Release notes Rayfract® versions 3.35 to 4.03 :

Version 4.03 released in Nov 2022 :

- Dec 10, 2022 : Puzzilli et al. describe Integrated geophysical methods for the seismic site characterization of Arquata del Tronto (AP) (Associazione Geotecnica Italiana 2019).
- Dec 9, 2022 : more robust **.HDR** batch import. We now handle an empty last line in the **.HDR** file.
- Dec 8, 2022 : for a long profile with close shot spacing uncheck option *Grid|Edit shot labeling parameters|Label shots on Surfer plot* so all shot points are marked with red triangle on Surfer plot.
- Dec 7, 2022 : refresh *Shot breaks* display when during trace-to-refractor mapping with **ALT+L** an error prompt is shown with text "Refractor not defined forward/backward 0".
- Dec 6, 2022 : Drupka et al. describe Application of Near-Surface Geophysical methods for imaging of Active Faults in the Himalaya (Geosciences and Mining Journal 2022, Department of Geology and Mines Bhutan).
- Dec 4, 2022 : added option ***Mapping|Don't fix velocity inversion***. Check this option before mapping traces to refractors in *Refractor|Shot breaks* with **ALT+L** so we don't automatically fix refractor 2 velocity inversions after prompting the user for these inversions.
- Dec 2, 2022 : automatically delete branch point 2 for velocity inversions on shot-sorted traveltime curves if refractor 2 coverage is just over 2 or 3 channels, when mapping traces to refractors in *Refractor|Shot breaks* with **ALT+L**. For higher coverage of refractor 2 move up branch point 2 to coincide with branch point 1 to fix the velocity inversion.
- Dec 1, 2022 : consistently handle velocity inversions during *Plus-Minus* and *Wavefront* method interpretation when using *Midpoint breaks* refractor mapping, independent of user option *Update branch points with Plus-Minus* in *Refractor|Midpoint breaks* **ALT+M** refractor mapping dialog.
- Nov 30, 2022 : retested WibuKey runtime/driver version 6.60 and version 6.51 in Window 11 22H2 64-bit Pro. Both work just fine. Version 6.51 driver also still works in Window 7 64-bit Pro.
- Nov 29, 2022 : don't automatically fix refractor velocity inversions during *Plus-Minus* and *Wavefront* method interpretation using *Shot breaks* refractor mapping.
- Nov 29, 2022 : automatically fix velocity inversions when updating *Shot breaks* branch points using *Midpoint breaks* **ALT+M** refractor mapping if refractors are covered sufficiently only.
- Nov 26, 2022 : improved updating of branch points in *Shot breaks* with pinching out weathering layer during *Depth|Plus-Minus* using *Midpoint breaks* mapping with shot station at same receiver station as for first/last spread channel mapped to weathering layer for forward/reverse shot direction.
- Nov 24, 2022 : improved branch point updating during Plus-Minus using *Midpoint breaks* **ALT+M** mapping for on-end shots with shot station at receiver station for first/last spread channel recorded.
- Nov 22, 2022 : improved error prompt when validating branch points in *Refractor|Shot breaks* during mapping with **ALT+L**. Prompt to delete branch points for current shot with **SHIFT+Z**.
- Nov 19, 2022 : enable option ***Update branch points with Plus-Minus*** in *Refractor|Midpoint breaks* **ALT+M** mapping dialog for Standard version 4.03 of our software.
- Nov 18, 2022 : improved error prompt when DeltatV terminates early because the weathering velocity can't be determined. Prompt to increase value of *Basement crossover* parameter in *DeltatV Static Corrections* dialog.
- Nov 16, 2022 : let user force extrapolation of tomograms and starting models in *Header|Profile* with check box *Extrapolate tomograms* and edit field *Extrapolate [Station spacings]*. Shot points inside the extrapolated starting model/tomogram are regarded for *WET inversion*. Test this with our updated free trial.
- Nov 10, 2022 : improved updating of branch points in *Shot breaks* with pinching out weathering layer / with outcropping refractors below topography during *Depth|Plus-Minus* using *Midpoint breaks* mapping with our Pro version.
- Nov 5, 2022 : allow negative *Min. velocity* in *Grid|Surfer plot Limits dialog.*

- Nov 5, 2022 : improved error prompt if *WET inversion* terminates early due to too low wavepath coverage in subsurface with strong velocity inversion etc. Prompt to repick first breaks and to repick branch points or to remap traces in *Midpoint breaks* for layered refraction starting model.
- Nov 4, 2022 : regard parameter ***Max. basement velocity*** specified by user with **ALT+M** in *Depth|Wavefront* depth section with option *Depth|Depth conversion Settings|Prefer Geometric basement velocity for Wavefront* unchecked.
- Nov 2, 2022 : if you have a **COORDS.COR** file with x/y/z coordinates for a x.5 station number at which you did not yet import a shot into your profile database :
  - select *File|Import Data* and reimport one shot for an adjacent shot station number
  - edit ***Shot Number*** to shot number not yet used for the profile in ***Import Shot*** dialog
  - edit ***Shot pos. [station no.]*** to x.5 in ***Import Shot*** dialog. Click ***Read*** button.
  - click ***Skip*** button in ***Import Shot*** dialog for all other shots
  - select *File|Update header data|Update Station Coordinates* and select your **COORDS.COR** file to update station coordinates in the profile database at all stations listed in the **.COR** file and interpolate between/extrapolate beyond stations listed in the **.COR** file.
  - don't pick first breaks for above copied shot so this dummy shot is disregarded during inversion of first breaks

- Oct 31, 2022 : automatically fix velocity inversions between refractor 1 and refractor 2 for 3-layer case when mapping first breaks to refractors in *Refractor|Shot breaks*.
- Oct 31, 2022 : improved updating of branch points in *Shot breaks* for 3-layer case with pinching out overburden refractor during Plus-Minus using *Midpoint breaks* mapping with our Pro version.
- Oct 30, 2022 : tested our latest version 4.03 with Golden Software Surfer 11 & WibuKey Runtime 6.60 under Windows 11 22H2 64-bit Pro. No issues found.
- Oct 28, 2022 : improved error prompts with invalid branch points when mapping traces to refractors in *Refractor|Shot breaks*. Show shot number in title and text of prompts.
- Oct 28, 2022 : Bonasera et al. describe A multidisciplinary approach to detect the seismogenic source of the Tortona 1828 earthquake (Piedmont, Northwest Italy) (Italian Journal of Geosciences, 2022).
- Oct 24, 2022 : automatically correct shot station outside receiver spread to the nearest active receiver station used to record the shot, during import into *Line type* Borehole spread/line. Ask user to confirm correction of the shot station during import of the shot.
- Oct 14, 2022 : Bernal et al. describe Geophysical Analysis of Soils and its Contribution to Disaster Risk Reduction for Millhuish area and for Challhuayaco area, San Marcos District, Huari Province in Peru (Instituto Geofisico del Peru 2022, in Spanish).
- Oct 12, 2022 : added more figures and updated figure captions in new checkerboard test tutorial .
- Oct 9, 2022 : updated Surfer plot titles and figure captions in our new checkerboard test tutorial. Added more figures showing DeltatV, XTV and WET dialogs and settings menus.
- Oct 9, 2022 : added links to DropBox .RAR archives in our new checkerboard test tutorial.
- Oct 5, 2022 : review our new tutorial showing ***checkerboard resolution test*** for our sample profile TRA9002 using multiscale Conjugate-Gradient WET inversion with WDVS@250Hz (Wavelength-Dependent Velocity Smoothing, Zelt and Chen 2016).
- Sep 30, 2022 : renamed parameter ***Weathering crossover*** in *DeltatV|Interactive DeltatV|Static Corrections* dialog to ***Basement crossover*** to discourage user from decreasing this parameter too much below default value of 10 stations. Updated status bar prompts and error messages.
- Sep 29, 2022 : Handoyo et al. show Characterization of the shallow subsurface structure across the Carrascoy Fault System (SE Iberian Peninsula) using P-wave tomography and Multichannel Analysis of Surface Waves (Geologica Acta, Sep 2022). See also Handoyo et al. Geophysical Imaging of the Critical Zone along the Eastern Betic Shear Zone (EBSZ), SE Iberian Peninsula (Applied Sciences, March 2022).
- Sep 28, 2022 : improved error prompt "Degenerated starting model grid !" when long refraction line starting model grid has too few rows. Show column and row counts in prompt.
- Sep 26, 2022 : regard Golden Software Surfer limit of max. 32,767 grid columns and max. 32,767 grid rows when generating **.GRD** grid file for initial/starting model for Pro license and with long lines e.g. with marine refraction lines.

- Sep 26, 2022 : improved prompt “Needed to increase forced grid cell size” now showing adjusted grid column and row counts. Force the grid cell size in *Header|Profile*. See 3016 tutorial Fig. 2.
- Sep 26, 2022 : Hogan and Margrave describe frequency-dependent Gaussian velocity smoothing (Crewes Research Report, Vol. 19/2007). This relates to our *WDVS smoothing* (Wavelength-Dependent Velocity Smoothing, Zelt and Chen 2016) using a Cosine-Squared smoothing function.
- Sep 17, 2022 : we added a slide to our 2018 Sinalunga work shop PowerPoint file showing Multiscale Conjugate-Gradient WET inversion of TRA9002 profile using DeltatV starting model & WDVS@250Hz. Here is the .pdf version.
- Sep 17, 20022 : added more figures to NGU_G1 tutorial. In Fig. 36 we show multiscale WET inversion using our earlier optimized DeltaV+layered XTV starting model (Fig. 25). We enable WDVS (Wavelength-Dependent Velocity Smoothing; Zelt and Chen 2016) for sharper imaging of known fault zones in the basement.
- Sep 16, 2022 : select new option ***File|Update data Settings|Don't apply shot delay and trigger delay to imported traces with 'Update Shotpoint coordinates' command*** when updating traces imported from ASCII.ASC with .SHO file listing shot delay and trigger delay for SEG-2 or SEGY traces for same profile. When exporting to ASCII.ASC the shot delay and trigger delay is already included in the exported first break traveltimes.
- Sep 12, 2022 : always regard *Min. elevation* specified in *Grid|Surfer plot Limits* during multirun WET inversion.
- Sep 9, 2022 : our SEG-2 import now supports 64-bit floating point sample format. Tested with ABEM Terraloc Pro 2 .SG2 files. All sample formats are converted to 32-bit floating point format when storing imported traces in the profile database.
- Sep 9, 2022 : improved display of wait cursor with new *WET progress dialog*.
- Sep 9, 2022 : show cancelled WET inversion during *WDVS smoothing* in status bar.
- Sep 7, 2022 : keep *WET progress dialog* with *Cancel* button alive during *WDVS smoothing*.
- Sep 7, 2022 : tested latest 4.03 and 4.03 Pro in Windows 10 Pro 32-bit 21H2 under Parallels with Surfer 11 free demo.
- Sep 4, 2022 : tested latest Golden Software Surfer Beta version 24 in Windows 7 64-bit & Windows 10 64-bit Pro with our latest version 4.03.
- Sep 4, 2022 : Trebsche et al. describe Combining geophysical prospection and core drilling: Reconstruction of a Late Bronze Age copper mine at Prigglitz-Gasteil in the Eastern Alps (Austria) (Archeological Prospection, Aug 2022).
- Sep 4, 2022 : Censini et al. describe Seismic tomography: A Vital Tool in the Preliminary Investigation Stage of any Hydropower Plant. Examples of Two Large Projects in Ethiopia: the Gibe III and the Grand Ethiopian Renaissance Dam Projects (Georisorse Italia Sas, 2013).
- Aug 27, 2022 : Justin Anning describes Comparing Sub Bottom Profiling and Seismic Refraction Tomography Results and Interpretations for Coastal Marine Geotechnical Projects (EEGS FastTIMES, Aug 2022).
- Aug 19, 2022 : recheck for heap leaks in Compuware HeapAgent for Win32 version 10.01 in Microsoft Visual Studio 2005 debug build. No new leaks or memory array boundary overwrites found.
- Aug 18, 2022 : terminate multirun WET inversion early if user clicks *Cancel* button in new *WET progress dialog*.
- Aug 13, 2022 : tested our latest Pro version 4.03 in Windows 10 21H2 running under VMWare Fusion 12.1.0 on Apple Intel 2018 macMini with WET option ***Enable AWE physical memory page caching*** checked. Run as Admin as shown in our AWE configuration .pdf.
- Aug 12, 2022 : show progress of WET inversion in ***new WET dialog with progress bar***. Allow early termination of WET with *Cancel* button. The last WET iteration completed is plotted in Surfer.
- Aug 12, 2022 : we now refresh *Refractor|Shot breaks display* when semi-automatic/polyline picking shot gather trace segments with option ***Processing|Refresh shot breaks when picking traces*** checked.
- Aug 11, 2022 : tested our latest version 4.03 in Windows 10 21H2 running under VMWare Fusion 12.1.0 on Apple Intel 2018 macMini.

- Aug 9, 2022 : faster invocation of Golden Software Scripter for plotting of tomograms and wavepath coverage plots. Helps with multirun WET inversion under Windows 10/11 64-bit.
- Aug 9, 2022 : we now refresh the opened *Refractor|Shot breaks display* after automatic picking with **ALT+B** in *Trace|Shot gather* with option ***Processing|Refresh shot breaks when picking traces*** checked.
- Aug 9, 2022 : our new dialog ***Grid|Edit shot labeling parameters*** allows forcing of the vertical offset between shot labels for shots positioned at same offset.
- Aug 6, 2022 : review an updated description of Microsoft Address Windowing Extensions supported with our Pro version. This allows accessing all installed RAM memory on your PC above 4GB limit. See our instructions on how to enable AWE for our Pro version software.
- July 31, 2022 : updated paragraph *Conclusions* in Aaknes-1 tutorial on last page.
- July 30, 2022 : view our updated help chapter on DeltatV inversion describing renamed control *Basement crossover* in *DeltatV|Interactive DeltatV|Static Corrections* dialog.
- July 29, 2022 : further updated help chapter on *Pseudo-2D DeltatV / Static corrections* dialog.
- July 29, 2022 : review Flinchum on What Do P-Wave Velocities Tell Us About the Critical Zone ? (Frontiers in Water, Jan 2022).
- July 28, 2022 : Shams describes The use of Surface Wave methods in terrain susceptible to shallow land slides in the city of Campos do Jordao, Brazil (thesis Univ. Sao Paulo, 2016).
- July 28, 2022 : Camacho describes Caracterización geofísica del sistema de fallas Alhama Murcia (FAM). Transepto la Torrecilla. Lorca, España (thesis Univ. de Granada, 2016).
- July 28, 2022 : improved WET error handling in connection with new WET progress dialog.
- July 23, 2022 : renamed DeltatV parameter *DeltatV|Interactive DeltatV|Static Corrections|Weathering crossover* to ***Basement crossover***. This emphasizes that this parameter must not be decreased (from default 10 stations) to avoid over-correction of basement-refracted arrivals to floating datum using too low *overburden velocity* obtained from this crossover value especially with strongly undulating topography and with too wide *Topography filter* parameter. See our NGU_G1 tutorial Fig. 30.
- July 23, 2022 : retest 4.03 in updated Windows 11 21H2. As fast as in Windows 7 64-bit Pro now.
- July 23, 2022 : redo profile-guided optimization for latest version 4.03 builds in Visual Studio 2022 Pro. Make sure new progress dialog display does not slow down WET inversion.
- July 22, 2022 : rebuilt our latest version 4.03 in Microsoft Visual Studio 2022 Pro version 17.2.6. Tested in Windows 10 21H1 and Windows 7 64-bit Pro.
- July 21, 2022 : review our updated .pdf help chapter *Picking first breaks*. We describe how to pick shear-waves on the last two pages, using our *Trace|Shotpoint gather* display.
- July 20, 2022 : write new *DeltatV settings* to **.PAR** file and restore from **.PAR** file.
- July 19, 2022 : added step-by-step instructions to NGU_G1 and Aaknes-1 tutorials on how to obtain NGU pessimized DeltatV interpretations using bad **DELTATV.PAR** files made available by NGU on July 4th, 2022. Compare against NGU_G1 DeltatV with default static corrections & layered XTV inversion and compare with default Aaknes-1 DeltatV.
- July 16, 2022 : updated figure captions and text on last page in Aaknes-1 tutorial.
- July 15, 2022 : view our latest help chapter on XTV inversion and parameters. We used the free CutePDF writer driver in Windows help viewer with *File|Print Topic* command to generate the .pdf .
- July 14, 2022 : view our latest help chapter on DeltatV inversion.
- July 14, 2022 : our updated free trial allows using *DeltatV|XTV parameters* dialog settings with *DeltatV|Automatic DeltatV* and comes with latest help file.
- July 14, 2022 : added *DeltatV|DeltatV Export options* dialog to edit export options without having to go through *DeltatV|Interactive DeltatV* main dialog. Use with *DeltatV|Automatic DeltatV*.
- July 14, 2022 : review .png showing latest help on *DeltatV|DeltatV Settings* menu items
- July 13, 2022 : review .jpg showing latest help on *DeltatV|Interactive DeltatV* main dialog
- July 13, 2022 : review latest help on *DeltatV|Interactive DeltatV|Static corrections* dialog
- July 13, 2022 : review latest help on *DeltatV|Interactive DeltatV|Export options* dialog
- July 11, 2022 : further updated help chapter on *Pseudo-2D DeltatV / Static corrections* dialog.

- July 10, 2022 : show *DeltatV inversion* with pessimized NGU DeltatV settings & parameters (Fig. 28) vs. our *Automatic DeltatV* (Fig. 29) in Aaknes-1 tutorial. Compare DeltatV **.PAR** files in Fig. 31.
- July 7, 2022 : further updated help chapter on *Pseudo-2D DeltatV / Static corrections* dialog. The *DeltatV weathering velocity* needs to represent the whole weathered overburden and not just the topmost "weathering layer" used in layered refraction interpretation with *Plus-Minus* method. So the DeltatV weathering velocity typically needs to be much higher than the layered refraction "weathering velocity". Otherwise *DeltatV static correction* will over-correct first breaks to floating datum especially with strongly undulating topography and strong topography curvature and with too wide *Topography filter* used for *Surface consistent* static corrections. The weathering/overburden velocity is estimated based on parameter *Weathering crossover*.
- July 6, 2022 : regard new *DeltatV|XTV parameters|Use above XTV settings for Automatic DeltatV* with *DeltatV|DeltatV Settings|Limit DeltatV velocity exported to maximum 1D-gradient velocity* checked.
- July 5, 2022 : added more figures to our latest tutorial NGU_G1 showing interactive DeltatV with pessimized DeltatV settings used by NGU for their 2020_044 report. Compare DeltatV settings.
- July 3, 2022 : updated help chapters *XTV inversion*, *Mapping traces to refractors* and *Pseudo-2D DeltatV / Static corrections* dialog options. Download & run our updated winhelp.exe installer.
- July 1, 2022 : added checkbox ***Use above XTV settings for Automatic DeltatV*** in *DeltatV|XTV parameters* dialog. Leave unchecked to force *Gradient model* XTV settings for *Automatic DeltatV*. See Fig. 27 in updated tutorial NGU_G1 .
- June 30, 2022 : added more figures to our latest tutorial NGU_G1 showing interactive DeltatV with layered XTV settings. Describe step-by-step how to obtain these figures.
- June 29, 2022 : you may want to configure your Parallels VM with ***Optimization, Resource usage*** set to ***Low*** to prevent spurious/bogus error prompts "Refractor not defined forward 0" e.g. with SAGEEP11 profile when mapping traces to refractors with ALT+L in *Refractor|Shot breaks*. These prompts can occur when running on 2011 MacBook Air with RAM memory issues or SSD issues and dead battery.
- June 28, 2022 : Garcia-Ocampo shows Resolution study of tomographic P-wave velocity models and geological interpretation at the Empordà basin (Thesis Univ. Barcelona 2017).
- June 28, 2022 : Marie Tungka shows Determining subsurface geology with seismic refraction tomography survey (2022 IOP Conf. Ser.: Earth Environ. Sci. 1003 012037).
- June 28, 2022 : added more figures to our latest tutorial NGU_G1 showing multiscale WET settings.
- June 27, 2022 : improved *File|Update header data|Update refractor branches from .BRN*
- June 27, 2022 : faster *Mapping|Delete branch points for all shots* in *Refractor|Shot breaks* display
- June 27, 2022 : our updated free trial allows export to .BRN and update with .BRN branch point files.
- June 26, 2022 : added more figures to our latest tutorial NGU_G1 with *Smooth inversion* output shown in Fig. 16 with RMS error 0.9%/0.55ms.
- June 25, 2022 : optimize DeltatV inversion in Fig. 4 in our short tutorial.
- June 23, 2022 : don't reset *DeltatV|Interactive DeltatV|Export Options|Max. velocity exported* to 5,000 m/s with option *DeltatV|DeltatV settings|Limit DeltatV velocity exported to maximum 1D-gradient velocity* checked.
- June 23, 2022 : don't enable *DeltatV|DeltatV settings|Limit DeltatV velocity exported to maximum 1D-gradient velocity* for short profiles when resetting *DeltatV settings* to defaults. Disable per default.
- June 22, 2022 : optimize DeltatV interpretation shown in latest tutorial NGU_G1. Add links to archives on DropBox.
- June 21, 2022 : we have added more figures to our latest tutorial NGU_G1 and now show layered refraction interpretation with *Plus-Minus* method in Fig. 10 with RMS error 2.8%/1.7ms.
- June 20, 2022 : added *OK/Cancel/Reset* buttons to ALT+M *model parameters* dialog in depth sections shown with *Depth|Plus-Minus* etc.

