Smooth inversion, Plus-Minus refraction of SAGEEP11 blind refraction data with Rayfract® version 3.25

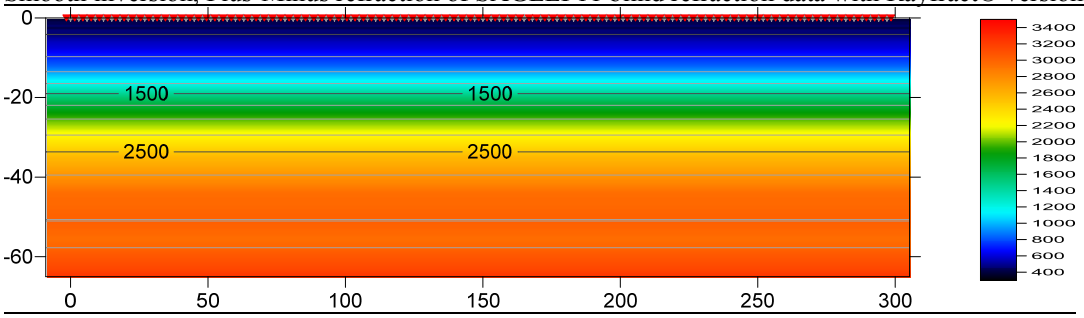

Fig. 1 : 1D-gradient starting model, both Smooth inversion flags for XTV inversion checked (Fig. 13), RMS error 4.3%

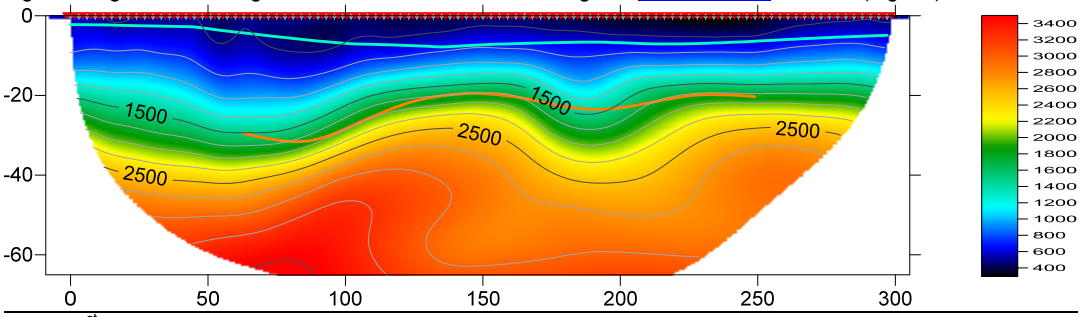

Fig. 2 : 1st run, starting model Fig. 1, wavepath width 30%, smoothing 5 columns by 3 rows, 100 iters., RMS error 0.8%

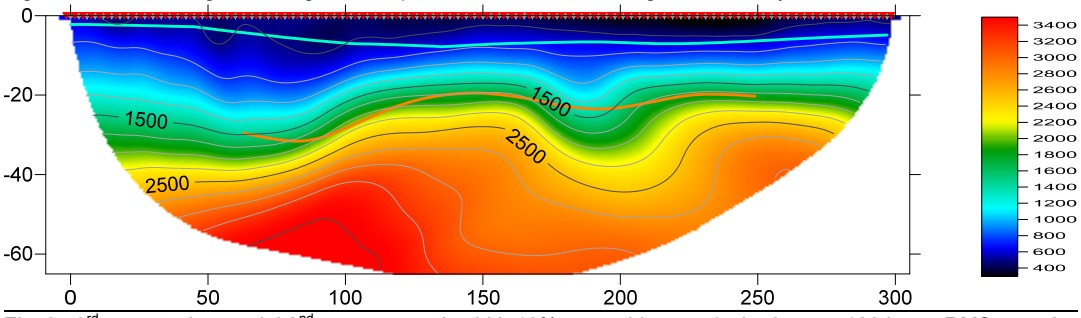

Fig. 3 : 3rd run, starting model 2nd run, wavepath width 10%, smoothing 5 cols. by 3 rows, 100 iters., RMS error 0.7%

