : *Refractor|Shot CMP breaks*. Shows fit between picked times (solid colored curves, red crosses) and modeled times (dashed blue curves, blue dots). Green dots are your reciprocal picks.

To create the profile database, import the data and browse the imported shots do these steps :

- ***File|New Profile***…, set *File name* to **`SH_60M`** and click *Save button*
- in the prompt shown next (Fig. 4) click ***Yes*** button to force ***Profile start*** / first channel at station no. 1
- in ***Header|Profile***… select *Line type* **`Refraction spread/line`** . Set *Station spacing* to 2.5 m. See Fig. 2.
- unzip archive https://rayfract.com/tutorials/SH_60M_INPUT.zip with **`SEG-2 .SG2`** shot files & file **`BREAKS.LST`** in directory **`C:\RAY32\SH_60M\INPUT`**
- select ***File|Import Data***… and set *Import data type* to **`SEG-2`**. See Fig. 3.
- click ***Select*** *button* and navigate into **`C:\RAY32\SH_60M\INPUT`**
- set control ***Files of type*** to **`ABEM files (*.SG2)`** and select a file e.g. **`ADX.SG2`** & click *Open*
- set control ***Take shot record number from*** to **`File number`**
- leave *Default spread type* at **`10: 360 channels`**
- click ***Import shots button*** .
- leave *Layout start* at 1 for all shots displayed in our *Import shot* dialog
- specify ***Shot pos. [station no.]*** 0.5, 0.5, 24.5, 24.5, 12.5, 12.5, 6.5, 6.5, 18.5, 18.5 and click *Read button* for *Shot Number* 1 to 10
- select *File|Update header data|Update First Breaks*. Select file **`BREAKS.LST`** & click *Open*.
- select option *Trace|Open Refractor|Shot CMP breaks with Shot gather*
- select *Trace|Shot gather* to obtain Fig. 1
- press SHIFT+Q to show *Frequency filter* dialog. Uncheck *Filter active*. Click *Filter*. See Fig. 11.
- click on title bar of *Trace|Shot gather* window and press CTRL+F1 to zoom trace amplitude
- browse shots in *Trace|Shot gather* window with F7/F8 (Fig. 1 left)
- click on title bar of *Refractor|Shot CMP breaks* window (Fig. 1 right) and press ALT+P. Edit *Maximum time* to 200 ms & press ENTER key to redisplay. Do the same for *Trace|Shot gather* window (Fig. 1 left).

Run default fail-safe Smooth inversion with 1D-gradient laterally averaged starting model :

- check option *Grid|Receiver station ticks on top axis*
- check option *Grid|CS_CENTERED font for shot points and receivers* to workaround Surfer symbol display issues
- edit *Grid|Surfer plot Limits* as in Fig. 8
- select *Model|WDVS Smoothing* and click radio button *restore WET smoothing and discard WDVS smoothing only.* Leave box *use WDVS for forward modeling of traveltimes* unchecked (Fig. 9).
- select ***Smooth invert|WET with 1D-gradient initial model***
- wait for the 1D-gradient starting model to display as in Fig. 5
- confirm prompt to continue with WET inversion to obtain WET output shown in Fig. 6 & 7

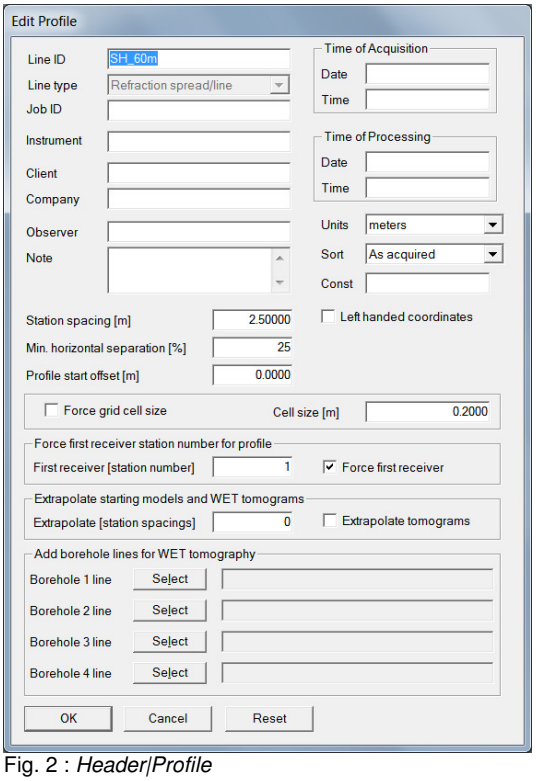

Fig. 2 : *Header|Profile*

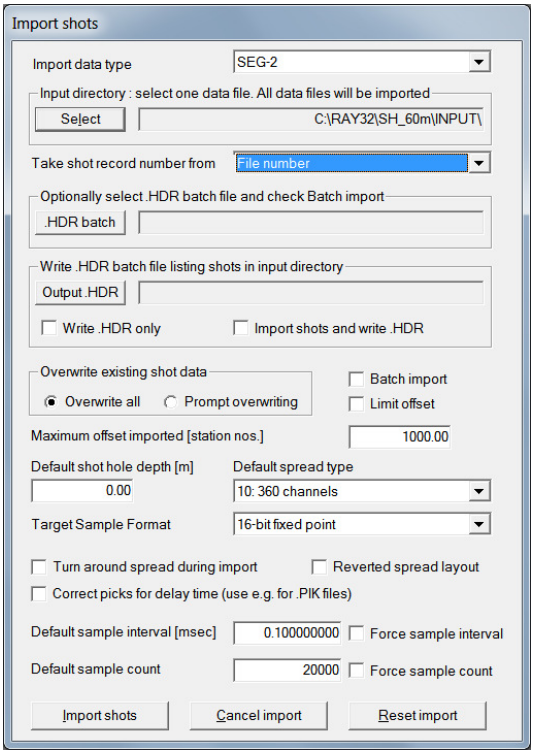

Fig. 3 : *File|Import Data*

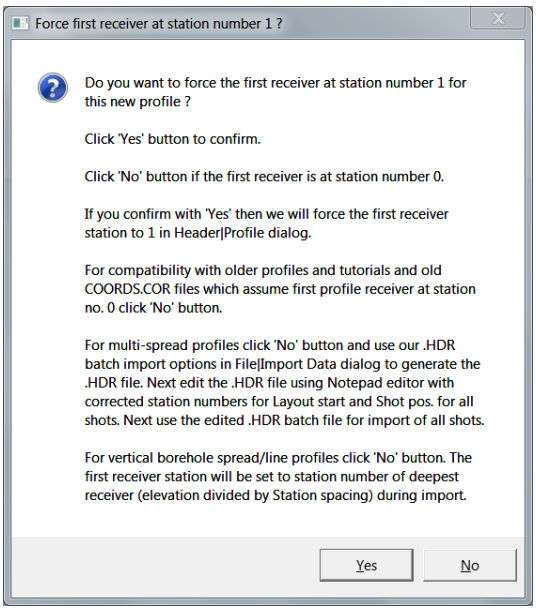

Fig. 4 : click *Yes* button to force the first receiver at station number 1 for this profile.

