TRA9002 multiscale Conjugate-Gradient WET inversion with DeltatV starting model using WDVS and showing checkerboard resolution test / Version 4.03 Pro Sep 2022 :



Fig. 1 : Pseudo-2D DeltatV starting model. *Grid cell size* forced to 1.0m in *Header*|*Profile*. *DeltatV Settings* as in Fig. 15. *XTV Parameters* dialog as in Fig. 17. *Common-offset dip estimation* dialog as in Fig. 18.



Fig. 2 : multiscale Conjugate-Gradient WET inversion with DeltatV starting model (Fig. 1 / Fig 14 / Fig. 16 / Fig. 19). 8th WET run output shown. WDVS@250Hz (Fig. 13, <u>Zelt and Chen 2016</u>). White lines are Plus-Minus refractors (overburden refractor and basement refractor).



Val de Travers RMS error 2.4%=1.20ms 31 WET itr. 50Hz Width 8.0% initial RUN7IT32.GRD v. 4.03

Fig. 3 : WET wavepath coverage plot obtained with Fig. 2. Unit is wavepaths per pixel. Note decreasing wavepath coverage to the right of horizontal offset 275m and below elevation of 850m due to velocity inversion (Fig. 2).



Fig. 4 : multiscale Conjugate-Gradient WET inversion with DeltatV starting model (Fig. 1). 8th WET run output shown. Same as Fig. 2.



Fig. 5 : Perturbed tomogram. Apply checkerboard with checker size 50m by 50m, checker anomaly 10 percent to initial tomogram (Fig. 2 / Fig. 4; Fig. 12). See <u>Garcia-Ocampo</u> thesis 2017 / their Fig. 3b.



Fig. 6 : True checker anomalies. Perturbed tomogram (Fig. 5) minus initial tomogram (Fig. 2 / Fig. 4). See <u>Garcia-Ocampo</u> thesis 2017 / their Fig. 3b.



Fig. 7 : inverted tomogram using the synthetic traveltimes forward-modelled over the perturbed tomogram (Fig. 5) with *Model*|*Model synthetic shots* with WDVS deactivated (Fig. 13). Use starting model Fig. 2 for Multirun Conjugate-Gradient WET inversion (Fig 14 / Fig. 16 / Fig. 19). Ideally should be same as the perturbed tomogram (Fig. 5).



Fig. 8 : Recovered checker anomalies. Inverted tomogram (Fig. 7) minus initial tomogram (Fig. 2). Ideally should be the same as Fig. 6 / Fig. 9. At bottom of tomogram rays and wavepaths are predominantly parallel to each other (Fig. 3.; D. J. White 1989), resulting in decreased resolution and lateral smearing of checker anomalies. Also to the right of horizontal offset 275m the wavepath coverage decreases more suddenly with depth (Fig. 3) below 850m elevation due to *velocity inversion* (Fig. 2 / Fig. 5 / Fig. 7), also resulting in decreased resolution and higher uncertainty.



Fig. 9 : True checker anomalies. Perturbed tomogram (Fig. 5) minus initial tomogram (Fig. 2). See <u>Garcia-Ocampo</u> thesis 2017 / their Fig. 3b. Same as Fig. 6.



Fig. 10 : inverted tomogram (Fig. 7) minus perturbed tomogram (Fig. 6). See<u>Garcia-Ocampo</u> thesis 2017 / their Fig. 3b. Should ideally be all-zero / no residual anomalies. Note increasing error with increasing depth below topography. At bottom of tomogram rays and wavepaths are predominantly parallel to each other (D. J. White 1989), resulting in decreased resolution and larger errors.



Fig. 11 : True checker anomalies. Perturbed tomogram (Fig. 5) minus initial tomogram (Fig. 2). See <u>Garcia-</u> Ocampo thesis 2017 / their Fig. 3b. Same as Fig. 6.

Edit checkerboard test di	alog						
Edit anomaly magnitude	and size	[percent]		ОК			
Anomaly length	50.000	[m]		Cancel			
Anomaly height	50.000	[m]		Reset			
Select input .GRD file D:\ray32\tra9002\TOMO_Sep4_2022\WETRUN8\VELOIT32.GF							
Select output .GRD file	D:\RAY32\TF	RA9002\TOMO_	OCT4_CHECKER	R\10PERCENT_!			

Fig. 12 : *Model*|*Create Checkerboard grid*. Available with our Pro version only.

