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

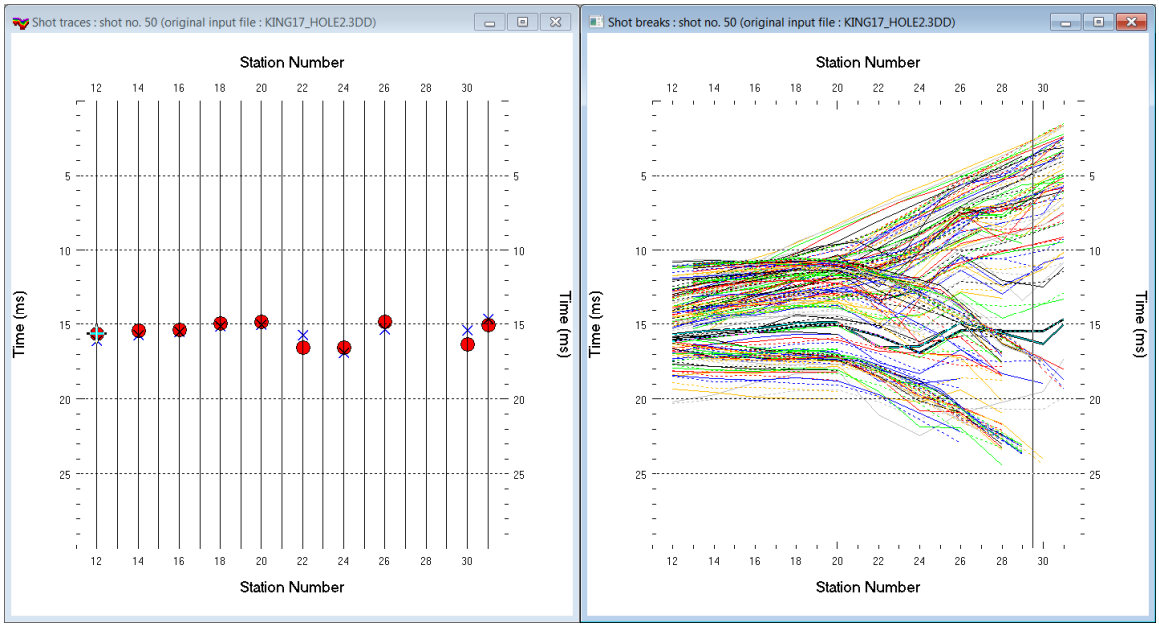

Fig. 1 : Picked and modeled times for hole KNG17HL2. Left : *Tace*|*Shot gather*, right : *Refractor*|*Shot breaks*. Shows fit between picked times (solid colored curves) and modeled times (dashed colored curves) after multirun CG WET.

- *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 `KNG17HL2` and import `.3DD` shots in `KNG17HL2 INPUT.RAR`
- create borehole profile `KNG17HL3` and import `.3DD` shots in `KNG17HL3 INPUT.RAR`
- select *File*|*Open Profile…* and `C:\RAY32\KING17\SEIS32.DBD`
- in *Header*|*Profile* click topmost *Select button* and select `C:\RAY32\KNG17HL2\SEIS32.DBD` . See Fig. 4.
- click *Borehole 2 line Select button* and select `C:\RAY32\KNG17HL3\SEIS32.DBD`
- unzip `KING17 BOUNDARY.RAR` in `C:\RAY32\KING17`
- in *WET Tomo*|*WET velocity constraints* select file `…\KING17\boundary\digitized.bln` . 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.

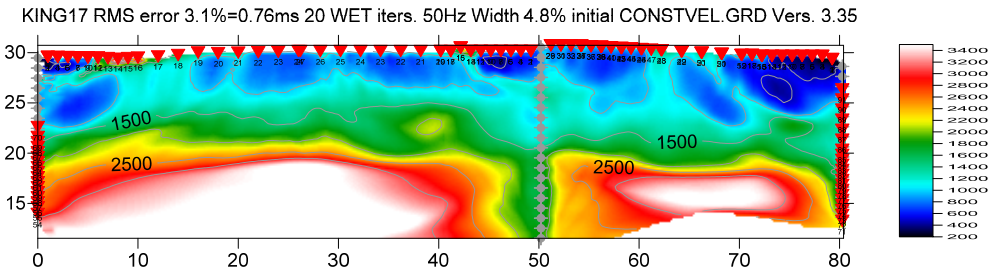

Fig. 2a : Default Smooth inversion output using constant-velocity starting model.