For compatibility with older profiles and tutorials and old COORDS.COR files which assume first profile receiver at station no. 0 click No button. For multi-spread profiles click No button and use our .HDR batch import options in *File|Import Data* dialog to generate the .HDR file. Next edit the .HDR file using MS Notepad editor with corrected station numbers for *Layout start* and *Shot pos.* for all shots. Next use the edited .HDR batch file for import of all shots.

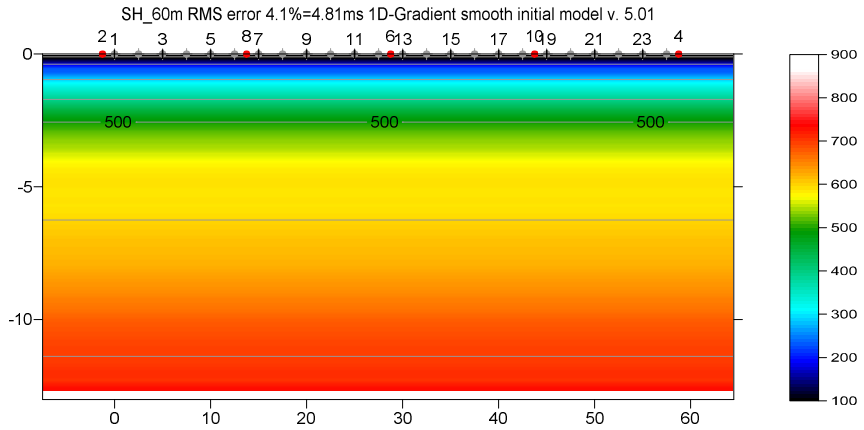

Fig. 5 : 1D-gradient starting model obtained with *Smooth invert|WET with 1D-gradient initial model.*

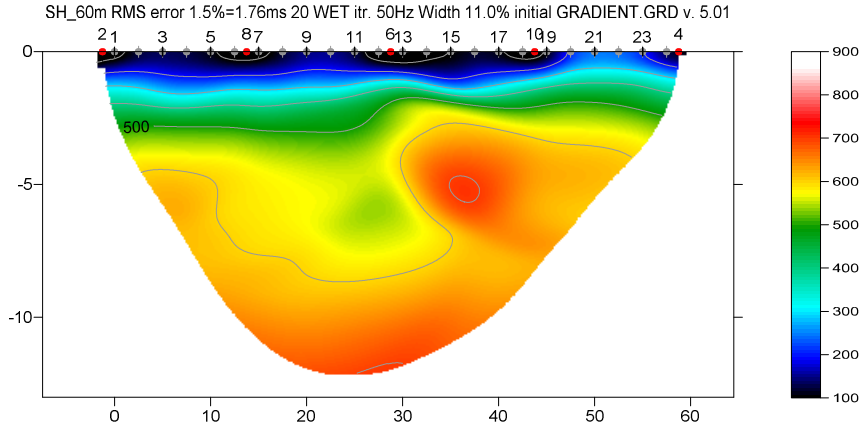

Fig. 6 : 2D WET output obtained with *Smooth invert|WET with 1D-gradient initial model* & starting model shown in Fig. 5. 20 WET iterations using Steepest Descent method & Gaussian update weighting & full WET smoothing. Don't discard WET smoothing after forward modeling. Leave WDVS disabled (Fig. 9).

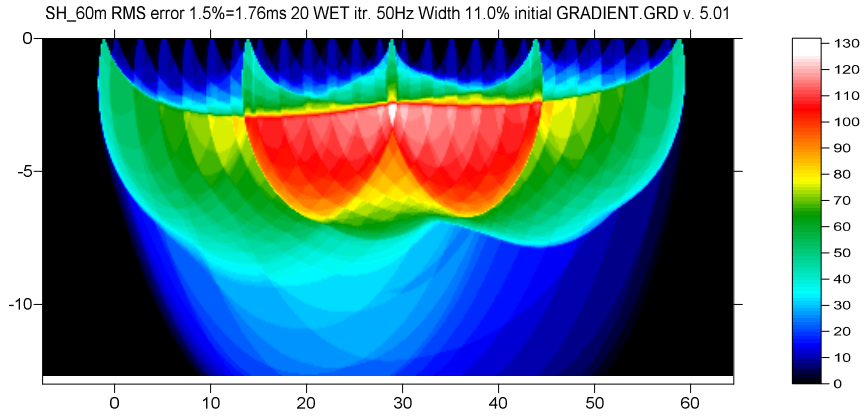

Fig. 7 : WET wavepath coverage plot obtained with Fig. 6. Unit is wavepaths per grid cell.

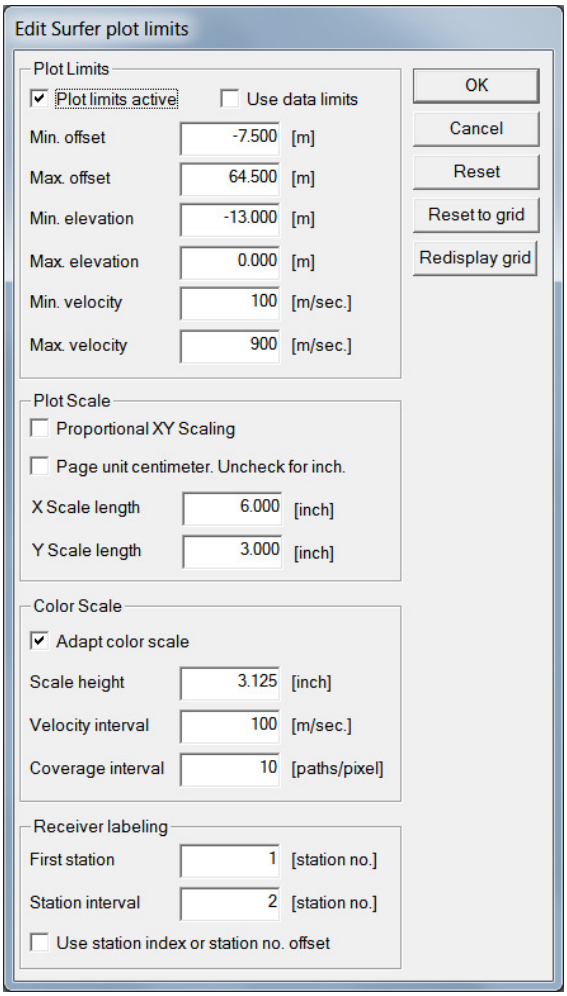

Fig. 8 (left) : *Grid|Surfer plot Limits* dialog .

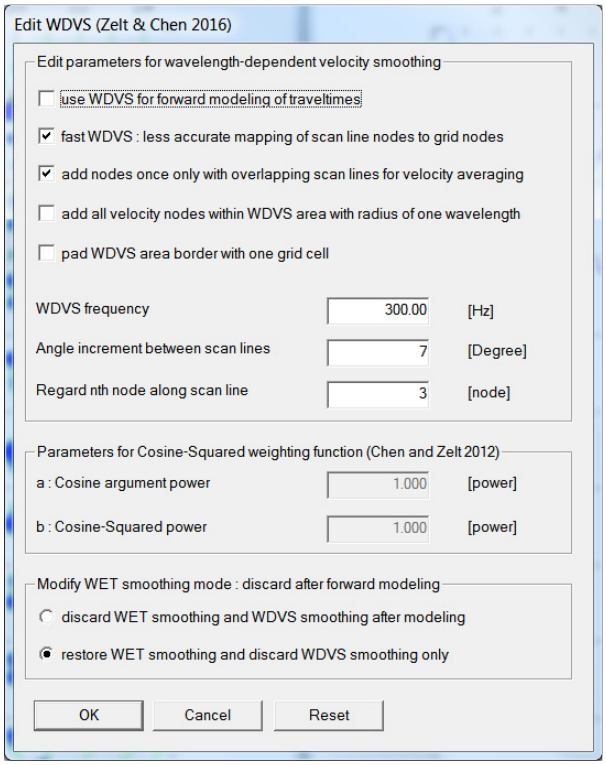

Fig. 9 : *Model|WDVS Smoothing* dialog .

