Uphole refraction survey with Rayfract® version 3.35 :

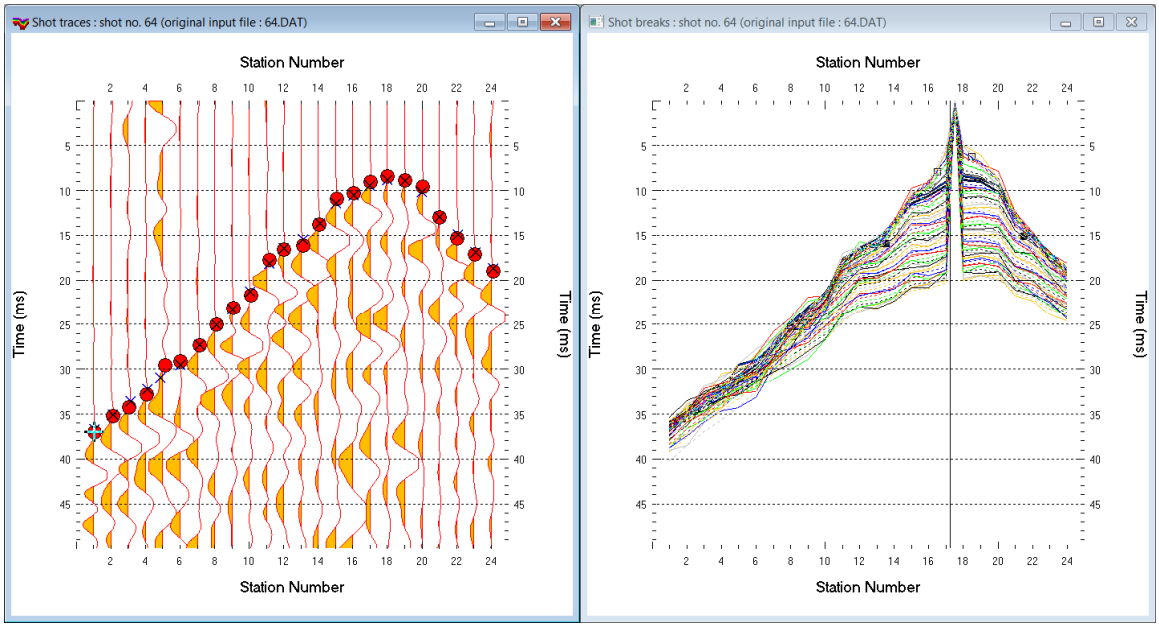

Fig. 1 : left : *Trace*|*Shot gather*, right : *Refractor*|*Shot breaks*. Shows fit between picked times (solid colored curves) and modeled times (dashed colored curves) obtained by forward modeling over Fig. 4