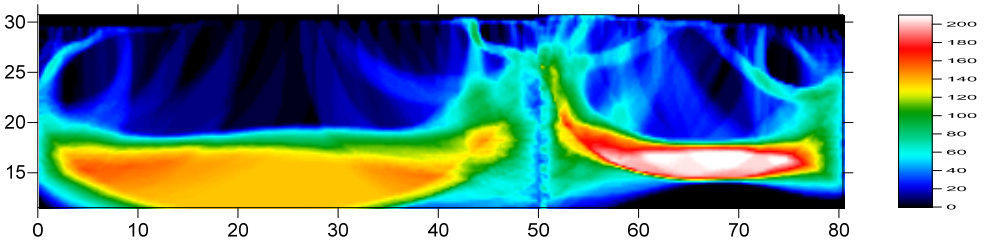

Fig. 2b : Wavepath coverage plot obtained with Fig. 2a. Unit is wavepaths per pixel.

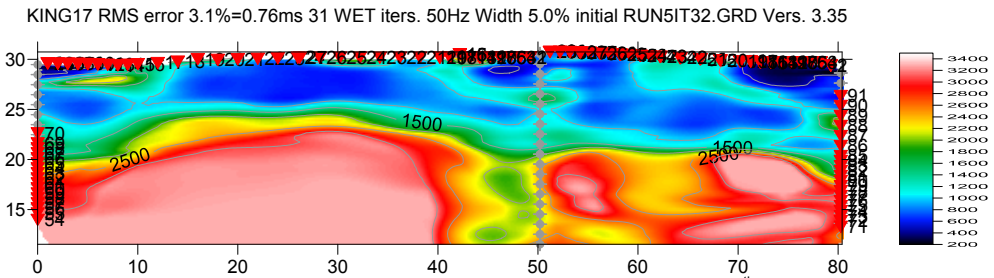

Fig. 3a : Multirun/Multiscale Conjugate-Gradient WET inversion. Output after 6th run shown.

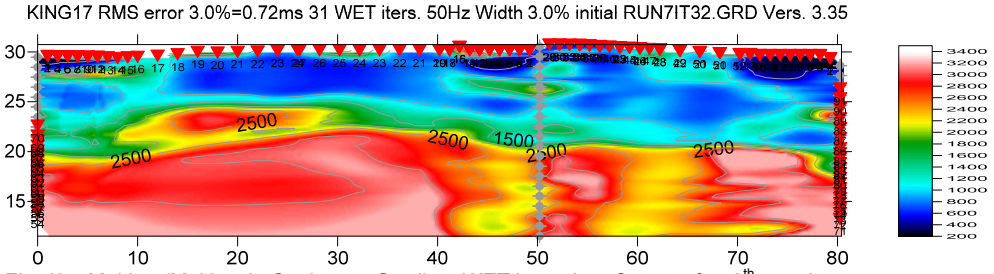

Fig. 3b : Multirun/Multiscale Conjugate-Gradient WET inversion. Output after 8th run shown.

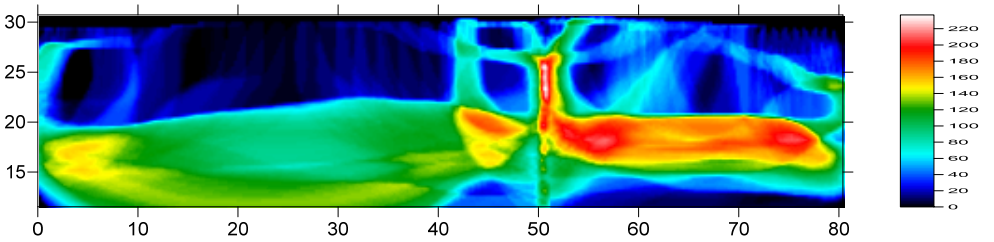

Fig. 3c : Wavepath coverage plot obtained with Fig. 3b. Unit is wavepaths per pixel.