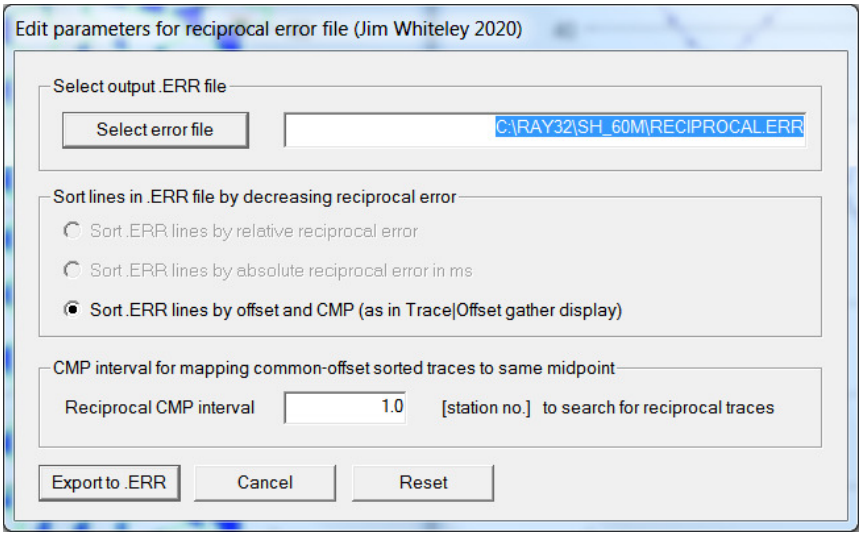

Fig. 10 : *Trace|Export reciprocal errors and update database*

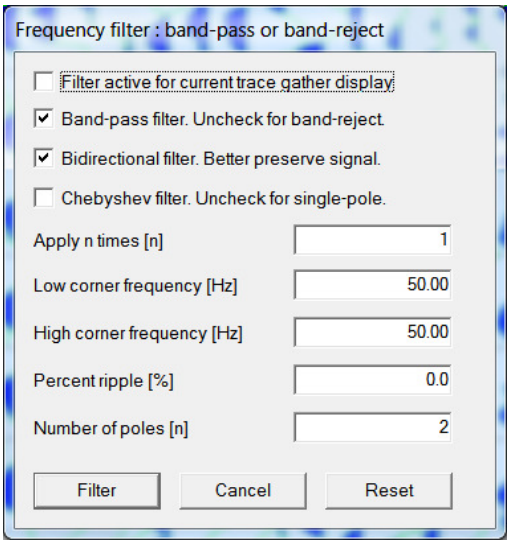

Fig. 11 : press SHIFT+Q in *Trace|Shot gather*. Uncheck box *Filter active for current trace gather display*. Click button *Filter*.

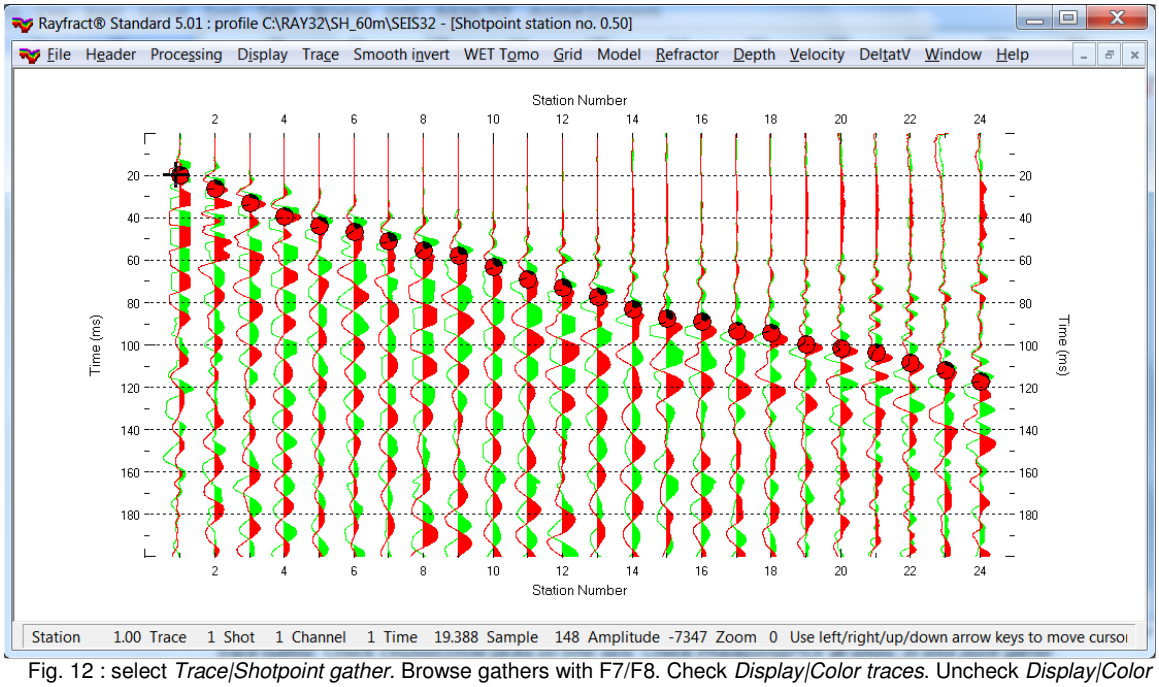

Fig. 12 : select *Trace|Shotpoint gather*. Browse gathers with F7/F8. Check *Display|Color traces*. Uncheck *Display|Color trace outline*. Check *Display|Show picks on time axis*. Check *Processing|Pick all shots, in shot point gather*.

Pick shear-wave first breaks in Trace|Shotpoint gather display

- select *Trace|Shotpoint gather*. Browse gathers with F7/F8. See Fig. 12.
- check *Display|Color traces*. Uncheck *Display|Color trace outline*.
- check *Display|Show picks on time axis*.
- check *Processing|Pick all shots, in shot point gather*.
- press SHIFT+Q. Uncheck box *Filter active*. Click button *Filter*. See Fig. 11.
- pick S-wave first breaks with left mouse button. See Fig. 12. Solid red circles are your picks.
- select *File|Export header data|Export First Breaks to .LST*. Click *Save* to save to **`BREAKS.LST`**.

