

TylerLine1 single-run WET/1D-Gradient starting model & once-derived Ricker wavelet 3.36 :

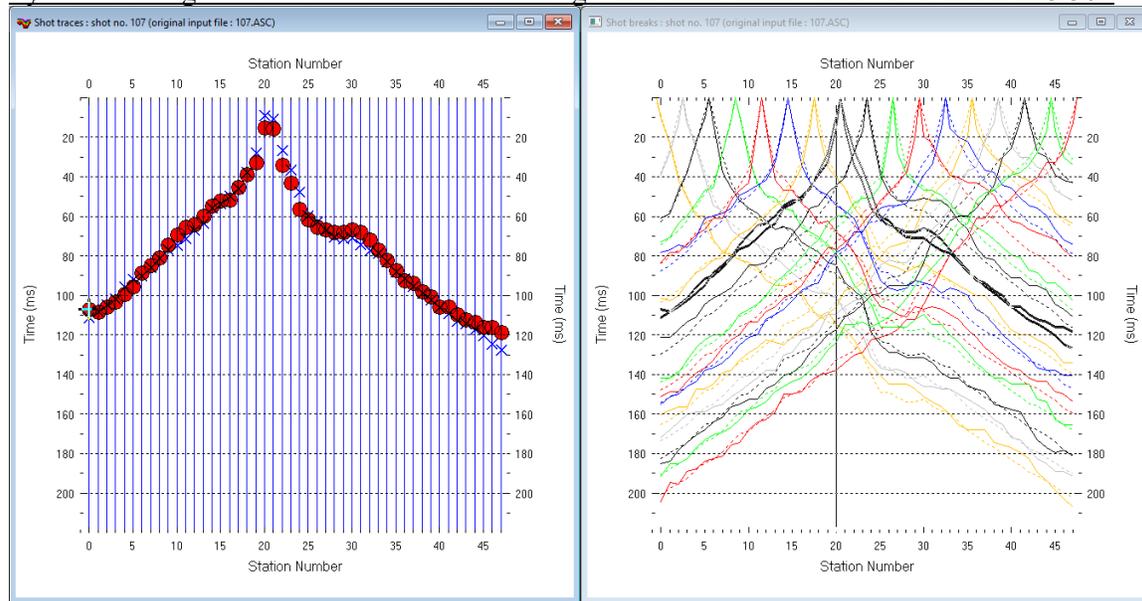


Fig. 1 : left : *Trace|Shot gather*, right : *Refractor|Shot breaks*. Shows fit between picked times (solid colored curves, red circles) and modeled times (dashed colored curves, blue crosses) obtained for single-run WET output (Fig. 10)

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

- **File|New Profile...**, set *File name* to **TYLERLN1** and click *Save button*
- in **Header|Profile...** set *Line type* to **Refraction spread/line**. Select *Units* **feet** & set *Station spacing* to 20.0 ft.
- check box *Force grid cell size* and set *Cell size[m]* to 3.0 ft. See Fig. 2.
- unzip [TYLERLN1 input.zip](#) with files 100.ASC to 116.ASC, COORDS.COR and SHOTPTS.SHO in directory **c:\RAY32\TYLERLN1\INPUT**
- select **File|Import Data...** and set *Import data type* to **ASCII column format**. See Fig. 3.
- click *Select button*, navigate into **c:\RAY32\TYLERLN1\INPUT** and select file **100.ASC**
- leave *Default spread type* at 10: **360 channels**. Check box *Batch import*.
- set *Default sample count* to 2,500 to setup the y scale for *Trace|Shot gather* & *Refractor|Shot breaks*
- click **Import shots button**. All .ASC shot files in directory **c:\RAY32\TYLERLN1\INPUT** are imported.
- select **File|Update header data|Update Station Coordinates**
- navigate into directory **c:\RAY32\TYLERLN1\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. Browse shots with F7/F8.

