WET NGU P1_6-7D : Conjugate Gradient&Cosine-Squared 3.36 DeltatV+XTV starting model :

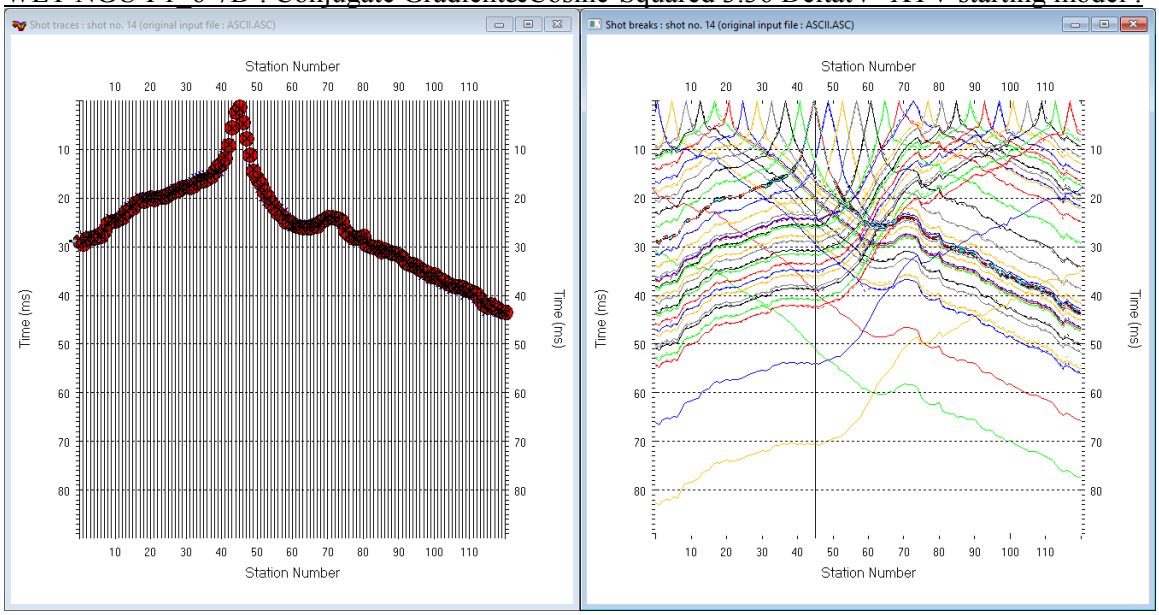

Fig. 1 : left : *Trace*|*Shot gather*, right : *Refractor*|*Shot breaks*. Shows fit between picked times (solid colored curves, red circles) and modeled times (dashed colored curves, blue crosses) obtained for 2D WET inversion output (Fig. 9)

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

- ***File*|*New Profile***..., set *File name* to `P1_6-7D` and click *Save button*
- in ***Header*|*Profile***... set *Line type* to `Refraction spread/line` . Set *Station spacing* to 2.0 m.
- check *box Force grid cell size* and set *Cell size[m]* to 0.4m. See Fig. 2.
- unzip `P1_6-7D.zip` with files `1_6-7DASCII.ASC, 1_6-7DCOORDS.COR, 1_6-7DSHOTS.SHO & 1_1D.CLR` in directory `C:\RAY32\P1_6-7D\INPUT`
- select ***File*|*Import Data***... and set *Import data type* to `ASCII column format`. See Fig. 3.
- leave *Default spread type* at `10: 360 channels`
- click *Select button*, navigate into `C:\RAY32\P1_6-7D\INPUT` and select file `P1_6-7DASCII.ASC`
- set *Default sample count* to 900 to setup the y scale for *Trace*|*Shot gather* & *Refractor*|*Shot breaks*
- click ***Import shots button*** for batch import of all shots contained in `P1_6-7DASCII.ASC`
- select *File*|*Update header data*|***Update Station Coordinates***
- navigate into directory `C:\RAY32\P1_6-7D\INPUT`
- select file `1_6-7DCOORDS.COR` . Click *Open button*.
- *File*|*Update header data*|***Update Shotpoint coordinates*** with `1_6-7DSHOTS.SHO`
- select *Trace*|*Shot gather* and *Window*|*Tile* to obtain Fig. 1