Plot your reciprocal traveltime picks on shot-sorted trace gathers :

Plotting your reciprocal traveltime picks on shot-sorted trace gathers lets you quality-control your first break picks and check the validity of your recording geometry specification (shot station numbers and receiver station numbers) :

- select ***Trace\Export reciprocal traveltime picks and update database***
- click button *Select error file* and click *Save* button (Fig. 10)
- click button *Export to .ERR*
- optionally check new option ***Trace\Open Refractor\Shot CMP breaks with Shot gather***
- select *Trace\Shot gather* to obtain a window display as in our Fig. 1
- check new version 4.05 option ***Display\Show reciprocal picks on Shot Gather***
- browse and zoom trace gathers with function keys F7/F8, F1/F2 etc. as usual
- navigate traces with arrow-left and arrow-right keys
- if a reciprocal pick was determined/matched to the current trace then this is plotted as a green dot on the trace
- also we show ***Reciprocal Shot/Channel*** and ***Reciprocal offset[m]/CMP*** in status bar at bottom of window (Fig. 1 left) if a reciprocal pick is available in the .ERR file

Here is the link to the .RAR archive with the SH_60M profile folder for above Fig. 6 :

https://www.dropbox.com/scl/fi/vjqy70ux4lhf4vcrnh5lt/SH_60m_Oct5_2024_DisableWDVS.rar?rlkey=mx0qhf3bls3tik96jxwqdr3t7&st=dw630das&dl=0

Select above link and copy with CTRL+C. Then paste the link into your web browser with CTRL+V and press RETURN key to download the .RAR archive.

Interactive WET tomography using default fail-safe 1D-gradient starting model

Next we show interactive WET tomography (Fig. 13) using the same 1D-gradient starting model obtained with *Smooth invert\WET with 1D-gradient initial model* as shown in Fig. 5. We discard WET smoothing after forward modeling (Fig. 16) trying to reach a better resolution. We increase the number of *WET iterations* from default 20 iterations to 50 iterations. Also we modify the *Ricker differentiation* from default *-1 [Gaussian]* to *0 [Ricker wavelet]* to better deal with the velocity inversion at depth of about 8m (Fig. 6).

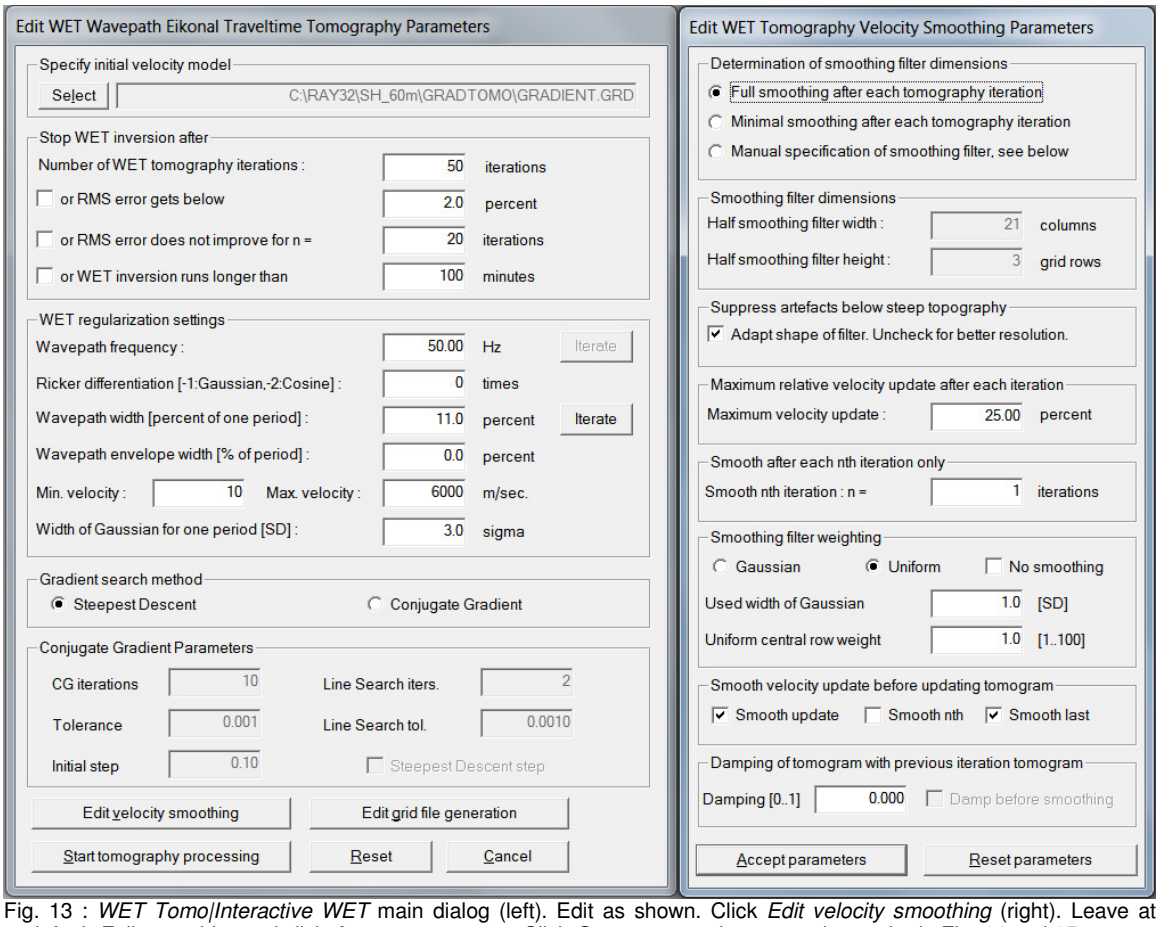

Fig. 13 : *WET Tomo|Interactive WET* main dialog (left). Edit as shown. Click *Edit velocity smoothing* (right). Leave at default *Full smoothing* and click *Accept parameters*. Click *Start tomography processing* to obtain Fig. 14 and 15.

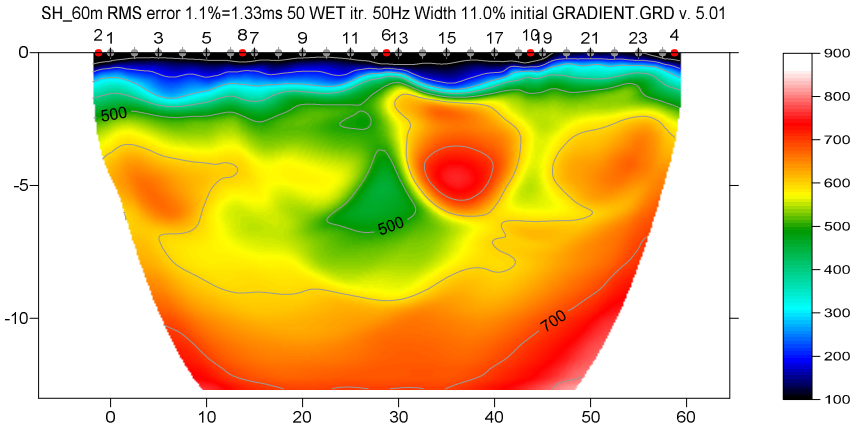

Fig. 14 : 50 Steepest-Descent WET iterations using a Ricker wavelet for weighting of WET velocity update across the wavepath (Fig. 13 left). Leave WET smoothing at default *Full smoothing* (Fig. 13 right). Starting model is Fig. 5. Discard WET smoothing (Fig. 16).