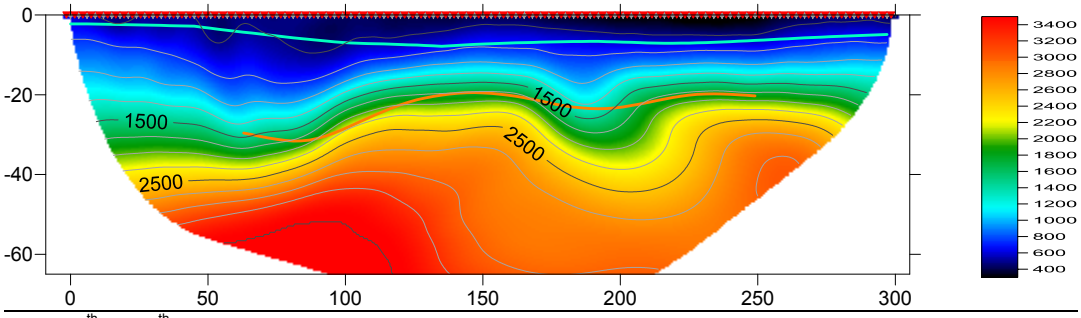

Fig. 4 : 5th run, 4th run as starting model, wavepath width 5%, smoothing 5 cols. by 3 rows, 100 iters., RMS error 0.7%

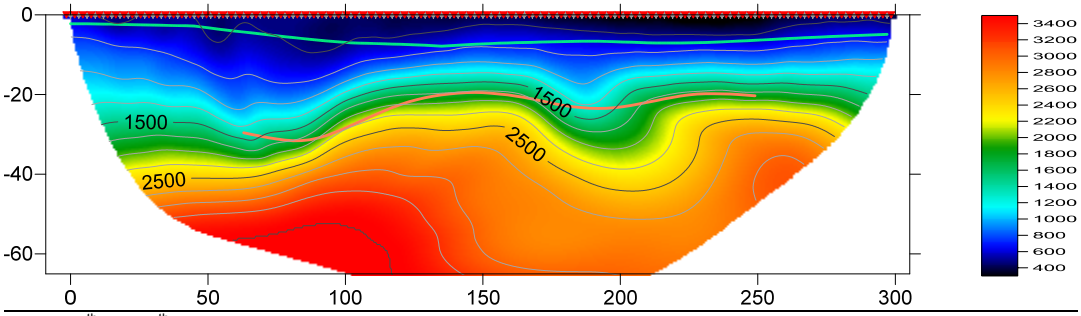

Fig. 5 : 7th run, 6th run as starting model, wavepath width 3%, smoothing 5 cols. by 3 rows, 100 iters., RMS error 0.6%

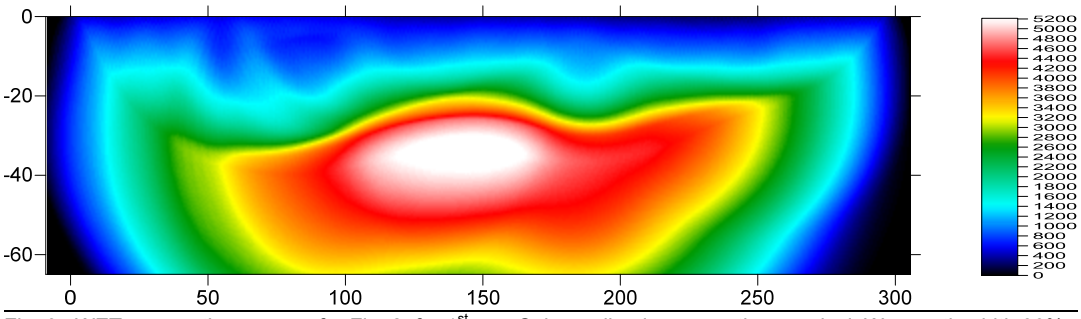

Fig. 6 : WET wavepath coverage for Fig. 2, for 1st run. Color coding is wavepaths per pixel. Wavepath width 30%.

