

Borehole refraction with receivers in 3 holes interpreted using Rayfract® 3.35 Pro

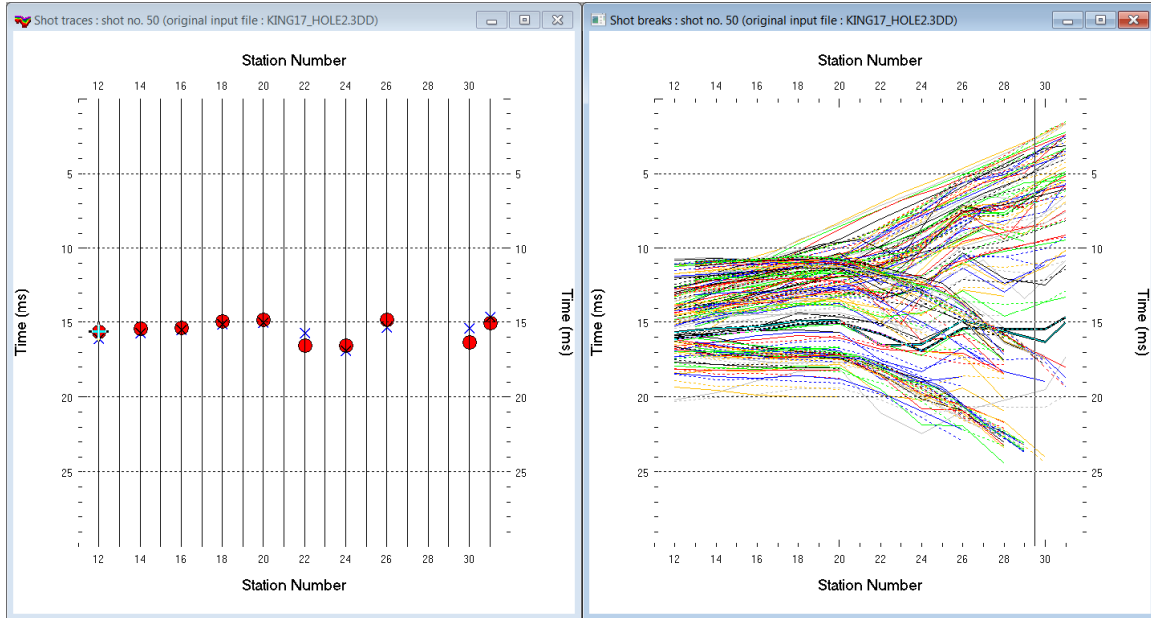


Fig. 1 : Picked and modeled times for hole KING17HL2. Left : *Trace|Shot gather*, right : *Refractor|Shot breaks*. Shows fit between picked times (solid colored curves) and modeled times (dashed colored curves) after multirun CG WET.

- *File|New Profile...*, set *File name* to KING17 and click *Save button*
- in *Header|Profile* set *Line type* to Borehole spread/line. Set *Station spacing* to 1.0m .
- set *Cell size [m]* to 0.3 . Check box *Force grid cell size*. See Fig. 4 .
- unzip [KING17 INPUT.RAR](#) with ...\INPUT\KING17_Hole1.3dd in C:\RAY32\KING17
- configure *File|Import data Settings* as in Fig. 5 .
- select *File|Import Data...* and set *Import data type* to Tweeton GeoTomCG .3DD . See Fig. 6 .
- leave *Default spread type* at 10: 360 channels. Set *Default sample count* to 2000 .
- click *Select button*, navigate into C:\RAY32\KING17\INPUT and select file KING17_Hole1.3dd
- click *Open button*, *Import shots button*. The *Import shot dialog* is shown for each shot in the .3DD file.
- for each shot leave *Layout start* and *Shot pos.* at shown values and click *Read button*
- create borehole profile KING17HL2 and import .3DD shots in [KING17HL2 INPUT.RAR](#)
- create borehole profile KING17HL3 and import .3DD shots in [KING17HL3 INPUT.RAR](#)
- select *File|Open Profile...* and C:\RAY32\KING17\SEIS32.DBD
- in *Header|Profile* click topmost *Select button* and select C:\RAY32\KING17HL2\SEIS32.DBD . See Fig. 4 .
- click *Borehole 2 line Select button* and select C:\RAY32\KING17HL3\SEIS32.DBD
- unzip [KING17 BOUNDARY.RAR](#) in C:\RAY32\KING17
- in *WET Tomo|WET velocity constraints* select file ...\KING17\boundary\digitized.blm . See Fig. 7 .
- check boxes *Polygon blanking active*, *Blank outside polygon & Extrapolate to top*
- uncheck *Pad polygon border* and click *OK*
- uncheck *Smooth invert|Smooth inversion Settings|Beydoun weighting for borehole WET*
- uncheck *WET Tomo|WET tomography Settings|Blank|Blank below envelope after last iteration*
- check *WET Tomo|WET tomography Settings|Blank|Blank no coverage after last iteration*
- check *WET Tomo|WET tomography Settings|Scale wavepath width*. See Fig. 8 .
- check *WET Tomo|WET tomography Settings|Scale WET filter height*
- check *WET Tomo|WET tomography Settings|Edit maximum valid WET velocity*
- check *WET Tomo|WET tomography Settings|Use full Steepest Descent step for Conjugate Gradient*
- select *Smooth invert|WET with constant-velocity initial model* for default interpretation. See Fig 2.