- 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*.

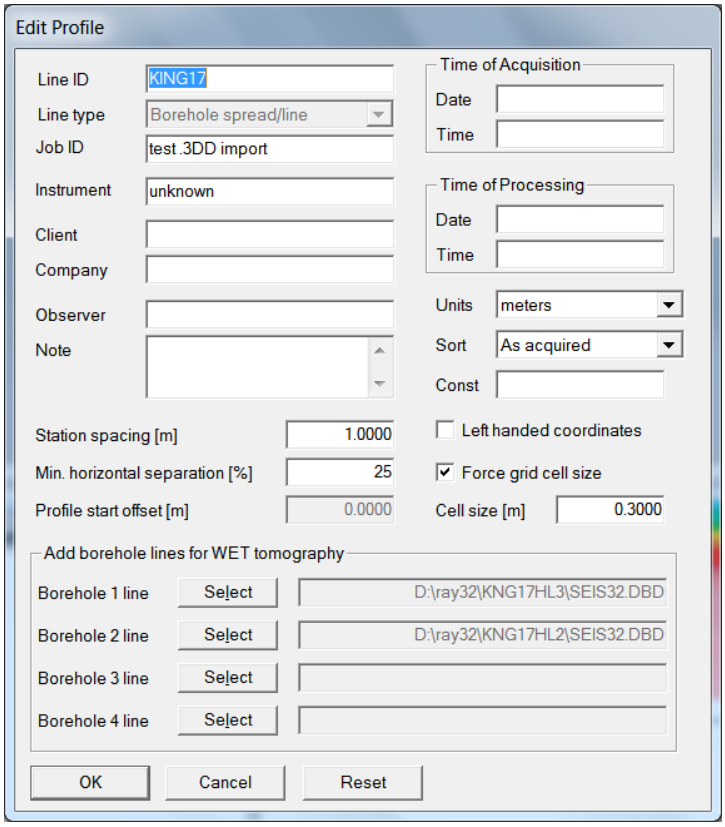

Fig. 4 : *Header|Profile* settings. Added borehole lines KNG17HL2 & KNG17HL3 with Select buttons.

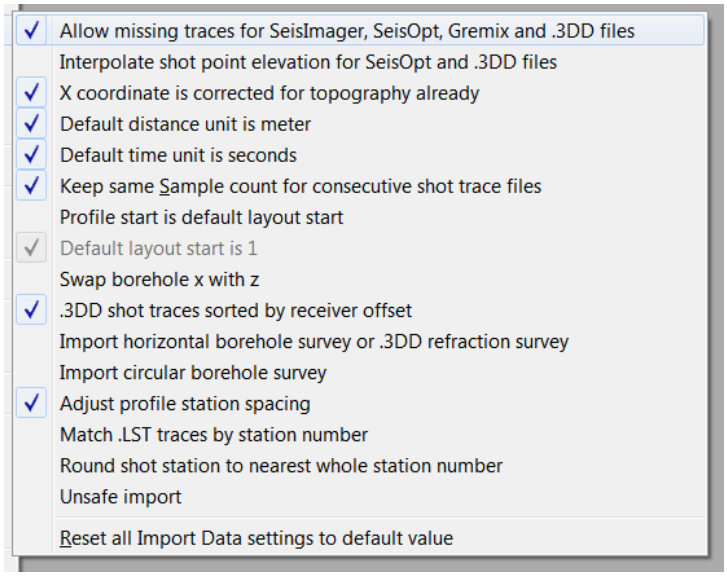

Fig. 5 : *File|Import Data Settings*.