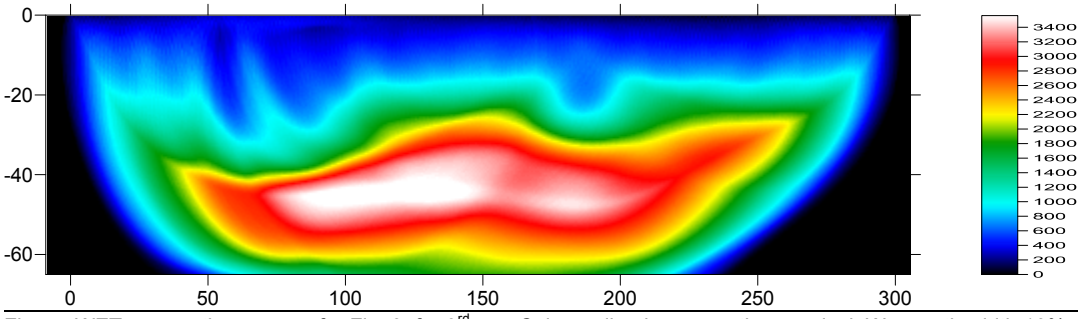

Fig. 7 : WET wavepath coverage for Fig. 3, for 3rd run. Color coding is wavepaths per pixel. Wavepath width 10%.

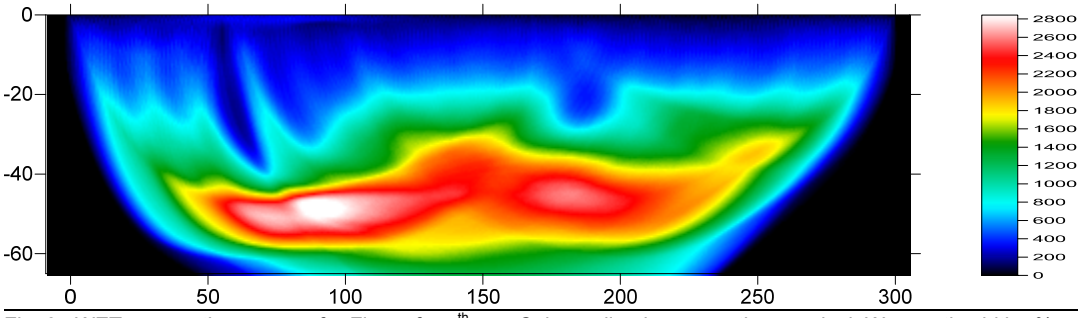

Fig. 8 : WET wavepath coverage for Fig. 4, for 5th run. Color coding is wavepaths per pixel. Wavepath width 5%.

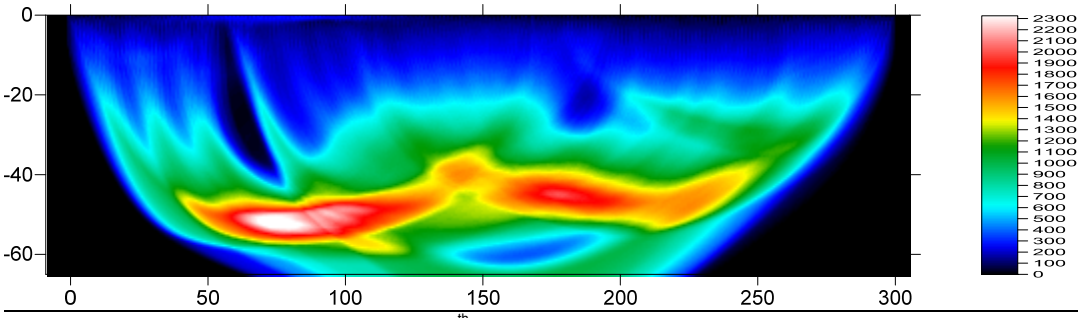

Fig. 9 : WET wavepath coverage for Fig. 5, for 7th run. Color coding is wavepaths per pixel. Wavepath width 3%.