- *File*|*New Profile…*, set *File name* to SUBS19 and click *Save button*
- set *Station spacing* to 3.0m in *Header*|*Profile…* . Set *Line type* to `Refraction spread/line` .
- set *Cell size [m] to* 0.5m in *Header*|*Profile..* Check box *Force grid cell size.* Click *button OK.*
- unzip `SUBS19 INPUT.rar` with `SEG-2 .DAT` files and `BATCH.HDR` in `C:\RAY32\SUBS19\INPUT`
- check *File*|*Import Data Settings*|*Profile start is default layout start*
- check *File*|*Import Data Settings*|*Default layout start is 1*
- select *File*|*Import Data…* and set *Import data type* to `SEG-2` . See Fig. 5.
- click button *.HDR batch* and select file `C:\RAY32\SUBS19\INPUT\BATCH.HDR`
- check box *Batch import* and click radio button *Overwrite all* . See Fig. 5.
- leave *Default spread type* at *10: 360 channels*
- click *Select button*, navigate into `C:\RAY32\SUBS19\INPUT` and select one `.DAT` file e.g. `40.DAT`
- click *Open button* and *Import shots button*
- confirm *Reset model and geometry data prompt* with *Yes button*.
- select *File*|*Update header data*|*Update First Breaks* and `C:\RAY32\SUBS19\INPUT\BREAKS.LST`
- select *Trace*|*Shot gather* and *Window*|*Tile* to obtain Fig. 1
- for each window click title bar, press ALT+P, set *Maximum time* to 50 ms and hit ENTER key
- for *Trace*|*Shot gather* click title bar. Press SHIFT+Q and check boxes *Filter active*, *Band-pass filter* and *Bidirectional filter*. See Fig. 6.
- set *Low corner frequency [Hz]* and *High corner frequency [Hz]* both to 200Hz. Click *Filter button*.
- in *Header*|*Shot* set *Type* to `Uphole shot` for shots no. 40 to 69. See Fig. 7. Browse shots with F7/F8. Uphole shots are not regarded when determining the 1D-gradient starting model. Leave shots no. 70 to 72 with default *Type* `Refraction shot` selected.
- select *Smooth invert*|*Custom 1D-gradient velocity profile…* . See Fig. 9.
- edit starting model grid limits as in Fig. 9. Check box *Force grid limits* and click button *OK*.
- uncheck *WET Tomo*|*WET tomography Settings*|*Blank*|*Blank below envelope after last iteration*
- check *Smooth invert*|*Smooth inversion Settings*|*Allow XTV inversion for 1D initial model*
- check *Smooth invert*|*Smooth inversion Settings*|*Optimize XTV for layered starting model*

- select *Smooth invert|WET with 1D-gradient initial model* and confirm prompts for default interpretation shown in Fig. 2
- select *Grid|Surfer plot Limits…* and click *button Reset to grid*. See Fig. 8.
- navigate into `C:\RAY32\SUBS19\GRADTOMO` directory and select `VELOIT20.GRD`
- check box *Plot limits active*. Set *Min. velocity* to 500 m/s and *Max. velocity* to 3,000 m/s.
- click button OK
- select *WET Tomo|Interactive WET tomography…*
- set *Number of WET tomography iterations* to 100. Set *Ricker differentiation* to -2 and click *button Edit velocity smoothing*. See Fig. 4.
- click radio button *Minimal smoothing after each tomography iteration*
- uncheck box *Automaticlly adapt shape of rectangular filter matrix*
- click button *Accept parameters* and button *Start tomography processing* to obtain Fig. 3
- Fig. 4 shows *WET parameters* used to obtain Fig. 3
- for help on *WET inversion* parameters see updated .pdf reference chapter ***WET Wavepath Eikonal Traveltime tomography***

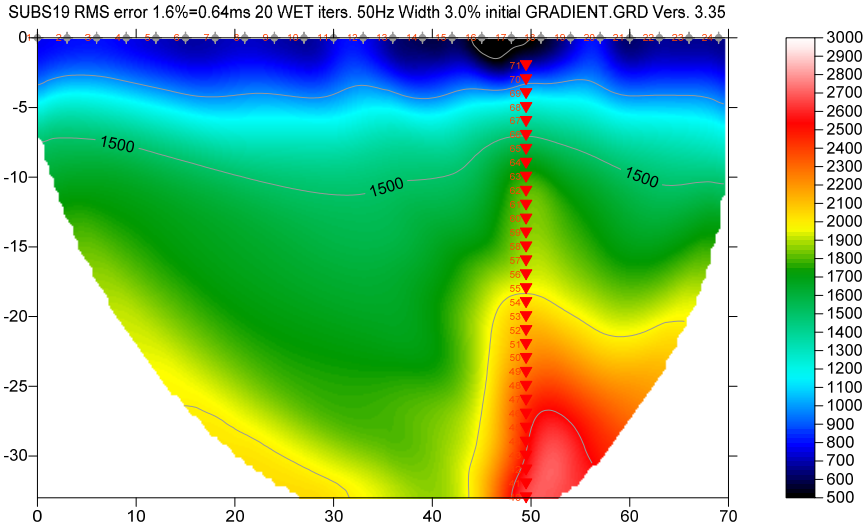

Fig. 2a : Smooth invert|WET with 1D-gradient initial model. 20 WET iterations. XTV inversion enabled.

