

Smooth inversion borehole survey GHD MDW2011, with SEG-2 input files, Rayfract® version 3.20 :

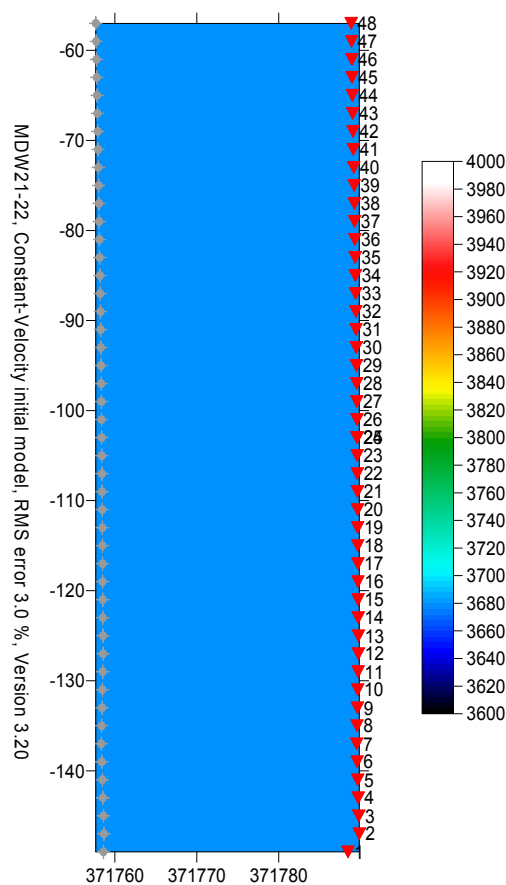


Fig. 1 : Constant-velocity initial model

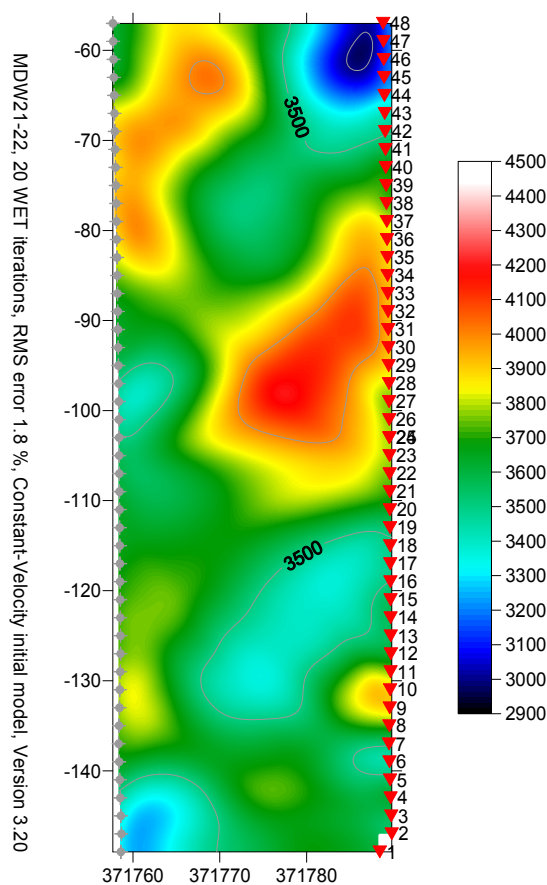


Fig. 2 : Smooth inversion, default parameters, 20 WET iterations, WET wavepath width 1.7%

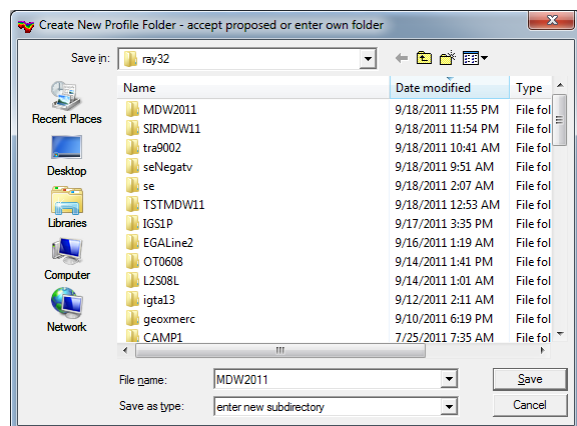


Fig. 3 : File|New Profile...