We show optimized Smooth inversion of the SAGEEP 2011 blind refraction data :

- set *Smooth invert|Smooth inversion Settings* as in Fig. 13 (default settings for version 3.25)
- select *Smooth invert|WET with 1D-gradient initial model* to determine the starting model (Fig. 1) with Rayfract® 3.25 Smooth XTV inversion, with XTV inversion enabled (Fig. 13)
- disable scaling of WET *wavepath width* & *filter height*, for maximum detail at depth (Fig. 14)
- limit *Maximum valid velocity* to 3,500 m/s, in *WET Tomo|Interactive WET tomography…* (Fig. 15)
- uncheck *WET Tomo|Interactive WET tomography…|or RMS error does not improve for n* = (Fig. 15)
- set *Half smoothing filter width* to 2 grid columns, *Half smoothing filter height* to 1 grid row (Fig. 16)
- for 1st WET run (Fig. 2 & 6) use *wavepath width* of 30%. For subsequent runs no. 2 to 8 use width 15%, 10%, 7%, 5%, 4%, 3% and 2% (Fig. 15).

- for each WET run, use VELOIT100.GRD & .PAR from previous run as starting model (GRADIENT.GRD for 1st run), and specify 100 *WET tomography iterations* per WET run (Fig. 15)
- click *button Start tomography processing* to start WET inversion (Fig. 15)
- in Windows Explorer, create subdirectories \RAY32\SAGEEP11\2ndRun, …\3rdRun, …, …\8thRun
- copy files VELOIT100.GRD & VELOIT100.PAR from \RAY32\SAGEEP11\GRADTOMO to …\2ndRun, and rename to 1stRunIt100.GRD & .PAR in ...\2ndRun directory, with Windows Explorer
- select 1stRunIt100.GRD as *Initial velocity model* for 2nd WET run, with *Select button* in *WET Tomo|Interactive WET tomography…* (Fig. 15)

Decreasing the width of wavepaths aka Fresnel Volumes corresponds to increasing the frequency, in Fresnel Volume Tomography theory. Wide wavepaths (low frequency, Fig. 2 & 6) make WET inversion less dependent on starting model and more robust, but give smooth tomogram. Narrow wavepaths (Fig. 5 & 9) give sharper tomogram, but WET inversion becomes more dependent on starting model (previous run) and less robust, especially with bad/noisy first break picks and strong refractor curvature, causing diffraction at basement corners (Fig. 5 & 9).

We plot refractors obtained with layer-based Plus-Minus refraction (Fig. 10 to 12), on Fig. 2 to 5. Overburden refractor is colored turquoise, basement refractor is colored orange.