To configure and run DeltatV+XTV inversion and display the pseudo-2D inversion output :

- uncheck *DeltatV*|*DeltatV Settings*|*Reduced offset 0.0 is valid trace with time 0.0*. See Fig. 11.
- check *DeltatV*|*DeltatV Settings*|*Suppress velocity artefacts*
- check *DeltatV*|*DeltatV Settings*|*Process every CMP offset*
- check *DeltatV*|*DeltatV Settings*|*Smooth CMP traveltime curves*
- select *DeltatV*|*XTV parameters*. Click button *Layer model.* Edit fields as in Fig. 14 & click *Accept*.
- select *DeltatV*|*Interactive DeltatV*. Confirm prompt and edit parameters as in Fig. 12.
- click *Export Options* and set *Gridding method* to `Nearest Neighbor` as in Fig. 13 & click *Accept*
- click button *DeltatV inversion*
- in dialog *Save DeltatV output* click yellow *Create new folder* icon at upper right
- name new folder as `Stack45Curr5%_Smooth2nd`. Double-click this new folder to enter it.

- set *File name* to **`Stack45Curr5%_Smooth2nd`**. Click *Save* button.
- wait for the *DeltatV+XTV inversion* to complete
- select *Grid*|*Grid and image DeltatV .TXT file*
- select **`C:\RAY32\P1_6-7D\Stack45Curr5%_Smooth2nd\MAXVELO.TXT`**
- select *Grid*|*Surfer plot Limits*. Click *Reset to grid*. Navigate into profile subdirectory **`C:\RAY32\P1_6-7D\Stack45Curr5%_Smooth2nd.`** Click on file **`MAXVELO.GRD`** & click *Open*.
- check *box* ***Plot limits active***. Set *Min. elevation* to 20m. Set *Max. elevation* to 72m. See Fig. 4.
- set *Min. velocity* to 500 m/s and *Max. velocity* to 6,000 m/s. Edit fields as in Fig. 4. Click *OK*.
- select *Grid*|*Image and contour velocity and coverage grids* & above **`MAXVELO.GRD`** to obtain Fig. 7

To configure and run WET inversion and display 2D inversion output :

- check *WET Tomo*|*WET tomography Settings*|*Blank no coverage after last iteration*.
- uncheck *WET Tomo*|*WET tomography Settings*|*Blank below envelope after last iteration*
- check *WET Tomo*|*WET tomography Settings*|*Write*|*Store modeled picks after last iteration only*
- check *WET Tomo*|*WET tomography Settings*|*Scale wavepath width*. See Fig. 15.
- check *WET Tomo*|*WET tomography Settings*|*Scale WET filter height*
- check *WET Tomo*|*WET tomography Settings*|*Edit maximum valid WET velocity*
- in *WET Tomo*|*WET velocity update* set *a* to 0.5 and *b* to 10.0. Click *OK*. See Fig. 5.
- set *WET Tomo*|*Interactive WET tomography*|***Ricker differentiation*** to -2 [Cosine-Squared]
- set *Min. velocity* to 200 m/s & *Max. velocity* to 5,700 m/s. See Fig. 6 (left).
- click radio button ***Conjugate Gradient***
- set *CG iterations* (outer loop) to 15 and *Line Search iters.* (inner loop) to 3. See Shewchuk 1994 .
- click button *Edit grid file generation* & set *Store each nth iteration only : n* = to 20. Click *OK*.
- click ***Edit velocity smoothing***. Check ***Manual specification of smoothing filter*** . See Fig. 6 (right).
- set ***Half smoothing filter width*** to 3 columns & set ***Half smoothing filter height*** to 1 rows
- uncheck ***Adapt shape of filter***. Set ***Maximum velocity update*** to 25% .
- set ***Smooth nth iteration : n =*** to 2 to obtain Fig. 8. Set to 3 to obtain Fig. 9.
- click ***Uniform*** *button*. Leave ***Damping*** at default 0.9. Click *Accept button*.
- click *button* ***Start tomography processing*** to obtain Fig. 8 & 10
- in Surfer 16 click on *menu View*. Check *Properties check box*.
- in Surfer 16 window for Fig. 8 click on *Custom colormap* button to right of *Colors label*. Click on *Load button*. Navigate into **`C:\RAY32\P1_6-7D\INPUT`** & select **`1_1D.CLR`** . Click *Open&Apply&OK*.