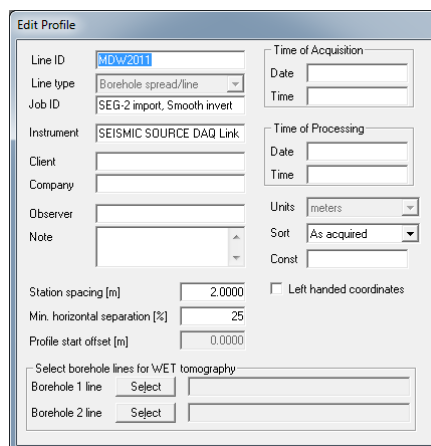


Fig. 4 : Header|Profile

To invert the data, please proceed as follows :

- start up Rayfract® via desktop icon. Select *File|New Profile...* . Set *File name* to MDW2011 and click *Save* button. See Fig. 3 above.
- select *Header|Profile* and set *Station spacing* to 2m. Specify *Line type* Borehole spread/line . See Fig 4.
- set *Line ID* to MDW 2011, *Job ID* to any text, *Instrument* to SEISMIC SOURCE DAQ Link, hit RETURN.
- download the SEG-2 and coordinate files from <http://rayfract.com/tutorials/mdw2011.zip>
- copy MDW2011.ZIP into \RAY32\MDW2011\INPUT and unzip to obtain SEG-2 files and coordinate files
- select *File|Import Data...* . Specify *Import data type* SEG-2, *Default shot hole depth* of 0.0. Leave *Default spread type* at 10:360 channels, or choose 02: 48 channels.

- click *Select button* and navigate to directory \RAY32\MDW2011\INPUT. Change *Files of type* from default .DAT to .SG2 . Select one .SG2 file e.g. SHOT0001.SG2 . Click *Open button* and *Import shots button*.
- for shot no. 1, set *Layout start* to -74 and *Shot pos.* to -74. Then click *Read button*.
- for shots 2 to 24, leave *Layout start* at -74, and set *Shot pos.* to -73, -72, ..., -51. Import with *Read button*.
- for shots 25 to 48, set *Layout start* to -51, and *Shot pos.* to -51, -50, ..., -28. Import with *Read button*.
- select *File\Update header data\Update Station Coordinates...* and COORDS.COR .
- select *File\Update header data\Update Shotpoint coordinates...* and SHOTPTS.SHO .
- select *File\Update header data\Update First Breaks...* and BREAKS.LST .
- review traveltimes with *Refractor\Shot breaks* as usual. See our manual, chapter 1.3.
- check *Post...* and *Label...* menu items at bottom of *Grid menu*, to show sources and receivers on tomogram
- check *Smooth invert\Smooth inversion Settings\Precompute static Beydoun weight matrix* , for conservative weighting . See http://rayfract.com/help/release_notes.pdf , notes for versions 3.02 and 3.03 .
- select *Smooth invert\WET with constant velocity initial borehole model* to invert the data. First obtain initial model shown in Fig. 1. Then obtain WET tomogram after 20 iterations, as in Fig. 2.
- uncheck *Smooth invert\Smooth inversion Settings\Precompute static Beydoun weight matrix*
- select *Smooth invert\WET with constant velocity initial borehole model* to reinvert the data. Obtain WET tomogram after 20 iterations, as in Fig. 5, and wavepath coverage plot as in Fig. 6.