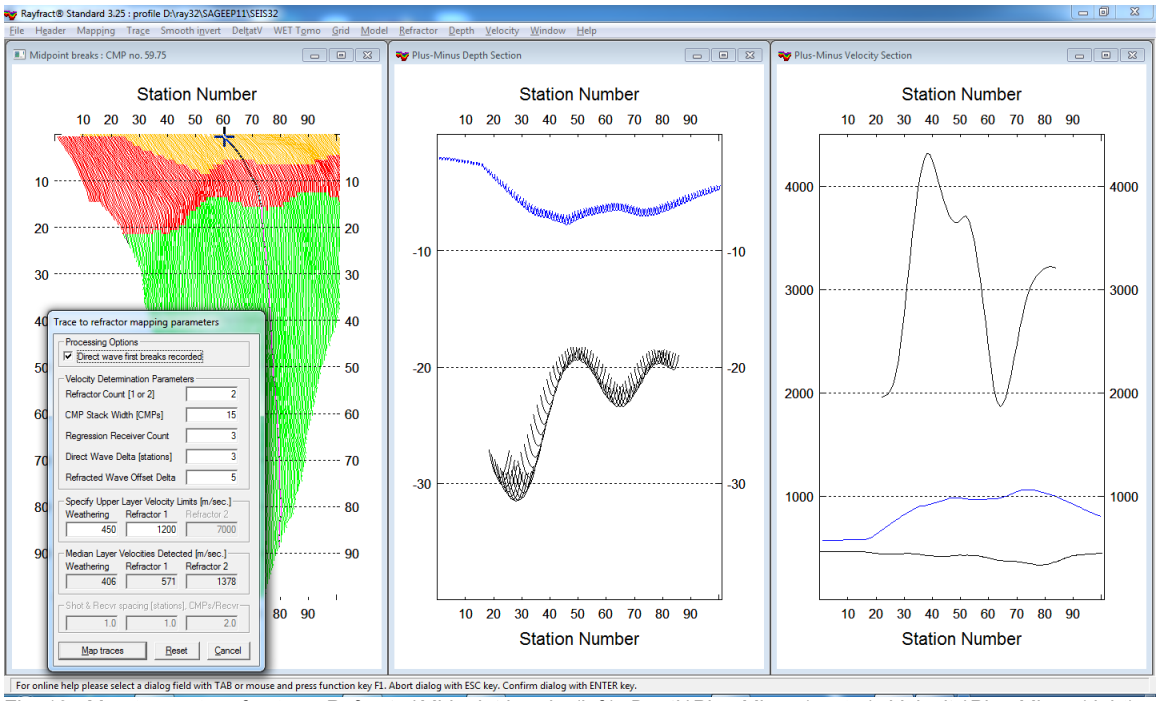

Fig. 10 : Map traces to refractors, *Refractor|Midpoint breaks* (left). *Depth|Plus-Minus* (center). *Velocity|Plus-Minus* (right).

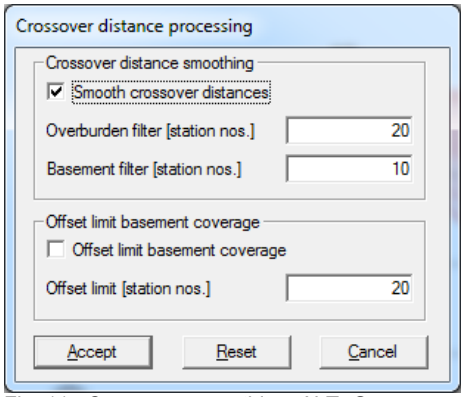

Fig. 11 : Crossover smoothing, ALT+G

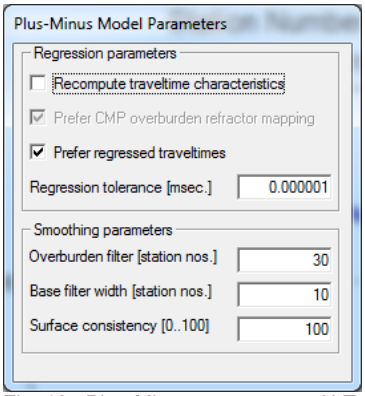

Fig. 12 : Plus-Minus parameters, ALT+M

Each of above eight WET runs took 20 minutes, with 100 *WET iterations* per run, over 10,100 picked traces. We timed this on MacBook Air with 1.8 GHz Intel Core i7 processor & two hyper-threaded CPU cores, using 4 threads total.

Click here for output of WET run no. 7 shown in Fig. 5 & 9. See our earlier SAGEEP11 publication, for blind interpretation of same data. Prof. Bob Whiteley compares our blind interpretation with true model built by Colin Zelt.

