

Multirun WET NGU P1-1 model : Steepest Descent & Cosine-Squared weighting version 3.35 :

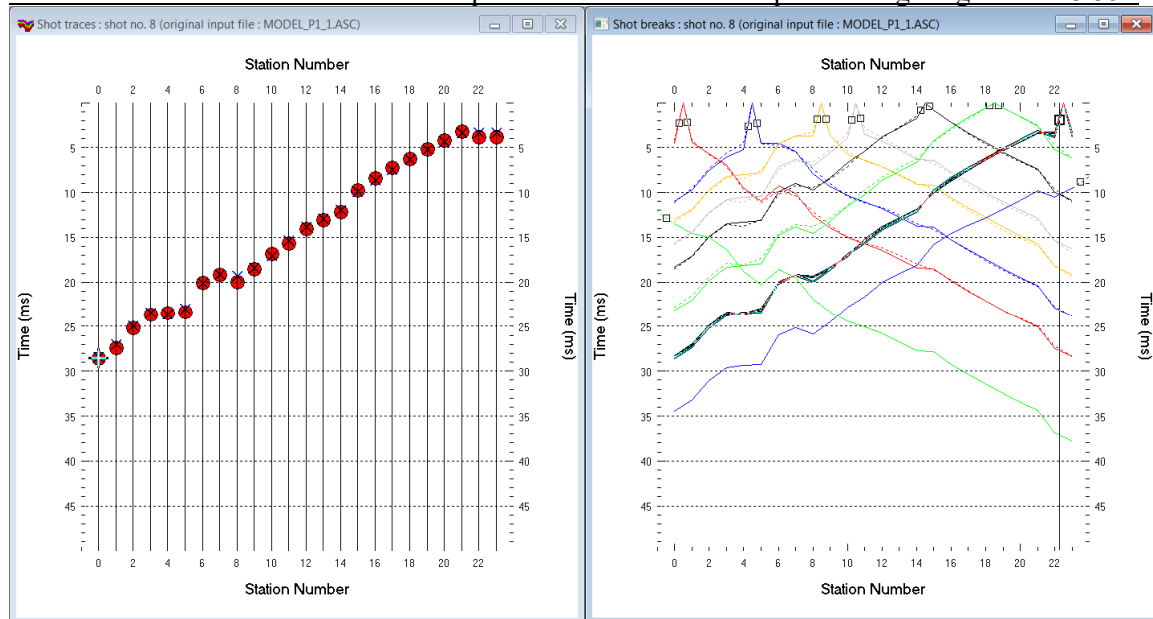
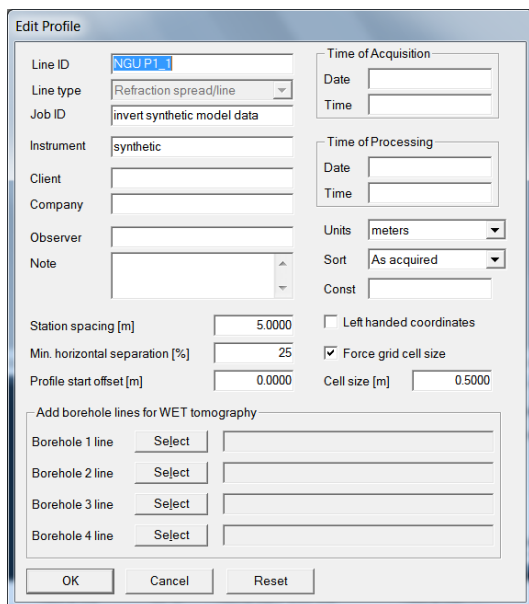


Fig. 1 : left : *Trace|Shot gather*, right : *Refractor|Shot breaks*. Shows fit between picked times (solid colored curves, red circles) and modeled times (dashed colored curves, blue crosses) obtained for multirun WET output shown in Fig. 9