Here some references to help file chapters and other relevant tutorials :

- for our ***multiscale WET*** inversion see updated help file chapter ***WET tomography processing***
- see also our SAGEEP11 tutorial showing ***Conjugate Gradient WET*** inversion using 1D-gradient initial model for SAGEEP11 synthetic data forward-modeled over fault zone model
- see also our 2017 tutorial showing ***Steepest Descent WET inversion*** using Plus-Minus layered refraction starting model for NGU 2017 P1_1 synthetic data

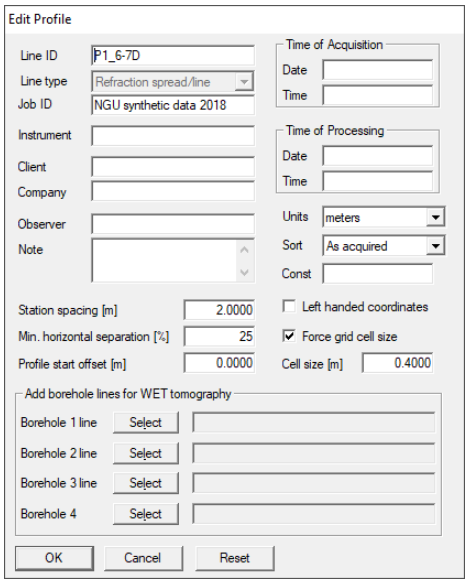