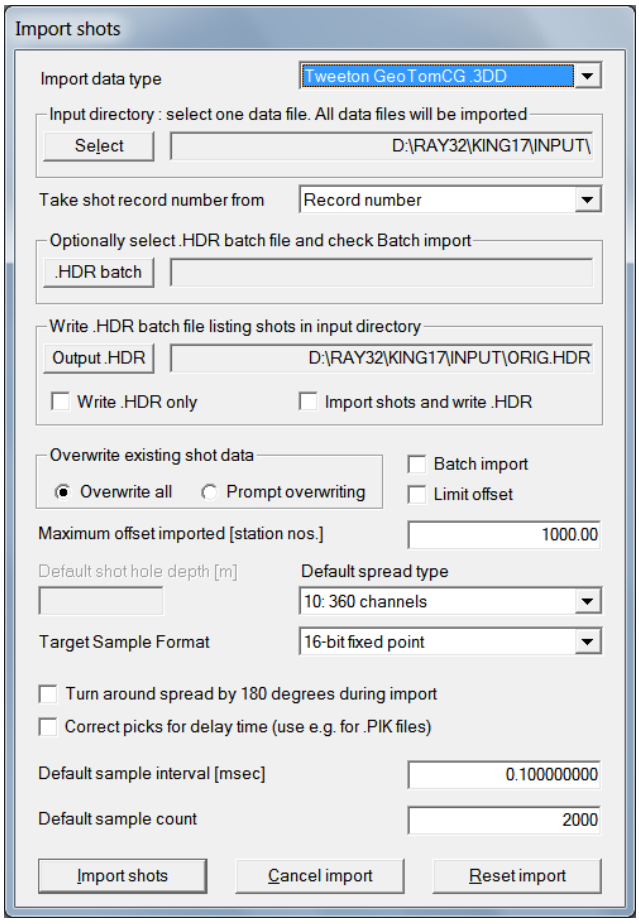

Fig. 6 : *File|Import Data*.

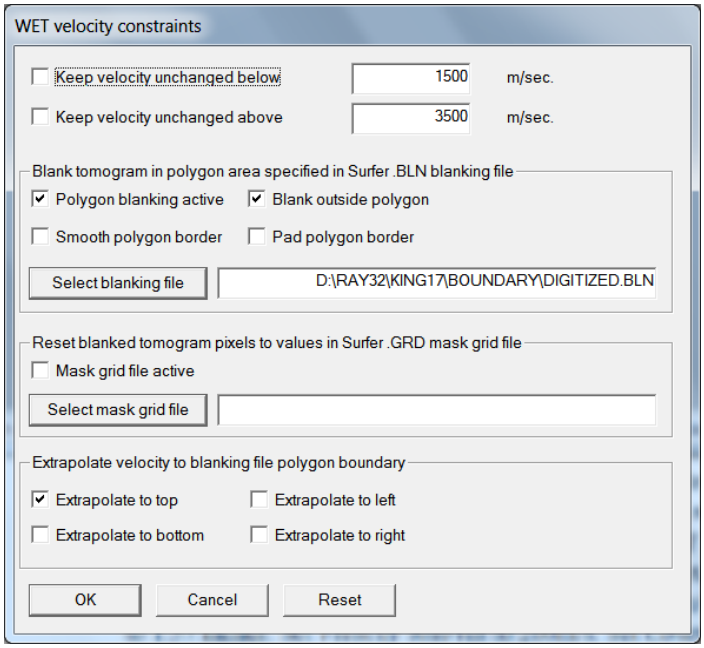

Fig. 7 : *WET Tomo|WET velocity constraints*.