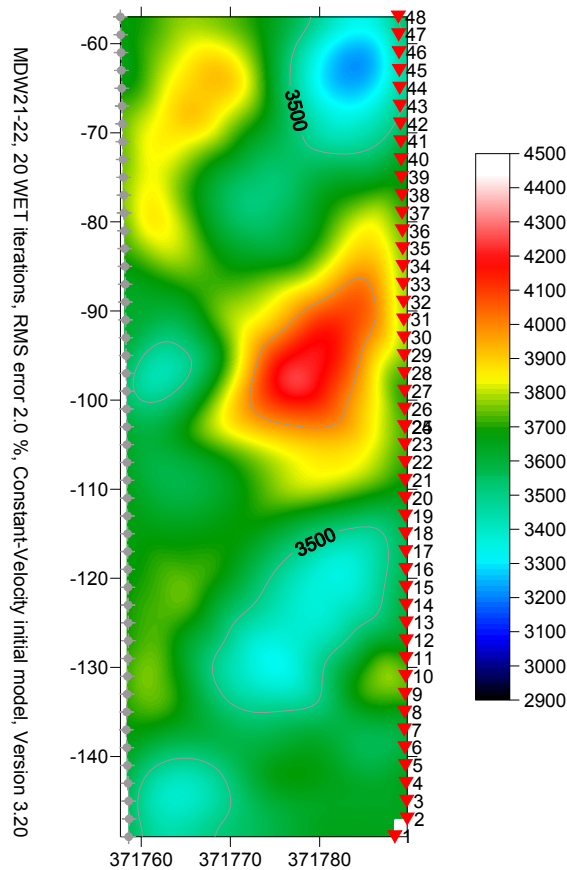


Fig. 5 : Smooth inversion with dynamic Beydoun weighting, 20 WET iterations

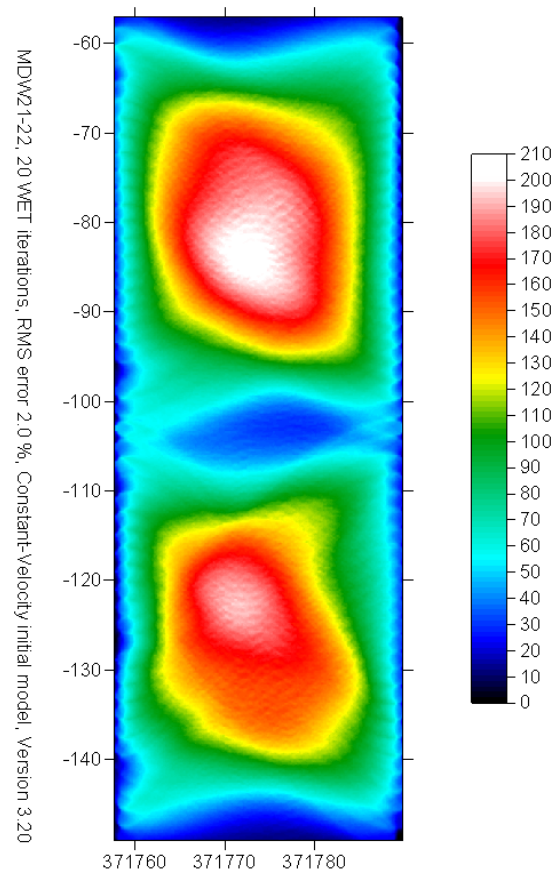


Fig. 6 : WET wavepath coverage for Fig. 5.
Coverage of subsurface with first break energy.

With dynamic Beydoun weighting (Fig. 5), imaged velocity anomalies are less pronounced than without (Fig. 2), especially in corners of tomogram, with low wavepath and seismic ray coverage. Also, the RMS error in Fig. 5 (2.0 %) is slightly higher than for Fig. 2 (1.8 %).

Select *Trace\Shot gather* to compare modeled (blue) to picked (red) first breaks. See Fig. 7 below.