KING17 RMS error 3.1%=0.76ms 20 WET iters. 50Hz Width 4.8% initial CONSTVEL.GRD Vers. 3.35

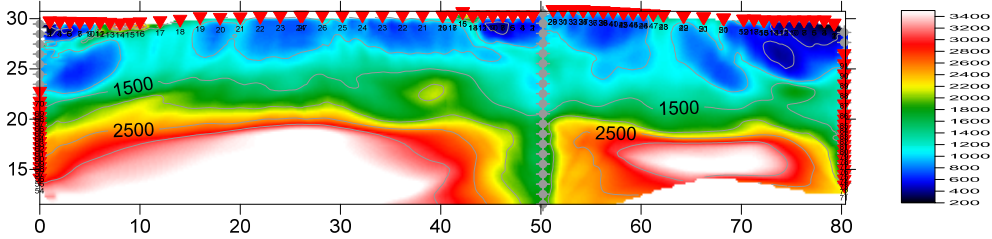


Fig. 2a : Default Smooth inversion output using constant-velocity starting model.

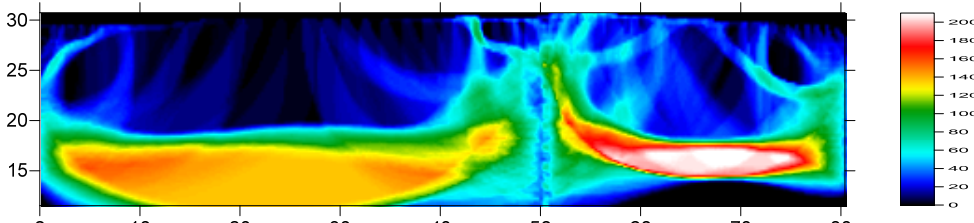


Fig. 2b : Wavepath coverage plot obtained with Fig. 2a. Unit is wavepaths per pixel.

KING17 RMS error 3.1%=0.76ms 31 WET iters. 50Hz Width 5.0% initial RUN5IT32.GRD Vers. 3.35

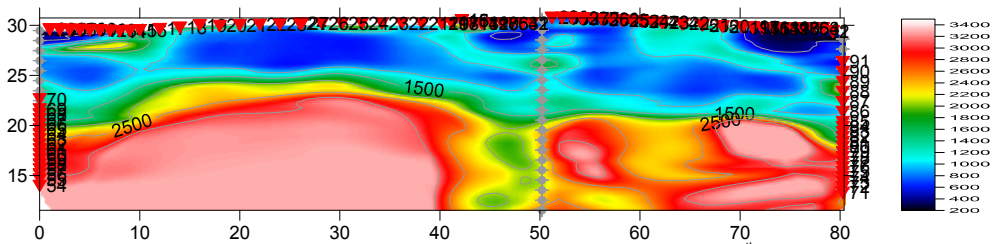


Fig. 3a : [Multirun/Multiscale Conjugate-Gradient WET inversion](#). Output after 6th run shown.

KING17 RMS error 3.0%=0.72ms 31 WET iters. 50Hz Width 3.0% initial RUN7IT32.GRD Vers. 3.35

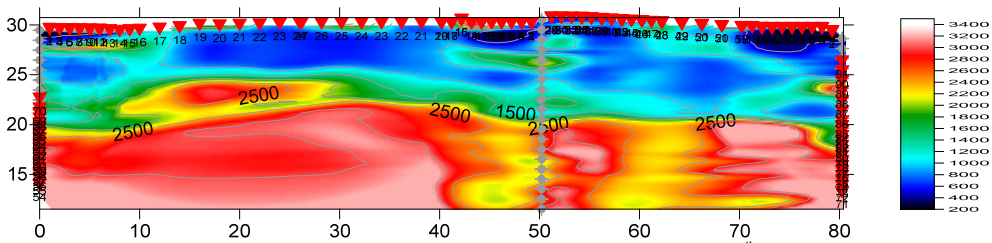


Fig. 3b : [Multirun/Multiscale Conjugate-Gradient WET inversion](#). Output after 8th run shown.