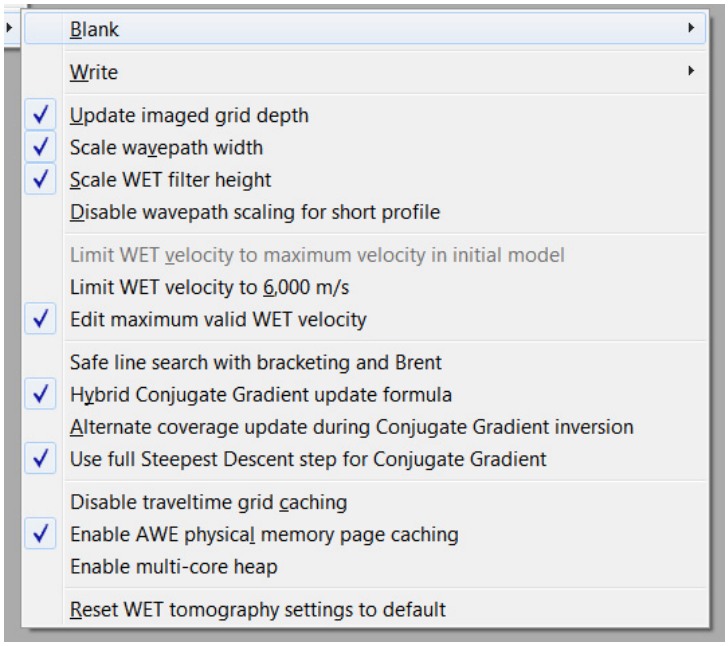

Fig. 8 : *WET Tomo|WET tomography Settings*

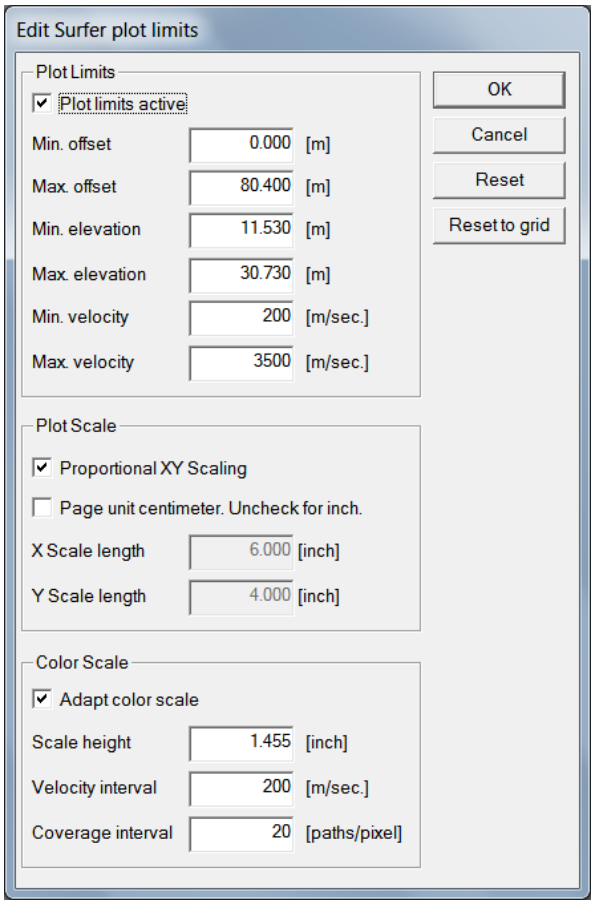

Fig. 9 : *Grid|Surfer plot Limits*

- 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 traveltime curves* & *Display synthesized traveltime curves*