Edit WDVS (Zelt & Chen 2016)

Edit parameters for wavelength-dependent velocity smoothing						
 ✓ use WDVS for forward modeling of traveltimes ✓ fast WDVS : less accurate mapping of scan line nodes to grid nodes ✓ add nodes once only with overlapping scan lines for velocity averaging add all velocity nodes within WDVS area with radius of one wavelength ✓ pad WDVS area border with one grid cell 						
 ☐ fast WDVS : less accurate mapping of scan line nodes to grid nodes ✓ add nodes once only with overlapping scan lines for velocity averaging ☐ add all velocity nodes within WDVS area with radius of one wavelength ☐ pad WDVS area border with one grid cell 						
 add nodes once only with overlapping scan lines for velocity averaging add all velocity nodes within WDVS area with radius of one wavelength pad WDVS area border with one grid cell 						
☐ add all velocity nodes within WDVS area with radius of one wavelength ☐ pad WDVS area border with one grid cell						
🔽 pad WDVS area border with one grid cell						
WDVS frequency 250.00 [Hz]						
Angle increment between scan lines 7 [Degree]						
Regard nth node along scan line [node]						
Parameters for Cosine-Souared weighting function (Chen and Zelt 2012)						
a : Cosine argument power [1.000 [power]						
b : Cosine-Squared power 1.000 [power]						
Modify WET smoothing mode : discard after forward modeling						
C discard WET smoothing and WDVS smoothing after modeling						
restore WET smoothing and discard WDVS smoothing only						
OK Cancel Reset						
OK Cancel Reset						

Fig. 13 : *Model*|*WDVS Smoothing*. Check box use *WDVS* for forward modeling of traveltimes for Fig. 2. (initial tomogram). Set *WDVS* frequency to 250Hz.

Uncheck this box use WDVS for forward modeling of traveltimes before forwardmodeling synthetic traveltimes over perturbed tomogram (Fig. 5) with Model|Model synthetic shots. Also uncheck this box before next obtaining the inverted tomogram (Fig. 7) based on these synthetic traveltimes using starting model Fig. 2.

Specify initial velocity model			Determination of smoothing filter dimensions
Select D:	\ray32\tra9002	TOMO\DELTATV.GRD	C Full smoothing after each tomography iteration
Stop WET inversion after			Minimal smoothing after each tomography iteration
Number of WET tomography iterations :	32	iterations	Manual specification of smoothing filter, see below
or RMS error gets below	20	percent	Smoothing filter dimensions
	2.0	percent	Half smoothing filter width : 3 columns
or RMS error does not improve for n =	20	iterations	Half smoothing filter height : 0 grid row:
or WET inversion runs longer than	100	minutes	, ·
WET regularization settings			Suppress artefacts below steep topography
Wavepath frequency :	50.00	Hz Iterate	Adapt shape of filter. Uncheck for better resolution.
Ricker differentiation [-1:Gaussian,-2:Cosine] :	-1	times	Maximum relative velocity update after each iteration
Wavepath width [percent of one period]:	8.0	percent Iterate	Maximum velocity update : 15.00 percent
Wavepath envelope width [% of period]:	0.0	percent	Smooth after each nth iteration only
Min. velocity : 10 Max. velocity :	5200	m/sec.	Smooth nth iteration : n = 1 iterations
Width of Gaussian for one period [SD] :	3.0	sigma	Smoothing filter weighting
Cradiant access wether			🖲 Gaussian 🔿 Uniform 🥅 No smoothin
C Steepest Descent	Coniugate (Gradient	Used width of Gaussian 5.0 [SD]
Continents Condinent Descente at	, 0		Uniform central row weight 1.0 [1100]
CG iterations 10 Line Sea	arch iters.	2	Smooth velocity update before updating tomogram
Tolerance 0.001 Line Sea	arch tol.	0.0010	Smooth update Smooth nth V Smooth last
Initial step 0.10	Steepest D	escent step	Damping of tomogram with previous iteration tomogram
Edit velocity smoothing	dit grid file gen	eration	Damping [01] 0.200 Damp before smooth

Fig. 14 : WET Tomo|Interactive WET Tomography main dialog (left). Edit velocity smoothing (right).