- June 20, 2022 : added controls ***limit maximum basement velocity*** and ***Max. basement velocity [m/sec]*** in *Depth|Plus-Minus* and *Depth|Wavefront* sections. Press ALT+M to bring up the *model parameters* dialog.
- June 17, 2022 : use *File|Export header data|Export refractor branches to .BRN* to export branch points for all shots to ASCII .BRN file.
- June 17, 2022 : use *File|Update header data|Update refractor branches from .BRN* to import branch points for all shots from ASCII .BRN file.
- June 16, 2022 : our latest tutorial shows import of NGU model G1 data and update of header data plus pseudo-2D DeltatV inversion.
- June 15, 2022 : new checkbox ***Update branch points with Plus-Minus (Pro only)*** in *Refractor|Midpoint breaks* mapping dialog displayed with ALT+M. With this option checked our Pro version will update branch points in *Refractor|Shot breaks* display once you click button *Map Traces* and next select *Depth|Plus-Minus* or *Depth|Wavefront* layered refraction method.
- June 15, 2022 : added new command ***Mapping|Delete branch points for all shots*** in *Refractor|Shot breaks* display.
- June 14, 2022 : updated text in new short tutorial and included fixed coordinate file G1.SHOTS.COR in archive input_ngu_g1.zip . Use fixed G1.SHOTS.COR instead of bad G1.COORDS.COR with version 4.02 of our software, with *File|Update header data|Update Station Coordinates*.
- June 13, 2022 : reset *Mapping|Gray picked traveltime curves* when user remaps traces to refractors in *Refractor|Midpoint breaks* display with ALT+M.
- June 12, 2022 : fixed .RAR archives referenced from our short tutorial.
- June 10, 2022 : view our short tutorial showing *Automatic DeltatV* inversion with default DeltatV settings of synthetic traveltimes for NGU report 2020_044 Fig. 11 model G1 (leftmost column).
- June 9, 2022 : add new option ***Extrapolate tomogram over 30 stations*** to *DeltatV|DeltatV settings* menu and to *Depth|Depth conversion Settings* menu.
- June 7, 2022 : check new option ***Smooth invert|Smooth inversion Settings|Extrapolate tomogram over 30 stations*** before running *Smooth invert|WET with 1D-gradient initial model* so WET inversion will regard off-end shots with shot points up to 30 station spacings away from first/last profile receiver.
- June 7, 2022 : ask user to confirm warning prompt about velocity artefacts below off-end shot points due to missing receivers when user checks above new option.
- June 4, 2022 : update profile's off-end topography after *File|Update header data|Update Shotpoint coordinates* with *File|Import Data Settings|Extrapolate receiver line coordinates* unchecked.
- June 4, 2022 : for version 4.02 builds export shotpoint-updated station coordinates with *File|Export header data|Export Station Coordinates*. Now *File|Update header data|Update Station Coordinates* with just exported **COORDS.COR** & *File|Update header data|Update Shotpoint coordinates* with previous **SHOTPTS.SHO**.
- June 2, 2022 : we have rebuilt our raywn402.exe base installer with latest help file. This now also installs **SEG2_Update.EXE** into your **C:\RAY32\BIN** folder. See instructions for version 4.01 base installer. After running the base installer next run our custom **rayup402.exe** or **rayup403.exe** installer coded to match the license number in your dongle. See our installation email for instructions.
- June 1, 2022 : ask user to open correct profile with *File|Open Profile* if user selects **.GRD** file in different profile directory than currently opened profile directory with *Grid menu* items.

Version 4.02 released in May 2022 :

- May 30, 2022 : write debug grids & mask grids & WDVS grids to **DEBUG** subdirectory in your currently opened profile database folder instead of writing to **C:\RAY32\DAT** with option *WET Tomo|WET tomography Settings|Write|Write blanked and mask grids and WDVS debug grids* checked.

- May 30, 2022 : ask user to open correct profile with *File|Open Profile* if user selects **.GRD** in different directory than currently opened profile directory with *Grid menu* item ***Export grid file to ASCII .TXT***
- May 30, 2022 : use our *Grid menu* item ***Export grid file to ASCII .TXT*** for WET tomogram .GRD files obtained for currently opened profile database only, to ensure consistent x/y/z coordinates in the exported .TXT file. See our .pdf reference on page 197.
- May 21, 2022 : updated introduction to help chapter *Pseudo-2D DeltatV inversion* in help file.
- May 21, 2022 : test our updated free trial now with latest help file included.
- May 20, 2022 : added paragraph ***Add correct x/y/z coordinates to SEG-2 trace headers*** to help file chapter *Seismic and header data import*. Describe usage of our new SEG2_Update utility.
- May 20, 2022 : updated paragraph ***WDVS velocity smoothing*** in help file chapter *Forward model traveltimes*. Describe new WDVS option.
- May 19, 2022 : added paragraph ***Shear wave picking*** at end of chapter *Picking first breaks* in updated help file. Show how to configure trace processing and display options for easy shear wave picking.
- May 18, 2022 : updated comments on DeltatV inversion in our 3016 tutorial on page 12. As shown in Fig. 4 in our synthetic thrust fault zone tutorial, our pseudo-2D *DeltatV inversion* can image local velocity inversions, with close enough shot and receiver spacing and favorable subsurface geology.
- May 15, 2022 : updated instructions and comments in our Line14_WDVS tutorial.
- May 14, 2022 : O'Sullivan describes Engineering geological investigation of earthquake-induced ground damage and tensile characteristics of loess-colluvium soils, Eastern Hillsborough Valley, Christchurch (Univ. of Canterbury thesis, 2015) correlating SRT profile over fault zone with borehole stratigraphy.
- May 13, 2022 : Mebrahtu describes Failure mechanisms and stability analysis of deep-seated landslides in the northwestern Rift escarpment, Ethiopia (Ruhr-Universität Bochum thesis, 2020) using SRT.
- May 13, 2022 : Himi et al. describe The Use of Geophysical Data in the Evaluation of Landslide Stability, correlating SRT with ERT and lithological log data (Universitat de Barcelona 2022).
- May 13, 2022 : add Fig. 39 and Fig. 40 to 3016 tutorial showing more samples of WDVSTIME.GRD imaging in Surfer. Explain asymmetric shape of WDVS area.
- May 12, 2022 : show multiscale WET with Plus-Minus layered refraction starting model in 3016 tutorial. Show how to obtain Plus-Minus method starting model.
- May 10, 2022 : show multiscale WET in 3016 tutorial for even better resolution of overburden layering and sharper contrast between overburden and basement.
- May 9, 2022 : further expanded text in 3016 tutorial on last few pages.
- May 8, 2022 : add Fig. 29 to 3016 tutorial showing interactive WET using DeltatV starting model : same as Fig. 23 but using WET *wavepath frequency* of 30Hz instead of default 50Hz.
- May 7, 2022 : correctly handle *Cancel* button in file selection dialog shown with *File|Update header data|Update Receiver Coordinates*. Test with 3016 tutorial.
- May 7, 2022 : show DeltatV artefacts warning prompt in 3016 tutorial. Reformat figures.
- May 6, 2022 : show interactive WET inversion using DeltatV starting model in 3016 tutorial with minimal WET smoothing. Use *Ricker wavelet* for back-projection of velocity update across wavepath.
- May 5, 2022 : updated archive 3016_SEG2.zip with fixed .SEG2 files so SEG-2 import works with *File|SEG-2 import settings|Receiver coordinates specified* checked as in Fig. 17 in 3016 tutorial.
- May 5, 2022 : in our updated 3016 tutorial we recommend on last page to update SEG-2 trace header fields SOURCE_LOCATION and RECEIVER_LOCATION with true x/y/z coordinates using SEG2_EDIT utility before importing these SEG-2 files into a profile database. Edit matching _3D.TXT response files with true x/y/z coordinates and then invoke SEG2_EDIT directly or via our SEG2_Update utility via *File, SEG-2 import settings, Update SEG-2 files with coordinates*.

- May 1, 2022 : added two more figures to latest tutorial. Describe how to generate Fig. 19 Surfer plot showing image map of WDVSTIME.GRD in Golden Software Surfer version 23.
- Apr 29, 2022 : added two more figures to latest tutorial. In Fig. 19 we show Surfer plot of WDVSTIME.GRD showing delay time along scan lines from central grid node, using WET grid velocity.
- Apr 28, 2022 : added Fig. 17 to latest tutorial showing how to configure *SEG-2 import settings*. Expanded text comparing Fig. 7 with Fig. 14.
- Apr 27, 2022 : added more figures to latest tutorial and described near-surface layering from borehole drilled at station 101. Added download links for .RAR archives. Updated text and captions.
- Apr 26, 2022 : our latest tutorial shows *Smooth inversion* (discarding *WET smoothing* after forward modeling) for refraction profile recorded over strongly weathered sandstone in Australia
- Apr 25, 2022 : review our updated brochure. We now use up to 32 CPU cores with Pro version for even faster parallelized WET inversion of large data sets recorded with long lines or land/marine streamer.
- Apr 23, 2022 : Burton et al. describe Hydrogeophysical Investigations of Earthen Dams-Two California Case Studies (CSEG Recorder, Dec 2017)
- Apr 23, 2022 : Hunter et al. describe Seismic site characterization with shear wave (SH) reflection and refraction methods (Journal of Seismology 2022)
- Apr 23, 2022 : Hunter et al. describe Shear wave velocity measurement guidelines for Canadian seismic site characterization in soil and rock (Natural Resources Canada 2012)
- Apr 14, 2022 : we recommend disabling Google Chrome software reporting tool for performance and privacy reasons.
- Apr 12, 2022 : Amanti et al. describe Le attività del Servizio Geologico d'Italia (Ispra) a seguito della sequenza sismica del 2016-2017 in Italia Centrale and correlate MASW with SRT and HVSR for seismic microzonation (Geological Survey of Italy).v
- Apr 9, 2022 : more robust SEGY import. Stop scanning shots in current SEGY file once 1000 shots have been scanned.
- Apr 8, 2022 : fixed broken/outdated links to publications listed at https://rayfract.com/modeling.htm
- Apr 7, 2022 : fixed broken/outdated links to publications listed at https://rayfract.com main page
- Apr 7, 2022 : Eulilli et al. describe Integrated geophysical surveys supporting shallow subsurface faults detection and characterization : two case studies in the Central Appennines (6th International INQUA Meeting on Paleoseismology, Active Tectonics and Archaeoseismology, Italy 2015)
- Apr 6, 2022 : Watts et al. published An Assessment of Geophysical Survey Techniques for Characterising the Subsurface Around Glacier Margins, and Recommendations for Future Applications (Frontiers in Earth Science, Feb 2022)
- Apr 3, 2022 : updated comments in our new tutorial on page 7
- Apr 1, 2022 : Samad et al. describe Detection of Soil Pipes using Refraction Seismics (SAGEEP 2022 conference abstract, Denver Colorado Mar 2022)
- Mar 30, 2022 : our Pro version can now use up to 32 CPU cores and OpenMP threads for parallelized *WET inversion* instead of maximum of 16 CPU cores with previous build.
- Mar 26, 2022 : Koley et al. describe Surface and underground seismic characterization at Terziet in Limburg—the Euregio Meuse–Rhine candidate site for Einstein Telescope (Classical and Quantum Gravity, Jan 2022)
- Mar 24, 2022 : tested latest 4.02 Standard build in Windows 11 Pro 21H2 with latest Surfer 23 version Feb 1, 2022. No issues found.
- Mar 22, 2022 : show *Band-Pass* and *High-Pass* frequency filters in our new tutorial (Fig. 26 and 27)
- Mar 21, 2022 : show how to sharpen *WET wavepath coverage plot* in our new tutorial (Fig. 25) and update figure captions and instructions
- Mar 19, 2022 : show alternative interpretation in our new tutorial using *Plus-Minus layered refraction* starting model

- Mar 17, 2022 : write new *DeltatV|DeltatV settings* and new *Model|Forward modeling Settings* to .PAR file with *DeltatV|DeltatV Settings|Write new DeltatV settings to .PAR file* checked.
- Mar 17, 2022 : prompt user to confirm when enabling *DeltatV|DeltatV Settings|Write new DeltatV settings to .PAR file*. Warn that resulting .PAR files are not downward compatible with earlier builds of our software.
- Mar 15, 2022 : view our updated brochure for latest specifications and capabilities
- Mar 14, 2022 : regard option *File|Import Data Settings|Default time unit is seconds* for import of GeoTomCG .3DD files. This option is unchecked when user selects GeomTomCG format in *Import Data* dialog or when user opens existing database with GeoTomCG format selected in this dialog.
- Mar 14, 2022 : show alternative interpretation in our new tutorial using *1D-gradient starting model*
- Mar 12, 2022 : write new WDVS parameters to .PAR file & restore from .PAR file
- Mar 12, 2022 : per default activate WDVS setting *Add nodes once only with overlapping scan lines*
- Mar 11, 2022 : updated text on page https://rayfract.com/pricing.htm to make it more clear that your Standard license is a permanent license and does NOT expire when paid support period expires. See also our Standard licensing agreement.
- Mar 11, 2022 : updated/expanded text in new tutorial and updated figure captions
- Mar 10, 2022 : view our new tutorial showing multiscale WET inversion of our Line14 sample profile made available by our Spanish reseller IGT/Medios Geofísicos S.L. We show improved lateral resolution in basement using multiscale WET inversion and WDVS velocity smoothing.
- Mar 7, 2022 : Soejono et al. show Interdisciplinary geoscientific approach to radioactive waste repository site selection (Journal of Maps, Dec 2021)
- Mar 7, 2022 : Polcino correlates downhole seismic with SRT and MASW (Studio Geologico Dott.ssa Sara Polcino 2008)
- Feb 27, 2022 : Flechsig et al. show Integrated geophysical and geological methods to investigate the inner and outer structures of the Quaternary Mýtina maar (W−Bohemia, Czech Republic) in (International Journal of Earth Sciences, Jan 2015)
- Feb 27, 2022 : Lindvall and Larsson show Combined tunneling site investigations with resistivity and refraction seismic in urban underwater environments (Lund University 2016 thesis)
- Feb 27, 2022 : Cho et al. describe Crossplot Interpretation of Electrical Resistivity and Seismic Velocity Values for Mapping Weak Zones in Levees (The Journal of Engineering Geology, Dec 2021)
- Feb 27, 2022 : Arndt et al. show P- and S-Wave Hybridseismics: Non-Destructive Geotechnical Site Characterizations Using State-Of-Science Surface Geophysics (6th International Conference on Geotechnical and Geophysical Site Characterization, Budapest, Sep 2021)
- Feb 23, 2022 : for easy instructions on how to copy or move files between Windows directories see https://www.howtogeek.com/667029/how-to-copy-or-move-files-and-folders-in-windows-10/
- Feb 23, 2022 : updated our Getting started instructions with above link
- Feb 22, 2022 : with ***Grid|Plot topography on tomogram*** checked edit the polyline colour for topo :
  - go into Surfer 22/23 velocity tomogram plot and check ***View, Contents***
  - in Surfer *Contents tab* click plus symbol left of item Base(Vector)-WAVEMODL.BLN
  - click on bottom-most *Polyline* label
  - in tab *Line properties* at bottom-left change colour from white to e.g. Forest Green or Pink
- Feb 18, 2022 : view our updated Canadian trademark registration
- Feb 15, 2022 : to enable *Model|Forward model traveltimes* command you first need to run our *Smooth invert|WET with 1D-gradient initial model* command and confirm prompts to obtain WET output.
- Feb 14, 2022 : to edit lateral refractor smoothing for *Plus-Minus, Wavefront and CMP intercept-time refraction* methods click *No button* in *WET continuation prompt*. Click on depth section title bar and press ALT+M to show the model parameters dialog. See help chapter ***WET inversion with layered refraction starting model*** on page 245 of our .pdf reference.

- Feb 11, 2022 : *DeltatV|XTV Parameters dialog* settings are not regarded for *DeltatV|Automatic DeltatV and WET inversion*. Instead we use XTV settings obtained by clicking *Gradient model* button in the XTV Parameters dialog, for *Automatic DeltatV* inversion.
- Feb 11, 2022 : *DeltatV|Interactive DeltatV* inversion does regard *DeltatV|XTV Parameters* settings.
- Feb 10, 2022 : Granja-Bruña et al. correlate ERT, SRT, Refraction Microtremor (ReMi), Magnetic Resonance sounding (MRS) and Vertical Electrical Sounding (VES) with sediment cores for infill geometry and reconstruction of former glacial formations (Journal of Applied Geophysics Dec 2021)
- Feb 10, 2022 : Simms et al. correlate ERT with SRT for identification of anomalous zones which could be sand boils along dam (U.S. Army Corps of Engineers/ERDC report Sep 2021)
- Feb 10, 2022 : Di Mauro et al. correlate P-wave velocity obtained with SRT with lithological log obtained from borehole
- Feb 10, 2022 : Ospina and Andrés use SRT and MASW to model velocity and determine lithology on top of salt mine (Univ. de los Andes thesis 2020)
- Feb 10, 2022 : Sandoval uses core drilling, SRT, Scanning Electron Microscopy (SEM) techniques, petrographic tests, X-ray diffraction tests and X-ray fluorescence for qualitative and quantitative description of the micro-macro structure of slates (UPC Barcelona thesis 2021)
- Feb 10, 2022 : Benboudiaf et al. use clustering of P-wave vs. S-wave velocity to differentiate geological layers based on seismic velocity (SEG Geophysics Oct 2021)
- Feb 7, 2022 : added more instructions for configuration of CodeMeter server via WebAdmin running under Windows 10 or 11 in our WebAdmin .pdf on page 3
- Feb 5, 2022 : when specifying a .BLN *blanking file* in *WET Tomo|WET Velocity constraints dialog* you may see a low-velocity artefact/layer below the blanked region with *blanking velocity* of 1,500m/s for water overburden. Specify a *blanking percentage* of 20% in column 4 of the .BLN header line and decrease the blanking velocity in column 3 by 20% to 1,300m/s to avoid this artefact.
- Feb 5, 2022 : updated Fig. 6/7/8 and instructions in WebAdmin .pdf
- Feb 2, 2022 : updated WebAdmin .pdf with Fig. 6/7/8 showing how to configure your router and server PC for public Internet access to CodeMeter server. Add WAN IP address for your router on client PC using WebAdmin (Fig. 4).
- Feb 2, 2022 : new DeltatV setting *Regard 3D source-receiver offset for all traces*. Uncheck to regard 3D source-receiver offset for traces max. 5 station spacings from shot station only. This option is unchecked per default. Checking this option may help with lines which are bent in xy plane.
- Feb 1, 2022 : view our updated 2022 color ad
- Jan 29, 2022 : we now host the CodeMeter 7.30a runtime installer for macOS 10.13 High Sierra.
- Jan 28, 2022 : renamed *interactive DeltatV static* options to *No statics/regard shot offset for all traces* and *No statics/regard shot offset for near traces*. Per default regard shot offset for all traces for determination of weathering velocity used to correct first breaks for shotpoint offsets from line.
- Jan 27, 2022 : added Fig. 5 to CodeMeter client/server configuration guide showing how to display active Rayfract® sessions in WebAdmin Dashboard, License Monitoring, Sessions tab. Updated text.
- Jan 26, 2022 : we now show in our CodeMeter client/server configuration guide ***how to enable remote WebAdmin read access for all clients*** in WebAdmin server configuration in Fig. 3. Without enabling this server option the client/server communication will not work.
- Jan 24, 2022 : updated Configure_CodeMeter_client_and_server_via_WebAdmin.pdf explicitly lists all steps mentioned in figure captions.
- Jan 24, 2022 : here is the current download link for CmAdmin_en.pdf CodeMeter Administrator Guide
- Jan 23, 2022 : new *DeltatV* and *refractor mapping* option *Regard true receiver coordinates for shot offset correction* is listed below option *Regard mapping for shot offset correction*
- Jan 23, 2022 : improved correction of first breaks for offset of shot point (including shot depth) from receiver line and correction for offset of receivers from receiver stations

- Jan 16, 2022 : tested Surfer 23 and CodeMeter 7.40 in Windows 11 21H2 with latest 4.02
- Jan 16, 2022 : redid profile-guided optimization using latest Visual Studio 2019 in Windows 10 21H1
- Jan 15, 2022 : tested latest Golden Software Surfer 23 released Jan 3, 2022 under Windows 7 64-bit Pro and Windows 10 version 21H1.
- Jan 14, 2022 : tested latest CodeMeter version 7.40 under Windows 10 21H1
- Jan 12, 2022 : reset weight of WDVS velocity grid nodes to zero outside WDVS area / with time above one WDVS period. Helps to suppress WDVS artefacts in WET tomograms.
- Jan 12, 2022 : fixed our new WDVS option *add all velocity nodes within WDVS area with radius of one wavelength.* Correctly determine time for velocity grid nodes inside WDVS area (Zelt and Chen 2016).
- Jan 6, 2022 : added radio button *No statics with true offsets incl. shot offsets* to *DeltatV|Interactive DeltatV|Static Corrections* dialog. Source-receiver offset is determined by Cartesian distance in 3D.
- Jan 6, 2022 : renamed former radio button *No static corrections applied* to *No static corrections with offset along topo*. Source-receiver offset is determined by station number difference. For station number difference smaller than or equal to 5 station spacings we use Cartesian distance in 3D instead.
- Jan 5, 2022 : edit the Contour Level method in Surfer Object Manager (named Contents in Surfer 22) :
  - on top of Surfer version 22 window check box *Contents*
  - in *Contents* window at left top left-click on *Contours map symbol*
  - in *Levels* tab set *Level method* to **`Simple`**. This is initialized to **`Advanced`** per default.