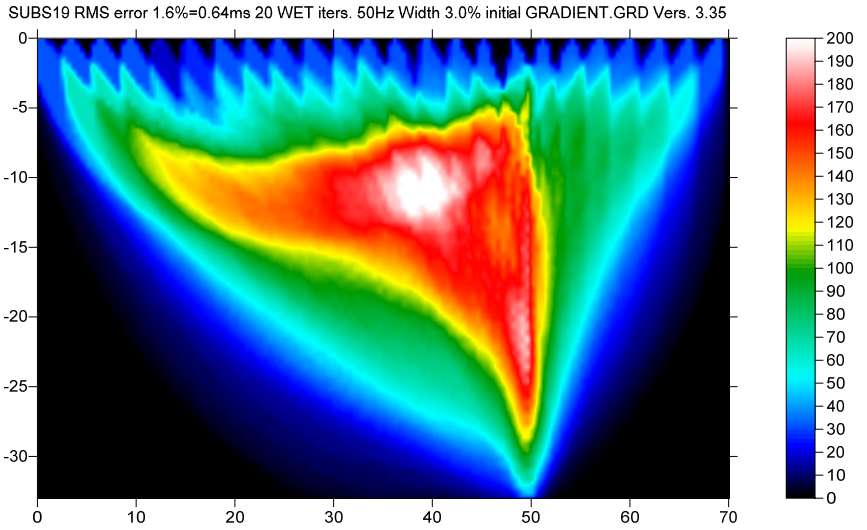

Fig. 2b : WET wavepath coverage plot obtained with Fig. 2a. Unit is wavepaths per pixel.

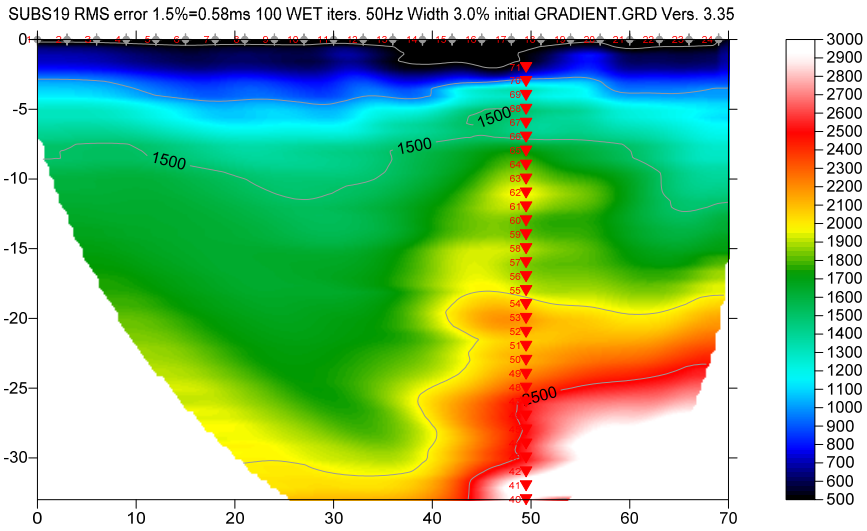

Fig. 3a : Tomogram with 1D-gradient starting model, 100 Steepest Descent WET iterations. Wavepath width 3%, Max. velocity 6,000 m/s. Minimal smoothing, don't adapt shape of rectangular filter. WET settings as in Fig. 4.