	Output Measured CMP Velocities		Blank
\checkmark	Output Horizontal offset of CMP pos. in meters		Write
	Output DeltatV results in Feet		<u>m</u> ine
	Allow regression over two CMP traces	✓	Update imaged grid depth
\checkmark	CMP is zero time trace	✓	Scale wavepath width
\checkmark	Reduced offset 0.0 is valid trace with time 0.0	✓	Scale WET filter height
	Enforce Monotonically increasing layer bottom velocity	✓	Disable wavepath scaling for short profile
	Suppress velocity artefacts		Limit WET velocity to maximum velocity in initial model
\checkmark	Process every CMP offset		Limit WET velocity to 6,000 m/s
\checkmark	Prefer Average over minimum interface velocity		Edit maximum valid WET velocity
\checkmark	Taper velocity steps at layer interfaces		
	Smooth CMP traveltime curves		Safe line search with bracketing and Brent
\checkmark	Weigh picks in CMP curves	✓	Hybrid Conjugate Gradient update formula
	Extrapolate output to all receivers		Alternate coverage update during Conjugate Gradient inversion
	Regard mapping for shot offset correction		Use full Steepest Descent step for Conjugate Gradient
	Regard true receiver coordinates for shot offset correction		Disable traveltime grid caching
	Regard 3D source-receiver offset for all traces		Force RAM allocation
\checkmark	Extrapolate tomogram over 30 station spacings		Enable AWE physical memory page caching
	Extra-large cell size		Cache AWE receiver grids in local memory
	Increase cell size		Large local cache for AWE receiver grids
	Decrease cell size		Unmap AWE allocation during WET
	Extra-small cell size		Enable multi-core heap
\checkmark	Edit cell size		Percet WET tomography settings to default
	Limit DeltatV velocity exported to maximum 1D-gradient velocity	1 -	Reset wer tomography settings to default
	Limit DeltatV velocity exported to 5 000 m/s		
		Fig. 1	16 : WET Tomo WET tomography Settings
	Write new DeitatV settings to .PAR file		
	Reset DeltatV settings to default		
	Reset DeltatV and WET and WDVS settings to .PAR file		

Fig.	15 :	DeltatV D	eltatV	Settings
------	------	-----------	--------	----------

XTV Parameters dialog	Common-offset curves dip estimation (Gebrande 1985, 1986)			
Enable Modified Dix layer inversion Intercept time layer inversion Intercept time layer inversion Image: State of the layer inversion Minimum velocity ratio : 1.15 ratio Minimum velocity increase : 1.00	Estimation of dip of common-offset sorted traveltime curves Image: Estimation of dip of common-offset curves to improve DeltatV velocities Station interval for linear regression 7 Image: Estimation of the state of the			
Multiple adjacent Intercept time layer inversion Image: Allow adjacent Intercept layer inversion Overlying layer velocity step : 0 percent Current layer velocity step : 25 Image: Prefer measured layer top velocity over inverted	Determination of true refractor velocity from apparent CMP velocity Average higher with lower estimate for true refractor velocity Lowest true velocity in percent of apparent 20 [Percent] Reject true refractor velocity lower than overburden velocity			
Keep XTV for Auto DeltatV or force to Gradient model Image: Use above XTV settings for Automatic DeltatV Gradient model Layer model Accept Cancel	OK Cancel Reset Fig. 18 : DeltatV Common-offset dip estimation dialog. Available with Pro version only.			

Fig. 17 : DeltatV|XTV parameters dialog

Edit WET ru	ıns - wavep	ath width					
Run No.	Freq. [Hz]	Width [%]	Width [ms]	Iterations		ОК	
Run 1 Run 2	50.0	26.0	5.200	20	Blank	Cancel	
Run 3	50.0	22.0	4.400	20	Blank	Reset	
Run 4	50.0	18.0	3.600	20	Blank	✓ WET runs active	
Run 5	50.0	15.0	3.000	20	Blank	🔲 Scale default widths	
Run 6	50.0	12.0	2.400	20	Blank	Plot runs in Surfer	
Run 7	50.0	10.0	2.000	20	Blank	Prompt run misfit	
Run 8	50.0	8.0	1.600	20	Blank	All runs completed	
Run 9	50.0	7.0	1.400	0	Blank	Current run no.	
Run 10	50.0	6.0	1.200	0	Blank	Resume current run	
Blank below wavepath envelope							

Fig. 19 : WET Tomo|Interactive WET|Iterate. Edit WET runs.

irid Math			? X
Input Grid	Variable	Blank	Add Grids
C:\RAY32\TRA9002\TOMO_Oct4_Checker\10PERCENT_50BY50.GRD	Α	Blank	
C:\RAY32\TRA9002\TOMO_Oct4_Checker\WETRun8_It32.GRD	В	Blank	Remove Grid
III III		Þ	Grid Info
Enter a function of the form f(A, B,) where A, B, are the variables in the lis $\frac{A - B}{A - B}$	st above.	•	
Output Grid File:			ОК

Fig. 20 : Use Surfer Grid Math to subtract grids from each other.

We used Surfer Grid Math to subtract two grids from each other e.g. subtract the initial tomogram WETRUN8 1t32.GRD from the perturbed tomogram 10PERCENT 50BY50.GRD (Fig. 20 / Fig 12).

Here is the .rar archive with <u>DeltatV+XTV and multiscale WET inversion files for Fig. 1 and Fig. 2</u>. Here is the .rar archive with <u>seis32.* profile database files for Fig. 2</u>. Here is the .rar archive with <u>checkerboard grids and multiscale WET inversion files for Fig. 7</u>. Here is the .rar archive with <u>seis32.* profile database files for Fig. 7</u>.

We thank our Swiss client GeoExpert AG for making available above refraction data.

Copyright © 1996-2022 Intelligent Resources Inc. All rights reserved.