- Dec 29, 2021 : increase maximum allowed value for WDVS parameter *Angle increment between scan lines* to 20 degrees from former 10 degrees. A larger increment results in faster WDVS smoothing.
- Dec 27, 2021 : improved accuracy of *Model|WDS smoothing* when checking new option *add all velocity nodes within WDVS area.* Regard all velocity grid nodes on interpolated boundary of WDVS area. Also improved speed of WDVS smoothing with this option checked.
- Dec 27, 2021 : write WDVSMASK.GRD and WDVSTIME.GRD for each 10th velocity grid node to C:\RAY32\DAT with option *WET Tomo|WET tomography Settings|Write|Write blanked and mask grids and WDVS debug grids* checked.
- Dec 22, 2021 : we offer two more options in our *Model|WDVS Smoothing* dialog :
  - check *add all velocity nodes within WDVS area with radius of one wavelength* to determine WDVS velocity as described by (Zelt and Chen 2016). Increase the *WDVS frequency* with this option checked to avoid WET artefacts and too high RMS errors.
  - check *pad wdvs area border with one grid cell* to avoid ragged tomogram bottom
  - these two options are not enabled for our free trial
  - enabling option *add all velocity nodes within WDVS area with radius of one wavelength* will substantially increase the WET runtime especially for small grid cell size.
  - we recommend leaving these new options unchecked for faster WET inversion
  - alternatively check our new WDVS option *add nodes once only with overlapping scan lines for velocity averaging* for a good and much faster approximation of full WDVS smoothing (Zelt and Chen 2016).

- Dec 18, 2021 : for shallow marine refraction surveys with sources located above the receiver spread we assume that shotpoint z in column no. 4 in the SHOTPT.SHO is at same level as the receiver spread, at shot station no. listed in 3rd-last column in the SHOTPTS.SHO obtained via *File|Export header data* :
  - lookup the interpolated shot station coordinates in the COORDS.COR also obtained via *File|Export header data* submenu
  - copy shot station z from COORDS.COR column no. 4 into column no. 4 in the SHOTPTS.SHO

  - set *shot depth* in SHOTPTS.SHO column no. 5 to difference between inline shot station z just copied from COORDS.COR and true source elevation above the receiver spread.
  - this will give you a *negative shot hole depth*

- Dec 18, 2021 : with negative shot hole depths check *WET Tomo|WET tomography Settings|Blank* option *Regard negative shot depth*. Also check option *Don't blank above topography* and specify a *blanking file* in *WET Tomo|WET velocity constraints* as in our SR6 tutorial.
- Dec 17, 2021 : test latest 4.02 free trial with updated *WDVS Smoothing* dialog, see bullet Dec 13, 2021.f
- Dec 16, 2021 : write line entry "Grid disk file name" with .TXT extension to .PAR file for DeltatV .TXT file.
- Dec 13, 2021 : new *Model|WDVS Smoothing* option ***add nodes once only with overlapping scan lines for velocity averaging***. This option can help to suppress WDVS artefacts and to speed up WDVS with small *Angle increment between scan lines*. With this option enabled you need to increase the *WDVS frequency* to prevent too large RMS errors.
- Dec 13, 2021 : increased default *WDVS frequency* from 200Hz to 300Hz.
- Dec 9, 2021 : our KING17 joint hole WET inversion works well with WDVS@250Hz and 100 Steepest-Descent WET iterations. *Discard WET smoothing* after forward modeling. Specify *Manual WET smoothing* with *half-width* 10 & *half-height* 1. Set *Max. velocity* to 3,200m/s. Set *Ricker differentiation* to -2 [Cosine-Squared]. Force *grid cell size* to 0.5m.
- Dec 7, 2021 : new menu item *File|SEG-2 import settings|Update SEG-2 files with coordinates* calls into our new SEG2_Update.EXE app. See below.
- Dec 5, 2021 : install our new SEG2_Update utility into your C:\RAY32 root directory. SEG2_Update.EXE lets you select a SEG-2 .DAT/.SG2/.SEG2 trace file. Next select the output directory. Now click button *Update matching SEG-2 files* to build a .BAT batch file with one line for each matching SEG-2 file (with same extension) for which a matching _3D.TXT file (same name) exists in same directory. Next we call this .BAT file to update your SEG-2 files calling into SEG2_EDIT.EXE utility. See also our tutorial SR6.pdf for details on invocation of SEG2_EDIT.EXE and sample SEG-2 and matching _3D.TXT files with 3D source and receiver coordinates.
- Dec 4, 2021 : here is an archive with the Free Pascal project files including .PAS source for above SEG2_Update. We used Lazarus development environment version 2.2.0RC2 released Oct 31/2021.
- Dec 2, 2021 : when you check option *Model|Model each receiver* for joint WET inversion with borehole profiles added in *Header|Profile* we now regard this option selected for the main/currently opened profile database for all added borehole profiles. For earlier builds you need to check this option for each of the added borehole profiles, after opening the borehole profile with *File|Open Profile*. We tested this with our KING17 joint WET inversion tutorial.
- Nov 30, 2021 : updated help file chapter *Calling Surfer* with more screen shots and improved text. Also updated paragraph ***Import GeoTomCG .3DD trace files*** in chapter *Seismic and header data import*.
- Nov 30, 2021 : how to pick a .BLN blanking file in Surfer 11 : display a WET tomogram with our *Grid menu* item *Image and contour*. Click on Map symbol in Object Manager at top-left. Now select item *Digitize* in *Map menu*. Once you have picked the closed polygon on the tomogram plot select *File menu* item *Save As* at top-left of window with polygon coordinates. Save to .BLN file e.g. digitized.bln .
- Nov 29, 2021 : updated logic for extrapolation of initial refraction method models for ***joint WET inversion*** with borehole profiles added in *Header|Profile*. Our joint WET inversion now works with ***boreholes which are outside the refraction spread*** i.e. laterally offset from first/last refraction receiver.
- Nov 23, 2021 : updated our one-page brochure and flyer showing support for latest Windows 11 and Surfer 22 versions. Advertise automatic mapping of traces to refractors for layered refraction methods.
- Nov 22, 2021 : updated comments and links in our P6 tutorial showing multiple/alternative starting models for WET inversion

- Nov 17, 2021 : retest 4.02 in Visual Studio 2005 with GDIView : no GDI resource leaks
- Nov 13, 2021 : retested 4.02 in Visual Studio 2005 with Heap Agent 10 : no memory leaks/overwrites
- Nov 12, 2021 : retested latest version 4.02 in latest Visual Studio 2019 with address sanitizer enabled
- Nov 11, 2021 : with a current 4.01 or 4.02 installation you need to clear your browser cache and download & run latest rayup402.exe or rayup402pro.exe update installer only. No need to first rerun the base installer raywn401.exe or raywn402.exe. Update help file with winhelp.exe installer.
- Nov 10, 2021 : for easy instructions on how to clear your web browser's cache see
  - https://www.pcmag.com/how-to/how-to-clear-your-cache-on-any-browser
  - Under Windows use key combination **Ctrl+Shift+Del** in your web browser to bring up dialog to clear browser cache. Under macOSX use key combination **Command+Shift+Delete** .

  We always recommend clearing your web browser's cache before downloading updated installers as described in our email. Otherwise you may end up with an outdated or even broken installer. We don't always change the version numbers included in the installer's filename when updating installers.

- Nov 10, 2021 : we have rebuilt and uploaded an improved raywn402.exe base installer. See our email for instructions on how to install our latest version 4.02 software.
- Nov 10, 2021 : be sure to first clear your web browser cache before downloading our fixed raywn402.exe base installer. Or download and run raywn401.exe base installer. Next run your custom rayup402.exe or rayup402pro.exe update installer as described in our email.
- Nov 5, 2021 : we renewed the SSL certificate for https://rayfract.com . Also we now display the SSL trust logo at bottom of web page.
- Nov 1, 2021 : we now fully support generation of layered refraction starting models for joint WET inversion with borehole line/spread. Tested with our 11REFR tutorial.
- Oct 30, 2021 : updated first page of our 11REFR tutorial and first page of 1611HOLE tutorial
- Oct 30, 2021 : improved robustness of our joint borehole inversion as shown in 11REFR tutorial
- Oct 27, 2021 : *File*|*Update header data*|*Update Receiver Coordinates* from .LST file resets receiver station coordinates to averaged coordinates of receivers linked to that station.
- Oct 26, 2021 : don't delete first break picks with *File*|*Update header data*|*Update Receiver Coordinates* from .LST file. Use *Update First Breaks* to update first breaks from .LST .
- Oct 26, 2021 : check *File*|*Export data settings*|*Export receiver coordinates* before selecting *File*|*Export header data*|*Export First Breaks to .LST* to export receiver coordinates instead of station coordinates.
- Oct 26, 2021 : don't reset reset receiver coordinates to linked/updated station coordinates with *File*|*Update header data*|*Update Station Coordinates*. Use button ***Reset Receiver Coordinates*** in *Header*|*Receiver* instead.
- Oct 24, 2021 : more robust import error handling if option ***Allow missing traces*** is unchecked and there are missing channels in input files. Tested with SAPRI12 tutorial and updated free trial.
- Oct 23, 2021 : further improved text and Table of Contents in updated .pdf reference
- Oct 23, 2021 : rebuild free trial installer with latest help file
- Oct 22, 2021 : further updated help file chapters *Introduction*, *Installation*, *WibuKey setup*, *Data processing sequence overview* etc.
- Oct 19, 2021 : we now host WibuKey 6.51 runtime installer from April 2019 on our website. Tested under Windows 7 64-bit Pro up to Windows 11 64-bit Pro.
- Oct 19, 2021 : also we host 32-bit WibuKey 5.20b runtime installer from 2007 on our website. Use with Rayfract® version 3.15 and earlier under Windows XP SP3 32-bit. We do not support these ancient versions from 2009 and earlier any longer.
- Oct 17, 2021 : tested 4.02 Standard with WibuKey runtime 6.51 and 6.60 in Windows 11 Pro 21H2

- Oct 16, 2021 : tested 4.02 Pro in Windows 11 Pro version 21H2 running in Parallels Desktop 17.1.0 VM. Tested with CodeMeter runtime version 7.30a and Surfer 11 free demo. This works just fine.
- Oct 10, 2021 : further updated help file chapters Introduction etc.
- Oct 9, 2021 : Herlambang and Riyanto use WET inversion with Plus-Minus and 1D-gradient starting model and Soil Penetration Test (SPT) for determination of depth of bedrock (IOP 2021).
- Oct 9, 2021 : Amanti et al. use MASW, SRT and HVSR for seismic microzonation (GNGTS 2017).
- Oct 9, 2021 : Awad et al. use ERT, SRT and MASW for dam safety review (GeoVirtual 2020).
- Oct 9, 2021 : Ronning et al. use multirun Conjugate-Gradient WET inversion with Plus-Minus and DeltatV starting model and compare with Geogiga DWTomo refraction inversion and borehole data (NGU Trondheim 2021).
- Oct 7, 2021 : further improved text and formatting in updated .pdf reference
- Oct 5, 2021 : updated .pdf reference re-generated from latest help file version
- Oct 5, 2021 : our 2017 .pdf reference is still available too
- Oct 2, 2021 : updated new documentation shows how to configure CodeMeter client and server
- Sep 29, 2021 : new documentation shows how to configure CodeMeter client and server in WebAdmin running on different PC's connected via WiFi. Ask us for a quote for a network license dongle.
- Sep 26, 2021 : added more screen shots of menus in updated help chapter Commands. Reformatted Bibliography paragraph at end of chapter Introduction.
- Sep 25, 2021 : restored raywn401.exe base installer with 4.01 reference database. This got updated by mistake to include 4.02 reference database in early September 2021. So running raywn401.exe and rayup401.exe update installer resulted in a bad installation with our import routine not working any longer. Running raywn401.exe and rayup402.exe update always worked fine. Now both installation sequences are working again.
- Sep 23, 2021 : updated help popup topic ***Allow missing traces*** in menu *File|Import Data Settings*.
- Sep 20, 2021 : updated help file chapter ***Pseudo-2D DeltatV inversion***. Describe all controls for dialog *DeltatV|Common offset dip estimation*.
- Sep 18, 2021 : tested 4.02 with new Golden Software Surfer version 22.1.151 Sep 7, 2021 build.
- Sep 18, 2021 : added paragraph *Import GeoTomCG .3DD trace files* in updated help chapter ***Seismic and header data import*** . Updated popup help topic ***Station spacing*** shown with F1 in *Header|Profile*.
- Sep 16, 2021 : updated help file chapter ***Seismic and header data import***
- Sep 15, 2021 : updated help file chapter ***WET tomography processing***
- Sep 14, 2021 : further updated help file chapter ***Seismic and header data import***
- Sep 14, 2021 : Nisio et al. show Preliminary study of hidden underground cavities under the Centocelle Park in the Rome urban area (Memorie della Societa Astronomica Italiana 108:353-372, Aug 2021). They nicely correlate ERT with SRT.
- Sep 14, 2021 : Benjumea et al. show Undercover karst imaging using a Fuzzy c-means data clustering approach (Costa Brava, NE Spain; Engineering Geology Volume 293, November 2021).
- Sep 13, 2021 : Ramiro Camacho uses SRT and passive ReMI for Reconstruction of Quaternary paleo-reliefs in the Olduvai Gorge (Tanzania) (Thesis at Universidad Complutense de Madrid, 2016).
- Sep 13, 2021 : review Siart C. (2018) Merging the Views: Highlights on the Fusion of Surface and Subsurface Geodata and Their Potentials for Digital Geoarchaeology. In: Siart C., Forbriger M., Bubenzer O. (eds) Digital Geoarchaeology. Natural Science in Archaeology. Springer, Cham. https://doi.org/10.1007/978-3-319-25316-9_16 .
- Sep 12, 2021 : improved help chapters ***Editing header data*** and ***Seismic and header data import***
- Sep 11, 2021 : updated description of menu ***More import Settings*** in chapter ***Commands*** in help file
- Sep 10, 2021 : updated section ***Release history*** in help file chapter ***Introduction*** with release notes for version 4.02. Rebuilt free trial installer with latest help file.

- Sep 8, 2021 : added paragraph *Export Surfer grid to ASCII* at end of chapter ***WET tomography processing*** in updated help file.
- Sep 8, 2021 : improved description of *Beydoun weighting* in help chapter ***Crosshole survey interpretation***. Added more references at end of chapter ***Introduction***.
- Sep 7, 2021 : Yang et al. describe First-arrival traveltime inversion of seismic diving waves observed on undulant surface. They apply gradient layer stripping equations described by Gibson et al. 1979 and used with our DeltatV method and estimate source and receiver specific velocity gradients to account for strongly undulating topography (GJI 2021). Shi et al. describe the same layer stripping method for 3D refraction interpretation (Journal of Earth Science 2015).
- Sep 3, 2021 : tested version 4.02 calling Surfer 21 July 2021 update/version 21.2.192 64-bit under Windows 10 64-bit Pro version 21H1.
- Aug 30, 2021 : further updated help file chapter ***Smooth inversion***.
- Aug 27, 2021 : further updated help file chapter ***Commands*** and other chapters.
- Aug 24, 2021 : further updated help file chapter ***Commands*** and chapter ***Mapping traces to refractors***.
- Aug 22, 2021 : updated ***File menu*** description in help chapter ***Commands*** in updated help file.
- Aug 19, 2021 : add shortcut descriptions for controls in chapter ***Filtering traces*** in updated help file.
- Aug 18, 2021 : add shortcut descriptions for ***DeltatV*** controls in updated help file.
- Aug 18, 2021 : improved shortcut descriptions of ***WET*** controls in updated help file.
- Aug 14, 2021 : added more short descriptions of ***WET*** controls in updated help file.
- Aug 14, 2021 : Raul et al. show multi-method geophysical investigation on a very large, slow-moving landslide (EAGE First Break, Aug 2021 issue).
- Aug 14, 2021 : updated one-page brochure and flyer .
- Aug 11, 2021 : our free trial now allows automatic first break picking and polyline guided picking.
- Aug 11, 2021 : update your current version 4.02 installation with our updated help file.
- Aug 10, 2021 : we now offer our ***trigger jitter removal*** dialog and menu items also for our Standard license and free trial, not just with our Pro license.
- Aug 10, 2021 : added button ***Backup times*** to *trigger jitter removal* dialog. Click to backup station coordinates, shot point coordinates including trigger delay and delay time and first breaks to **`COORDS.COR`**, **`SHOTPTS.SHO`** and **`BREAKS.LST`** in **`Backup`** subdirectory of currently opened profile.
- Aug 8, 2021 : prompt user to confirm activation of option ***Model|Model each receiver not receiver stations*** . Ask user to ensure correct receiver coordinates in *Header|Receiver* dialog.
- Aug 8, 2021 : added button ***Reset receiver coordinates*** in *Header|Receiver* dialog to reset coordinates for all receivers to their linked receiver stations.
- Aug 7, 2021 : added more options to ***Edit trigger jitter removal*** dialog in *Processing menu* shown with *Trace|Shot gather* opened. This dialog is available with our Pro version only.
- Aug 5, 2021 : review The Effect of Aspect and Elevation on Critical Zone Architecture in the Reynolds Creek Critical Zone Observatory: A Seismic Refraction Study (Travis Nielson et al. Front. Water, 19 July 2021)
- Aug 2, 2021 : tested version 4.02 of our software with Microsoft Windows 10 May 2021 21H1 update
- Aug 2, 2021 : rebuilt version 4.02 with Visual Studio 2019 Version 16.10.4 for improved conformance with Windows 10 Pro 64-bit
- July 31, 2021 : added popup help topics for all controls in *WET Tomo|Coverage plot setup* dialog. Updated paragraph on ***WDVS Smoothing*** in chapter *Forward model traveltimes*. Use our updated help installer to update your installation of our software.
- July 31, 2021 : updated Test21 tutorial with *WDVS Smoothing settings* recommendations
- July 31, 2021 : updated mdw2011 crosshole survey tutorial describes how to
  - determine station numbers for ***Shot pos.*** and ***Layout start*** for *Line type* **`Borehole spread/line`**
  - how to generate, edit and apply COORDS.COR and SHOTPTS.SHO files once you imported your SEG-2 shots into the profile

  - see also our .pdf reference chapter ***Crosshole survey interpretation*** on page 113 and following
- July 30, 2021 : Ross et al. show Seismic refraction investigation of the Strengbach watershed (Vosges Mountains, France) using P and S-wave first-arrival tomography (EOST at Univ. Strasbourg 2017).
- July 29, 2021 : Fabien-Ouellet shows an integrated approach to shallow seismic interpretation in his 2014 thesis (Univ. Laval). Also see https://gfabieno.github.io/bib/Fabien-Ouellet-2014.pdf .
- July 24, 2021 : Jaramillo Lopez shows correlation between geomechanical properties, number of blows and geophysical data (Thesis Jaramillo Lopez, Universidad Politécnica Salesiana Sede Quito, 2021)
- July 24, 2021 : added references section to our latest tutorial D1P2NO24.pdf
- July 23, 2021 : added more figures to latest tutorial D1P2NO24.pdf and updated text. Enable WDVS@600Hz and sharpen wavepath coverage plot to visualize low-velocity region.
- July 21, 2021 : our latest tutorial shows improved imaging of constructed low-velocity zones in Stillwater model dam (Thesis Leti Wodajo Univ. of Mississippi 2018)
- July 15, 2021 : updated instructions in Sapri12 tutorial showing SeisImager PlotRefa .VS import
- July 14, 2021 : renamed option in ***Modeling\|WDVS Smoothing*** dialog to easier to understand text ***restore WET smoothing and discard WDVS smoothing only*** .
- July 13, 2021 : allow toggling import option ***File\|Import Data\|Reverted spread layout*** for all import data types. This option is regarded if option ***Turn around spread during import*** is checked only.
- July 7, 2021 : view new .pdf explaining how to download seismic data files and header files needed for our tutorials. Also we give recommendations on how to learn about Rayfract® functionality.
- July 5, 2021 : Dr. Hector Hinojosa shows using body wave SRT for geotechnical engineering in Karst terrains (Linkedin Nov 2020). Shows usage of Poisson's Ratio plots to detect water-saturated zones at top-of-bedrock.
- July 4, 2021 : review new documentation showing installation of CodeMeter runtime and generation of license request file and import of license update file.
- July 4, 2021 : updated text in our new Test21 tutorial . Use our our updated free trial for this tutorial.
- July 3, 2021 : Parsa Bakhtiari Rad compares near-surface reflection with SRT for imaging of soft soil subsurface (SAGEEP 2021; Univ. of Mississippi)
- June 30, 2021 : we now prompt to check ***Smooth invert\|Smooth inversion Settings\|No shot position checking*** if shot points apparently are not located at traveltime curve minimum during WET inversion.
- June 30, 2021 : we now support importing **`Geogiga DWTomo .TTX`** traveltime files with recording geometry via our ***File\|Import Data*** dialog. Test this with our updated free trial. Email us your .TTX if you encounter any issues.
- June 26, 2021 : added Fig. 22 to Test21 tutorial showing selection of DMT .SEG2 files during import
- June 25, 2021 : show peudo-2D DeltatV starting model in our Test21 tutorial
- June 23, 2021 : our new tutorial shows imaging of a highly weathered granitic basement in Australia with thick overburden. Also we show import of DMT SUMMIT X .SEG2 files.
- June 22, 2021 : added SEG-2 import option ***File\|SEG-2 import settings\|Set SEG-2 import settings for DMT SUMMIT X .SEG2 import***. Test this with our updated free trial.