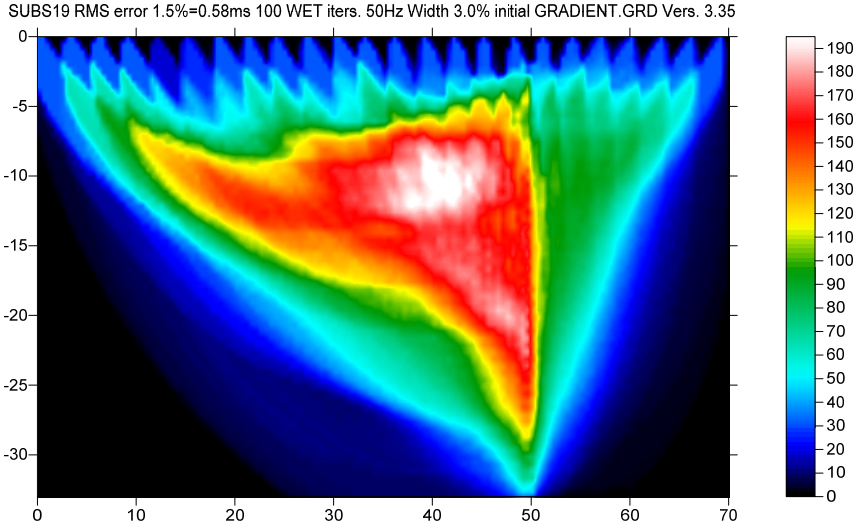

Fig. 3b : WET wavepath coverage plot obtained with Fig. 3a. Shows number of wavepaths per pixel.

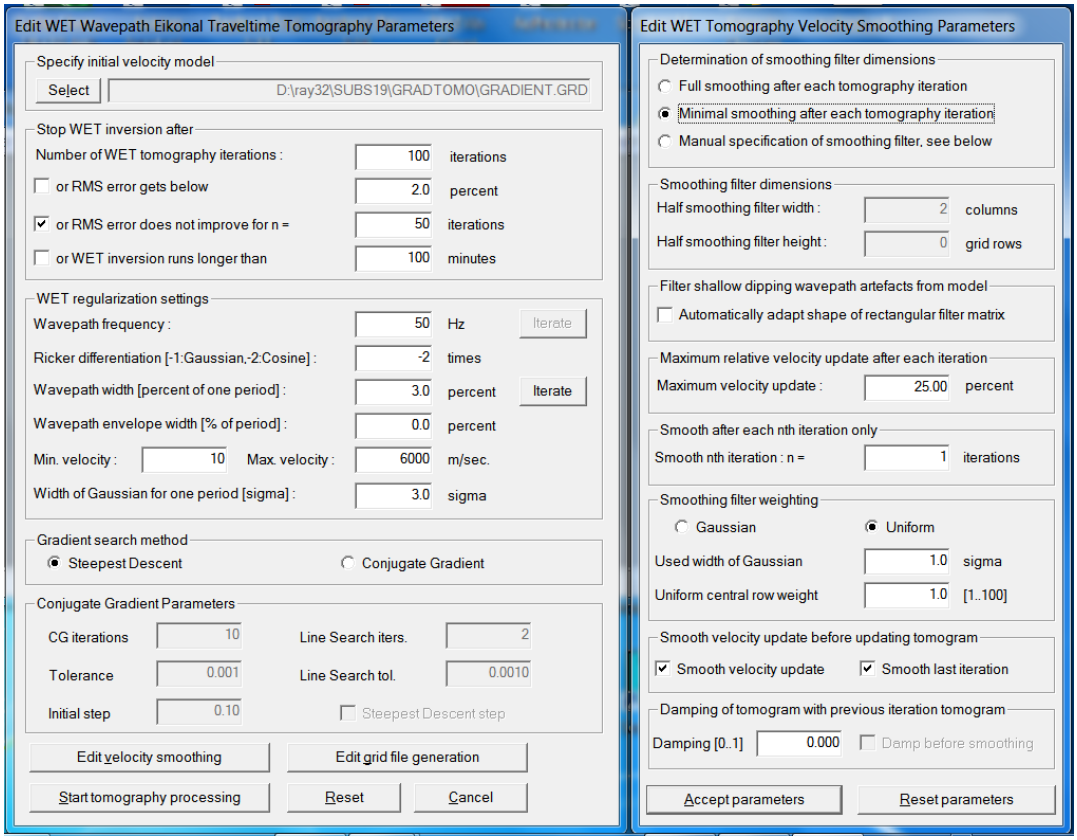

Fig. 4 : WET parameter settings for Fig. 3. left : main interactive WET dialog. right : edit velocity smoothing