To configure and run *Smooth inversion* and display the 1D-gradient starting model :

- check **Smooth invert|Smooth inversion Settings|Output inversion results in Feet**. See Fig. 10.
- leave other **Smooth invert|Smooth inversion Settings** at defaults. See Fig. 10.
- leave **DeltatV|DeltatV Settings** at defaults. See Fig. 6.
- select **Smooth invert|WET with 1D-gradient initial model** and confirm. Cancel *WET continuation*.
- select **Grid|Surfer plot Limits**. Click *Reset to grid*. Navigate into profile subdirectory **c:\RAY3\TYLERLN1\GRADTOMO**. Click on file **GRADIENT.GRD** & click *Open*
- check box **Plot limits active**. Uncheck box *Proportional XY Scaling*. Set *Y Scale length* to 3.0 inches.
- set *Min. velocity* to 1,000 ft/s and *Max. velocity* to 8,000 ft/s. Edit fields as in Fig. 4. Click *OK*.
- select **Grid|Image and contour velocity and coverage grids** & above **GRADIENT.GRD** to obtain Fig. 7

Edit Profile

Line ID: TYLER LINE 1
 Line type: Refraction spread/line
 Job ID: Sinkhole imaging

Instrument: _____
 Client: _____
 Company: _____
 Observer: _____
 Note: _____

Time of Acquisition
 Date: _____
 Time: _____

Time of Processing
 Date: _____
 Time: _____

Units: feet
 Sort: As acquired
 Const: _____

Left handed coordinates
 Force grid cell size

Station spacing [ft]: 20.0000
 Min. horizontal separation [%]: 25
 Profile start offset [ft]: 0.0000
 Cell size [ft]: 3.0000

Add borehole lines for WET tomography

Borehole 1 line: Select
 Borehole 2 line: Select
 Borehole 3 line: Select
 Borehole 4 line: Select

OK Cancel Reset

Import shots

Import data type: ASCII column format

Input directory: select one data file. All data files will be imported
 Select: D:\ray32\TYLERLN1\input\

Take shot record number from: DOS file name

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
 Overwrite all Prompt overwriting
 Batch import Limit offset

Maximum offset imported [station nos.]: 1000.00

Default shot hole depth [ft]: 0.00
 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]: 0.100000000
 Default sample count: 2500

Import shots Cancel import Reset import

Fig. 2 : Header|Profile

Fig. 3 : File|Import Data

Edit Surfer plot limits

Plot Limits
 Plot limits active

Min. offset: -50.000 [ft]
 Max. offset: 1000.000 [ft]
 Min. elevation: 200.000 [ft]
 Max. elevation: 413.000 [ft]
 Min. velocity: 1000 [ft./sec.]
 Max. velocity: 8000 [ft./sec.]

Plot Scale
 Proportional XY Scaling
 Page unit centimeter. Uncheck for inch.
 X Scale length: 6.000 [inch]
 Y Scale length: 3.000 [inch]

Color Scale
 Adapt color scale
 Scale height: 4.000 [inch]
 Velocity interval: 500 [ft./sec.]
 Coverage: 20 [paths/pixel]

OK
 Cancel
 Reset
 Reset to grid

Fig. 4 : Grid|Surfer plot Limits

Edit WET Wavepath Eikonal Traveltime Tomography Parameters

Specify initial velocity model
 D:\ray32\TYLERLN1\GRADTOMO\GRADIENT.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 ft./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

Suppress artefacts below steep topography
 Adapt shape of filter. Uncheck for better resolution.

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 No smoothing
 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 Damp before smoothing

Fig. 5 : left : WET Tomo|Interactive WET tomography

right : Edit velocity smoothing. Leave at defaults.

- Output Measured CMP Velocities
- Output Horizontal offset of CMP pos. in meters
- Output DeltatV results in Feet
- Allow regression over two CMP traces
- CMP is zero time trace
- Reduced offset 0.0 is valid trace with time 0.0
- Enforce Monotonically increasing layer bottom velocity
- Suppress velocity artefacts
- Process every CMP offset
- Prefer Average over minimum interface velocity
- Taper velocity steps at layer interfaces
- Smooth CMP traveltime curves
- Weigh picks in CMP curves
- Extrapolate output to all receivers
- Extra-large cell size
- Increase cell size
- Decrease cell size
- Extra-small cell size
- Edit cell size
- Limit DeltatV velocity exported to maximum 1D-gradient velocity
- Limit DeltatV velocity exported to 5000 m/s
-
-

Fig. 6 : DeltatV|DeltatV Settings. Leave settings at their defaults.