Version 4.01 released in June 2021 :

- June 19, 2021 : check ***File\|SEG-2 import settings\|Ignore SEG-2 station numbers in trace headers*** to determine source and receiver locations from SEG-2 trace header entries SOURCE_LOCATION and RECEIVER_LOCATION. Use for import of DMT SUMMIT X .SEG2 files.

- June 19, 2021 : to import DMT SUMMIT X .SEG2 files check *File|SEG-2 import settings* options
  - ***Receiver Coordinates specified***
  - ***Ignore SEG-2 station numbers .***

  Next select *File|Import Data* and
  - click on ***Select*** button
  - navigate into your input directory or directory where you copied the .SEG2 trace files
  - set ***Files of type*** drop box to **DMT (*.SEG2)** entry
  - select one of your .SEG2 files and click *Open* button
  - click ***Import shots*** button. Click *Read* button to import each shot displayed.

- June 19, 2021 : don't show outdated SEG-2 import options to determine trace data start any longer.
- June 18, 2021 : fixed joint inversion with *Borehole lines* added to main profile in *Header|Profile* when main profile has fewer receiver stations than in added borehole lines.
- June 17, 2021 : recompiled our app with latest Microsoft Visual Studio 2019 version 16.10.2 for improved performance and improved compatibility with Microsoft Windows 10 64-bit Pro
- June 17, 2021 : prompt to check ***File|Import Data Settings|Allow shot inline offset from shot station larger than two spacings*** if required when importing shots with *File|Import Data* or with *File|Update header data|Update Shotpoint coordinates*.
- June 16, 2021 : updated method to compute receiver inline offset from receiver station
- June 16, 2021 : match GeoTomCG .3DD traces to selected *Default spread type* channels and prompt to import matched traces only if the spread type is too short / has too few channels.
- June 11, 2021 : improved GeoTomCG .3DD import with irregular receiver spacing. Prompt to select *Default spread type* with more channels or increase *Station spacing* if appropriate.
- June 9, 2021 : check ***Model|Forward modeling Settings|Model each receiver not receiver stations*** to forward model at each receiver's location and not at averaged receiver station locations. This can improve the accuracy of WET inversion with irregular receiver spacing but will slow down WET and requires more RAM memory for caching of modeled receiver grids.
- June 5, 2021 : Hartl et al. show tunnel based SRT (University of Leoben, Austria 2019)
- May 30, 2021 : updated Conclusions paragraph in Aaknes-1 tutorial
- May 20, 2021 : updated help file chapter *Picking first breaks* with paragraph on new dialog *Trace|Export reciprocal errors*. This dialog is enabled for our free trial as well.
- May 20, 2021 : our latest software version 4.01 works fine with latest Golden Software Surfer 21.
- May 16, 2021 : Andrea Gomez Casalta compares separate ERT & SRT interpretation with RES2DINV® and Rayfract® with joint inversion using Zond Software ERT & SRT and correlates results with borehole data (Thesis Andrea Gomez Casalta, Institut Cartografic i Geologic de Catalunya 2019).
- May 8, 2021 : write additional columns to .ERR file with shot and receiver station numbers for matched reciprocal trace pairs.
- May 6, 2021 : separate words in .ERR file column headers with underscore '_' characters instead of space characters for easier import into Microsoft Excel spreadsheet
- May 5, 2021 : our new dialog *Model|Export reciprocal errors* lets you specify and generate an ASCII .ERR file with columns listing absolute reciprocal error, relative reciprocal error (Jim Whiteley 2020) and forward shot&channel and reverse shot&channel used to computer these reciprocal errors. Sort this .ERR file in MS Excel by any column to identify bad shots or receivers. .ERR lines are sorted by offset (m) and CMP station as in our *Trace|Offset gather* display. Any trace pair with relative reciprocal picking error above 5 percent or absolute error exceeding 5ms or 10ms needs to be repicked.
- May 4, 2021 : updated free trial installer allows exporting reciprocal errors (see above bullet) and WDVS smoothing. We now enable *Trace|Offset gather* and *Refractor|Offset breaks* for free trial.
- Apr 28, 2021 : view our EGU 2021 abstract entitled Improved interpretation of SAGEEP 2011 blind refraction data using Frequency-Dependent Traveltime Tomography.

- Apr 24, 2021 : Koley S. describes in detail both theory and application of DeltatV and WET inversion to characterize a dipping fault zone (Koley, Vrije Univ. Amsterdam, 2020), correlated with borehole drilling information.
- Apr 22, 2021 : check *DeltatV|Common-offset dip estimation|Reject true velocity lower than overburden velocity* and redo *DeltatV inversion* to prevent too slow DeltatV velocity sections e.g. with our THRUST tutorial.
- Apr 21, 2021 : in the special case where both option *Smooth invert|Smooth inversion Settings|Output inversion results in Feet* and option *Model|WDVS Smoothing|Discard WET smoothing* are checked our *WET inversion* now works correctly. For older builds uncheck *Output inversion results in Feet*, redo the WET inversion in meters and then convert your …\VELOIT20.GRD into feet with *Grid menu*.
- Apr 19, 2021 : updated help file chapter *Pseudo-2D DeltatV inversion* with paragraph on new dialog *DeltatV|Common-offset dip estimation*. This dialog is enabled for our Pro software version only.
- Apr 19, 2021 : updated help file chapter *Installation and licensing* recommends installing CodeMeter runtime version 6.90b in Windows 7 64-bit Pro virtual machine running in Parallels Desktop on macOS instead of installing latest CodeMeter version 7.20 which crashes in Windows 7 64-bit virtual machine.
- Apr 17, 2021 : we now share our SAGEEP2021 WDVS presentation annotated slides on YouTube.
- Apr 16, 2021 : download CodeMeterRuntime.exe version 6.90 installer for Windows 7 64-bit Pro compatibility when running under Parallels Desktop version 16 on macOS. The latest CodeMeter runtime version 7.20 crashes after installation in Windows 7 64-bit Pro running under Parallels.
- Apr 10, 2021 : new dialog *DeltatV|Common-offset dip estimation* lets you edit parameters for ***estimation of dip of common-offset sorted traveltime curves***, and for ***better estimation of true refractor velocity based on apparent CMP velocity and this estimated offset curve dip during DeltatV inversion*** in case of strong refractor dip (Gebrande and Miller 1985; Gebrande 1986). This dialog is available with our Pro version only and is disabled for our Standard software version.
- Apr 10, 2021 : we now flip refractors when imaging a turned-around .GRD tomogram in *Grid menu*.
- Apr 9, 2021 : Barbero and Naldi (2018) show good match between MASW, SRT and ERT in landslide area.
- Mar 30, 2021 : average first breaks in *Refractor|Offset breaks* for adjacent traces with CMP position difference smaller than 0.5 station numbers. This results in a more regular display.
- Mar 29, 2021 : Alvaro Polin Tornero shows synthetic modeling of cavity in dam in his thesis (Univ. Uppsala 2018). View synthetic modeling of air-filled cavity (Parsa Bakhtiari Rad, NCPA 2021) using our *WDVS-enabled WET inversion* in latest version 4.01 of our software released in March 2021.
- Mar 29, 2021 : updated free trial installer allows WDVS smoothing, can call into Surfer 9 to 21 Beta and comes with latest help file.
- Mar 26, 2021 : updated OT0608 tutorial with runtime info using our Pro version on 2020 macMini.
- Mar 26, 2021 : version 4.01 completes 10 WET runs for 1_1D tutorial in 90 seconds on 2020 macMini with 3.0 GHz Intel Core i5 processor using all 6 cores in native Windows 10 64-bit Pro installation via Boot Camp Assistant using our Pro version. This takes 2 minutes using 4 cores in Parallels Desktop 14 on the same 2020 macMini and 3 minutes on 2017 iMac with 2.3 GHz Intel Core i5 processor using 4 cores, in Windows 7 64-bit Pro virtual machine running under Parallels Desktop 16.
- Mar 24, 2021 : added Conclusions paragraph to Aaknes-1 tutorial
- Mar 22, 2021 : view our SAGEEP 2021 expanded abstract demonstrating our new WDVS option
- Mar 21, 2021 : updated help file chapter *Forward model traveltimes* with section on *Model|Create Checkerboard grid dialog*. Updated references in chapter *Introduction*.
- Mar 19, 2021 : updated *Model|Create Checkerboard grid* lets you edit the *Anomaly magnitude* in percent of the background velocity (Zelt Geophys. J. Int. 1998). Each anomaly (checker) is

determined by multiplying this percentage with local grid velocity and weighting with sin(x offset)sin(y offset) functional and then adding this velocity delta to or subtracting from local grid velocity in a checker pattern. This dialog is available with our Pro version only.

- Mar 19, 2021 : our SAGEEP 2021 presentation slides are now available.
- Mar 17, 2021 : updated *DeltatV* help popup topics and *Pseudo-2D DeltatV* chapter in help file.
- Mar 15, 2021 : improved accuracy of SEG-2 import for marine refraction surveys with towed hydrophone streamer.
- Mar 13, 2021 : fixed *Smooth invert|WET with 1D-gradient initial model* when enabling AWE for our Pro version with *WET Tomo|WET tomography Settings|Enable AWE physical memory page caching* and checking option *Cache AWE receiver grids in local memory*
- Mar 13, 2021 : we rebuilt and extensively tested our software with latest MSVC Address Sanitizer.
- Mar 11, 2021 : updated help topics *Conjugate Gradient* in *WET Tomo main* dialog and *Damping* in *Edit velocity smoothing* dialog in help file.
- Mar 9, 2021 : run Ray336_Scripts.exe on PC where you installed our version 3.36 or 4.01 software. The updated scripts in `C:\RAY32\DAT` folder work with Surfer 9 to 21 Beta.
- Mar 9, 2021 : updated `AUTOTOMO.BAS` Surfer script to setup the color scale for velocity tomogram with *Min. velocity* and *Max. velocity* limits if *Adapt color scale* checked in *Grid|Surfer plot Limits*.
- Mar 9, 2021 : updated `AUTOTOMO.BAS` Surfer script to set the contour map velocity interval for velocity tomogram to *Velocity interval* if *Adapt color scale* checked in *Grid|Surfer plot Limits*.
- Mar 8, 2021 : show WET output using *WDVS frequency* of 200Hz and 300Hz in PALMFIG4 tutorial.
- Mar 7, 2021 : view our latest PALMFIG4 tutorial showing WDVS-enabled *WET inversion* of Dr. Derecke Palmer 1980 Fig. 4 synthetic data. We fixed the shot positions to obtain lower RMS error.
- Mar 6, 2021 : allow *WET inversion* and forward modeling with just two shots in profile instead of 3.
- Mar 3, 2021 : updated help chapter ***Filtering traces*** describes new ***Trace|Shot gather|Processing|Edit Trigger Jitter Removal*** dialog fields. This dialog is available with our Pro software version only.
- Mar 1, 2021 : view synthetic modeling of air-filled cavity (Parsa Bakhtiari Rad, NCPA 2021) using our *WDVS-enabled WET inversion*. Travel times were forward-modeled with WDVS enabled at 200Hz.
- Mar 1, 2021 : we show *WDVS-enabled WET inversion* with pseudo-2D DeltatV starting model in our updated SR6 marine refraction tutorial. We discard WET smoothing after forward modeling for higher resolution. Also we show ***trigger jitter removal*** to decrease the RMS error and increase resolution.
- Feb 27, 2021 : check *Model|WDVS Smoothing|use WDVS for forward modeling* to better remove artefacts from pseudo-2D DeltatV starting model with *DeltatV|Automatic DeltatV and WET inversion*. Tune *WDVS frequency* as described in help file chapter *Forward model traveltimes*.
- Feb 27, 2021 : *Grid|Reset DeltatV and WET settings to .PAR file* now also restores WDVS settings stored in .PAR file. With older .PAR files without WDVS settings we leave WDVS at current settings.
- Feb 27, 2021 : we store WDVS settings to .PAR file when writing .PAR files during WET inversion.
- Feb 25, 2021 : we have updated our OT0608 tutorial showing layered refraction interpretation with Wavefront method in Fig. 25.
- Feb 25, 2021 : updated free trial installer allows WDVS smoothing, can call into Surfer 9 to 21 Beta and comes with latest help file.
- Feb 23, 2021 : view our SAGEEP 2021 presentation in session Seismic Body Waves Methods II
- Feb 21, 2021 : don't discard WET smoothing in *Model|WDVS Smoothing* with *Conjugate-Gradient* search method specified in *WET Tomo|Interactive WET*, to ensure that WET inversion converges.

- Feb 21, 2021 : use default *Steepest-Descent* search method in *WET Tomo|Interactive WET* when enabling WDVS smoothing in *Model|WDVS Smoothing* dialog, for more robust WET inversion. Use default full WET smoothing or minimal WET smoothing, in *Edit velocity smoothing* dialog.
- Feb 20, 2021 : use more descriptive names for controls in *Model|WDVS Smoothing* dialog. Add radio button *discard WDVS smoothing only and restore WET smoothing.* Update help file chapter *Forward model traveltimes* with help on updated WDVS Smoothing dialog.
- Feb 17, 2021 : we have updated our OT0608 tutorial with traveltime curve displays on last page. Note the high degree of consistency of first break picks and good fit with modeled times.
- Feb 17, 2021 : we now also show traveltime curve displays in our Aaknes-1 tutorial on last page. Note the inconsistent first break picks compared to above OT0608 tutorial.
- Feb 16, 2021 : updated help chapter ***Forward modeling*** showing new ***Model|WDVS Smoothing*** dialog fields.
- Feb 16, 2021 : we moved *Model|Fast WDVS* option into *Model|WDVS Smoothing* dialog. We will copy your current setting of *Model|Fast WDVS* option into your *Model|WDVS Smoothing* dialog when you open an existing profile database.
- Feb 11, 2021 : we show WDVS-enabled WET inversion with default 1D-gradient starting model in our updated OT0608 tutorial. We discard WET smoothing after forward modeling for higher resolution.
- Feb 11, 2021 : we describe the geological setting in updated RJJ9TO10 tutorial
- Feb 11, 2021 : allow *WET wavepath frequency* and *WDVS frequency* range 0.01Hz to 10'000Hz
- Feb 9, 2021 : view our latest GSA Today color ad in Feb 2021 issue
- Feb 8, 2021 : option *WDVS Smoothing|discard WET smoothing after forward modeling* can help to improve the WET resolution if the starting model is close to the final/true model already e.g. for lines OT0608 and GEOXMERC with homogeneous overburden. Use WDVS frequency of 100Hz and wavepath width of 8 percent. But in other situations such as for Broad Epikarst model we recommend not discarding WET smoothing to avoid engraving of the wavepaths into the WET tomogram.
- Feb 7, 2021 : Oyan 2019 shows determination of rock mass anisotropy and lists detailed processing steps including data import and calling into Surfer and Voxler
- Feb 6, 2021 : Chen and Zelt 2017 show Comparison of Full Wavefield Synthetics with Frequency-Dependent Traveltimes Calculated Using Wavelength-Dependent Velocity Smoothing
- Feb 6, 2021 : option *WDVS Smoothing|discard WET smoothing after forward modeling* can help to improve the WET resolution for crosshole surveys such as IGTA13. Use WDVS frequency of 125Hz and force cell size to 0.5m. Leave wavepath width at default 1.6 percent.
- Feb 4, 2021 : added box ***discard WET smoothing after forward modeling*** in ***Model|WDVS Smoothing*** dialog. With this box checked we restore the unsmoothed WET velocity grid after forward modeling during WET inversion, discarding the WDVS smoothed grid at this time (Zelt and Chen 2016).
- Feb 2, 2021 : Chen et al. 2017 show detection of a known near-surface target through application of frequency-dependent traveltime tomography (FDTT) and full-waveform inversion to P- and SH-wave seismic refraction data. Our combination of WET inversion with WDVS smoothing can be considered as a form of FDTT.
- Jan 29, 2021 : we now can offer ***network licenses*** to our software. Share your USB dongle license between multiple PC's connected to the same WiFi network. The user limit is one per dongle per default but can be increased to two or higher. Ask us for a quote. You may also share a network license via VPN. You may need to add a NAT address translation rule on your router.
- Jan 24, 2021 : view the Olson Engineering refraction webinar on YouTube showing field usage of our software with a theoretical background.
- Jan 21, 2021 : Davarpanah et al. 2020 obtain dynamic modulus of elasticity (Young's modulus) directly from P-wave velocity, S-wave velocity and density rho in equation (1). Density rho can be estimated from P-wave velocity with Gardner's relationship rho = 0.23 $Vp^{0.25}$.
- Jan 19, 2021 : updated Surfer **`.BAS`** scripts to work with Surfer 21 Beta. Run Ray336_Scripts.exe on PC where you installed our version 3.36 or 4.01 software. These updated scripts in **`C:\RAY32\DAT`** folder work with Surfer 9 to 21 Beta.