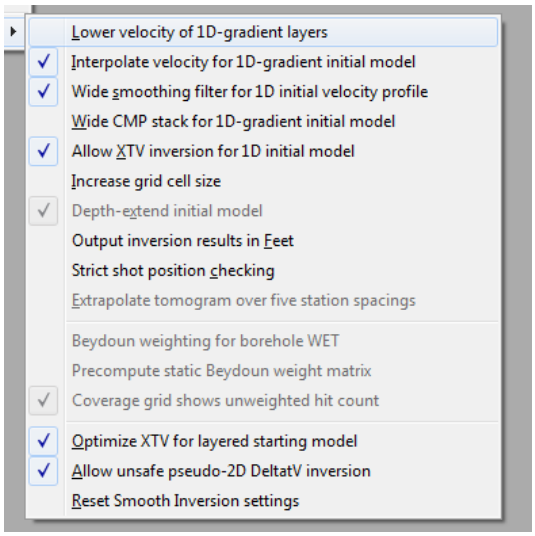

Fig. 13 : *Smooth invert|Smooth inversion Settings*

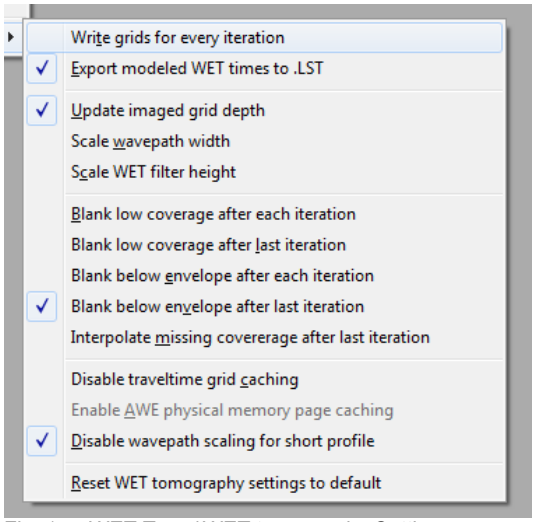

Fig. 14 : *WET Tomo|WET tomography Settings*

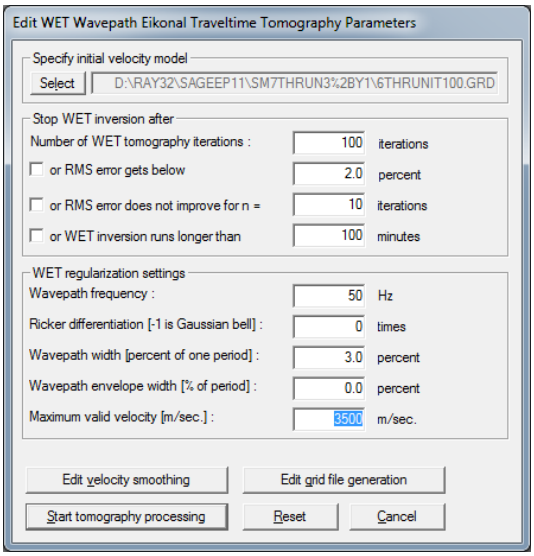

Fig. 15 : *WET Tomo|Interactive WET tomography…*

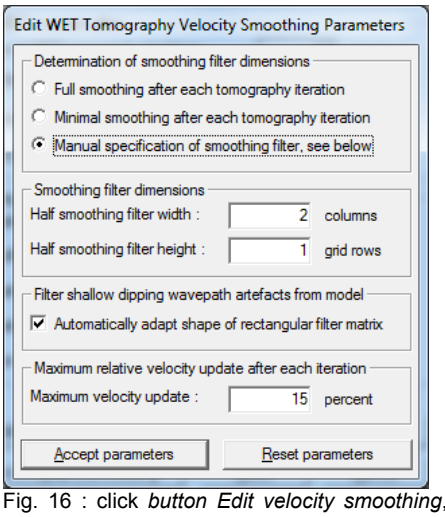

Fig. 16 : click *button Edit velocity smoothing*, in *WET Tomo|Interactive WET tomography…*

For all settings used see ASCII parameter file VELOIT100.PAR, for VELOIT100.GRD tomogram. To restore inversion settings to VELOIT100.PAR, select VELOIT100.GRD with *Grid|Reset DeltatV and WET settings to .PAR file...* .

The size of each grid file is 222 rows by 601 columns, as determined by our Smooth inversion method, for the GRADIENT.GRD starting model. But the depth range covered by 2D WET tomograms is only about 158 grid rows, to maximum depth of about -82m, during 7th WET run and for WET iteration no. 75.