- *File|New Profile...*, set *File name* to **NGUP1_1** and click *Save* button
- in *Header|Profile...* set *Line type* to **Refraction spread/line**. Set *Station spacing* to 5.0 m.
- check box *Force grid cell size* and set *Cell size[m]* to 0.5m. See Fig. 2.
- unzip [NGUP1_1.zip](#) with files **ASCII.ASC**, **COORDS.COR** and **SHOTPTS.SHO** in directory **C:\RAY32\NGUP1_1\INPUT**
- select *File|Import Data...* and set *Import data type* to **ASCII column format**. See Fig. 3.
- leave *Default spread type* at **10: 360 channels**
- click *Select* button, navigate into **C:\RAY32\NGUP1_1\INPUT** and select file **ASCII.ASC**
- set *Default sample count* to 500 to setup the y scale for *Trace|Shot gather* & *Refractor|Shot breaks*
- click *Import shots* button. The *Import shot dialog* is shown for each shot in the **.ASC** file.
- for each shot leave *Layout start* and *Shot pos.* at shown values and click *Read* button
- select *File|Update header data|Update Station Coordinates*
- navigate into directory **C:\RAY32\NGUP1_1\INPUT**
- select file **COORDS.COR**. Click *Open* button.
- *File|Update header data|Update Shotpoint coordinates* with **SHOTPTS.SHO**
- select *Trace|Shot gather* and *Window|Tile* to obtain Fig. 1
- uncheck *WET Tomo|WET tomography Settings|Blank no coverage after last iteration*
- uncheck *WET Tomo|WET tomography Settings|Blank below envelope after last iteration*
- check *WET Tomo|WET tomography Settings|Write|Store modeled picks after last iteration only*
- select *Refractor|Shot breaks*. Check *Mapping|Pick branch points between receivers*.
- uncheck *Mapping|Automated updating of station V0*
- in *Refractor|Shot breaks* pick branch points adjacent to shot points with **CTRL+F1**. See Fig 1.
- press **ALT+L** to map traces to refractors based on your picked branch points
- select *Header|Station &* click *Reset v0* & set *v0* to 500 m/s. Click button *Interpolate v0 only*.
- select *Depth|Plus-Minus* & confirm. When prompted to continue with WET click *No*. See Fig. 11.
- select *Refractor|Shot breaks* & repeat last 3 bullets to redisplay *Plus-Minus* depth section
- **ALT+M** in *Plus-Minus* depth window. Set *Overburden&Base filter width* to 2 stations. See Fig. 12.
- press **ENTER** to redo *Plus-Minus*. When prompted to continue with WET click *Yes*. See Fig. 11.

- select **Grid|Surfer plot Limits**. Click button **Reset to grid**. Navigate into profile subdirectory **C:\RAY32\NGUP1_1\LAYRTOMO**. Click on **VELOIT20.GRD** and click **Open**.
- check box **Plot limits active**. Set **Min. elevation** to 50m. Set **Max. elevation** to 100m. See Fig. 4.
- set **Min. velocity** to 500 m/s and **Max. velocity** to 6,000 m/s. Click **OK**.
- check **WET Tomo|WET tomography Settings|Edit maximum valid WET velocity**
- in **WET Tomo|WET velocity update** set **a** to 0.5 and **b** to 10.0. Click **OK**. See Fig. 5.
- set **WET Tomo|Interactive WET tomography|**Ricker differentiation**** to -2 [Cosine-Squared]
- set **Min. velocity** to 500 & **Max. velocity** to 5,500 m/s. See Fig. 6 (left).
- click button **Edit grid file generation** & set **Store each nth iteration only : n =** to 20. Click **OK**.
- click **Edit velocity smoothing**. Check **Manual specification of smoothing filter**. See Fig. 6 (right).
- set **Half smoothing filter width to 3 columns** & set **Half smoothing filter height to 1 rows**
- uncheck **Automatically adapt shape of rectangular filter matrix**. Set **Smooth nth iteration : n =** to 20 .
- click **Gaussian** button. Set **Used width of Gaussian** to 5.0 sigma. Leave **Damping** at 0.0.
- click **Accept parameters** and **Iterate** & check **WET runs active**. Edit as in Fig. 7 and click **button OK**.
- click button **Start tomography processing** to obtain Fig. 9 & 10.