Fig. 2 : *Header|Profile*

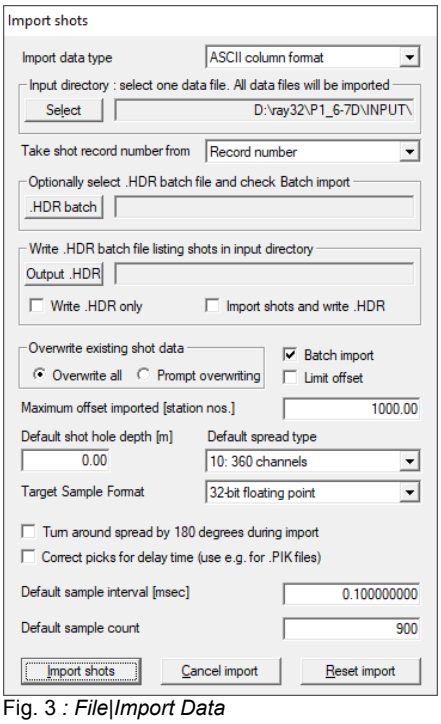

Fig. 3 *: File|Import Data*

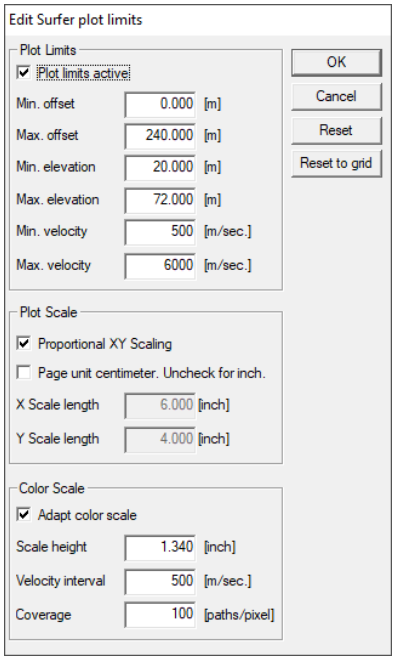

Fig. 4 : *Grid|Surfer plot Limits*

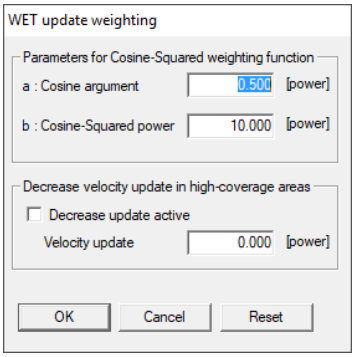

Fig. 5 : *WET Tomo|WET Update weighting*

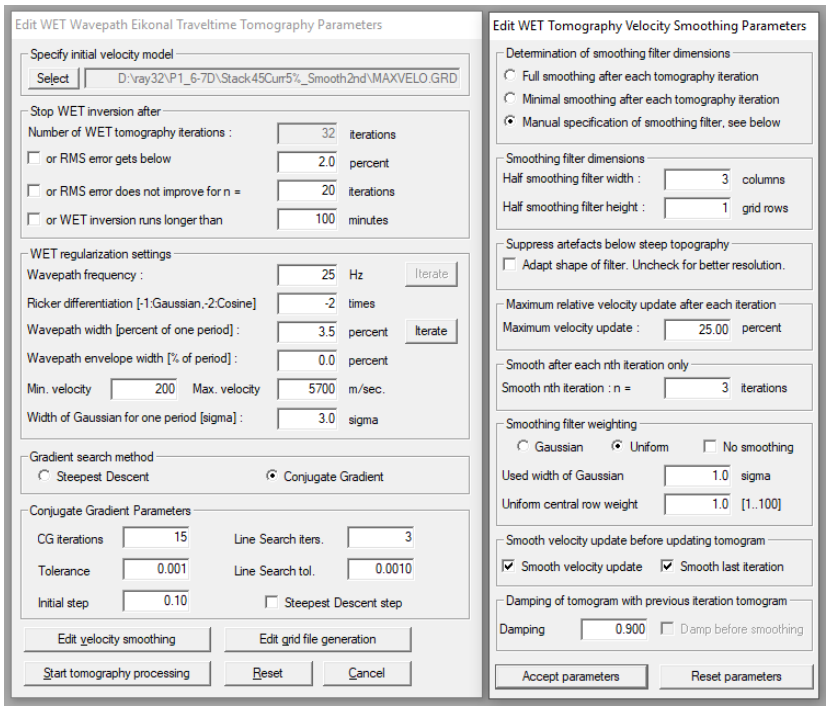

Fig. 6 : left : WET Tomo|Interactive WET tomography
right : Edit velocity smoothing

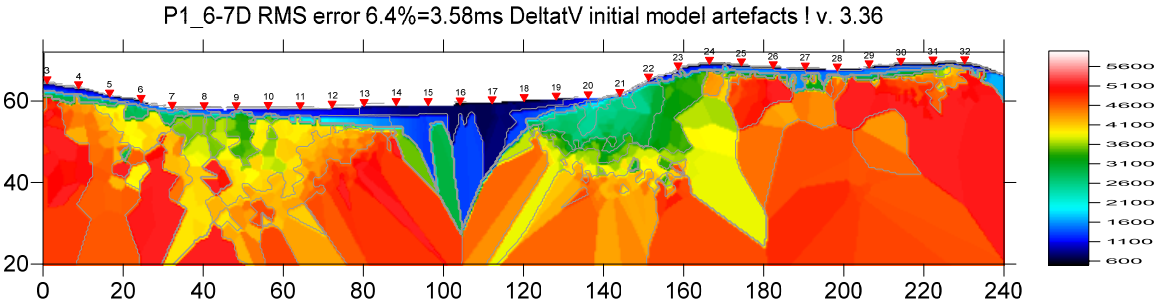

Fig. 7 : *DeltatV|Interactive DeltatV* output. See Fig. 11/12/13/14 for *DeltatV Settings & parameters* and *XTV parameters*