In Fig. 14 we reach a smaller RMS error compared to Fig. 6. Also the velocity inversion at depth of about 8m becomes better visible.

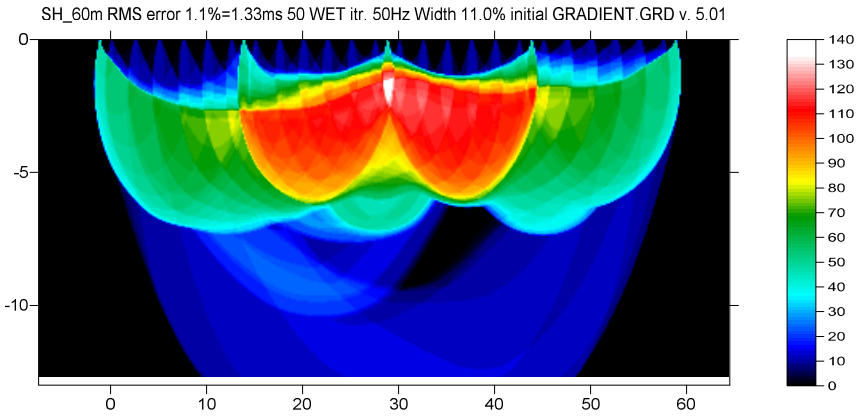

Fig. 15 : WET wavepath coverage plot obtained with Fig. 14. Unit is wavepaths per grid cell.

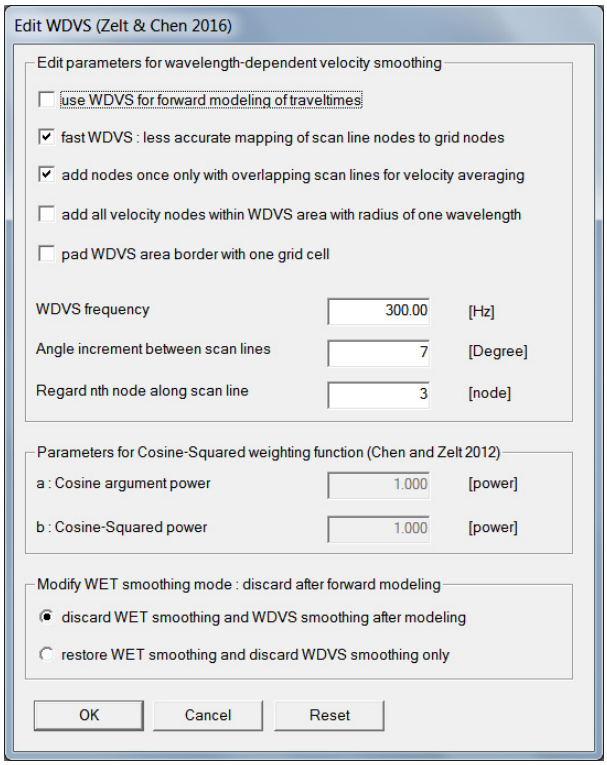

Fig. 16 : *Model|WDVS Smoothing*. Check option Discard WET smoothing and WDVS smoothing after modeling. Click OK button.

Here is the link to the .RAR archive with the SH_60M profile folder for above Fig. 14 :

https://www.dropbox.com/scl/fi/7pt1naxzdeekpeh2f17kt/SH_60m_GradTomo_50WETIters_RickerDiff0_Oct13_2024.rar?rlkey=tq1t20738dg9ly381zpl9vjsf&st=8gmu4vjy&dl=0

Select above link and copy with CTRL+C. Then paste the link into your web browser with CTRL+V and press RETURN key to download the .RAR archive.

Smooth invert using 1D-gradient starting model and discarding WET smoothing

Next we show re-running our Smooth invert using the same 1D-gradient starting model shown in Fig. 5. But now we discard the WET smoothing as shown in Fig. 16 :

- select *Model|WDVS Smoothing*
- check option *Discard WET smoothing* (Fig. 16) and click button OK.
- select *Smooth invert|WET with 1D-gradient initial model*
- wait for the same 1D-gradient starting model to display as in Fig. 5
- confirm prompt to continue with WET inversion to obtain refined WET output shown in Fig. 17 & 18

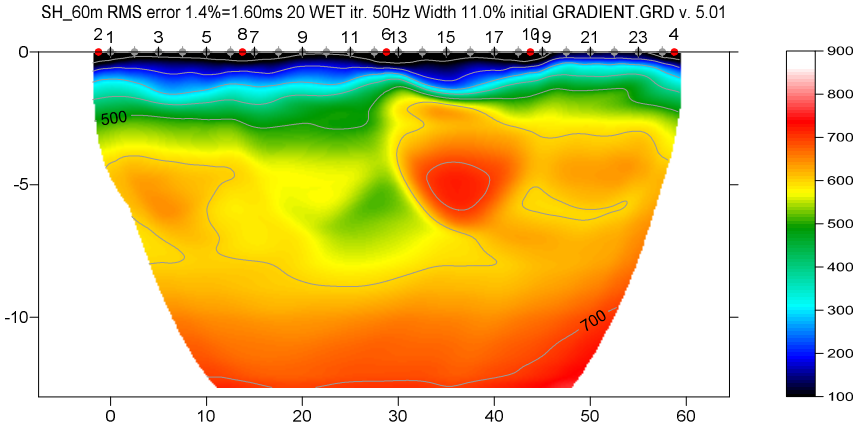

Fig. 17 : 2D WET output obtained with *Smooth invert|WET with 1D-gradient initial model* & starting model shown in Fig. 5. 20 WET iterations using Steepest Descent method & Gaussian update weighting & full WET smoothing. Discard WET smoothing after forward modeling. Leave WDVS disabled (Fig. 16).

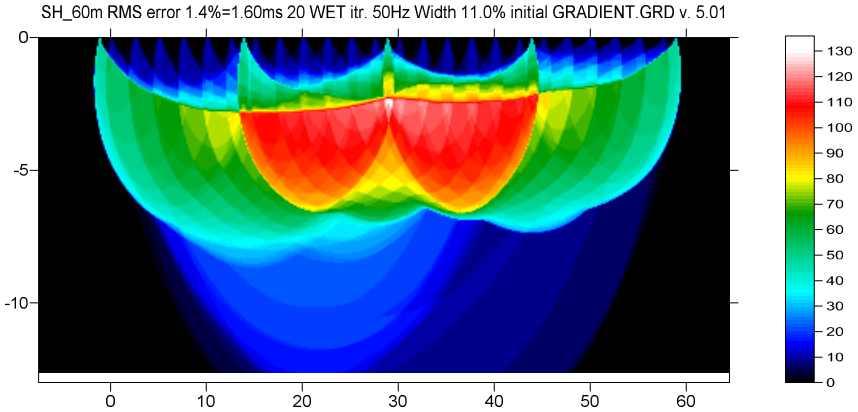

Fig. 18 : WET wavepath coverage obtained with Fig. 17. Unit is wavepaths per grid cell.

Here is the link to the .RAR archive with the SH_60M profile folder for above Fig. 17 :

https://www.dropbox.com/scl/fi/ku4os7jrb1j1gn5epsehk/SH_60m_GradTomo_SmoothInvert_DiscardWET_Oct18_2024.rar?rlkey=ufm7of2fyvltoe2vibg2pwqx0&st=9u3x7zdd&dl=0

Select above link and copy with CTRL+C. Then paste the link into your web browser with CTRL+V and press RETURN key to download the .RAR archive.