Edit Profile

Line ID: Time of Acquisition: Date: Time:

Line type: Time of Processing: Date: Time:

Job ID: Units:

Instrument: Sort:

Client: Const:

Company:

Observer:

Note:

Station spacing [m]: ☐ Left handed coordinates

Min. horizontal separation [%]: ☒ Force grid cell size

Profile start offset [m]: Cell size [m]:

Add borehole lines for WET tomography

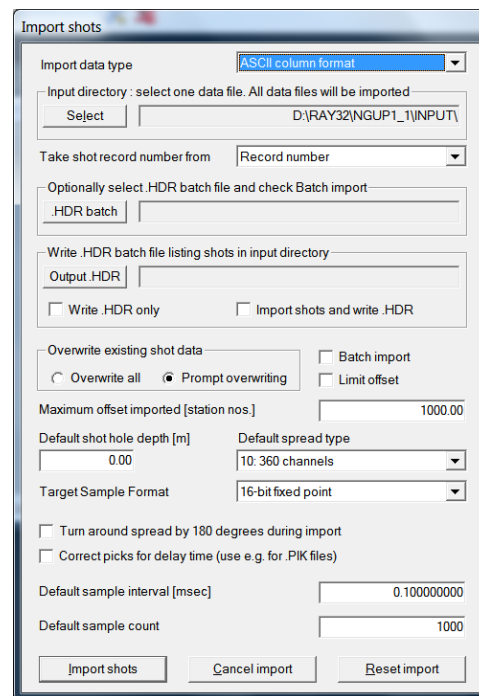
Borehole 1 line:

Borehole 2 line:

Borehole 3 line:

Borehole 4 line:

Fig. 2 : Header|Profile



Import shots

Import data type:

Input directory: select one data file. All data files will be imported

Select:

Take shot record number from:

Optionally select .HDR batch file and check Batch import

.HDR batch:

Write .HDR batch file listing shots in input directory

Output .HDR:

☐ Write .HDR only ☐ Import shots and write .HDR

Overwrite existing shot data ☐ Batch import

☐ Overwrite all ☒ Prompt overwriting ☐ Limit offset

Maximum offset imported [station nos.]:

Default shot hole depth [m]: Default spread type:

Target Sample Format:

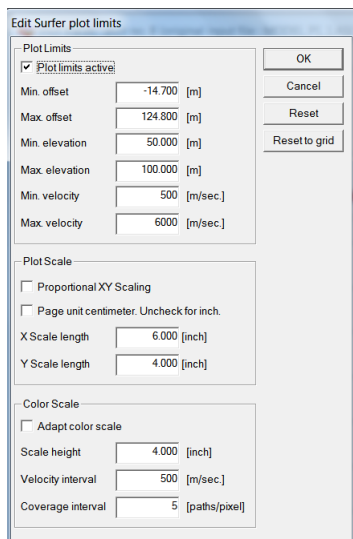
☐ Turn around spread by 180 degrees during import

☐ Correct picks for delay time (use e.g. for .PIK files)

Default sample interval [msec]:

Default sample count:

Fig. 3 : File|Import Data



Edit Surfer plot limits

☒ Plot limits active

Min. offset: [m]

Max. offset: [m]

Min. elevation: [m]

Max. elevation: [m]

Min. velocity: [m/sec.]

Max. velocity: [m/sec.]

Plot Scale

☐ Proportional XY Scaling

☐ Page unit centimeter. Uncheck for inch.