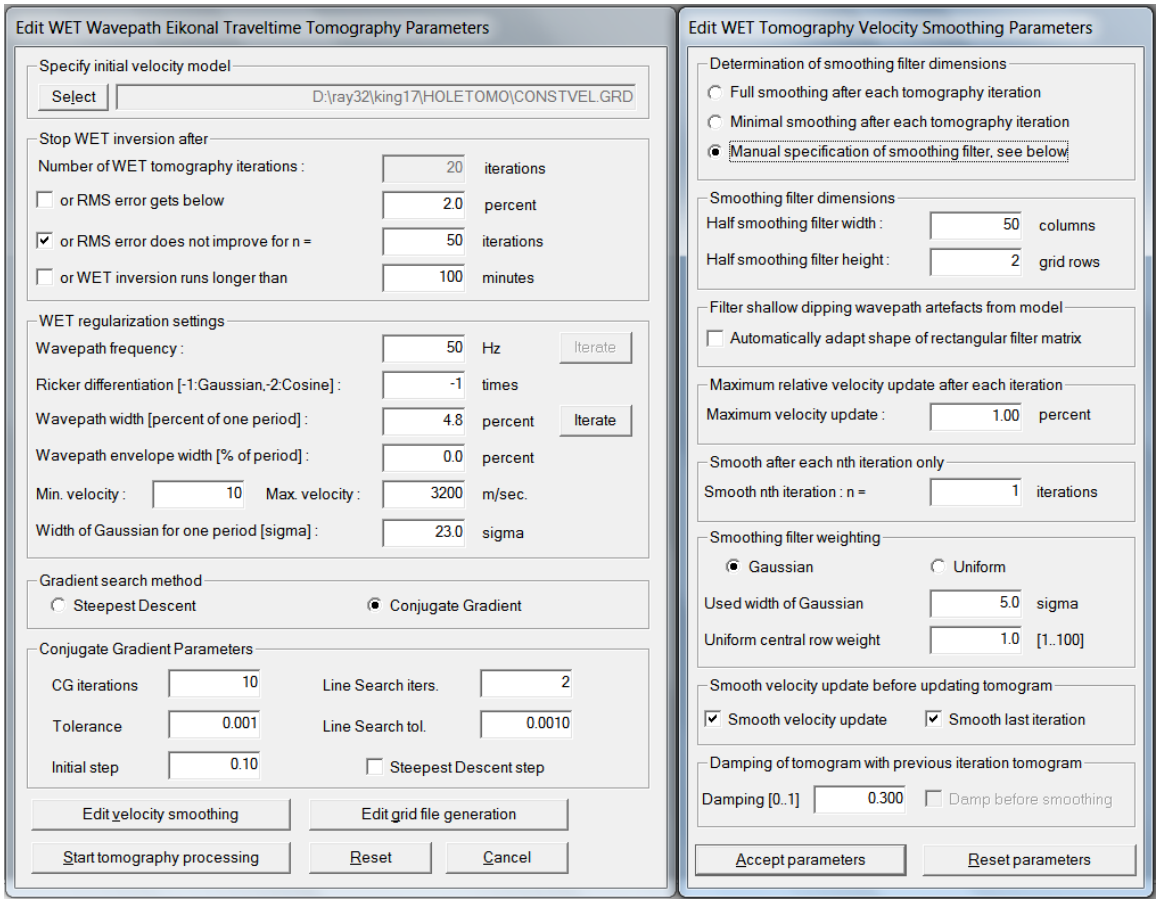

Fig. 10 : *WET Tomo|Interactive WET tomography* (left) and *Edit velocity smoothing* (right).

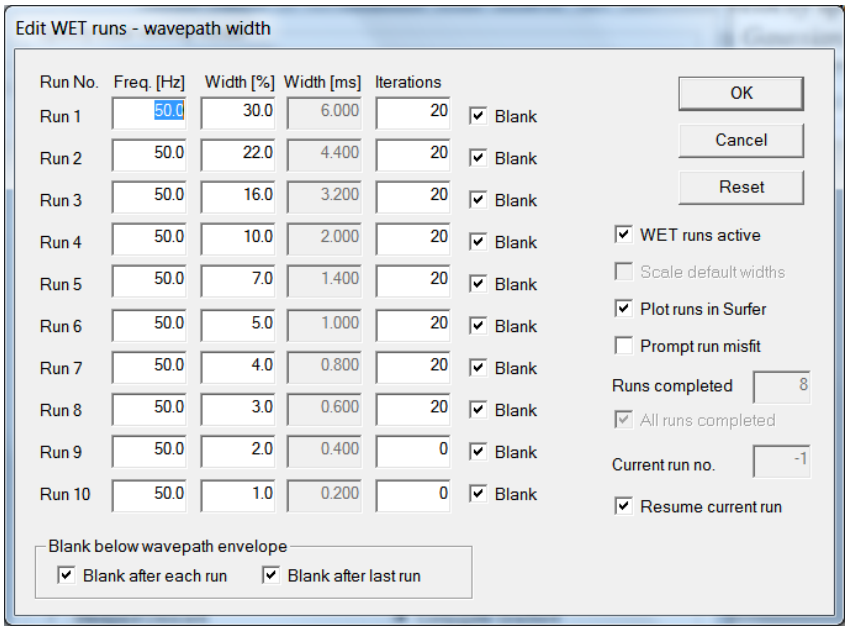

Fig. 11 : *WET Tomo|Interactive WET tomography|Iterate settings* for multiscale tomography (multirun WET).

- 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 .