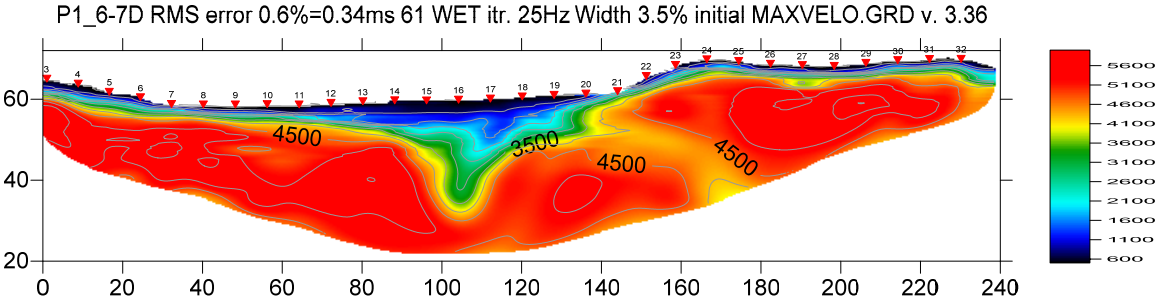

Fig. 8 : WET output. Starting model is Fig. 7. See Fig. 1 for misfit. *Smooth nth iteration* = 2.

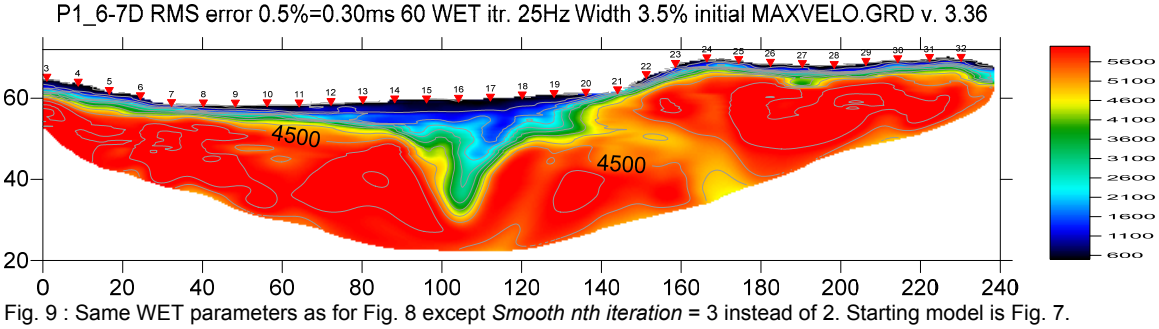

Fig. 9 : Same WET parameters as for Fig. 8 except *Smooth nth iteration* = 3 instead of 2. Starting model is Fig. 7.

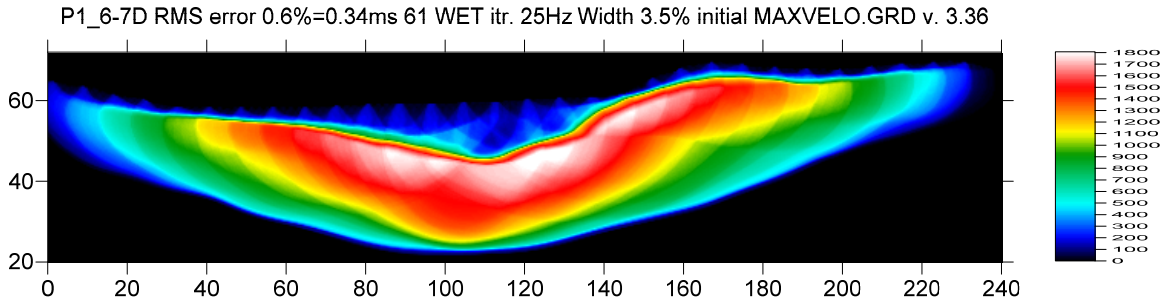

Fig. 10 : Wavepath coverage plot obtained with Fig. 8. Unit is wavepaths per pixel.