X Scale length: [inch]

Y Scale length: [inch]

Color Scale

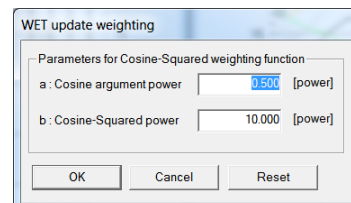
☐ Adapt color scale

Scale height: [inch]

Velocity interval: [m/sec.]

Coverage interval: [paths/pixel]

Fig. 4 : Grid|Surfer plot Limits



WET update weighting

Parameters for Cosine-Squared weighting function

a: Cosine argument power: [power]

b: Cosine-Squared power: [power]

Fig. 5 : WET Tomo|WET update weighting

Edit WET Wavepath Eikonal Traveltime Tomography Parameters

Specify initial velocity model
 D:\ray32\NGUP1_1\LAYRTOMO\PLUSMODL.GRD

Stop WET inversion after

Number of WET tomography iterations : iterations

☐ or RMS error gets below percent

☐ or RMS error does not improve for n = iterations

☐ or WET inversion runs longer than minutes

WET regularization settings

Wavepath frequency : Hz

Ricker differentiation [-1:Gaussian,-2:Cosine] : times

Wavepath width [percent of one period] : percent

Wavepath envelope width [% of period] : percent

Min. velocity : Max. velocity : m/sec.

Width of Gaussian for one period [sigma] : sigma

Gradient search method

☒ Steepest Descent ☐ Conjugate Gradient

Conjugate Gradient Parameters

CG iterations Line Search iters.

Tolerance Line Search tol.

Initial step ☐ Steepest Descent step

Edit WET Tomography Velocity Smoothing Parameters

Determination of smoothing filter dimensions

☐ Full smoothing after each tomography iteration

☐ Minimal smoothing after each tomography iteration

☒ Manual specification of smoothing filter, see below

Smoothing filter dimensions

Half smoothing filter width : columns

Half smoothing filter height : grid rows

Filter shallow dipping wavepath artefacts from model

☐ Automatically adapt shape of rectangular filter matrix

Maximum relative velocity update after each iteration

Maximum velocity update : percent

Smooth after each nth iteration only

Smooth nth iteration : n = iterations

Smoothing filter weighting

☒ Gaussian ☐ Uniform

Used width of Gaussian sigma

Uniform central row weight [1..100]

Smooth velocity update before updating tomogram

☒ Smooth velocity update ☒ Smooth last iteration

Damping of tomogram with previous iteration tomogram

Damping [0..1] ☐ Damp before smoothing

Fig. 6 : left : WET Tomo|Interactive WET tomography.