- Jan 19, 2021 : more robust Surfer version handling in Surfer **.BAS** scripts
- Jan 16, 2021 : updated CAMP1 tutorial with description of geological setting on last page
- Jan 14, 2021 : our earlier POISSON tutorial shows imaging of Poisson's ratio based on P-wave and S-wave velocity. Pick S-wave shots in *Trace|Shot point gather* with pairs of shots with opposite trace polarity recorded at same shot point.
- Jan 14, 2021 : Enrione and Naldi 2014 compare SRT and MASW for same profile
- Jan 12, 2021 : Terzic et al. 2017 show seismic hazard analysis for dam site with adjacent fault zone
- Jan 6, 2021 : updated RJJ9TO10 tutorial with WDVS-enabled WET inversion using Plus-Minus method layered refraction starting model and using default 1D-gradient starting model.
- Jan 3, 2021 : view our updated color ad
- Jan 3, 2021 : tested our latest version 4.01 under Windows 10 64-bit Oct 2020 update
- Jan 1, 2021 : updated free trial installer comes with latest help file and works with Surfer 9 to 20 Beta
- Dec 30, 2020 : skip plotting refractors on tomogram if …**\LAYRTOMO\PLUSMODL.CSV** layer model .CSV file is missing. To install updated **.BAS** Surfer scripts download & run Ray336_Scripts.exe on PC where you installed our version 3.36 or 4.01 software. These scripts work with Surfer 9 to 20 Beta.
- Dec 28, 2020 : updated SAGEEP11_16 tutorial with more figures and sections Conclusions & References. Added more download links to .RAR archives with profile database & Surfer files.
- Dec 26, 2020 : updated SAGEEP11_16 tutorial with Fig. 28 to 32 demonstrating the improvement in WET tomogram resolution when decreasing the *WDVS frequency* compared with Fig. 24
- Dec 25, 2020 : updated SAGEEP11_16 tutorial comparing Conjugate-Gradient multiscale WET inversion using WDVS and minimized WET smoothing vs. same WET inversion without WDVS
- Dec 24, 2020 : review our updated black-and-white ad
- Dec 23, 2020 : updated free trial installer comes with latest help file and works with Surfer 9 to 19
- Dec 20, 2020 : updated help file chapters *Introduction* and *Forward model traveltimes*. Updated description of *WDVS parameters* and how to tune them for your current profile. Refer to tutorials.
- Dec 19, 2020 : updated Aaknes-1 tutorial with instructions on how to vary *WDVS frequency* and WDVS parameter *Regard nth node* on last page.
- Dec 17, 2020 : updated Aaknes-1 tutorial comparing WET inversion using WDVS and minimal WET smoothing vs. WET inversion without WDVS and using full WET smoothing.
- Dec 11, 2020 : updated CAMP1 tutorial comparing WET inversion with and without WDVS using same WET inversion settings with minimized WET smoothing in Fig. 10a and Fig. 10b.
- Dec 9, 2020 : updated NORCAL14 tutorial with WET+WDVS using minimized WET smoothing. Show WET with 1D-gradient starting model from 2014 with WDVS. Disable WDVS and compare.
- Dec 8, 2020 : updated NORCAL14 tutorial with WDVS-enabled WET inversion using Plus-Minus method layered refraction starting model.
- Dec 7, 2020 : updated EPIKINV tutorial with WDVS-enabled WET inversion using Plus-Minus method starting model. We also show 100 Steepest-Descent WET iterations without WDVS.
- Dec 6, 2020 : updated JENNY13 tutorial with WDVS-enabled Automatic WET using Plus-Minus starting model. Added heuristics for tuning WET and WDVS parameters on last page.
- Dec 5, 2020 : updated JENNY13 tutorial shows WDVS-enabled Smooth inversion and compares with 2013 interpretation without WDVS. Enabling WDVS gives sharper image of basement top.
- Dec 1, 2020 : our website uses secure https transfer protocol showing the lock symbol in address bar
- Nov 27, 2020 : decreased default *WDVS frequency* from 300Hz to 200Hz
- Nov 24, 2020 : download CodeMeterRuntime.exe version 6.90 installer for Windows 7 compatibility
- Nov 23, 2020 : updated CAMP1 tutorial shows WDVS enabled WET with 1D-gradient & Plus-Minus layered refraction starting models. Enabling WDVS dramatically improves WET resolution.

- Nov 17, 2020 : added WET blanking option *Pad boundary polygon for borehole tomogram blanking*
- Nov 15, 2020 : updated free trial installer comes with latest help file and works with Surfer 9 to 19
- Nov 15, 2020 : disable WDVS per default when user opens an old profile with *File|Open Profile…*
- Nov 15, 2020 : pad blanking polygon when user selects *WET Tomo|WET tomography Settings|Blank|Blank outside borehole tomogram*. Alternatively blank via *WET Tomo|WET Velocity constraints* using your own blanking file.
- Nov 12, 2020 : new option *Model|Fast WDVS Smoothing*. Check for faster but less accurate WDVS smoothing. Was enabled per default before Nov 10, 2020. See bullet for Nov 10, 2020.
- Nov 11 2020 : disable WDVS per default when user creates new profile with *File|New Profile…*
- Nov 11, 2020 : when user forces *grid cell size* increase row and column count by one if required so all shot point and receiver symbols are plotted in Surfer on tomogram. Test with IGTA13 tutorial.
- Nov 11, 2020 : increased default *WDVS frequency* from 200Hz to 300Hz
- Nov 11, 2020 : increased default *WDVS angle increment* from 4 degrees to 7 degrees
- Nov 11, 2020 : increased default *WDVS Regard nth node* from 2 to 3
- Nov 10, 2020 : more accurately map scan line nodes to velocity grid nodes during WDVS smoothing
- Nov 8, 2020 : expanded our EPIKINV tutorial with more figures, links and comments
- Nov 6, 2020 : we updated our EPIKINV tutorial (Sheehan et al. 2005) showing WET output obtained with WDVS (Zelt and Chen 2016) enabled. See Zelt, C. A. and J. Chen, Frequency-dependent traveltime tomography for near-surface seismic refraction data, Geophys. J. Int., 207, 72-88, 2016 .
- Nov 5, 2020 : added paragraph *WDVS velocity smoothing* to help chapter *Forward model traveltimes*. Nov 4, 2020 : updated base install .pdf showing how to run our raywn401.exe base installer
- Nov 3, 2020 : fixed download links for .RAR archives in SR6 tutorial
- Oct 31, 2020 : updated 11REFR tutorial shows WET with WDVS enabled and minimized smoothing.
- Oct 28, 2020 : check *WET Tomo|WET tomography Settings|Write|Write blanked and mask grids and WDVS debug grids* to write WDVSTIME.GRD and WDVSVELO.GRD to C:\RAY32\DAT with WDVS smoothing enabled in *Model|WDVS Smoothing* dialog.
- Oct 28, 2020 : our updated free trial now allows editing *Model|WDVS Smoothing*. See next bullet.
- Oct 26, 2020 : new dialog ***Model|WDVS Smoothing…*** lets you edit parameters for Wavelength-Dependent Velocity Smoothing (Zelt and Chen 2016). You can edit these WDVS parameters :
  - ***Use WDVS for forward modeling of traveltimes***. If checked we do WDVS velocity smoothing before running our Eikonal solver to forward-model traveltimes over current velocity grid.
  - ***WDVS frequency*** in Hz (1Hz to 10'000 Hz). Used to determine the duration of one wavelength i.e. one period in time. Is set to 200Hz per default. Should be two to four or eight times the ***Wavepath frequency*** specified in *WET Tomo|Interactive WET tomography…* . See (Zelt and Chen 2016). Increase to decrease WDVS smoothing and to speed up WDVS.
  - ***Angle increment*** in degrees (values 1 to 10). This determines the angular separation between straight scan lines radiating outwards from the current grid node when determining the WDVS averaged velocity at that node. Increase this parameter to speed up WDVS. Default is 4 degrees.
  - ***Regard nth node*** (values 1 to 5). Regard each nth node along current angle and scan line when determining WDVS velocity at current grid node via weighted average. Increase to speed up WDVS. Default is 2.

- Oct 24, 2020 : use multiple CPU cores in parallel for WDVS velocity smoothing.
- Oct 21, 2020 : new option ***WET Tomo|WET tomography Settings|Wavelength-dependent velocity smoothing***. See Zelt & Chen 2016 paper. Tested with lines ZONDDATA and LINE14 and TRA9002.

- Oct 16, 2020 : new base install .pdf showing how to run our raywn401.exe base installer
- Oct 15, 2020 : updated free trial installer comes with latest help file and works with Surfer 9 to 19
- Oct 15, 2020 : show traveltime misfit prompt asking you to improve your first break picks in help file chapters *Smooth inversion* and *WET Tomography Processing*. Refer to slope1.pdf tutorial showing how to identify traces with inconsistent picks regarding reciprocity principle in *Trace*|*Offset gather* display.
- Oct 13, 2020 : in http://rayfract.com/samples/SAGEEP2011shootout.pdf Prof. Bob Whiteley compares the GRM interpretation (Stoyer, 2012) of the SAGEEP2011 blind refraction session synthetic data with our published blind WET interpretation (Rohdewald, 2011) and the true model (Zelt et al. 2013).
- Oct 8, 2020 : review Mebrahtu et al. Tectonic conditioning revealed by seismic refraction facilitates deep-seated landslides in the western escarpment of the Main Ethiopian Rift (Geomorphology 2020)
- Oct 6, 2020 : updated help file chapters *Editing header data* and *Seismic and header data import* describing new fields in *Header*|*Profile* and *File*|*Import Data* dialogues. Updated chapter *Introduction*.
- Oct 5, 2020 : added Fig. 18 to Aaknes-1 tutorial showing prompt to improve your first break picks regarding the traveltime reciprocity principle if RMS error exceeds 5 percent
- Oct 3, 2020 : allow toggling of *File*|*Import Data*|*Reverted spread layout* checkbox for import data types SEG-2 and SEGY only. For all other data type selections this checkbox is disabled and reset.
- Oct 2, 2020 : added ***File*|*Import Data*|*Reverted spread layout*** checkbox. For previous 4.01 build use *File*|*More import Settings*|*Reverted receiver spread layout* option instead. See below in Sep 24 bullet.
- Sep 30, 2020 : use free SeiSee software for viewing of SEGY trace headers
- Sep 29, 2020 : always update shot point coordinates with true coordinates stored in SEG-2 trace header when batch-importing with .HDR batch file. Don't interpolate between receiver coordinates.
- Sep 28, 2020 : don't show irrelevant geometry warning prompts for shot stations outside first/last profile receiver station.
- Sep 27, 2020 : do not check *File*|*Import data Settings*|*Extrapolate receiver line coordinates* every time user selects a profile in *File menu*. Uncheck this setting when user creates a new profile and when resetting import settings to defaults.
- Sep 26, 2020 : support import of SEGY .SGY with missing traces for free trial with *File*|*SEGY import Settings*|*No receiver coordinates specified in .SGY file* unchecked
- Sep 26, 2020 : ask user to confirm warning prompt when resetting DeltatV & WET parameters to .PAR file belonging to .GRD selected in different profile.
- Sep 25, 2020 : updated our SR6 tutorial. Uncheck *File*|*Import data Settings*|*Extrapolate receiver line coordinates* before importing the SEG-2 .DAT files so off-end shotpoints get absolute coordinates specified in the .DAT. Otherwise the following update with SHOTPTS.SHO does not work.
- Sep 24, 2020 : check ***File*|*More import Settings*|*Reverted receiver spread layout/towed streamer*** if spread channel no. decreases with inline offset along profile. Check for towed streamer with channel no. 1 closest to towing device and recorder. Also check *File*|*Import Data*|*Turn around spread* to unflip reverted spread for display and processing. Use with SEG-2 and SEGY formats.
- Sep 20, 2020 : determine *Layout start* and *Shot pos.* in station numbers for SEGY import as for SEG-2 import with ***Import Data*|*Turn around spread*** checked. Use for marine refraction with towed spread.
- Sep 20, 2020 : regard *Import Data*|*Take shot record number from* selection **`DOS file name`** when importing SEGY files with just one shot per .SGY file. Select option **`Record number`** to determine SEGY shot number from SEGY header field **`Field Record No`**. We allow a shot number range 0…999. The imported shot number is set to SEGY shot number modulo 1000.
- Sep 19, 2020 : support importing SEGY .SGY files with missing traces with import option *Allow missing traces* checked and with SEGY option *No receiver coordinates specified in .SGY* unchecked.

- Sep 17, 2020 : added new field ***First receiver [station number]*** to *Header|Profile* dialog. Check box *Force first receiver* to enforce *First receiver [station number]* during import with *File|Import Data…*
- Sep 17, 2020 : *First receiver [station number]* is not forced during import with .HDR batch import enabled or with *File|Import Data Settings|Profile start is default layout start* checked or when importing ASCII.ASC files which specify fixed station numbers already.
- Sep 15, 2020 : ***Copying minimized WET smoothing settings optimized for one profile to another profile is not recommended and not supported***. Default full WET smoothing filter size and default wavepath width are determined automatically based on grid dimensions (grid cell size, number of columns & rows), velocity distribution in the starting model and maximum picked time. Since these parameters are specific to each profile and starting model you need to always start with our Smooth inversion. Next you can optionally try step-wise decreasing of WET smoothing, for consistently picked traveltimes and correctly specified recording geometry.
- Sep 14, 2020 : updated install3.36 tutorial : you need to run your custom rayup336.exe installer (matching your license number programmed into your USB dongle) after running the base installer raywn336.exe. Or run rayup401.exe after raywn401.exe for version 4.01. See our email with detailed installation/update instructions.
- Sep 10, 2020 : updated free trial installer comes with latest help file and works with Surfer 19 Beta
- Sep 9, 2020 : regard ***Grid|GS CENTERED font*** option when plotting source symbols (as red circles instead of red triangles). To install updated **.BAS** Surfer scripts download & run Ray336_Scripts.exe on PC where you installed our version 3.36 or 4.01 software.
- Sep 9, 2020 : plot source and receiver symbols at correct horizontal offset when imaging turned-around grid with *Grid|Surfer plot Limits* activated.
- Sep 7, 2020 : version 4.01 completes 10 WET runs for our 1_1D tutorial in about two minutes on 2020 macMini with 3.0 GHz 6-Core Intel Core i5 processor, using 4 cores in Parallels Desktop 16. This takes about 3 minutes on 2017 iMac with 2.3 GHz Intel Core i5 processor using 4 cores, in Windows 7 64-bit Pro virtual machine running under Parallels Desktop 16.
- Sep 4, 2020 : added more links and recommendations to our tutorial AAKNES-1 on last two pages.
- Sep 1, 2020 : added link to Sheehan et al. 2005 in tutorial AAKNES-1. Sheehan et al. objectively compare our fail-safe default Smooth inversion method using 1D-gradient starting model with other commercially available seismic refraction tomography software.
- Aug 30, 2020 : added option *WET Tomo|WET tomography Settings|Cache AWE receiver grids in local memory*. Can be enabled for our Pro version only. This helps to speed up WET inversion when using more than 4 logical CPU cores with option *Enable AWE physical memory page caching* checked. Tested with 6 CPU cores on Apple 2020 macMini. However WET still runs faster when using 4 CPU cores only instead of all 6 cores.
- Aug 23, 2020 : added more figures to new tutorial AAKNES-1
- Aug 18, 2020 : updated figures in new tutorial AAKNES-1 : increase *WET wavepath width* from default 6.5% to 12% for more robust inversion with uncertain recording geometry & first break picks. Show good correlation of *Refractor|Offset breaks* display with WET tomogram. Updated text.
- Aug 13, 2020 : Carollo et al. describe Joint interpretation of seismic refraction tomography and electrical resistivity tomography by cluster analysis to detect buried cavities (JAG July 2020). See also Capizzi et al. (Univ. Palermo 2017).
- Aug 13, 2020 : Colombo et al. nicely explain the 3D CMP refraction recording geometry and apparent velocity processing using CMP bins (SEG Geophysics 2016). This has been described earlier e.g. by Thomas Ruehl 1995 : Determination of shallow refractor properties by 3D-CMP refraction seismic techniques. EAGE First Break 1995, volume 13, pp. 69-77.
- Aug 13, 2020 : our latest tutorial AAKNES-1 shows smooth WET interpretation of dense refraction survey with uncertain picks due to low signal-to-noise ratio. We show WET inversion using both the default 1D-gradient starting model and Plus-Minus method layered refraction starting model.
- Aug 10, 2020 : we don't yet have permission from NGU to publish our new NGU21 tutorial so we had to delete this again from our website.

- Aug 10, 2020 : in our new tutorial NGU21 we now also show *Conjugate-Gradient WET inversion* using Plus-Minus starting model and minimal WET smoothing. This seems to improve the resolution.
- Aug 8, 2020 : our new tutorial NGU21 shows *Smooth inversion using 1D-gradient and Plus-Minus method starting models*. After 100 WET iterations the WET output is almost identical.
- July 31, 2020 : version 3.16 of our software released in 2010 and earlier versions do not work with WibuKey Win32 / Win64 driver 6.00a and later driver versions. The dongle manufacturer changed the encryption method and communication protocol with the dongle for driver 6.00a and later in 2010.
- July 31, 2020 : Ortega Perez et al. use SRT and OSL (Optically Stimulated Luminescense) to determine evolution of water storage capacity for the four Melque reservoirs in central Spain during the period A.D. 600–1900 (Geoarcheology 2017). Refraction profile sediment depths were cross-checked by manual augering.
- July 30, 2020 : Capizzi et al. use ERT & SRT & cluster analysis for imaging of cavities validated with synthetic data (Univ. Palermo 2017)
- July 30, 2020 : Carollo et al. show joint interpretation of seismic refraction tomography and electrical resistivity tomography by cluster analysis to detect buried cavities (JAG July 2020)
- July 29, 2020 : Hutchinson et al. show Stratigraphic Analysis with Refraction Tomography (GSA 2019)
- July 23, 2020 : updated free trial installer comes with latest help file and works with Surfer 19 Beta
- July 22, 2020 : updated **.BAS** Surfer scripts work with latest Surfer 19 Beta. Download & run Ray336_Scripts.exe on PC where you installed our version 3.36 or 4.01 software.
- July 20, 2020 : after updating to Windows 10 May 2020 Update you need to rerun our help installer .
- July 15, 2020 : show fewer status bar messages when back-projecting residuals during WET inversion
- July 13, 2020 : show fewer status bar messages when forward modeling traveltime over velocity grids
- July 13, 2020 : limit size of buffer allocated for reading or writing Surfer format .GRD files to actual size of the data before reading or writing the data section. Earlier builds allocate maximum size allowed in .GRD data section.
- July 11, 2020 : before importing SEG-2/SEGY/GeoTomCG .3DD trace files with irregular receiver spacing check *File|Customize spread types* items *Customize Default spread type&One spread per shot*. This allows more accurate modeling of recording geometry and receiver positions as shown in *Header|Receiver*. Please note that you cannot open such a profile database with older version 3.36 or 3.35 builds of our software, once you import shots with these *Customize spread types* items checked.
- July 7, 2020 : we have ported our Pro version to Intel C++ 19 compiler. Our recompiled version 4.01 Pro software now runs up to 10 percent faster, both in Windows 7 64-bit and Windows 10 64-bit.
- July 1, 2020 : recompiled our app with latest Microsoft Visual Studio 2019 for improved conformance with Windows 10 64-bit. We still fully support Windows 7 64-bit as well.
- June 25, 2020 : don't plot receiver station labels on top axis for Borehole spread/line
- June 25, 2020 : reset receiver station labeling in *Grid|Surfer plot Limits* when user opens profile database with older app version and then reopens with version 4.01.
- June 25, 2020 : automatically update profile database with IMPSHOTS.SHO at end of import into *Line type* Borehole spread/line as for Refraction spread/line. This ensures that shot coordinates are always stored correctly in the database. Use *File|Update header data|Update Shotpoint coordinates* with …\INPUT\IMPSHOTS.SHO for version 3.36 builds after import into Borehole spread/line.
- June 22, 2020 : for *Line type* Borehole spread/line write shot station without inline offset into *Shot station* and *Shot pos.* columns in exported ASCII.ASC & BREAKS.LST files.
- June 22, 2020 : uncheck ***File|Import Data Settings|Assume regular/equidistant receiver spacing*** to better support import of irregularly spaced receivers e.g. with GeoTomCG .3DD import into

Borehole spread/line. Uncheck to minimize the offset between receiver coordinates and receiver stations as shown in *Header|Receiver*. Check if all receiver spacings are multiples of *Header|Profile|Station spacing*. This option is unchecked per default. Check to restore import behaviour as with older builds.