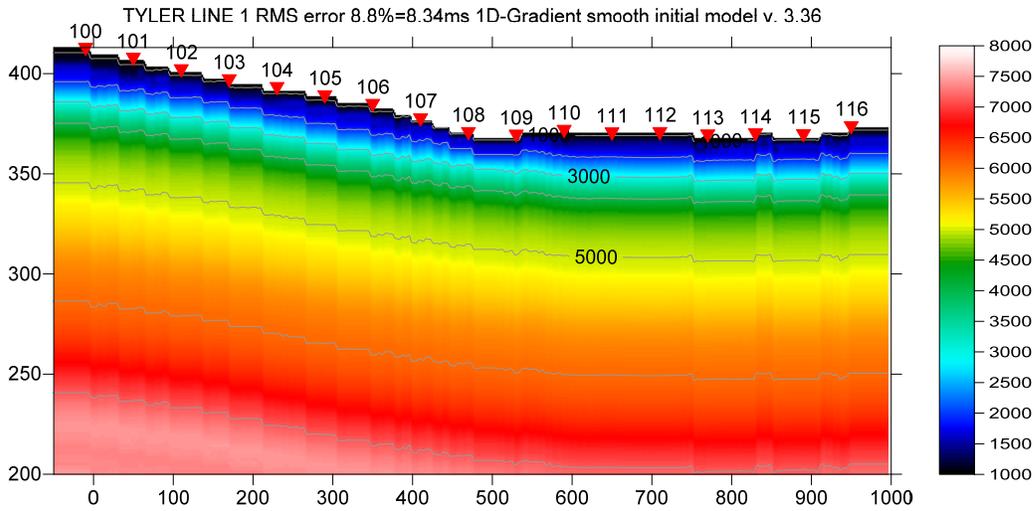


Fig. 7 : 1D-gradient starting model. See Fig. 6&10&11 for *DeltatV* & *Smooth inversion* & *WET Tomo Settings*

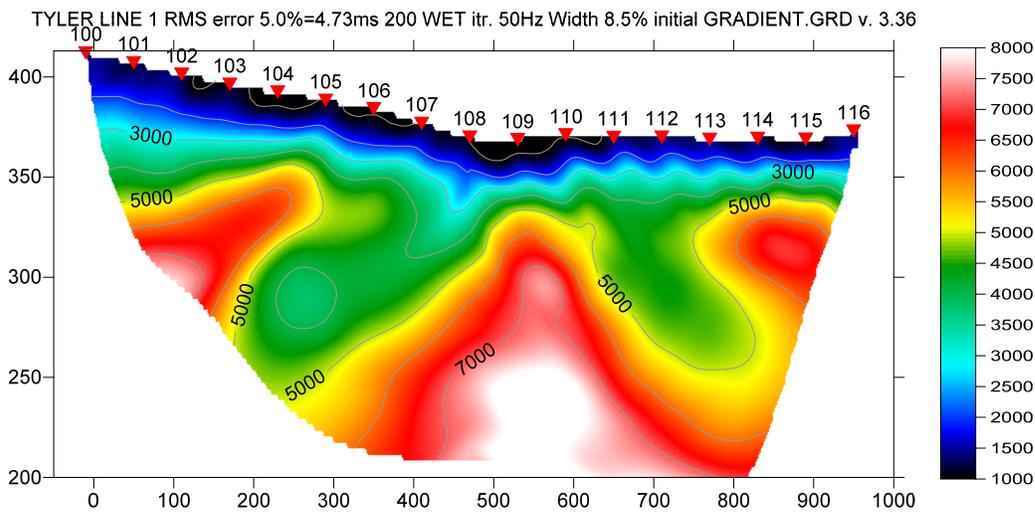


Fig. 8 : Single-run WET inversion using 200 *Steepest Descent* iterations and full smoothing (Fig. 5). Starting model is Fig. 7. See Fig. 1 for misfit between modeled and picked times.