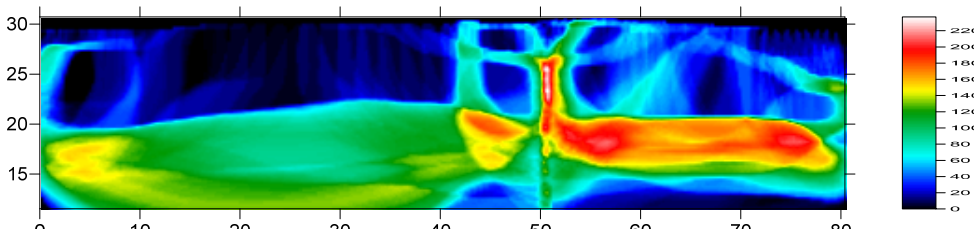


Fig. 3c : Wavepath coverage plot obtained with Fig. 3b. Unit is wavepaths per pixel.

- select *Grid/Surfer plot Limits*. Check *Proportional XY Scaling*. Click button *Reset to grid* & select C:\RAY32\KING17\HOLETOMO\VELOIT20.GRD. Check box *Plot limits active*. See Fig. 9.
- set *Min. velocity* to 200m/s and *Max. velocity* to 3500m/s. Check *Adapt color scale* & set *Scale height* to 1.455 inches. Set *Velocity interval* to 200m/s. Set *Coverage interval* to 20. Click *OK* button.

Edit Profile

Line ID:

Line type:

Job ID:

Instrument:

Client:

Company:

Observer:

Note:

Station spacing [m]:

Min. horizontal separation [%]:

Profile start offset [m]:

Time of Acquisition
Date:
Time:

Time of Processing
Date:
Time:

Units:

Sort:

Const:

Left handed coordinates

Force grid cell size

Cell size [m]:

Add borehole lines for WET tomography

Borehole 1 line:

Borehole 2 line:

Borehole 3 line:

Borehole 4 line:

Fig. 4 : Header|Profile settings. Added borehole lines KNG17HL2 & KNG17HL3 with Select buttons.

Allow missing traces for SeisImager, SeisOpt, Gremix and .3DD files
Interpolate shot point elevation for SeisOpt and .3DD files

X coordinate is corrected for topography already

Default distance unit is meter

Default time unit is seconds

Keep same Sample count for consecutive shot trace files

Profile start is default layout start

Default layout start is 1

Swap borehole x with z

.3DD shot traces sorted by receiver offset

Import horizontal borehole survey or .3DD refraction survey

Import circular borehole survey

Adjust profile station spacing

Match .LST traces by station number

Round shot station to nearest whole station number

Unsafe import

Fig. 5 : File|Import Data Settings.

Import shots

Import data type: **Tweeton GeoTomCG .3DD**

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

Take shot record number from: **Record number**

Optionally select .HDR batch file and check Batch import

Write .HDR batch file listing shots in input directory

Write .HDR only Import shots and write .HDR

Overwrite existing shot data
 Overwrite all Prompt overwriting

Batch import
 Limit offset

Maximum offset imported [station nos.]

Default shot hole depth [m]

Default spread type **10: 360 channels**

Target Sample Format **16-bit fixed point**

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. 6 : File|Import Data.

WET velocity constraints

Keep velocity unchanged below m/sec.

Keep velocity unchanged above m/sec.

Blank tomogram in polygon area specified in Surfer .BLN blanking file
 Polygon blanking active Blank outside polygon
 Smooth polygon border Pad polygon border

Reset blanked tomogram pixels to values in Surfer .GRD mask grid file
 Mask grid file active

Extrapolate velocity to blanking file polygon boundary
 Extrapolate to top Extrapolate to left
 Extrapolate to bottom Extrapolate to right

Fig. 7 : WET Tomo|WET velocity constraints.