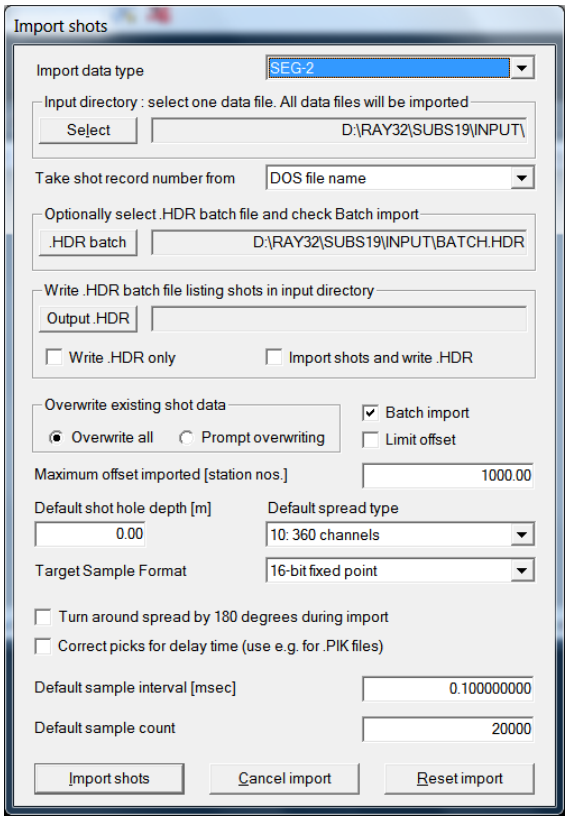

Fig. 5 : import shots with *File*|*Import Data*…

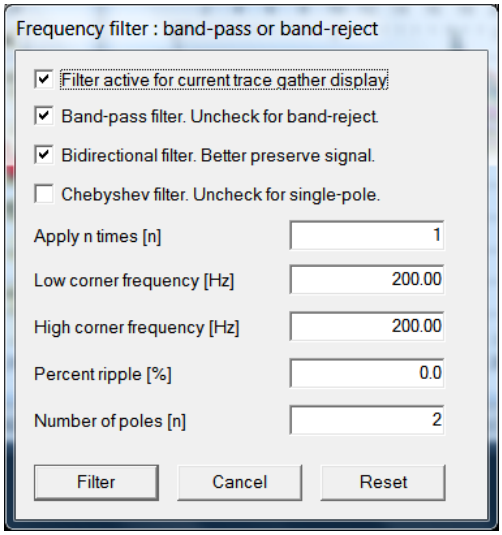

Fig. 6 : Bandpass filter. Press SHIFT+Q in *Trace|Shot gather*.

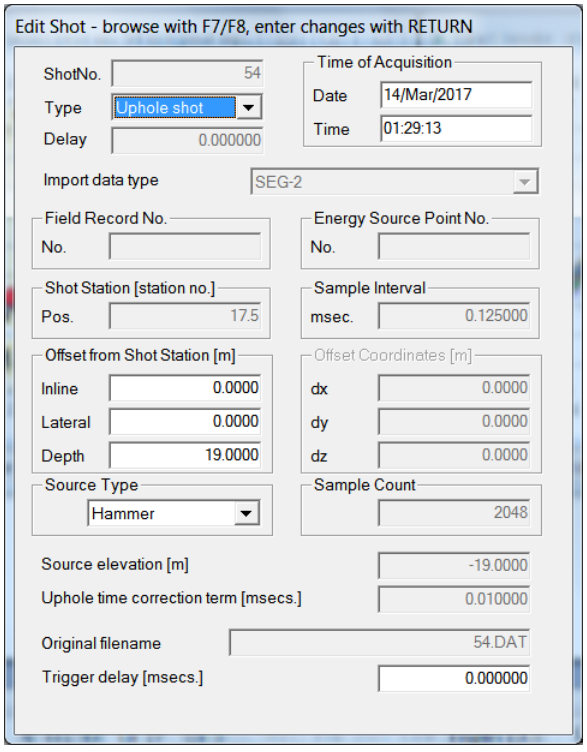

Fig. 7 : edit shot data in *Header|Shot*

We support importing uphole shots with the source positioned in more than one borehole, into the same `Refraction spread/line` profile. This should give a laterally more continuous and higher-resolution tomogram.