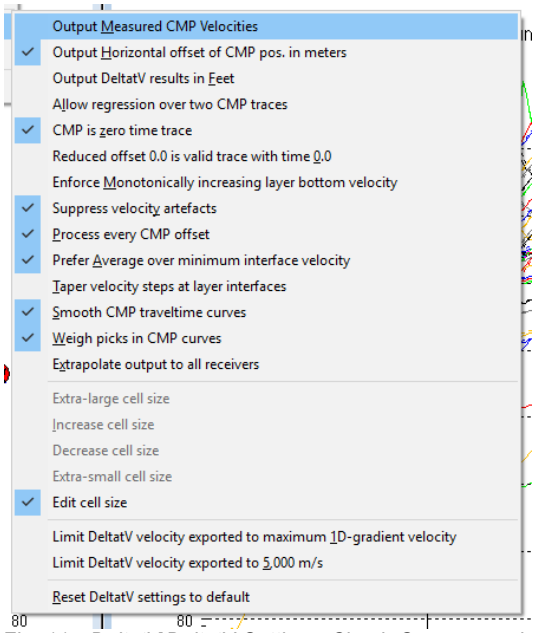

Fig. 11 : *DeltatV|DeltatV Settings*. Check *Suppress velocity artefacts* to enforce continuous CMP sorted traveltime curves and filter out bad picks from traveltime curves.

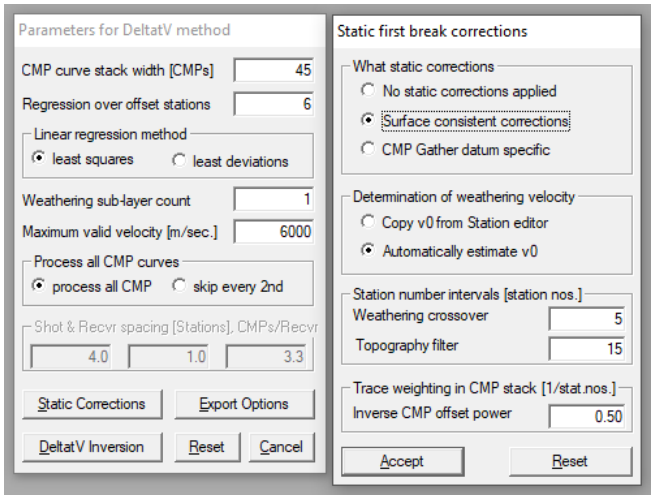

Fig. 12 : edit parameters in dialog *DeltatV|Interactive DeltatV* (left). Click button *Static Corrections* to edit more parameters (right). Check radio button *No static corrections applied* to completely disable static corrections. Increase *Inverse CMP offset power* from default 0.5 to 0.9 to give more weight to central CMP curve when stacking CMP curves. This increases the lateral resolution. Decreasing *Inverse CMP offset power* to 0.2 increases lateral smoothing.