- June 22, 2020 : moved some options from *File|Import Data Settings* into new menu *File|More import Settings*.
- June 17, 2020 : improved import of GeoTomCG .3DD. Import shots with just one receiver trace.
- June 16, 2020 : we reprocessed OT0608 profile with *Conjugate-Gradient WET using Cosine-Squared update weighting and optimized WET smoothing* to obtain a sharper tomogram.
- June 15, 2020 : we have redone multiscale WET inversion of SAGEEP 11 blind refraction session synthetic data with version 4.01 of our software. We forced the *grid cell size* to 1.0m in *Header|Profile*. See Fig. 21 on last page of our updated tutorial.
- June 13, 2020 : Geophysical investigations of pyroclastic density current processes and deposit properties at Mount St. Helens, Washington (Cleveland Gase Thesis Boise State Univ. 2016)
- June 13, 2020 : Nielson shows hydrogeophysical imaging of critical zone with ERT and SRT (Master Thesis, Boise State Univ. 2017)
- June 12, 2020 : updated description of import settings and DeltatV settings in help file . Also updated chapter on WET tomography processing, paragraph *Decrease WET velocity smoothing*.
- June 12, 2020 : improve error prompt when not enough RAM available for fast WET inversion. Prompt user to force larger *grid cell size* in *Header|Profile* or to install more RAM. Display how much KB of RAM are needed to cache all shot or receiver traveltime grids. Our Pro license can use up to 1TB of RAM under Windows 10 Pro 64-bit for caching of traveltime grids. Our Standard license can use up to 4GB of RAM.
- June 9, 2020 : check *DeltatV|DeltatV Settings|Write new DeltatV settings to .PAR file* to write new setting *Regard mapping for shot offset correction* to .PAR file. Uncheck so older version 3.36 builds of our software can still read newly generated .PAR files.
- June 7, 2020 : moved some commands from *Processing menu* shown with *Trace menu* gather displays, to new *Display menu*.
- June 7, 2020 : updated paragraph *System Requirements* in help file chapter *Introduction*

Version 3.36 released in June 2020 :

- June 6, 2020 : update *Grid|Surfer plot Limits|First station* & *Station interval* fields when user imports (additional) shots into profile database. Set *Station interval* to (profile length)/10 in station numbers. These parameters are used with option *Grid|Receiver station ticks on top axis* checked.
- June 6, 2020 : Liu et al. show Constraints on the shallow deformation around the Main Frontal Thrust in central Nepal from refraction velocities (Tectonophysics 2020).
- June 4, 2020 : *Processing|Edit trigger jitter removal* lets you edit parameters for removal of trigger jitter with *Processing|Remove gun jitter for shot/for all shots* in *Trace|Shot gather* with our Pro version.
- May 30, 2020 : Rodriguez-Pradilla uses P-wave SRT for rock-mass classification and for structural tunnel-reinforcement design (SEG TLE Feb 2015).
- May 26, 2020 : in *Trace|Shot gather display* we now offer ***Processing|Remove gun jitter for shot*** and
  Remove gun jitter for all shots commands with our Annual Pro & Permanent Pro software versions. Use with marine refraction surveys to correct trigger delay of shot(s) based on assumed P-wave velocity of 1,500 m/s in water and known distance between source and closest receiver channel. We tested this with our SR6 tutorial data.
- May 26, 2020 : Mattsson et al. compare WET interpretation with conventional refraction processing for imaging of granitic bedrock in Sweden with thin overburden and mapped deformation zones. Mattsson shows deep weathering and diving waves due to gradual increase of velocity with depth in overburden and below top-of-basement. These results are contrary to unrealistic NGU synthetic model 1_1D which shows no increase of velocity with depth inside basement and abrupt velocity increase to over 4,000 m/s below thin weathering layer or even

directly below topography. These extremely sharp velocity increases at layer boundaries with no layer-internal velocity gradients prevent reliable interpretation with our DeltatV method. DeltatV assumes diving waves due to gradual increase of velocity with depth. This assumption is realistic for most field surveys we have ever seen. See our tutorials in archives TUTORIAL.ZIP and OLDTUTOR.ZIP for interpretation of client's field survey data.

- May 26, 2020 : our Plus-Minus starting model works fine for WET inversion of NGU model 1_1 synthetic traveltime data.
- May 26, 2020 : our default Smooth inversion method is able to determine a good 1D-gradient starting model for WET inversion of NGU P1_6-7D synthetic model data. This NGU model is more realistic than model 1_1D and shows deep weathering with a wide low-velocity fault zone, allowing for diving waves.
- May 22, 2020 : plot overburden refractor over whole profile length for *Wavefront method* depth and velocity sections. Tested with our GEOXMERC tutorial.
- May 21, 2020 : DeltatV apparent velocity pseudo-sections can be compared to ER apparent resistivity pseudo-sections. See e.g. https://pages.mtu.edu/~ctyoung/LOKENOTE.PDF chapter 2.3 on page 8. Quote : "The pseudosection is useful as a means to present the measured apparent resistivity values in a pictorial form, and as an initial guide for further quantitative interpretation. One common mistake made is to try to use the pseudosection as a final picture of the true subsurface resistivity."
- May 21, 2020 : write *DeltatV|DeltatV Settings|Regard mapping for shot offset correction* to .PAR file & restore from .PAR file
- May 21, 2020 : use larger font size for printing of axis legends and labels. Tested with HP OfficeJet Pro 8720 & Adobe PDF & CutePDF Writer printer drivers.
- May 21, 2020 : fixed printing Plus-Minus depth and velocity sections
- May 18, 2020 : new option *Mapping|Smooth CMP curves in Refractor|Midpoint Breaks*. Earlier builds regard *DeltatV|DeltatV Settings|Smooth CMP traveltime curves* for *Refractor|Midpoint breaks*.
- May 18, 2020 : initialize Surfer grid size same way as before Feb 27, 2020. This results in finer grids. You can always force the *grid cell size* in *Header|Profile*.
- May 18, 2020 : update *Grid|Surfer plot Limits|First station* & *Station interval* fields when user opens existing profile database with this latest version.
- May 18, 2020 : update *Grid|Surfer plot Limits|First station* after user imports (additional) shots.
- May 17, 2020 : as shown in our SAGEEP10 short course tutorials and our short manual we always recommend running our Smooth inversion as a first step during interpretation. Next you can try to improve the resolution by increasing the number of WET iterations and decreasing WET smoothing.
- May 17, 2020 : for typical field surveys with traveltime curves showing deep weathering and reciprocal traveltime picking errors and recording geometry errors always first use ***default Full WET smoothing***.
- May 17, 2020 : ***copying minimized WET smoothing settings optimized for one profile to another profile is not recommended and not supported***. Default full WET smoothing is determined automatically based on grid dimensions and velocity distribution in the starting model. Since these parameters are specific to each profile and starting model you need to always start with our Smooth inversion. Then you can try step-wise decreasing of WET smoothing.
- May 17, 2020 : ***if you decrease WET smoothing too much then you effectively prevent WET inversion from improving on the starting model***. This is true for any starting model : Plus-Minus, pseudo-2D DeltatV or 1D-gradient obtained with our *Smooth invert|WET with 1D-gradient initial model*.
- May 17, 2020 : you need to ***interactively adapt WET smoothing to your profile data*** (first breaks and recording geometry). Don't force some arbitrary smoothing copied from another profile and assume that this should just work with your current data. This is not supported.
- May 17, 2020 : for multi-run WET inversion of synthetic data as shown in SAGEEP11_16 tutorial you can decrease ***WET smoothing*** more than for single-run WET inversion of field surveys as shown e.g. in our new P6 tutorial. For P6 we leave WET smoothing at default *Full smoothing* and

increase the *WET iteration count* only, from default 20 to 100. But we keep using default *Ricker differentiation -1 [Gaussian]*, default *Steepest Descent search method* and default *Full smoothing*.

- May 8, 2020 : select which CPU cores are used for our application in Windows Task Manager
- May 8, 2020 : or specify CPU affinity with start /AFFINITY command in Windows Command Prompt. Determine the AFFINITY mask value in Windows Calculator in Programmer mode.
- May 8, 2020 : our Standard license can use up to 4 CPU cores for WET inversion. Our Pro license can use up to 16 CPU cores in parallel for faster WET inversion.
- May 8, 2020 : our Standard license can use up to 4 GB RAM under Windows 7/8/10 64-bit. Our Pro license can use up to 1 TB RAM under Windows 10 Pro 64-bit.
- May 6, 2020 : we have updated our brochure with latest specifications.
- May 3, 2020 : Díaz-Curiel et al. use WET inversion and dynamic probing super-heavy tests to determine dynamic moduli, stress–strain moduli relationships and bearing capacity for helipad construction (JAG Apr 2020)
- May 2, 2020 : Macklin et al. show Strain-dependent Stiffness of the Weathered Melbourne Formation (15th Australasian Tunnelling Conference 2014, Sydney) with downhole VSP and pressuremeter tests
- Apr 30, 2020 : updated free trial installer comes with latest help file and works with Surfer 18
- Apr 29, 2020 : updated help file chapter *Introduction*. Add popup help topics for new import options and Grid menu options. Refer to new tutorials.
- Apr 29, 2020 : for inspection of SEGY trace headers use SeiSee software. Also supports bandpass filter and flexible trace display.
- Apr 27, 2020 : our P6 tutorial shows fault zone imaging in Norway. Traveltime curves and results show gradual increase of velocity with depth below topography and deep weathering along fracture zone. This contrasts with the strictly Plus-Minus layered refraction assumption used by NGU for their modeling, with unrealistic abrupt velocity increase to over 4,000 m/s directly below thin weathering layer or topography. We have asked NGU to use more realistic models of weathered subsurface in future, with deep weathering. The modeled velocity should increase gradually with depth both in overburden and in basement. Of course the Plus-Minus method works best for synthetic data obtained by forward modeling over such strongly layered models.
- the SAGEEP 11 blind refraction model uses more realistic velocity gradients and deep weathering including a dipping fault zone, all of which are better modeled with diving waves and seismic refraction tomography than with strictly critically refracted rays used with classical refraction methods.
- (Hagedoorn 1959) already shows Fresnel volumes (seismic transmission volume) and gradual increase of velocity with depth both in basement and in overburden, resulting in curved rays and diving waves in Fig. 1 of his classical Plus-Minus refraction method paper.
- Apr 26, 2020 : describe how to obtain the .BLN file used for water layer blanking in our SR6 tutorial
- Apr 26, 2020 : show in SR6 tutorial how to call SEG2_EDIT utility to add source/receiver geometry to SEG-2 trace headers using supplied .TXT files
- Apr 24, 2020 : new option *File|Import Data Settings|Use bent line inline offset for shot pos. and layout start*. Check to use accumulated inline offset along bent line (regarding receiver x/y/z) to determine *Shot Pos.* & *Layout Start* in station numbers during SEG-2 & SEGY import. Check this option for our SR6 tutorial. This option is unchecked per default.
- Apr 21, 2020 : more accurately determine *shot pos.* and *layout start* in station numbers during SEGY import for slightly crooked lines as for SEG-2 import, with *File|SEGY import Settings|No receiver coordinates specified in .SGY file* unchecked or with *File|SEG-2 import Settings|Receiver Coordinates specified in .DAT or .SG2 file* checked
- Apr 20, 2020 : improved SEGY import now regards options *File|Import data Settings|Flip sign of X coordinate for all sources and receivers* & *Flip sign of Y coordinate for all sources and receivers*
- Apr 15, 2020 : updated **.BAS** Surfer scripts work with latest Surfer 18. Download & run Ray336_Scripts.exe on PC where you installed our version 3.36 software.
- Apr 15, 2020 : updated free trial installer works with Surfer 18

- Apr 15, 2020 : improved ***DeltatV static corrections***. *Surface-consistent corrections* per default instead of *CMP gather datum corrections*. Decreased default width of ***Topography filter*** used for surface-consistent corrections, from previous 100 to new 15 stations. This prevents over-correction of traveltimes in case of strongly undulating topography. Try disabling static corrections completely with option ***No static corrections*** in *DeltatV|Interactive DeltatV|Static Corrections* dialog.
- Apr 11, 2020 : show in SR6 tutorial how to map traces to refractor, determine *Plus-Minus method* layered refraction starting model and run WET inversion using this layered starting model
- Apr 7, 2020 : show in SR6 tutorial how to suppress velocity inversion artefact in WET tomogram by disabling scaling of WET *wavepath width* & *filter height*
- Apr 5, 2020 : our new SR6 tutorial shows WET inversion of shallow marine refraction data using multiple starting models. We show water layer blanking with sources above the refraction spread.
- Apr 5, 2020 : enable *WET Tomo|WET Velocity constraints dialog* even before running any inversion
- Mar 30, 2020 : added field *Use station index or station no. offset* to *Grid|Surfer plot limits* dialog. Check in case of irregular receiver spacing with *Grid|Receiver station ticks on top axis*, see below.
- Mar 28, 2020 : new Grid menu option ***Receiver station ticks on top axis***. Shows station numbers on top axis. Configure as in next bullet. On bottom axis we still always show horizontal inline offset.
- Mar 27, 2020 : added fields *First station* & *Station interval* to ***Grid|Surfer plot Limits*** dialog. Use these to specify first receiver station to be labeled, and the station interval to determine following stations to be labeled with ***Grid|Label receiver stations*** checked.
- Mar 25, 2020 : our Pro version now allows writing & reading Surfer .GRD files with up to 100,000,000 grid cells. Force the grid cell size in *Header|Profile* dialog.
- Mar 23, 2020 : added DeltatV starting model & WET inversion to Mt. Bulga tutorial. Show how to recognize dipping fault zone in common offset sorted raw traveltime plot before any inversion.
- Mar 20, 2020 : updated free trial installer
- Mar 18, 2020 : added DeltatV starting model & WET inversion to SAGEEP11 blind refraction tutorial. Show how WET inversion improves lateral offset errors in DeltatV. Also show how to visualize basement fault zone in CMP sorted raw traveltime data plot before running any inversion.
- Mar 14, 2020 : added DeltatV method interpretation to latest P6 tutorial . DeltatV based WET gives better match to raw traveltime plots than Plus-Minus & 1D-gradient based WET. Improved figure captions.
- Mar 14, 2020 : improve prompt if referenced spread type is missing from reference database. Prompt to import spread types from `MYSPREAD.SPR` in your profile directory.
- Mar 14, 2020 : improve prompt during time-to-depth conversion for layered refraction methods if basement refractor coverage is too short
- Mar 10, 2020 : our latest P6 tutorial shows fracture zone detection in bedrock. Also we show `.HDR` batch import of `SEG-2 .SG2` files with bad recording geometry in `SOURCE_LOCATION/RECEIVER_LOCATION` trace header fields. Also we show how to create your `COORDS.COR` with elevations.
- Mar 9, 2020 : check ***File|Import data Settings|Database transaction for whole import*** to use one database transaction covering the whole import routine including import of shot traces & updating of trace headers. This option is unchecked per default.
- Feb 29, 2020 : added button ***Reset top elevation*** to *Smooth invert|Custom 1D-gradient velocity profile* dialog. Resets field *Grid top elevation* to highest elevation of any source/receiver along profile.
- Feb 29, 2020 : support blanking of water layer with WET blanking option *Regard negative shot depth* checked and *Smooth invert|Smooth inversion Settings|Output inversion results in Feet* checked.
- Feb 25, 2020 : *Smooth invert* now blanks the initial `GRADIENT.GRD` model with `.BLN` blanking file selected in *WET Tomo|WET velocity constraints* dialog with option *Blank initial model* checked

- Feb 25, 2020 : added option ***Pad outside border*** in *WET Tomo|WET velocity constraints* dialog. This option is regarded if option *Pad polygon border* is checked only. Tested with TUNNEL16 tutorial. Uncheck *Pad outside border* to pad inside polygon border with *Pad polygon border* checked.
- Feb 23, 2020 : updated free trial installer
- Feb 23, 2020 : prompt to specify valid *weathering velocity v0* in *Header|Station* when user clicks button ***Correct breaks*** with *DeltatV|DeltatV Settings|Regard mapping for shot offset correction* checked or prompt to uncheck this option. *Refractor|Shot breaks|Mapping menu* shares the same option.
- Feb 19, 2020 : added button ***Redisplay Grid*** to *Grid|Surfer plot Limits* dialog. For older builds use *Grid|Image and contour velocity and coverage grids* instead.
- Feb 19, 2020 : *Grid|Surfer plot Limits* settings are not regarded when displaying the initial 1D-gradient or DeltatV starting model. To redisplay the starting model use above *Redisplay Grid* button and select …**\GRADTOMO\GRADIENT.GRD** or …**\TOMO\DELTATV.GRD** .
- Feb 19, 2020 : force the grid limits for the starting model using our *Smooth invert|Custom 1D-gradient velocity profile* dialog.
- Feb 18, 2020 : use *Surfer Grid Info* command (in Surfer 11 *Grid menu*) to display the grid cell size for …**\GRADTOMO\VELOIT20.GRD** etc. You can force the grid cell size in our *Header|Profile* .
- Feb 16, 2020 : fixed using option ***depth below topo*** in *DeltatV|Interactive DeltatV|Export Options*
- Feb 16, 2020 : alternatively use command ***Grid|Convert elevation to Depth below topography***. Image the converted **.GRD** with *File|Image and contour velocity and coverage grids*.
- Feb 10, 2020 : retry deleting flag files used for communication with Golden Software Scripter when plotting starting models & WET tomograms. Theses files may be locked by anti-virus scanner.
- Feb 10, 2020 : don't crash with *Trace gather* window(s) open when user confirms to continue with *WET inversion* using the layered refraction starting model obtained with Plus-Minus method etc.
- Feb 9, 2020 : uncheck ***DeltatV|DeltatV Settings|Weigh picks in CMP curves*** for short or low-coverage lines to avoid over-interpretation and artefacts. This helps for 1_1D DeltatV inversion & CLUD1 Smooth inversion with more realistic 1D-gradient starting model.
- Feb 9, 2020 : for long and high-coverage lines check ***DeltatV|DeltatV Settings|Smooth CMP traveltime curves & Suppress velocity artefacts***. These options are not recommended for short/low-coverage lines.
- Feb 9, 2020 : add exceptions for Windows Defender in Windows 10 Security Center, for root folder **C:\RAY32** and file **C:\RAY32\BIN\RAYFRACT32.EXE** to improve robustness of our app when plotting models in Surfer and when running WET inversion
- Feb 3, 2020 : updated tutorial NGUP1_1. In *Refractor|Shot breaks* check ***Mapping|Pick branch points between receivers*** & uncheck ***Automated updating of station V0*** before picking the branch points adjacent to shot positions.
- Jan 26, 2020 : *File|Import data Settings|Extrapolate receiver line coordinates* is checked whenever you (re)open a profile database. Uncheck to force *shot station* coordinates for offend shots to *shot point* coordinates listed in **SHOTPTS.SHO** .
- Jan 26, 2020 : restored *DeltatV* resolution when inverting NGU 1_1D synthetic data
- Jan 26, 2020 : show error prompt and exit our app when starting up under Microsoft Windows XP. Prompt to run under Windows 7/8/10 .
- Jan 16, 2020 : redetermine shot dx/dy/dz offset from *shot station* for not reimported shots, at end of import after automatic updating with **IMPSHOTS.SHO** . Next we redetermine *inline* and *lateral offset* from shot station for all shots in profile database.
- Jan 15, 2020 : adapt **.HDR** batch import so works with absolute shot point coordinates in shot records
- Jan 13, 2020 : store absolute shot point coordinates x/y/z in shot record in database. Previously we stored relative dx/dy/dz offset from *shot station* x/y/z in shot record only.
- Jan 7, 2020 : updated SAPRI12 tutorial : check ***Smooth invert|Smooth inversion Settings|No shot position checking*** if shot positions don't exactly match traveltime curve minima in *Refractor|Shot*

breaks display to avoid error prompts. Use this option as a last resort only to avoid bad interpretations.