Smooth invert using pseudo-2D DeltatV starting model and discarding WET smoothing

Next we show running our Automatic DeltatV and WET inversion using the pseudo-2D DeltatV starting model shown in Fig. 19. We again discard the WET smoothing as shown in Fig. 16 :

- select *Model|WDVS Smoothing*
- check option *Discard WET smoothing* (Fig. 16) and click button OK.
- select *DeltatV|Automatic DeltatV and WET inversion*
- wait for the pseudo-2D DeltatV starting model to display as in Fig. 19
- confirm prompt to continue with WET inversion to obtain WET output shown in Fig. 20 & 21

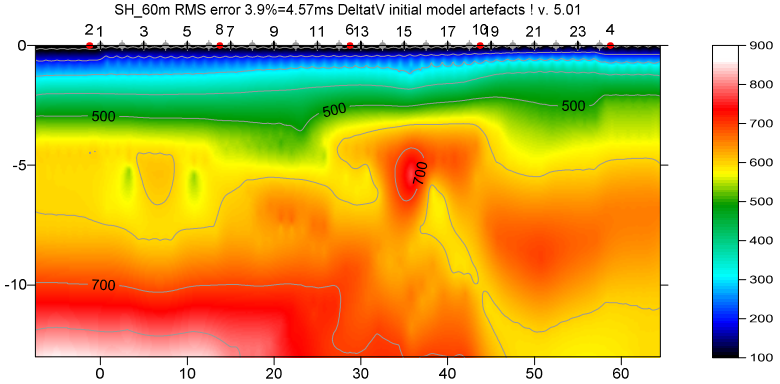

Fig. 19 : Pseudo-2D DeltatV starting model obtained with *DeltatV|Automatic DeltatV and WET inversion*. We leave DeltatV settings in *DeltatV|DeltatV Settings* menu at their defaults. See Fig. 22.

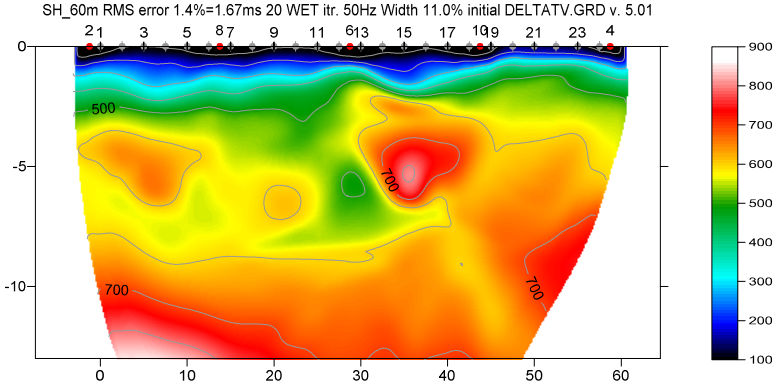

Fig. 20 : 2D WET output obtained with *DeltatV|Automatic DeltatV and WET inversion* & starting model shown in Fig. 19. 20 WET iterations using Steepest Descent method & Gaussian update weighting & full WET smoothing. Discard WET smoothing after forward modeling. Leave WDVS disabled (Fig. 16). We leave DeltatV settings in *DeltatV|DeltatV Settings* menu at their defaults. See Fig. 22.

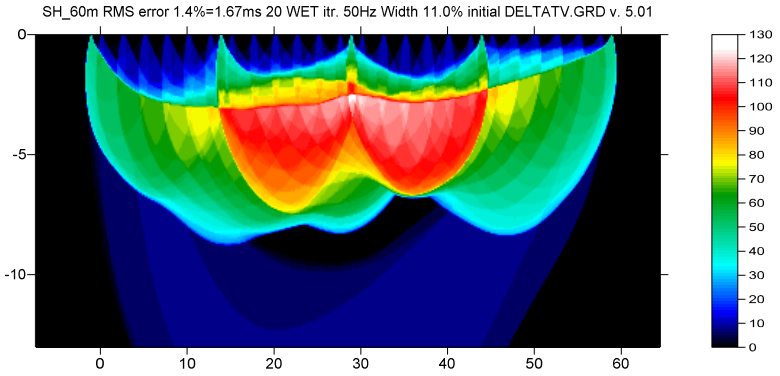

Fig. 21 : WET wavepath coverage plot obtained with Fig. 20. Unit is number of wavepaths per grid cell.

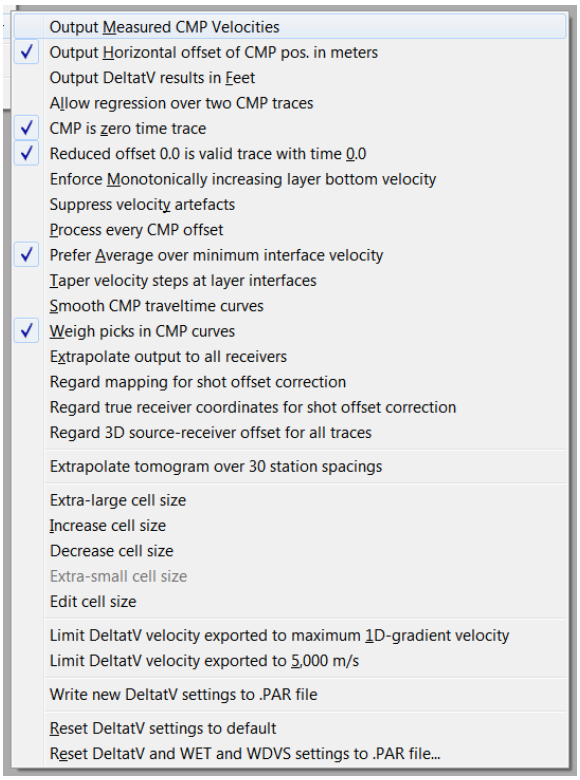

Fig. 22 : *DeltatV|DeltatV Settings*. Leave settings at their defaults as shown.

Note the good match between the pseudo-2D DeltatV starting model in Fig. 19 and the resulting 2D WET tomogram in Fig. 20. Also note the good match between Fig. 20 and Fig. 17 using our fail-safe 1D-gradient starting model.

Pseudo-2D DeltatV fails to give a realistic starting model in case of strong topography or with strong lateral velocity change in the overburden. See e.g. our tutorial https://rayfract.com/tutorials/1_1D.pdf . Always first run our Smooth invert as shown above in Fig. 6 using our fail-safe 1D-gradient starting model obtained by laterally averaging 1D DeltatV velocity profiles (Fig. 5; Sheehan 2005).

Here is the link to the .RAR archive with the SH_60M profile folder for above Fig. 20 :

https://www.dropbox.com/scl/fi/junrcad5tcdg22bi5mxg4/SH_60m_DeltatV_And_WET_Nov3_2024.rar?rlkey=ft5eh9ujo833pnrp3b8tx3ny7&st=rpcgpnrx&dl=0

Select above link and copy with CTRL+C. Then paste the link into your web browser with CTRL+V and press RETURN key to download the .RAR archive.