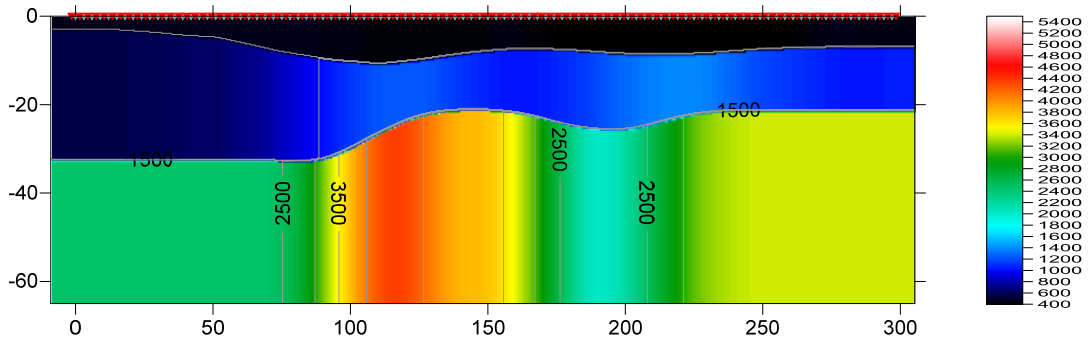

Fig. 17 : Plus-Minus layered starting model, RMS error 6.8%, version 3.31

In Fig. 17 we show a ***layered starting model*** obtained by converting the .CSV exported from our ***Plus-Minus Depth section*** (Fig. 10) to Surfer format .GRD. Use this starting model for 2D WET inversion with *WET Tomo menu* (Fig. 18).

To obtain Fig. 17 we first ***export the depth section to .CSV layered model file*** :

- map traces to refractors in ***Refractor|Midpoint breaks*** with ALT+M (Fig. 10 left)
- smooth *crossover distances* with ALT+G (Fig. 11)
- select ***Depth|Plus-Minus*** to obtain depth section (Fig. 10 center)
- press ALT+M and edit overburden, basement *refractor smoothing* (Fig. 12)
- press ENTER key to recompute depth section
- select ***Window|Export ASCII Model of depth section…***
- create subdirectory C:\RAY32\SAGEEP11\EXP331JULY14 with *Create New Folder icon*
- double-click this subdirectory and *Save button*, to write PLUSMODL.CSV to disk

Next we convert the layer model .CSV to Surfer .GRD with Rayfract® 3.31 released in July 2014 :

- select ***Grid|Convert .CSV layer model to Surfer .GRD...***
- navigate into C:\RAY32\SAGEEP11\EXP331JULY14 and select PLUSMODL.CSV
- now navigate into C:\RAY32\SAGEEP11\GRADTOMO and select GRADIENT.GRD
- select ***Grid|Image and contour velocity and coverage grids...***
- select C:\RAY32\SAGEEP11\EXP331JULY14\PLUSMODL.GRD to obtain Fig. 17

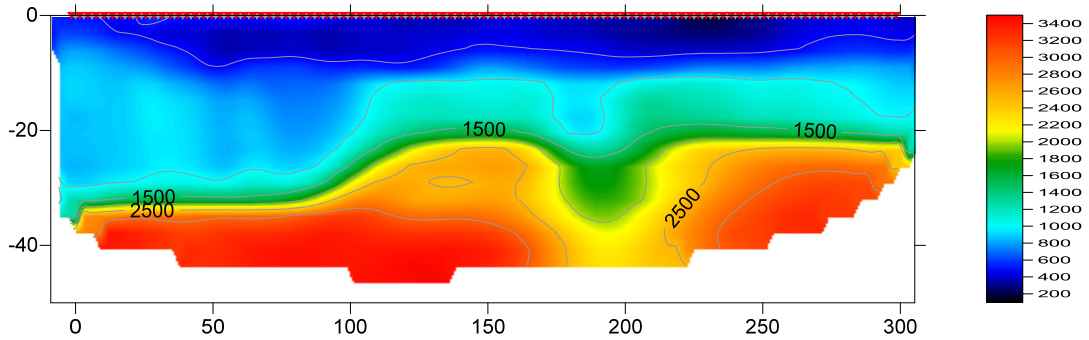

Fig. 18 : Conjugate Gradient WET inversion, Gaussian smoothing, starting model Fig. 17, RMS error 0.9%, 61 WET iterations, max. WET velocity 3,500 m/s, version 3.31.

Runtime for Fig. 18 was 4 minutes using 4 CPU cores on MacBook Air, for WET inversion of 10,100 first breaks using a grid with 4,510 velocity nodes. Note the correctly imaged ***shallow velocity inversion*** at depth of 5m between offset 50m and 100m . For true model see Zelt et al. 2013.

Click here for a .RAR archive with the PLUSMODL.GRD starting model and VELOIT62.GRD tomogram shown in Fig. 18, plus matching .PAR and .FIT files and the PLUSMODL.CSV layer model.