- Jan 7, 2020 : regard lateral offset from extrapolated receiver line for shot points just outside first/last receiver station when determining SEG-2 shot station number
- Jan 2, 2019 : faster trace display in *Trace*|*Shot gather*
- Jan 2, 2019 : faster mapping of traces to refractors in *Refractor*|*Midpoint breaks* display
- Jan 2, 2019 : determine SEG-2 *Shot pos. [station no.]* more consistently regarding accumulated inline offset along receiver line
- Jan 2, 2019 : speed up caching of receiver geometry over all shot files contained in input directory selected in *File*|*Import Data*
- Dec 30, 2019 : updated help file chapter *Introduction*
- Dec 27, 2019 : Gaines et al. detect perched water bodies using surface-seismic time-lapse traveltime tomography (SEG 2010)
- Dec 25, 2019 : write new *WET Tomography Settings*|*Blank & Write* submenu flags to **.PAR** file
- Dec 24, 2019 : updated help file chapter *Seismic and header data import* : describe ***File*|*Import Data*|*Take shot record number from*** choices for *Import data type* SEG-2 .
- Dec 19, 2019 : to import SARA srl SEG-2 shot files which are named by time stamp : ***set File*|*Import Data*|*Take shot record number from*** to choice ***File Number***. Our latest 3.36 build will then sequentially number the imported shots, starting at *Shot no.* 1 as shown in *Header*|*Shot*.
- Dec 19, 2019 : with SEG-2 keyword SHOT_SEQUENCE_NUMBER specified in SEG-2 trace headers our import routine will use these values to number imported shots, with ***File*|*Import Data*|*Take shot record number from*** set to choice ***File Number***. Otherwise we number imported shots sequentially.
- Dec 19, 2019 : write a **.HDR** batch file in *File*|*Import Data* and edit the ***Shot no. in db*** in column 3 as you like. Then select the edited **.HDR** with button *.HDR batch* & click *Batch import* & *Import shots*.
- Dec 18, 2019 : make **.HDR** batch import more robust. Detect too long shot filenames in **.HDR** file when resulting in full file paths (including drive and directory) exceeding Windows limit of 260 characters.
- Dec 16, 2019 : we now quote *shot filenames* in **.HDR** batch files generated in *File*|*Import Data* with enclosing “”. Special filename characters including space chars. and column separators ':,; are preserved when running the **.HDR** batch.
- Dec 16, 2019 : we still support running old **.HDR** batch files with unquoted filenames in *File*|*Import Data*. But for these unquoted shot filenames we don’t allow space chars. and column separators.
- Dec 12, 2019 : more robust determination of *Shot no.* during **SEG-2** import : number shots sequentially if shot no. can’t be determined from *DOS file name* or SEG-2 *File number* or *Record number*.
- Dec 10, 2019 : write new *WET smoothing parameters* to **.PAR** file & restore from **.PAR** .
- Dec 9, 2019 : check *WET Tomo*|*WET velocity constraints*|*Blank initial model* to blank the starting model **.GRD** with *blanking file* selected in same dialog. Also check *Polygon blanking active*.
- Dec 7, 2019 : limit time zoom with **CTRL+F1** in *Refractor*|*Midpoint breaks* to 8 levels as previously.
- Dec 2, 2019 : our latest 3.36 build works fine under Windows 10 64-bit Pro, Nov 2019 update.
- Dec 2, 2019 : improved error prompt if bad velocity in grid during WET, with negative shot depth.
- Dec 1, 2019 : Storniolo shows Wetting Front Geometry and Fluid Migration in the Vadose Zone Using Surface Time-Lapse Seismic First-Arrival Tomography (Univ. of Tennessee, Knoxville 2012).
- Dec 1, 2019 : Frydenlund correlates SRT with ERT & borehole data (NTNU Trondheim 2017).
- Nov 27, 2019 : smooth weathering velocity for *Plus-Minus/Wavefront/CMP intercept-time refraction* using smoothing filter width *Overburden filter [station nos.]* specified using **ALT+M** in depth section.

- Nov 27, 2019 : check *Depth|Depth conversion Settings|Don't smooth weathering velocity* to skip smoothing of v0 during layered refraction interpretation with *Plus-Minus/Wavefront/CMP refraction*.
- Nov 23, 2019 : Zhang describes how to determine RQD from visual core inspection and from P-wave velocity measurement on intact core (in laboratory) & in-situ rock mass (in field).
- Nov 22, 2019 : updated free trial installer
- Nov 21, 2019 : *WET Tomo|WET tomography Settings|Force RAM allocation* now runs WET with *traveltime grid caching* enabled for even less available memory than for previous builds.
- Nov 20, 2019 : regard current setting of option *Conjugate Gradient* in main WET dialog when resetting *WET velocity smoothing* via *Reset* button. Set *Damping* to 0.9 and *Maximum velocity update* to 15% for *Conjugate Gradient* method. Set to 0.0 & 25% for *Steepest Descent* method.
- Nov 20, 2019 : don't assert with *WET wavepath scaling* and negative shot depth when re-selecting starting model. For earlier builds uncheck *WET Tomo|WET tomography Settings|Scale wavepath width*.
- Nov 17, 2019 : Toto et al. show fault characterization using ERT & SRT & seismic reflection & impressive geological evidence
- Nov 16, 2019 : if you start data import with *Import Shots* button in *File|Import Data…* but then don't import any shots using *End* or *Skip* buttons, the station coordinates in *Header|Station* will remain empty. See next bullet.
- Nov 16, 2019 : reimport automatically backed up coordinates with *File|Update header data|Update Station Coordinates* & **C:\RAY32\<your profile name>\BACKUP\COORDS.COR**
- Nov 15, 2019 : don't check geometry after generating **.HDR** batch file in *File|Import Data …*
- Nov 15, 2019 : *DeltatV|Interactive DeltatV|Static Corrections|Copy v0 from Station editor* works again, after using button *Correct breaks* in *Header|Station*. This is faster than DeltatV option *Automatically estimate v0* for long & densely recorded profiles. Map traces to refractors in *Refractor|Midpoint breaks*.
- Nov 13, 2019 : after mapping traces to refractors in ***Refractor|Midpoint breaks*** press button ***Correct breaks*** in *Header|Station* to correct picks for shot hole depth and shot point lateral offset. Now reopen *Refractor|Midpoint breaks* and remap traces, based on corrected picks. Now select *Depth|Plus-Minus*.
- Nov 13, 2019 : Terzic et al. show Fault Characterization and Dam Seismic Hazard Assessment (Terzic et al. 2019 GHD). See also their slide show showing combination of SRT with trenching.
- Nov 10, 2019 : *DeltatV|DeltatV Settings|Regard mapping for shot offset correction* with negative or positive *Shot depth* and layered subsurface for improved correction of your first break picks during *DeltatV inversion* and when computing the 1D-gradient starting model with *Smooth invert*.
- Nov 10, 2019 : improved checking of maximum allowed *CMP stack width* for *DeltatV inversion* and *Refractor|Midpoint breaks display*. Regard available RAM/virtual memory.
- Nov 10, 2019 : select *Refractor|Reset Midpoint breaks CMP stack width to default* if you increased the *CMP stack width* too much in **ALT+M** mapping dialog & the display does not open any longer.
- Nov 8, 2019 : we strongly recommend to use our ***1D-gradient starting model*** for WET inversion to avoid artefacts in the *DeltatV starting model*. See Nurul Nida et al. 2019 and Sheehan et al. 2005 and our .pdf reference chapters *DeltatV inversion* & *Smooth inversion* & *WET tomography*
- Nov 8, 2019 : for *DeltatV inversion* theory & usage recommendations see our 2011 paper.
- Nov 8, 2019 : faster validation of *DeltatV CMP stack width*. Automatically decrease stack width if not enough RAM available, for *Automatic DeltatV&WET inversion*.
- Nov 5, 2019 : Mapping sand and clay-filled depressions on a coastal chalk clifftop using gravity, SRT and borehole data for landslide hazard assessment in Normandy, France (Jacob et al. BRGM 2018)
- Nov 5, 2019 : improved contour level setup in **.BAS** Surfer scripts and tested with latest Surfer 17 Beta. Download & run `Ray336 Scripts.exe` on PC where you installed our version 3.36 software.

- Nov 2, 2019 : in *Refractor|Shot breaks* check ***Mapping|Regard mapping for shot offset correction*** for better correction of first breaks for negative shot depth for marine refraction surveys using our *DeltatV* & *Smooth inversion*.
- Nov 2, 2019 : the CmStick USB dongle driver / ***CodeMeter runtime version 6.90*** is not supported any longer under Microsoft Windows XP. See link for supported Windows versions.
- Nov 2, 2019 : if you need to run our latest software version 3.36 under Windows XP 32-bit we can build a custom version for you using CodeMeter runtime version 6.81.
- Nov 2, 2019 : *Grid|Blank polygon area in grid* works with both **`.GRD`** and blanking file **`.BLN`** specified in feet & *Smooth invert|Smooth inversion Settings|Output inversion results in Feet* checked .
- Nov 2, 2019 : increased default ***CMP stack width*** to max. 300 for *DeltatV|Interactive DeltatV* and max. 40 for *Refractor|Midpoint breaks*. Formula : stack width [in CMP's] = (profile length in stations)/5 .
- Nov 2, 2019 : more robust error handling when RAM memory allocation fails. Display prompt with clear message. Then shut down our app once the user clicks OK button.
- Oct 25, 2019 : check ***WET Tomo|WET tomography Settings|Blank|Regard negative shot depth*** for marine refraction surveys with sources above the receiver spread. See bullets dated Sep 22.
- Oct 25, 2019 : for marine refraction survey set *WET Tomo|Interactive WET tomography|Min. velocity* to e.g. 1,300 m/s to force the minimum velocity obtained in WET tomograms.
- Oct 25, 2019 : for marine refraction surveys blank the starting model with *Grid|Blank polygon area in grid* and the blanking file obtained with *Grid|Generate blanking file between sources and receivers*.
- Oct 25, 2019 : *WET Tomo|WET velocity constraints|Pad polygon border* is now unchecked per default.
- Oct 25, 2019 : to zoom traveltime curves in *Refractor|Shot breaks* press ALT+P. Edit *Minimum&Maximum station number* & *Maximum time*. Hit ENTER key to accept changes.
- Oct 19, 2019 : see new help .pdf for screen shots showing installation of Visual C++ 2017 runtime with **`raywn336.exe`** base installer used for installation of latest version 3.36 of our software
- Oct 19, 2019 : Ostrowski & Lasocki show landslide characterization using SRT and ERT (Porto 2018)
- Oct 16, 2019 : improved **`SEG-2`** & Geometrics PlotRefa **`.VS`** import with import options *Allow missing traces* & *Adjust Receiver station coordinates* both checked & when not re-importing all shots.
- Oct 16, 2019 : don't allow toggling import options in *File|Import data Settings* submenu when shots have been imported already. Prompt the user to export and backup header data & select *File|Reinitialize Profile* & reenter *Header|Profile* info & then adjust import options from their defaults. This is required to ***prevent corruption of the profile database & recording geometry***.
- Oct 16, 2019 : more robust *WET inversion* with *Ricker differentiation* set to -2 *[Cosine-Squared]*. Prevent *math exception prompts* with pow function. Dismiss these with *OK button* for older builds.
- Oct 9, 2019 : as a rule of thumb set *DeltatV|Interactive DeltatV|CMP curve stack width [CMPs]* to ***(line length in station numbers)/5***. E.g. with line length of 500m assuming a *Station spacing* of 2m set *CMP curve stack width* to 50. For line length of 2km set to 200. With a station spacing of 4m set to (line length in meters)/20. But set to at least 20, especially for short receiver spreads.
- Oct 7, 2019 : updated topic *Edit velocity smoothing* in help file chapter *WET tomography processing*. Use latest `winhelp.exe` installer. Also updated chapters *Commands* & *Seismic and header data import* & *Pseudo-2D DeltatV inversion* : improved description of interactive DeltatV parameters.
- Oct 7, 2019 : updated SAPRI12 tutorial showing import of **`SeisImager PlotRefa .VS`** . In *Trace|Shot gather* check *Processing|Show dead traces* so you can repick shot no. 8 as described in the tutorial.
- Oct 7, 2019 : our CLUD1 tutorial shows import & Smooth invert of Optim® SeisOpt @2D data files

- Oct 6, 2019 : Zelt et al. 2013 compare refraction tomography software using synthetic data for a known fault model.
- Oct 6, 2019 : Jacob et al. use gravity, SRT and borehole data to map sand and clay-filled depressions on a coastal chalk clifftop for landslide hazard assessment (BRGM 2018)
- Oct 6, 2019 : added check box ***No smoothing*** in *WET Tomo|Interactive WET tomography|Edit velocity smoothing dialog*. Click this button to completely disable *WET smoothing*. See next bullet.
- Oct 6, 2019 : for older 3.36 builds ***completely disable WET smoothing*** as follows : set *Smooth nth iteration : n* = to 100 and uncheck both *Smooth velocity update* & *Smooth last iteration*.
- Oct 6, 2019 : updated **TUNNEL16 HoleTomo Mar14.RAR** archive with latest version 3.36 **.GRD** & **.PAR** files. This archive is referenced from our updated **TUNNEL16** tutorial.
- Oct 5, 2019 : for theory of WET inversion see Schuster 1993 paper .
- Oct 1, 2019 : renamed WET smoothing option *Smooth velocity update* to *Smooth update*. Check to smooth velocity update for every WET iteration. Added option *Smooth nth* to smooth velocity update for each nth iteration only. Renamed option *Smooth last iteration* to *Smooth last*. *Smooth velocity update* is per default enabled & *Smooth nth* per default disabled.
- Sep 29, 2019 : improved robustness of **SEG-2** import. Commas "," in number strings read from **SEG-2** trace headers are converted to decimal points ".".
- Sep 29, 2019 : *WET velocity update* now is smoothed for each nth iteration only. This can improve the lateral resolution in WET tomograms e.g. for our 1_1D tutorial with *Smooth nth iteration* set to 35.
- Sep 28, 2019 : when toggling *File|Import data Settings|Default Layout start is 1* with *Allow missing traces* checked you need to *File|Reinitialize Profile* before reimporting shots to avoid shot point geometry errors
- Sep 25, 2019 : improved *WET velocity constraints* polygon blanking
- Sep 25, 2019 : improved *WET smoothing* when *WET velocity constraints* polygon blanking is activated
- Sep 25, 2019 : *Grid|Blank polygon area in grid* now regards the blanking flag in 2nd column of **.BLN** header line. Set to 1 to blank inside & 0 to blank outside. Edit blanking velocity in 3rd column. Our earlier software builds regards *WET Tomo|WET velocity constraints|Blank outside polygon* instead.
- Sep 22, 2019 : ***Grid|Generate blanking file between sources and receivers*** writes Surfer format **.BLN** blanking file to disk with polygon of area between sources and receivers. The ***blanking velocity*** in header column no. 3 is set to 1,500 m/s. Use for water layer blanking for marine surveys with sources positioned above the receiver spread. Specify negative shot hole depths in *Header|Shot* or in **SHOTPTS.SHO** to move sources above receiver spread.
- Sep 22, 2019 : in *WET Tomo|WET velocity constraints* dialog click button *Select blanking file* & select above **.BLN** and check box *Polygon blanking active*. Click button OK to confirm.
- Sep 22, 2019 : *Grid|Generate blanking file between sources and receivers* writes coordinates to the **.BLN** blanking file in feet with *Smooth invert|Smooth inversion Settings|Output inversion results in Feet* checked
- Sep 22, 2019 : when writing **GRADIENT.GRD** and **DELTATV.GRD** starting model grids we automatically extend these grids upwards to include all sources with negative shot hole depths
- Sep 14, 2019 : Himi et al. image landslides with ERT and SRT to determine sliding surfaces and internal landslide structure (EAGE NSG Porto 2018)
- Sep 14, 2019 : *File|Update header data|Delete all first breaks for all shots* deletes all first break picks from your profile database
- Sep 14, 2019 : *File|Update header data|Update First Breaks* deletes shot picks for all shots listed in your selected **BREAKS.LST** before updating shot traces with picks as listed in your **BREAK.LST**
- Sep 14, 2019 : our **SEG-2** import now determines *Layout start* and *Shot pos.* in station numbers based on 3D inline offsets instead of offset along major coordinate. This helps with curved lines.
- Sep 14, 2019 : more robust **SEG-2** import truncates field **ACQUISITION_TIME** to 15 characters before writing to profile database. All other string type **SEG-2** header values are also truncated if too long.

- Sep 9, 2019 : in *Trace*|*Shot gather* display check *Processing*|*Show dead traces* to display dead/missing traces. These are always shown with earlier builds of our software. Reimport your **SEG-2** shots with *File*|*Import data Settings*|*Allow missing traces* & *File*|*SEG-2 import settings*|*Receiver Coordinates specified in .DAT or .SG2 file* checked to suppress display of dead traces.
- Sep 9, 2019 : if *Processing*|*Show dead traces* is unchecked in *Trace*|*Shot gather* etc. then we do not allow picking of dead traces, neither with left mouse button click nor with polyline picking
- Sep 3, 2019 : we now support import of x/y/z coordinates specified in SEG-2 trace headers for **SOURCE_LOCATION** and **RECEIVER_LOCATION** keywords. Separate x, y and z coordinates by one or more space characters. Check *File*|*SEG-2 import settings*|*Receiver Coordinates specified in .DAT or .SG2 file* and *File*|*Import data Settings*|*Allow missing traces* to enable this x/y/z coordinate import.
- Sep 3, 2019 : use SEG2_EDIT http://pubs.usgs.gov/of/2003/ofr-03-141/ to add **SOURCE_LOCATION** and **RECEIVER_LOCATION** fields to SEG-2 trace headers.
- Sep 3, 2019 : ***File*|*Update header data*|*Update Receiver Coordinates*** lets you update profile database trace headers with receiver x/y/z specified in columns 6/7/8 of **BREAKS.LST** file. Also we will re-determine receiver station x/y/z coordinates by averaging receiver coordinates linked to that station by common *station number*.
- Sep 3, 2019 : export *receiver x/y/z* coordinates into columns 6/7/8 of **BREAKS.LST** with *File*|*Export header data*|*Export First Breaks* with option *File*|*Export data Settings*|*Export receiver coordinates to .3DD and .LST* checked
- Aug 19, 2019 : use SEG2_EDIT http://pubs.usgs.gov/of/2003/ofr-03-141/ to stack traces in **SEG-2** formatted shot files
- Aug 16, 2019 : better diagnose ***too short basement refractor coverage*** with *Plus-Minus* method
- Aug 16, 2019 : don't allow *WET Tomo*|*Interactive WET Tomo*|*Ricker differentiation* of 1 *[once differentiated Ricker wavelet]* if user actives multirun WET with *Iterate button*
- Aug 15, 2019 : *Header*|*Receiver* dialog now shows both *Station coordinates* x/y/z and *Receiver coordinates* x/y/z. Station coordinates are copied from *Header*|*Station* for same *Station number* while Receiver coordinates are the x/y/z imported from *shot file*.
- Aug 12, 2019 : we have uploaded input files for our sinkhole tutorial Tyler Line1 . Also we have reprocessed this data with our latest 3.36 Standard software.
- Aug 12, 2019 : our Rayfract® software offers multiple interpretation methods and parameters to explore the non-uniqueness of the solution space. It is the user's job to sufficiently explore the solution space with our methods and varying parameters, and to find an appropriate combination of methods and parameters for each individual data set. This choice may be guided by a-priori information e.g. from boreholes or other geophysical methods. For good parameter combinations see our tutorials, our short manual and our SAGEEP 2010 short course. We recommend to always first run our *Smooth inversion* method with *1D-gradient starting model*. Next you can increase the *WET iteration count* to 100 in *WET Tomo*|*Interactive WET*.
- Aug 10, 2019 : Grelle and Guadagno determine WSI Water Seismic Index from P-wave and S-wave surveys along the same line to better map the groundwater table (Journal of Applied Geophysics 2009)
- Aug 5, 2019 : better regard *forced grid cell size* specified in *Header*|*Profile* for initial model
- Aug 2, 2019 : Manning shows karst imaging over igneous basement correlated with GPR interpretation in his AGU 2019 poster & Youtube video (Texas A&M University 2019)
- Aug 1, 2019 : we per default check again option ***Blank below envelope after last iteration*** in menu *WET Tomo*|*WET tomography Settings*|*Blank* for more reliable imaging at bottom of tomogram
- July 28, 2019 : Mendieta shows Seismic Refraction and Electrical Resistivity Tests for Fracture Induced Anisotropy in a Mountain Watershed (Mendieta Master Thesis 2017 Boise State Univ.)
- July 28, 2019 : Benjumea et al. use our *WET inversion* to reconstruct 3D image of the Emporda Basin (Benjumea et al. EUREGEO 2015 Proceedings pp. 29-31)
- July 26, 2019 : updated tutorial CFE15.pdf : check *WET Tomo*|*WET tomography Settings*|*Blank*|***Blank outside borehole tomogram*** before running *Smooth invert* and *WET Tomo*|*Interactive WET*

- July 26, 2019 : updated our latest Walkaway19 tutorial : show forcing of *grid cell size* to 0.2m and describe how to pick the topography *blanking file* in Surfer
- July 25, 2019 : as shown by (Watanabe 1999, Fig. 4) for crosshole surveys, it is not possible to reliably image seismic subsurface velocity at a resolution much smaller than one wavelength of dominant frequency of the first break pulse. E.g. with 100 Hz and basement velocity of 4,000 m/s, one wavelength is 4000/100 = 40m. In case of bad or noisy picks and recording geometry errors, resolution may not be better than two wavelengths. For refraction surveys, resolution at bottom and edges of tomogram is further reduced, because here rays and wavepaths are aligned predominantly parallel to each other (White 1989). In our 1_1D tutorial we are imaging fault zones not wider than 10m @ 4,000 m/s. This is far below one wavelength of 40m, see above.
- July 25, 2019 : the minimum-structure **smooth 1D starting model is recommended for robust WET inversion of lines shorter than 0.5 km**, to prevent artefacts caused by the starting model (Sheehan et al. 2005, Fig. 1) and to prevent our WET inversion getting stuck in a local minimum of the traveltime misfit function (Schuster 1993, Equation 1). See our SAGEEP11 presentation, thrust12, epikinv, mtbulga tutorials etc.
- July 25, 2019 : disable *DeltatV|DeltatV Settings|Suppress velocity artefacts* per default. This gives better vertically resolved 1D-gradient starting model when trying to image LVL Low-Velocity-Layers e.g. for our GS0801 and COFFEY04 tutorials. See bullets dated July 1 & July 6th, 2019.
- July 24, 2019 : our latest 3.36 software works fine under Windows 10 64-bit Pro May 2019 update
- July 18, 2019 : don't cache *initial model* **.GRD** any longer & always re-read initial model **.GRD** from disk to (re)determine the width and height of *WET smoothing filter* for *full/minimal smoothing*
- July 15, 2019 : check *WET Tomo|WET tomography Settings|Write|Keep WET smoothing record in database* to keep WET smoothing settings when user changes *grid cell size*. The WET smoothing *filter size* is updated based on the initial model's cell size during next WET inversion except if the user selected *Edit velocity smoothing|Manual smoothing* earlier.
- July 14, 2019 : update *WET velocity smoothing filter size* in database when user (re)selects initial model grid in *WET Tomo|Interactive WET tomography* except if she selected *Edit velocity smoothing|Manual smoothing* earlier
- July 14, 2019 : compare stored *weathering velocity v0* with edited v0 in *Header|Station* with two decimal digits precision to prevent spurious prompts about 'Changed station coordinates'
- July 9, 2019 : reset *WET velocity smoothing* and delete starting model grids when user imports shots or updates header data with station coordinates or shot point coordinates.
- July 8, 2019 : delete …**\HOLETOMO\CONSTVEL.GRD** starting model when user changes/forces *grid cell size* in *Header|Profile*.
- July 8, 2019 : reset *WET smoothing* to defaults and force re-determination of *WET smoothing* when user changes/forces *grid cell size* in *Header|Profile*.
- July 8, 2019 : for earlier builds of our software : after you change/force the *grid cell size* in *Header|Profile* determine a new starting model with *Smooth invert*. Now review and accept WET smoothing in *WET Tomo|Interactive WET tomography|Edit velocity smoothing*. Edit the smoothing as required and click *Accept parameters button*.
- July 6, 2019 : for our COFFEY04 tutorial decrease *WET wavepath width* to 2% or 2.5% from default 3.5%. Uncheck *Disable wavepath scaling for short profile*. Don't *suppress DeltatV velocity artefacts* for 1D-gradient starting model obtained with *Smooth inversion*. These settings give better vertical resolution and show low-velocity layers LVL as in above tutorial in Fig. 1.
- July 5, 2019 : our latest tutorial shows reprocessing of Walkaway VSP data with version 3.36
- July 2, 2019 : *File|Import data Settings|Reset all Import Data settings to default value* resets new import options and *File|Import Data* dialog controls
- July 1, 2019 : we tested our new **GeoTomCG .3DD** import into *Line type* **Refraction spread/line** with our tutorial data OT0608, GEOXMERC and GS0801 after export to **.3DD**. Set *Ricker differentiation* to 1, decrease *WET wavepath width* to 2% from default 4% and uncheck *Adapt filter shape* in *Edit velocity smoothing* for GS0801 to better image the low-velocity layer LVL in the landslide.