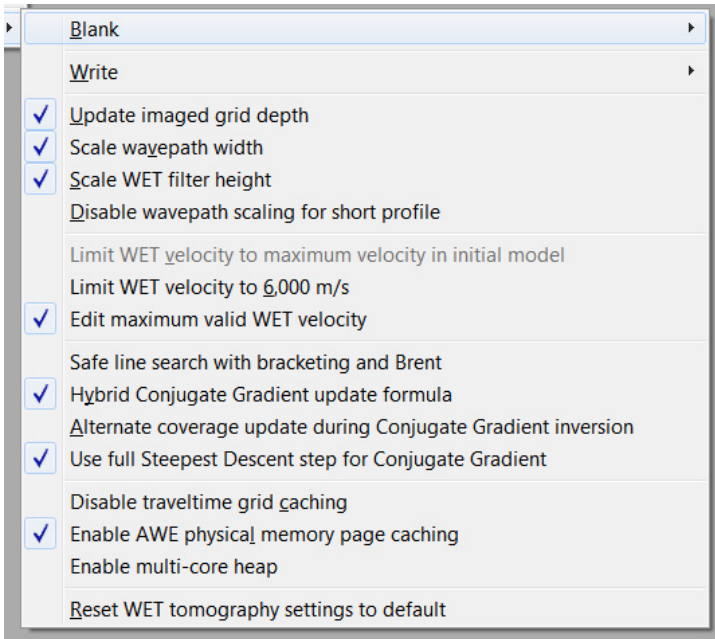


Fig. 8 : WET Tomo|WET tomography Settings

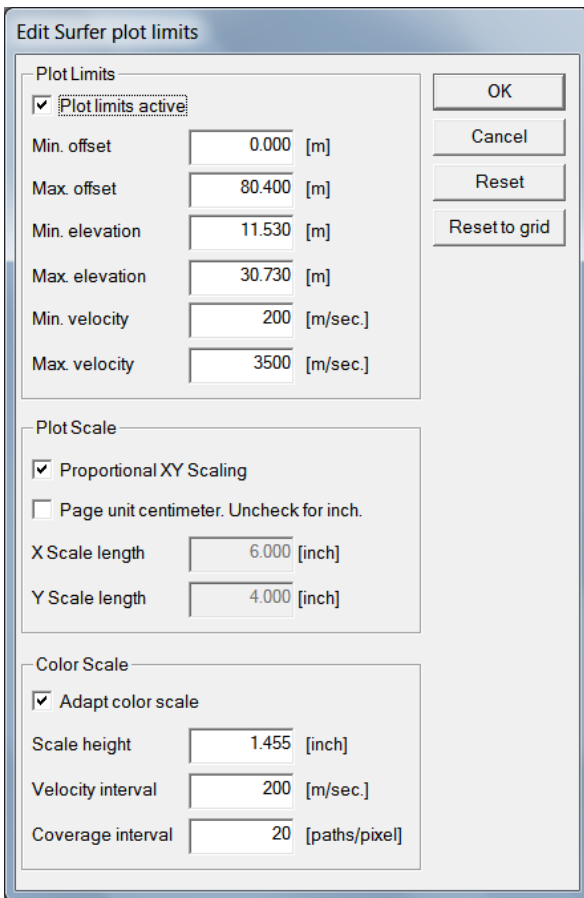


Fig. 9 : Grid|Surfer plot Limits

- set *WET Tomo|Interactive WET tomography|Max. velocity* to 3200m/s. Set *Width of Gaussian for one period [sigma]* to 23. Check radio button *Conjugate Gradient* and confirm prompt. See Fig. 10 (left).
- click button *Edit velocity smoothing* & click *Manual specification of smoothing filter*
- set *Half smoothing filter width* to 50 & *Half smoothing filter height* to 2. Uncheck *Automatically adapt shape of rectangular filter matrix*. Set *Maximum velocity update* to 1.0 percent. See Fig. 10 (right).
- in frame *Smoothing filter weighting* click radio button *Gaussian*. Set *Used width of Gaussian* to 5.0 sigma. Set *Damping [0..1]* to 0.3 & click button *Accept parameters*.
- click button *Iterate*. Check *WET runs active*, *Blank after each run* & *Blank after last run*. See Fig. 11 .
- click *Edit grid file generation*. Set *Store each nth iteration only : n =* to 20. Click *Accept parameters*.
- click button *OK* & *Start tomography processing* to obtain output for *WET runs* 1 to 8. See Fig. 3 .
- select *File|Open Profile...* and *C:\RAY32\KNG17HL2\SEIS32.DBD*
- select *Trace|Shot gather* and *Window|Tile* to obtain Fig. 1
- for each window click title bar, press ALT+P, set *Maximum time* to 30 ms and hit ENTER key
- click title bar of *Refractor|Shot breaks* window. Uncheck *Mapping|Display raytraced traveltimes*.
- check *Mapping|Color picked traveltimes curves & Display synthesized traveltimes curves*

The image shows two side-by-side dialog boxes from a software application. The left dialog box is titled "Edit WET Wavepath Eikonal Traveltime Tomography Parameters" and contains several sections of controls. The right dialog box is titled "Edit WET Tomography Velocity Smoothing Parameters" and contains controls for smoothing filter dimensions and weighting.