right : Edit velocity smoothing

Edit WET runs - wavepath width

| Run No. | Freq. [Hz] | Width [%] | Width [ms] | Iterations | |
|---------|-----------------------------------|-----------------------------------|------------------------------------|---------------------------------|---|
| Run 1 | <input type="text" value="50.0"/> | <input type="text" value="30.0"/> | <input type="text" value="6.000"/> | <input type="text" value="20"/> | <input checked="" type="checkbox"/> Blank |
| Run 2 | <input type="text" value="50.0"/> | <input type="text" value="26.0"/> | <input type="text" value="5.200"/> | <input type="text" value="20"/> | <input checked="" type="checkbox"/> Blank |
| Run 3 | <input type="text" value="50.0"/> | <input type="text" value="24.0"/> | <input type="text" value="4.800"/> | <input type="text" value="20"/> | <input checked="" type="checkbox"/> Blank |
| Run 4 | <input type="text" value="50.0"/> | <input type="text" value="22.0"/> | <input type="text" value="4.400"/> | <input type="text" value="20"/> | <input checked="" type="checkbox"/> Blank |
| Run 5 | <input type="text" value="50.0"/> | <input type="text" value="20.0"/> | <input type="text" value="4.000"/> | <input type="text" value="20"/> | <input checked="" type="checkbox"/> Blank |
| Run 6 | <input type="text" value="50.0"/> | <input type="text" value="18.0"/> | <input type="text" value="3.600"/> | <input type="text" value="20"/> | <input checked="" type="checkbox"/> Blank |
| Run 7 | <input type="text" value="50.0"/> | <input type="text" value="16.0"/> | <input type="text" value="3.200"/> | <input type="text" value="20"/> | <input checked="" type="checkbox"/> Blank |
| Run 8 | <input type="text" value="50.0"/> | <input type="text" value="14.0"/> | <input type="text" value="2.800"/> | <input type="text" value="20"/> | <input checked="" type="checkbox"/> Blank |
| Run 9 | <input type="text" value="50.0"/> | <input type="text" value="12.0"/> | <input type="text" value="2.400"/> | <input type="text" value="0"/> | <input checked="" type="checkbox"/> Blank |
| Run 10 | <input type="text" value="50.0"/> | <input type="text" value="1.0"/> | <input type="text" value="0.200"/> | <input type="text" value="0"/> | <input checked="" type="checkbox"/> Blank |

Blank below wavepath envelope

☒ Blank after each run ☒ Blank after last run

☒ WET runs active

☐ Scale default widths

☒ Plot runs in Surfer

☐ Prompt run misfit

Runs completed

☒ All runs completed

Current run no.

☒ Resume current run

Fig. 7 : WET Tomo|Interactive WET tomography|Iterate lets you edit the multirun WET wavepath width or WET frequency schedule. Also lets you edit the number of WET iterations for each run & blanking after each run.

NGU P1_1 initial PLUSMODL.GRD Vers. 3.35

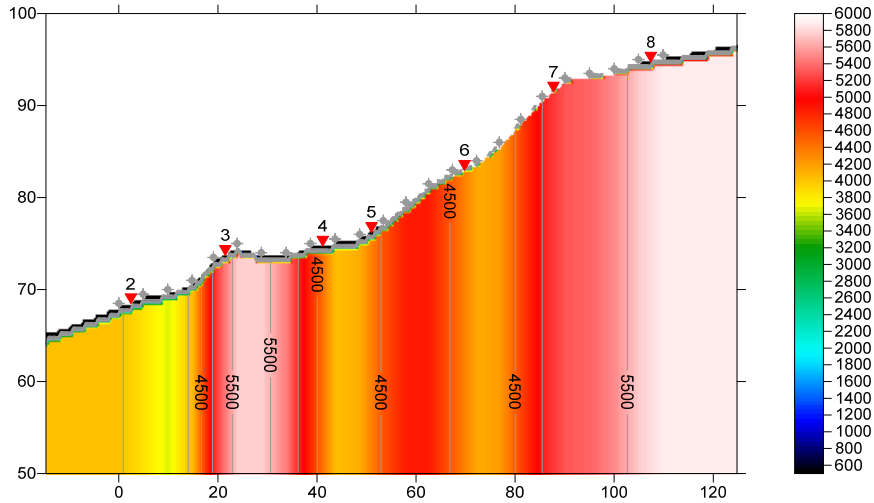


Fig. 8 : Depth|Plus-Minus with Overburden filter & Base filter width = 2 stations. See Fig. 11&12.