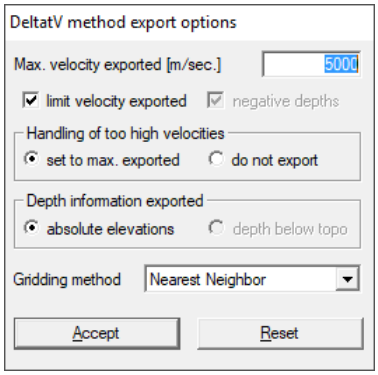

Fig. 13 : *DeltatV|InteractiveDeltatV|Export Options*

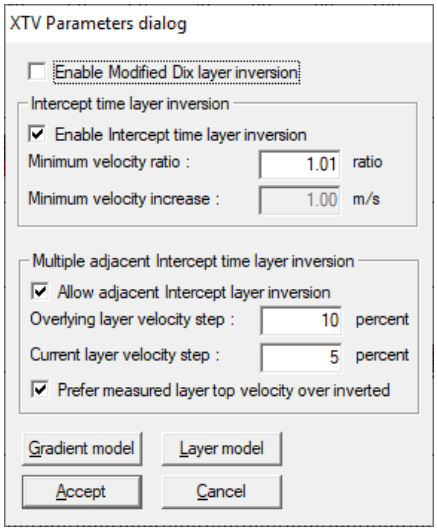

Fig. 14 : edit *XTV parameters*

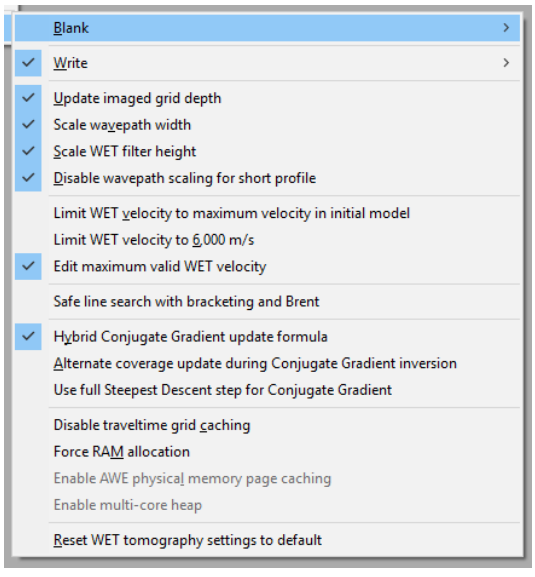

Fig. 15 : edit menu *WET Tomo|WET tomography Settings*

To restore database files and result files :

Subdirectories **C:\RAY32\P1_6-71D\Stack45Curr5%_Smooth3rd**, …**\INPUT** and …**\seis32_Mar3_2019** are available in this .RAR archive. Open the …**\Stack45Curr5%_Smooth3rd\VELOIT61.PAR** file e.g. with Windows Notepad editor to review *WET inversion* parameters used.

Use Rayfract® 3.36 command ***Grid|Reset DeltatV and WET settings to .PAR file…*** with file …**\Stack45Curr5%_Smooth3rd\VELOIT61.GRD** to reset your profile's *DeltatV and WET inversion settings* to …**\Stack45Curr5%_Smooth3rd\VELOIT61.PAR**.

Or quit our software via ***File|Exit***. In Windows Explorer copy all 34 **seis32.*** database files from directory …**\seis32_Mar3_2019** into **C:\RAY32\P1_6-7D** directory. Now reopen your profile with ***File|Open Profile…*** and **C:\RAY32\P1_6-7D\SEIS32.DBD** .

Summary, parameter optimization :

NGU 2018 report with Fig. 4.5.2 showing *WET inversion* of above synthetic model data is available at http://www.ngu.no/upload/Publikasjoner/Rapporter/2018/2018_015.pdf . For above Fig. 8 & Fig. 9 we further improve our DeltatV+XTV settings for pseudo-2D starting model and 2D WET inversion settings compared to settings used for Fig. 4.5.2.

We optimized DeltatV+XTV and WET settings to more clearly image the overburden layers and the double fault zone and minimize artefacts in basement. We changed the following settings compared to Fig. 4.5.2 :

- *DeltatV stack width* 45 instead of 30 to minimize artefacts in basement
- *Static* setting *Inverse CMP offset power* 0.50 (default) instead of 0.20 to increase lateral resolution
- unchecked XTV option *Enable Modified Dix layer inversion* to remove artefact in basement
- increased XTV *Overlying layer velocity step* from 0 percent to 10 percent to better resolve overburden
- decreased XTV *Current layer velocity step* from 25 percent to 5 percent to better resolve overburden
- increased WET smoothing parameter *Smooth nth iteration* : n = from 2 (Fig. 8) to 3 (Fig. 9) for sharper layer & fault zone boundaries

WET inversion shown in Fig. 8 with 15 Conjugate-Gradient iterations and parameters shown in Fig. 6 took about 90 seconds on 2017 Apple iMac (2.3 GHz Intel Core i5 processor) running Windows 10 Pro 64-bit in Parallels Desktop 14 for Mac Pro Edition.

We thank Georgios Tassis at NGU for making available above report and synthetic data.

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