Also import surface-based refraction shots into the same profile, positioned along the receiver spread. See e.g. our tutorial Coffey04.

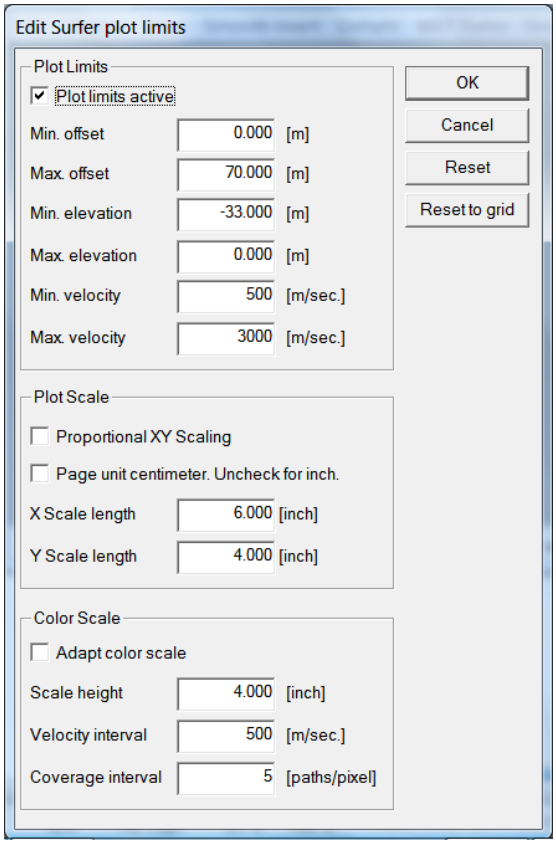

Fig. 8 : edit Surfer plot limits and velocity scale with *Grid*|*Surfer plot Limits*…

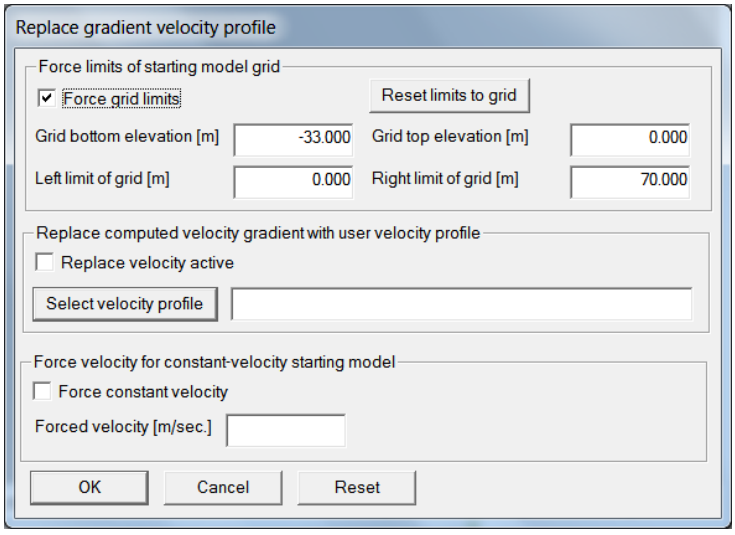

Fig. 9 : force limits of starting model grid with *Smooth invert*|*Custom 1D-gradient velocity profile*…

We thank our Malaysian client Subsurface Engineering Sdn Bhd for this high-resolution data set and giving us permission to use these data for this tutorial.