Edit WET Wavepath Eikonal Traveltime Tomography Parameters

- Specify initial velocity model:** Select
- 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
- Buttons:** Edit velocity smoothing, Edit grid file generation, Start tomography processing, Reset, Cancel

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
- Buttons:** Accept parameters, Reset parameters

Fig. 10 : *WET Tomo|Interactive WET tomography* (left) and *Edit velocity smoothing* (right).

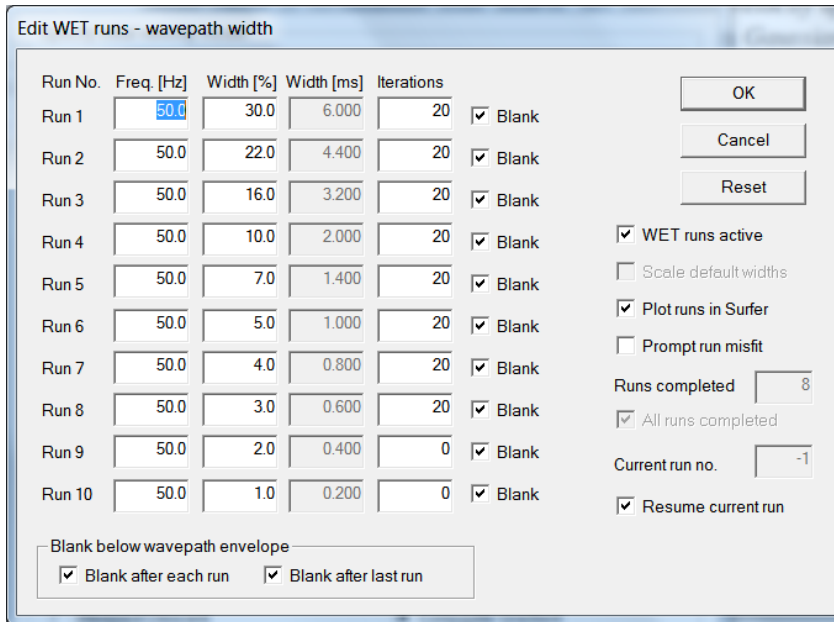


Fig. 11 : WET Tomo|Interactive WET tomography|Iterate settings for multiscale tomography (multirun WET).

- for *WET parameters* used and multirun Conjugate-Gradient WET output see archive [KING17 Multirun CGWET July2017.RAR](#)
- archive [KNG17HL2.RAR](#) contains profile database files for borehole spread KNG17HL2
- archive [KNG17HL3.RAR](#) contains profile database files for borehole spread KNG17HL3

Before importing a GeoTomCG .3DD survey file involving multiple boreholes (with all y coordinates = 0.0) you need to split the .3DD file such that all traces contained in one .3DD file are recorded with receivers located in the same Borehole spread/line or along the same Refraction spread/line .

Pick the ...\\INPUT\\DIGITIZED.BLN blanking file in Golden Software Surfer on CONSTVEL.SRF starting model plot with Surfer **Map|Digitize command** as described in <https://support.goldensoftware.com/hc/en-us/articles/226661208-How-can-I-create-a-BLN-file-in-Surfer> . Pick points (polygon corners) a little bit outside the tomogram boundary for *WET inversion and blanking* to work reliably.

For help on *WET inversion* parameters see [pdf reference](#) chapter **WET Wavepath Eikonal Traveltime tomography**. For latest help info see our *Help menu | Contents | WET tomography processing*. Install the latest help file version with installer [winhelp.exe](#) .

Note the improved vertical resolution at top of basement in Fig. 3 showing [multiscale Conjugate-Gradient tomography](#) when compared to Fig. 2 showing single-run Steepest-Descent WET inversion.

Our Standard license supports adding one borehole line/spread to main spread profile in *Header|Profile* only. Use our [Pro license](#) to add two borehole lines as shown in Fig. 4 .