NGU P1_1 RMS error 1.0%=0.28ms 20 WET iters. 50Hz Width 14.0% initial RUN7IT20.GRD Vers. 3.35

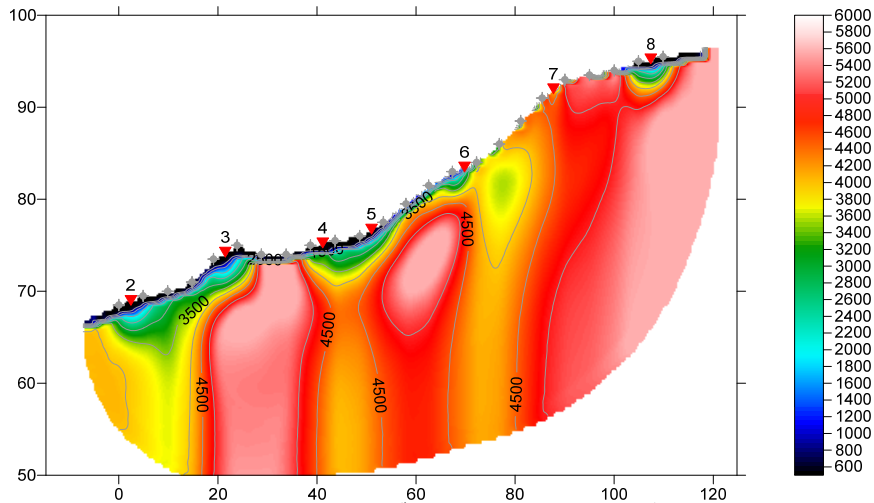


Fig. 9 : Multirun WET showing output of 8th run. Starting model for 1st run is Fig. 8.

NGU P1_1 RMS error 1.0%=0.28ms 20 WET iters. 50Hz Width 14.0% initial RUN7IT20.GRD Vers. 3.35