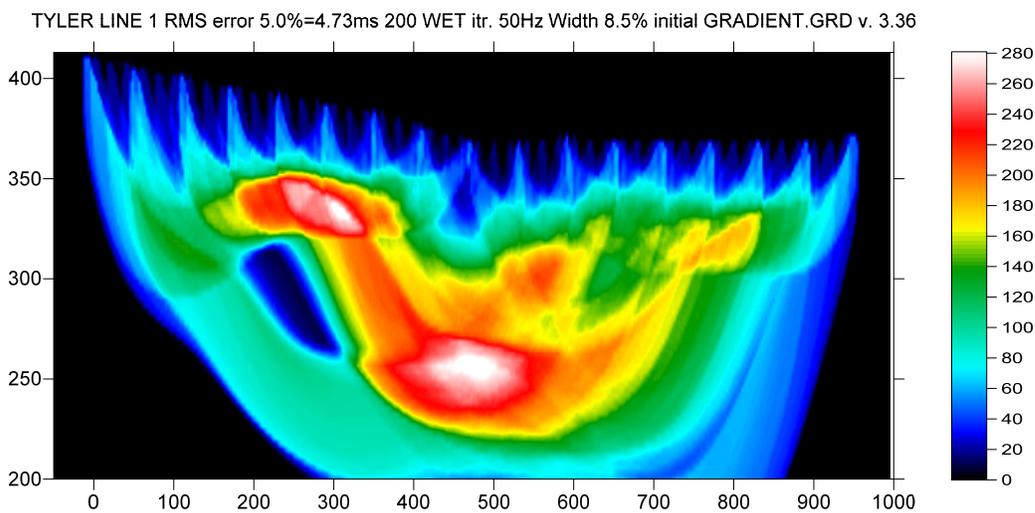


Fig. 9 : WET wavepath coverage plot obtained with Fig. 8. Unit is wavepaths per pixels.

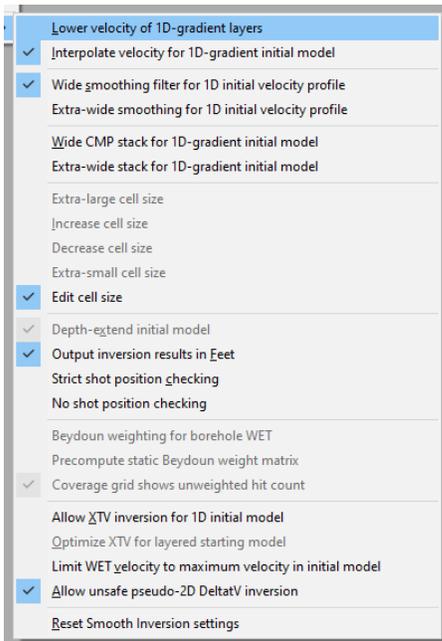


Fig. 10 : edit menu *Smooth invert*|*Smooth inversion Settings*. Check *Output inversion results in Feet* to obtain starting model Fig. 7 in feet.