Multiscale WET inversion using 1D-gradient starting model and discarding WET smoothing

Next we run our ***multiscale WET inversion*** to further improve the resolution in the WET tomogram. We use the same ***fail-safe 1D-gradient starting model*** shown in Fig. 5. We again discard the WET smoothing as shown in Fig. 16. We edit the *Surfer plot Limits* to better visualize the velocity inversion. We enable scaling of *WET wavepath width* and *WET filter height*. We use proven default settings in *WET Tomo|Interactive WET* dialog and default WET smoothing :

- select *Model|WDVS Smoothing*
- check option *Discard WET smoothing* (Fig. 16) and click button OK.
- select *Smooth invert|WET with 1D-gradient initial model*
- wait for the same 1D-gradient starting model to display as in Fig. 5
- confirm prompt to continue with WET inversion to obtain refined WET output shown in Fig. 17 & 18
- edit *Grid|Surfer plot Limits* as in Fig. 23. Click button *OK*.
- uncheck option *WET Tomo|Blank|Blank below envelope after last iteration*
- uncheck *WET Tomo|WET tomography Settings|Disable wavepath scaling for short profile* (Fig. 24).
- select *WET Tomo|Interactive WET*. Edit main dialog and WET smoothing as in Fig. 25 : reset parameters to their defaults.
- in *WET Tomo|Interactive WET* main dialog click *Iterate* button. Leave settings at defaults (Fig. 26).
- check box *WET runs active* (Fig. 26). Click *OK* button. Click button *Start tomography processing*.

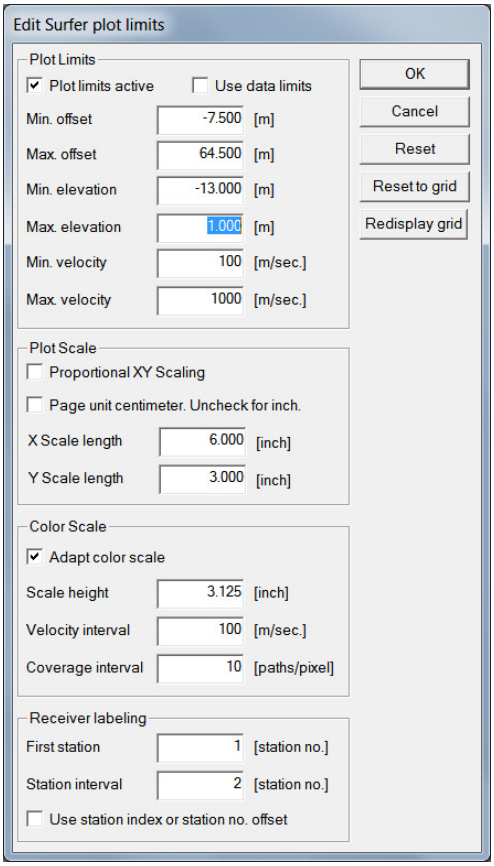

Fig. 23 : *Grid|Surfer plot Limits*

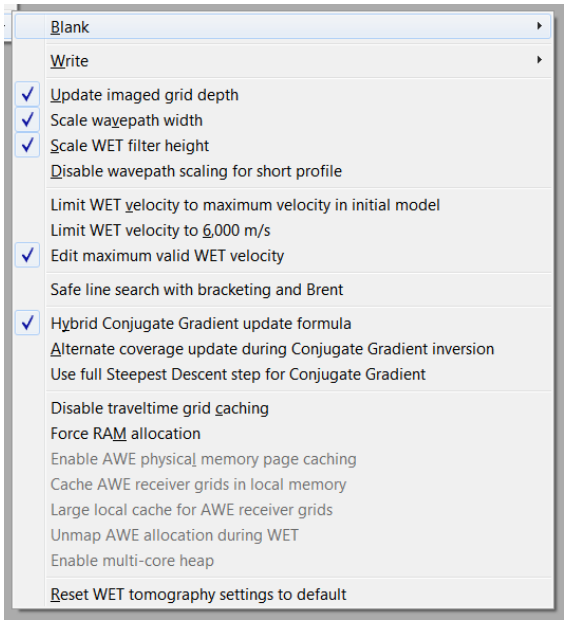

Fig. 24 : *WET Tomo|WET tomography Settings*. Uncheck *Disable wavepath scaling for short profile* to enable scaling of wavepath width and WET filter height.

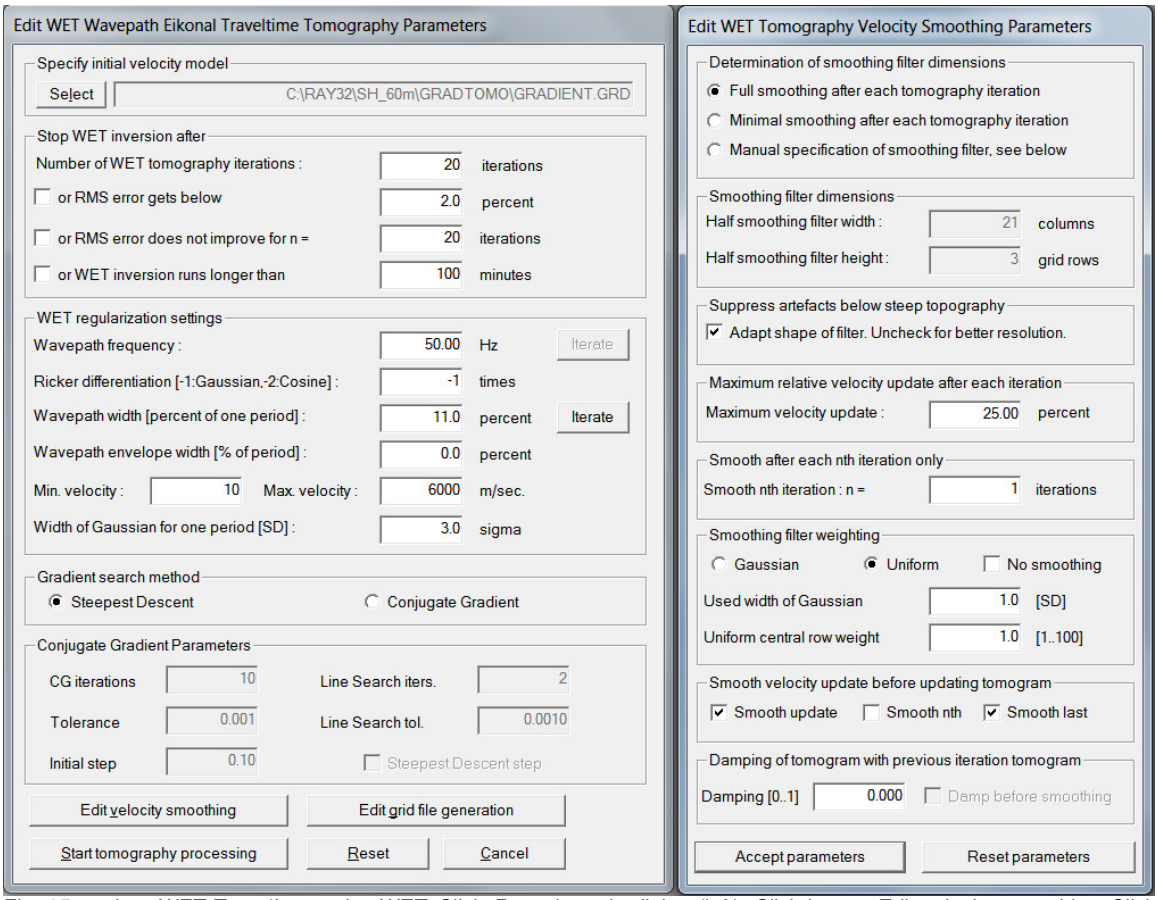

Fig. 25 : select *WET Tomo|Interactive WET*. Click *Reset* in main dialog (left). Click button *Edit velocity smoothing*. Click button *Reset parameters* (right). Click button *Accept parameters*. Click button *Iterate*. Edit as in Fig. 26.