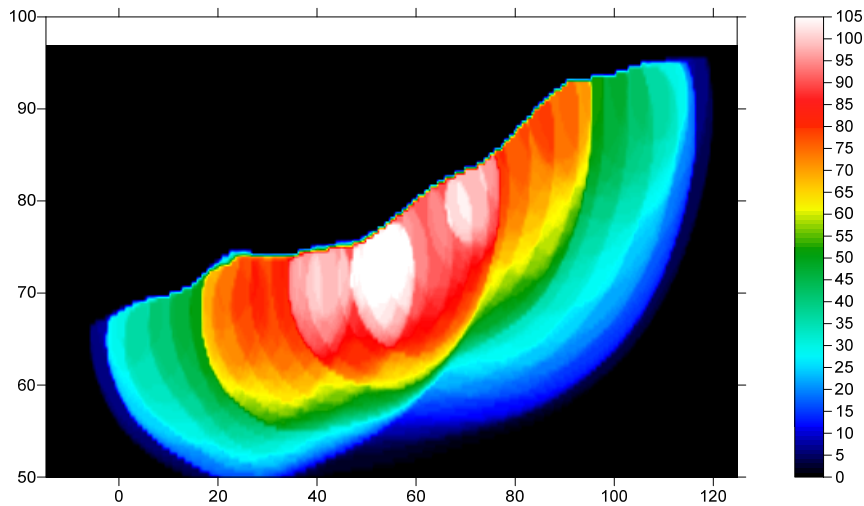


Fig. 10 : Wavepath coverage plot obtained with Fig. 9

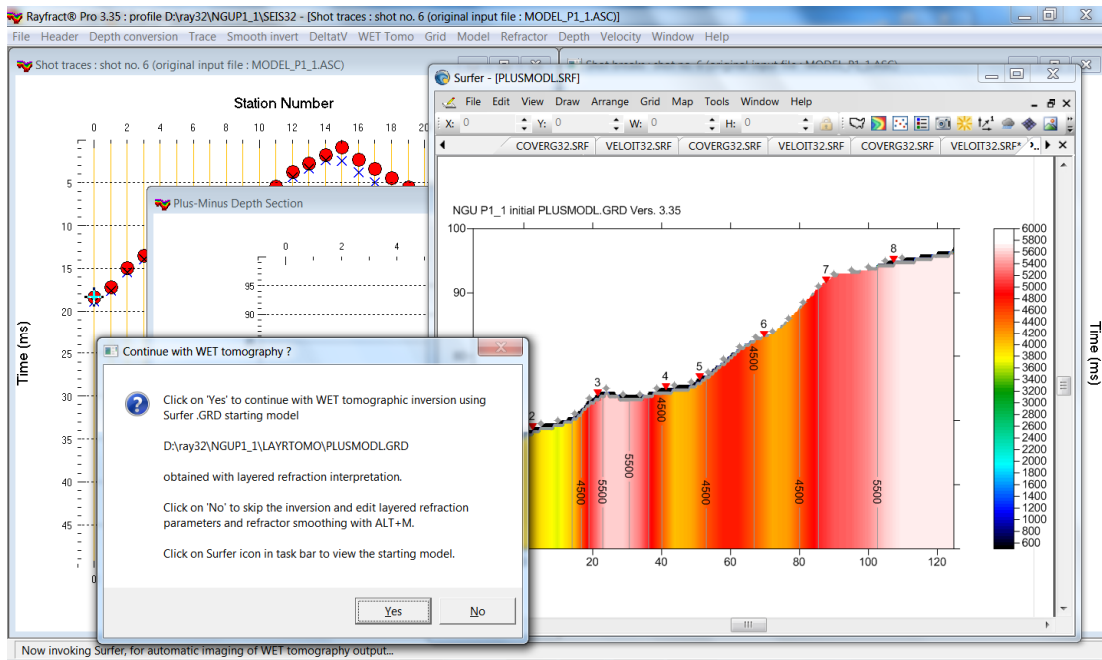


Fig. 11 : *Depth|Plus-Minus*. Click **No** and edit lateral refractor smoothing as in Fig. 12. Click **Yes** to obtain Fig. 9&10.

Plus-Minus Model Parameters

Regression parameters

☐ Recompute traveltimes characteristics

☐ Prefer CMP overburden refractor mapping

☒ Prefer regressed traveltimes

Regression tolerance [msec.]

Smoothing parameters

Overburden filter [station nos.]

Base filter width [station nos.]

Surface consistency [0..100]

Fig. 12 : press **ALT+M** in *Plus-Minus Depth Section* window. Edit *Overburden filter [station nos.]* and *Base filter width [station nos.]*. Press **ENTER** to recompute *Plus-Minus depth section*. Click **Yes** in prompt to continue with WET. See Fig. 11.

➤ For our [multiscale WET](#) inversion see updated [help file](#) chapter *WET tomography processing*.

Subdirectories ...**\LAYRTOMO\WETRUN1** up to ...**\WETRUN8**, ...**\INPUT** and ...**\seis32_Sep17** are available in this [RAR archive](#). Open the ...**\WETRUN8\VELOIT20.PAR** file e.g. with Windows Notepad editor to review *WET inversion* parameters used.

Use Rayfract® 3.35 command **Grid|Reset DeltatV and WET settings to .PAR file...** with Surfer **.GRD** file ...**\LAYRTOMO\WETRUN8\VELOIT20.GRD** to reset your profile's *DeltatV* and *WET inversion settings* to ...**\LAYRTOMO\WETRUN8\VELOIT20.PAR**.

Or quit our software via **File|Exit** and copy all 33 **seis32.*** database files from directory ...**\seis32_Sep17** into your **C:\RAY32\NGUP1_1** directory with Windows Explorer. Now reopen your profile : select **File|Open Profile...** and **C:\RAY32\NGUP1_1\SEIS32.DBD**.

We copied the shot point elevations from the original **.SHO** file to shot stations in the **.COR** file. This prevents interpolation of shot point elevation between adjacent receivers. See our [updated help file](#) chapter *Editing header data* at bottom of paragraph *Elevation specification*.

The NGU report with Fig. 6.1.2 showing *multirun WET inversion* of above synthetic model data is available at http://www.ngu.no/upload/Publikasjoner/Rapporter/2017/2017_025.pdf. We thank Georgios Tassis at NGU for making available above synthetic data and this report.