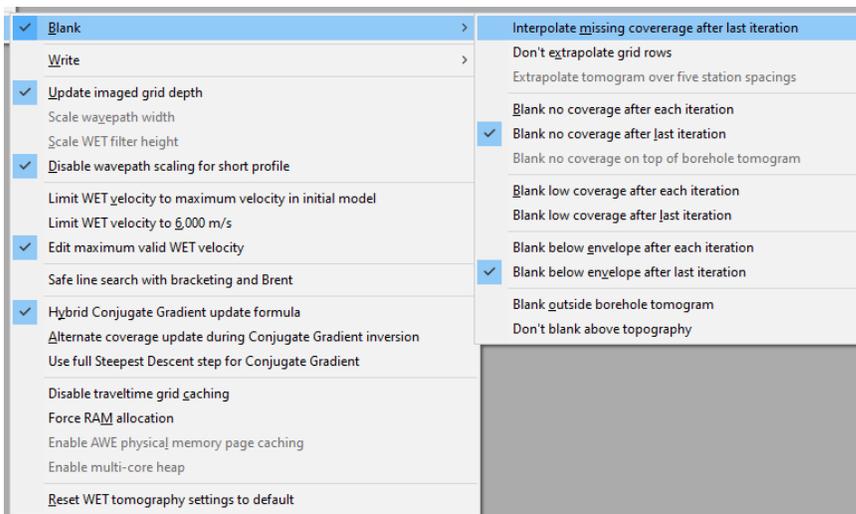


Fig. 11 : use default *WET Tomo*|*WET tomography Settings* and blanking settings

To configure and run [WET inversion](#) and display 2D inversion output :

- check *WET Tomo*|*WET tomography Settings*|*Edit maximum valid WET velocity*. See Fig. 11.
- set *WET Tomo*|*Interactive WET tomography*|*Number of WET tomography iterations* to 200 (Fig. 5)
- set **Ricker differentiation** to 1 [*Ricker wavelet once differentiated in time*]
- click button *Edit grid file generation* & set *Store each nth iteration only : n =* to 20. Click *OK*.
- click ***Edit velocity smoothing***. Leave all controls at their defaults. See Fig. 5 (right). Click **esc** key.
- click ***button Start tomography processing*** to obtain Fig. 8 & 9

Summary :

In our [2006 tutorial](#) we show almost the same output after 200 WET iterations. Also we show layered refraction interpretation using the *Wavefront method*.

WET inversion shown in Fig. 8 using 200 *Steepest-Descent* WET iterations with *full smoothing* (see Fig. 5) took about 50 seconds on 2017 Apple iMac. This iMac comes with 2.3 GHz Intel Core i5 processor running 4 OpenMP threads under Windows 10 Pro 64-bit in Parallels Desktop 14 for Mac. For even faster processing we recommend our Pro version which can use up to 16 OpenMP threads for parallel WET inversion using available CPU cores.

For a published interpretation of above data done with GeoTomo software see Fig. 9 / page 341 in [Thomas L. Dobecki and Sam B. Upchurch 2006. Geophysical applications to detect sinkholes and ground subsidence. The Leading Edge, Volume 25, Issue 3, pp. 336-341 \(March 2006\)](#). See [Fig. 9 link](#).

Our Rayfract® software offers multiple [interpretation methods and parameters](#) to explore the non-uniqueness of the solution space. It is the user's job to sufficiently explore the solution space with our methods and varying parameters, and to find an appropriate combination of methods and parameters for each individual data set. This choice may be guided by a-priori information e.g. from boreholes or other geophysical methods. For good parameter combinations see our [tutorials](#), our [short manual](#) and our [SAGEEP 2010 short course](#). We recommend to always first run our *Smooth inversion* method with *1D-gradient starting model*. Next you can increase the **WET iteration count** to 100 or 200 in *WET Tomo\Interactive WET* as shown above. Vary **Ricker differentiation** : test values -1[*Gaussian*], -2[*Cosine-Squared*], 0 and 1. Values 1 and 0 will not work when increasing the *WET wavepath width* or with *multirun WET* inversion.

For processing of lines longer than the recommended minimum length of 500m for our pseudo-2D *DeltatV* method see [OT0608.pdf](#) & [GEOXMERC.pdf](#) . *DeltatV* and *Smooth inversion* using **1D-gradient starting model** obtained by [laterally averaging DeltatV](#) can match each other nicely for long lines as shown in these .pdf tutorials.

We thank Tom Dobecki for making available above input files and giving us permission to write this tutorial.

For an objective comparison of tomographic refraction analysis methods see [Zelt et al. 2013](#) (JEEG, September 2013, Volume 18, Issue 3, pp. 183–194).

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