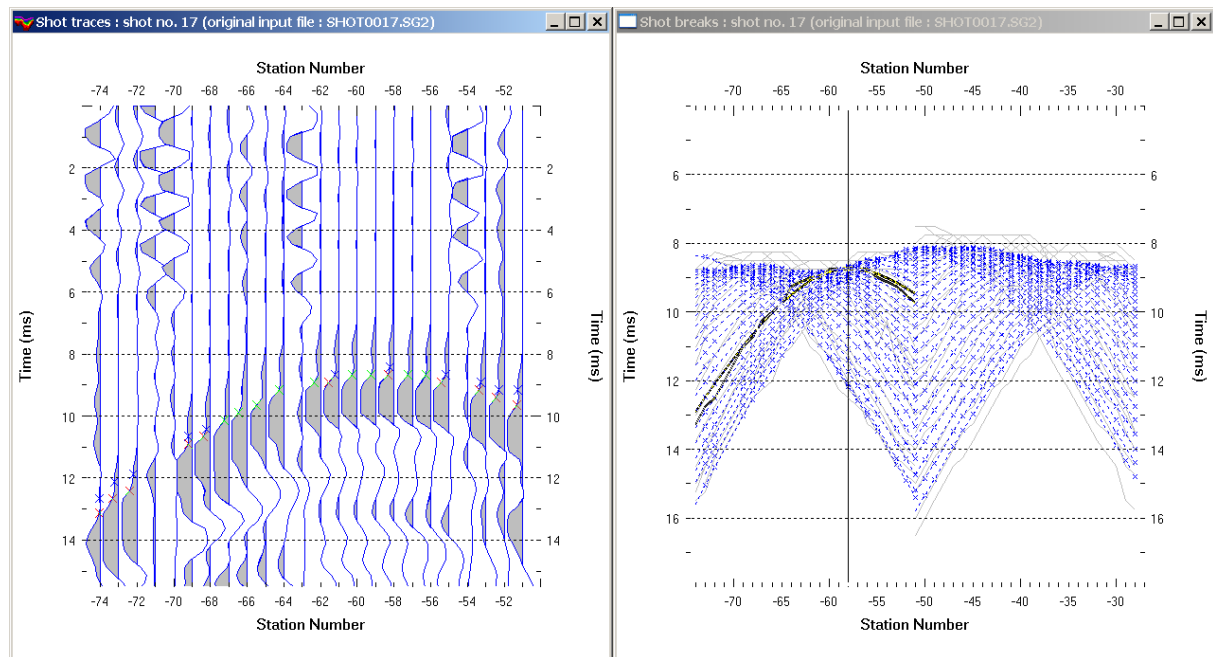


Fig. 7 : Trace|Shot gather (left) for shot no. 17, Refractor|Shot breaks (right)

Note the good agreement between picked (red) and modeled (blue) first break picks (Fig. 7, left). First breaks are picked quite consistently for the whole borehole profile (Fig. 7, right).

By convention elevation of *borehole receiver stations* is negative, relative to elevation 0 at topography. As a consequence *station numbers* are negative too. **Determine Station numbers by dividing the station elevation with Station spacing** specified in *Header|Profile*.

Borehole-recorded shots can be positioned outside the active receiver spread. But the *Shot pos.[station no.]* specified during import into profile with *Line type Borehole spread/line* has to match an active receiver station no. used to record this shot. Once all shots have been imported go into *Header|Shot* and review and optionally edit fields *dx* and *dz* in frame *Offset from Shot Station*. Tab through dialog controls until absolute coordinate fields *x* and *z* in frame *Source Coords.* are updated.

For more details see our Help menu, Contents, Crosshole survey interpretation. Or view our .pdf reference <https://rayfract.com/help/rayfract.pdf> chapter Crosshole survey interpretation on page 113 and following pages.

For description of our COORDS.COR and SHOTPTS.SHO file formats see Help menu, Contents, File formats or chapter File formats on page on page 192 ff. of <https://rayfract.com/help/rayfract.pdf>.

Once you have imported your SEG-2 shots with correct *Shot pos.* and *Layout start* in station numbers, please

- select **File|Export header data|Export Station coordinates** to COORDS.COR
- edit x/y/z coordinates for receiver station numbers in COORDS.COR using Microsoft Notepad
- select **File|Update header data|Update Station coordinates** with your edited COORDS.COR file
- select **File|Export header data|Export Shot Point coordinates** to SHOTPTS.SHO
- edit shot point x/y/z coordinates in SHOTPTS.SHO using Microsoft Notepad
- select **File|Update header data|Update Shotpoint coordinates** with your edited SHOTPTS.SHO file

Please remember that for *Line type Borehole spread/line* all y coordinates need to remain at zero. So edit x and z only in COORDS.COR and SHOTPTS.SHO files. As shown in Fig. 1 and Fig. 2 boreholes can deviate from the vertical. For horizontal boreholes check option **File|Import Data Settings|Import horizontal borehole survey** before importing your SEG-2 shot files. For import into circular receiver spread planted on tunnel wall see our [Tunnel16 tutorial](#) using option **File|Import Data Settings|Import circular borehole survey**.

We thank Zivko Terzic at GHD in Australia, for making available this consistent borehole data set.