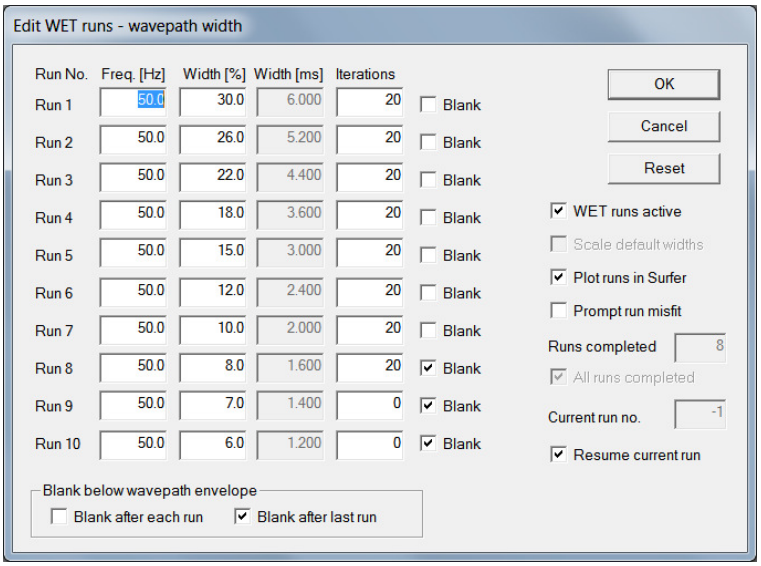

Fig. 26 : *Edit WET runs* dialog for Multiscale WET inversion. Check box *WET runs active*. Click button *OK*.

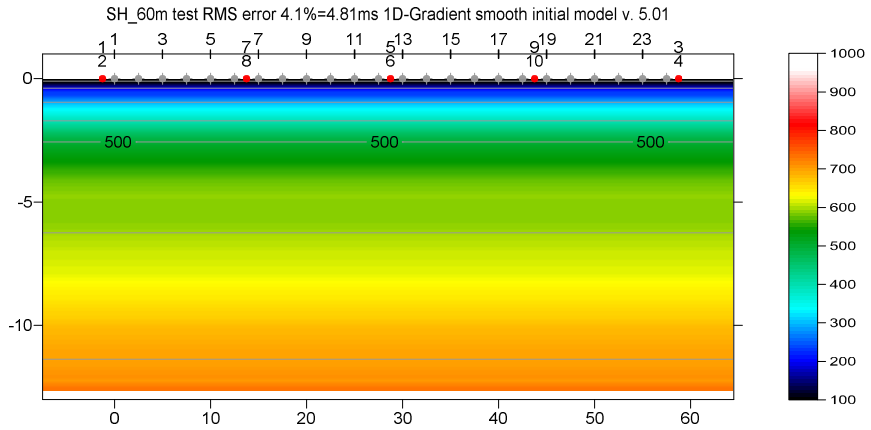

Fig. 27 : 1D-gradient starting model obtained with *Smooth invert|WET with 1D-gradient initial model.* Same as Fig. 5.

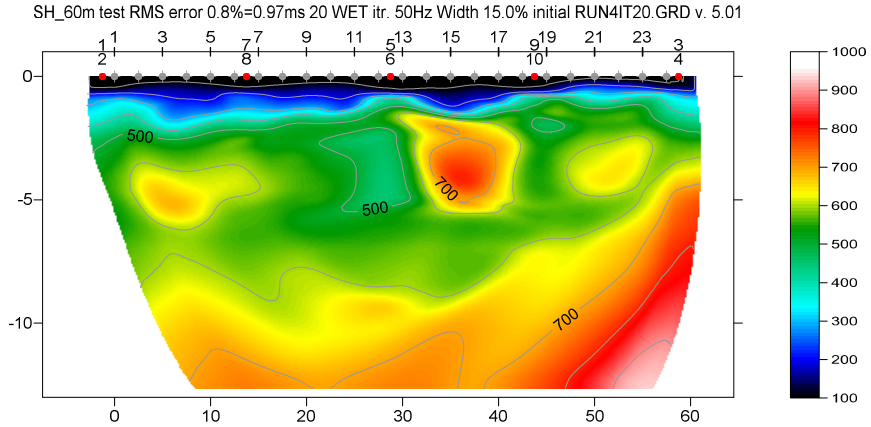

Fig. 28 : WET output after 5 WET runs. Scale *WET wavepath width* and *WET filter height* (Fig. 24). *Discard WET smoothing after forward modeling* (Fig. 16). Default *WET Tomo|Interactive WET* settings and default WET smoothing (Fig. 25). Enable ***multiscale WET inversion*** (Fig. 26). Starting model for first WET run is Fig. 27.

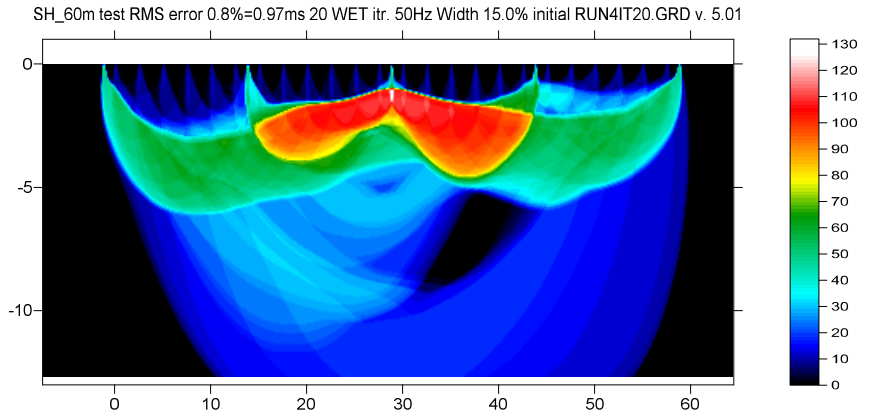

Fig. 29 : WET wavepath coverage plot obtained with Fig. 28. Unit is wavepaths per grid cell.

Here is the link to the .RAR archive with the SH_60M profile folder for above Fig. 28 :

https://www.dropbox.com/scl/fi/nqepgn9ybio1k89lnjk31/SH_60m_Multiscale_WET_Nov10_2024.rar?rlkey=0gee5zhhvo7ts8iyjs4esl8p4&st=293msux2&dl=0

Select above link and copy with CTRL+C. Then paste the link into your web browser with CTRL+V and press RETURN key to download the .RAR archive.

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