- July 1, 2019 : check new options *File*|*Customize spread types*|*Customize Default spread type* and ***One spread per shot*** when receiver coordinates vary over time in the same spread layout between shots such as in marine streamer surveys
- July 1, 2019 : use new options *File*|*Import data Settings*|*Flip sign of X coordinate for all sources and receivers* and *Flip sign of Y coordinate for all sources and receivers* with import of **`GeoTomCG .3DD`** if you want to turn around the line during import. We automatically determine the major coordinate as X or Y coordinate depending on which increases faster along the line.
- June 28, 2019 : we increased the default value for parameter ***Maximum tolerance*** to 70 percent in *File*|*Update header data*|*Update Station coordinates* dialog. This helps with import of **`GeoTomCG .3DD`** files into profiles with *Header*|*Profile*|*Line type* **`Refraction spread/line`** profiles.
- June 27, 2019 : we now allow **`GeoTomCG .3DD`** import into profile with *Line type* **`Refraction spread/line`** and regard y coordinates for refraction lines
- June 27, 2019 : check *File*|*Import data Settings*|*Y coordinate is zero 0.0* to reset y coordinates to zero when importing **`GeoTomCG .3DD`** files
- June 27, 2019 : check ***File*|*Import data Settings*|*Customize Default spread type*** to automatically customize selected *Default spread type* to match irregular receiver layout with missing traces. Enabling this option will cause database revision to fail when opening this profile with earlier 3.36 or earlier version of our software. Enabling this allows more accurate modeling of recording geometry and receiver positions.
- June 19, 2019 : updated Walkaway tutorial with download link for input data
- June 18, 2019 : fixed assertion failure when importing SEG-2 shots into *Line type* **`Borehole spread/line`** without coordinates specified in SEG-2 files. Click *Ignore button* to skip these prompts.
- June 16, 2019 : we now show the ***Ray Id*** in *Header*|*Receiver* after import of `GeoTomCG .3DD` shots
- June 16, 2019 : Petronis et al. image a volcanic cone with SRT and ERT
- June 14, 2019 : enable *DeltatV*|*DeltatV Settings*|*Suppress velocity artefacts* per default
- June 14, 2019 : disable *WET Tomo*|*WET tomography Settings*|*Blank*|*Blank below envelope after last iteration* per default when creating a new profile or when resetting WET tomography settings
- June 13, 2019 : updated recommendations on last page of P1_6-7DGrad tutorial. We recommend to always first run our *Smooth invert*|*WET with 1D-gradient initial model* method. Next you can increase the ***WET iteration count*** and decrease ***WET smoothing*** in *WET Tomo*|*Interactive WET tomography*. Try both ***Steepest Descent*** and ***Conjugate-Gradient*** methods.
- June 13, 2019 : we now correctly re-determine the *Shot station no.* with ***File*|*Import Data*|*Turn around spread*** checked. This helps with import of SEG-2 streamer data.
- June 10, 2019 : Advisian et al. show groundwater exploration with ERT and SRT (Advisian 2016)
- June 7, 2019 : delete **`…\GRADTOMO\GRADIENT.GRD & DLTAGRAD.GRD`** starting models when importing shots, except when importing synthesized/extrapolated far-offset shots during layered refraction interpretation with Plus-Minus and Wavefront methods
- June 5, 2019 : added Fig. 16 to our 1_1D tutorial showing our new option ***No smoothing***. This option makes it easier to completely disable WET smoothing. Enabled *No smoothing* option overrides all other parameters in *Edit velocity smoothing* dialog except *Maximum velocity update* and *Damping*.
- June 3, 2019 : if *File*|*Import data Settings*|*Adjust Receiver station coordinates* is not checked we prompt the user to confirm re-centering receiver stations if one or more receivers are offset from their receiver station, at end of import
- May 30, 2019 : check *File*|*Import data Settings*|*Adjust Receiver station coordinates* to ***re-center all receiver stations at average of coordinates for all receivers linked to each station*** at end of import. This helps with importing irregularly spaced streamer data. Tested with SEG-2 streamer shots.
- May 30, 2019 : *File*|*Reinitialize profile* resets profile to initial state. All imported data, first break picks, recording geometry and results are permanently deleted from the profile.
- May 29, 2019 : check *File*|*Import data Settings*|*Check all shots for station spacing* to check all shot files in input directory if they suggest adjustment of the profile's *Station spacing*. Uncheck to check first shot file only.

- May 27, 2019 : support again importing multiple **PlotRefa .VS** and **GeoTomCG .3DD** files into same profile and in same *File|Import Data* session
- May 26, 2019 : check *File|Export data Settings|Export receiver coordinates to .3DD and .LST* to export receiver coordinates specific to each trace. Uncheck to export *receiver station coordinates* which are averaged over all receivers linked to this station.
- May 26, 2019 : our *File|Import Data* now scans all shot files with same *file format* as the selected file in input directory and caches the receiver geometry for all shots. We then map receiver coordinates to station numbers. In a 2nd pass these shots are actually imported into the profile using these station numbers. Tested for **SEG-2** & **GeoTomCG .3DD** & **PlotRefa .VS** file formats.
- May 23, 2019 : we now display *weathering velocity v0* with 4 decimal digits in *Header|Station*
- May 20, 2019 : for detailed help with Golden Software Surfer Automation error messages see https://support.goldensoftware.com/hc/en-us/articles/360006089653-Surfer-Automation-Errors
- May 20, 2019 : also see our .pdf reference on page 208 and our *Help|Contents|Calling Surfer*
- May 20, 2019 : prompt once only during import/for first input file to adjust profile's *Station spacing*
- May 20, 2019 : to not prompt at all to adjust the *station spacing* : uncheck *File|Import data Settings|Adjust profile station spacing* before selecting *File|Import Data*
- May 19, 2019 : we now show imported receiver x/y/z coordinates and receiver offset from receiver station dx/dy/dz in ***Header|Receiver*** dialog
- May 19, 2019 : at end of our import routine we now ***re-center receiver stations*** at average of all actual *receivers* linked to that station. We update receiver dx/dy/dz to offset from repositioned station.
- May 19, 2019 : use *File|SEG-2 import settings|Flip sign of x coordinate for all sources and receivers* if **SOURCE_LOCATION** and **RECEIVER_LOCATION** SEG-2 trace header fields don't increase with increasing **CHANNEL_NUMBER** field
- May 19, 2019 : use *Grid|Turn around grid file by 180 degrees* to flip back resulting tomograms
- May 19, 2019 : updated free trial installer
- May 19, 2019 : fixed **Interpex Gremix .GRM** import for free trial with *Allow missing traces* checked
- May 16, 2019 : we have improved our SEG-2 and GeoTomCG **.3DD** import routines and now better support import of irregular receiver spreads with import option ***Allow missing traces*** and SEG-2 option ***Receiver geometry specified*** checked
- May 16, 2019 : we tested our improved SEG-2 import with a marine hydrophone streamer survey recorded using ***Geometrics GeoEel*** streamer
- May 3, 2019 : we support import of GeoTomCG **.3DD** files picked & exported from REFLEXW
- May 3, 2019 : to import GeoTomCG **.3DD** into *Line type* **Refraction spread/line** first check *File|Import data Settings|Import horizontal borehole survey or .3DD refraction survey*. We assume that all y coords. in **.3DD** files are 0.0 .
- Apr 28, 2019 : when you change the *Shot pos. [station no.]* interactively or via **.HDR** batch file during import with *File|Import Data…* we now automatically update the shot x/y/z coordinates in the **IMPSHOTS.SHO** file after interpolating coordinates for all profile stations at end of import
- Apr 28, 2019 : if you want to edit **IMPSHOT.SHO** first copy it to e.g. **MYSHOTS.SHO** and then edit **MYSHOTS.SHO** and apply with *File|Update header data|Update Shotpoint coordinates*. Our import routine called via *File|Import Data…* overwrites **IMPSHOTS.SHO** each time again.
- Apr 21, 2019 : Savelli et al. investigate landslide with SRT and sediment core
- Apr 21, 2019 : try running our software under Windows 7 64-bit. While our software also works fine under Windows 10 64-bit our *WET inversion* runs about 20% faster under Windows 7 64-bit.
- Apr 21, 2019 : fixed **RECEIVER_LOCATION** values in jenny13.zip SEG-2 **.DAT** files. Deleted extra channels 25 to 48. The fixed **.DAT** files can be imported without issues with our version 3.35 and 3.36.
- Apr 18, 2019 : *File|Import data Settings|Allow missing traces* now is regarded for SEG-2 import if *File|SEG-2 import settings|Receiver Coordinates specified in .DAT or .SG2 file* is checked only
- Apr 18, 2019 : updated free trial installer

- Apr 17, 2019 : *File|Update header data|Update Shotpoint coordinates* accepts again abbreviated **`SHOTPTS.SHO`** files with last column **`upholeTime`** as with version 3.35. See **`\RAY32\DOC\SHORTPTS.SHO`**.
- Apr 16, 2019 : before SEG-2 import into profile jenny13 uncheck *File|Import data Settings|Allow missing traces*. Set *Default spread type* to **`01: 24 channels`**. Otherwise *Smooth inversion* etc. will not work for this profile due to invalid/extra receiver positions and channels in the **`.SG2`** trace files.
- Apr 10, 2019 : Bottari et al. map fault zone with ERT, SRT, GPR, magnetic data and cluster analysis
- Apr 10, 2019 : Bottari et al. investigate landslides with ERT and SRT
- Apr 10, 2019 : updated P1_6-7DGrad tutorial. Fig. 15 shows *Smooth inversion Settings*.
- Mar 27, 2019 : write *Conjugate Gradient* iteration no. & *Line Search* iteration no. to **`.STX`** file
- Mar 26, 2019 : updated 1_1D tutorial; added Fig. 9 showing true model as built by NGU in Fig. 3.1.1
- Mar 26, 2019 : updated P1_6-7DGrad tutorial. Fig. 9 shows true model used by NGU in Fig. 3.1.1 .
- Mar 22, 2019 : our latest tutorial shows ***Conjugate-Gradient WET inversion using 1D-gradient starting model*** for NGU 2018 P1_6-7D synthetic fault zone model.
- Mar 12, 2019 : we now normalize the absolute RMS error with average picked time instead of maximum picked time, over all traces modeled. This results in larger normalized RMS errors.
- Mar 12, 2019 : check *Model|Forward modeling Settings|Normalize RMS error with maximum picked time* to normalize RMS error with maximum picked time
- Mar 12, 2019 : *File|Update header data|Update Geometry* supports again **`.PRN`** files with 3 columns : station no, z coordinate, x coordinate. See your **`\RAY32\DOC\5.PRN`** sample survey geometry file.
- Mar 12, 2019 : allow for missing shot depth in Interpex Gremix **`.GRM`** file
- Mar 11, 2019 : Skenderija investigates mass movement in quarry using ERT and SRT (Zagreb 2018)
- Mar 11, 2019 : Hauck & Hilbich estimate ice content in rock slide using ERT and SRT (Fribourg 2018)
- Mar 6, 2019 : latest CodeMeter & WibuKey drivers are available at this updated URL
- Mar 4, 2019 : changed *Midpoint breaks mapping* parameters *Regression Receiver Count*, *Direct Wave Delta*, *Refracted Wave Offset Delta* from defaults 2/2/3 back to 3.35 defaults 3/3/5. This makes estimation of weathering velocity less susceptible to bad picks or geometry errors at source.
- Mar 4, 2019 : above parameter *Regression Receiver Count* is regarded to determine the weathering velocity used during *DeltatV+XTV* inversion for static correction of first breaks
- Mar 4, 2019 : deleted an unnecessary reference to Visual C++ 2005 runtime from our app rebuilt in Visual Studio 2017. Now our updated app can run without Visual C++ 2005 redistributable installed.
- Mar 3, 2019 : our latest tutorial shows ***Conjugate-Gradient WET inversion using DeltatV+XTV starting model*** for NGU 2018 P1_6-7D synthetic fault zone model. We optimized DeltatV+XTV and WET inversion settings to more clearly image overburden and double fault zone and minimize artefacts.
- Feb 20, 2019 : Valois et al. assess sinkhole geometry using ERT and SRT
- Feb 20, 2019 : Avalos et al. image a buried bedrock valley with SRT using cores and wells
- Feb 18, 2019 : Tomás et al. investigate a landslide with LiDAR, boreholes, GPR and SRT (2018)
- Feb 18, 2019 : Ostrowski & Lasocki show landslide characterization using SRT and ERT (Porto 2018)
- Feb 18, 2019 : Ostrowski et al. show fault zone imaging using SRT (EAGE NSG Barcelona 2016)
- Feb 14, 2019 : fixed extrapolation of basement refractor elevation below first profile receiver with our ***CMP Intercept-time*** layered refraction method. First map traces to refractors in *Refractor|Midpoint breaks* display to enable this *Depth menu* item. See our help chapter *Mapping traces to refractors*.
- Feb 9, 2019 : clear error message if ***Trace|Shot gather*** fails to load traces from a corrupt database. Ask user to reimport shots into a new profile database. This will happen if you open a profile

database with version 3.26 or later of our software and next open the database with version 3.25 or earlier. We changed the sample format from 16-bit integer to 32-bit floating point for version 3.26.

- Feb 6, 2019 : ported our Standard and Pro software to ***Visual Studio 2017 & Visual C++ 14***. WET inversion now runs up to 25% faster than in version 3.35 also thanks to Profile-Guided Optimization.
- Feb 6, 2019 : to run our latest version 3.36 under Windows 7 64-bit Pro & Windows XP SP3 download & install Visual C++ 2017 redistributable. This is not needed for Windows 10.
- Feb 6, 2019 : fixed a bug which caused our *Refractor|Shot breaks* display to crash occasionally. For earlier builds of our software press **ALT+Y** to refresh this display.
- Jan 28, 2019 : access our extensively hyper-linked help file via our Help menu. Use ***Help menu Contents item*** to browse our help file chapters with embedded links to *DeltatV* and *WET parameters*. Or use ***Help menu item Search for Help On*** to search our help file for a parameter name and description.
- Jan 28, 2019 : for popup help describing interactive *DeltatV/XTV/WET parameters* use TAB key to navigate to interesting parameter field e.g. in *WET main dialog* & in *WET smoothing dialog*. Next press **F1 key** to obtain ***popup help window*** describing this parameter
- Jan 25, 2019 : see our new documentation ConfigureAWEforPro.pdf for how to enable use of memory above 4 GB limit for our Annual or Permanent Pro license
- Jan 23, 2019 : when working through our latest tutorials in **TUTORIAL.ZIP** be sure to force the ***grid cell size*** in *Header|Profile* e.g. to 0.4m as in 1_1D tutorial. ***WET smoothing filter dimensions half-width and half-height*** are specified in grid columns&rows having the extent of one grid cell.
- Jan 23, 2019 : when you activate ***Conjugate Gradient*** method in *WET Tomo|Interactive WET tomography* the total number of *WET iterations* is determined with the two Conjugate-Gradient specific controls ***CG Iterations*** (outer loop) : 10 per default and ***Line Search iters.*** (inner loop) : 2 per default. This results in 32 *WET iterations* total per default. Field *Number of WET iterations* is ignored for Conjugate Gradient. See also http://www.cs.cmu.edu/~quake-papers/painless-conjugate-gradient.pdf on page 53 : algorithm B5 (Shewchuk 1994). One f'(x) evaluation is done with one WET iteration.
- Jan 9, 2019 : run our BasConvrt.exe installer to update your old Surfer script versions of **AUTOTOMO.BAS** & **DELTATV.BAS** e.g. coming with our version 3.21 so these can work with Golden Software Surfer 11
- Jan 3, 2019 : prompt if **SEGY .SGY** file has bad fields **NS** (number of samples) or **DT** (sample interval) in binary file header. Use **DT** value specified in first trace header if bad **DT** value in file header.
- Dec 31, 2018 : speed up resetting temporary grids to zero or blank value during *WET inversion*
- Dec 30, 2018 : speed up *WET inversion* during iterations with no smoothing
- Dec 28, 2018 : for help on calling Surfer via Scripter see goldensoftware.com tips
- Dec 27, 2018 : added radio button ***No smoothing*** in *WET Tomo|Interactive WET tomography|Edit velocity smoothing dialog*. Click this button to completely disable *WET smoothing*. See next bullet.
- Dec 23, 2018 : to ***completely disable WET smoothing*** set *Smooth nth iteration : n* = to 100 and uncheck *Smooth last iteration* in *WET Tomo|Interactive WET tomography|Edit velocity smoothing*. We showed this in our tutorial sageep11_16.pdf in Fig. 14 in 2016 already for *Conjugate-Gradient multiscale WET inversion*. This also works for our tutorial 1_1D .
- Dec 19, 2018 : updated instructions on how to uninstall and reinstall green WibuKey driver
- Dec 18, 2018 : review install3.36.pdf showing installation of our version 3.36 software under Windows 10 64-bit. Be sure to first disable all of your antivirus software including Windows Defender.
- Dec 16, 2018 : Himi et al. use ERT, SRT and EMT to image seepage and mortar injection zones in an earthen dam (Univ. Barcelona 2018)
- Dec 14, 2018 : limit *WET envelope width* to *WET wavepath width* during ***multirun WET***
- Dec 8, 2018 : Jacob et al. use gravity, SRT and borehole data to map sand and clay-filled depressions on a coastal chalk clifftop for landslide hazard assessment (BRGM 2018)

- Dec 8, 2018 : prompt user if **SEG-2 UNIT** field specifies **FEET** and *Header|Profile|Units* says meter. Ask user to check *File|SEG-2 import settings|Get distance unit from user* and to check *File|Import Data Settings|Default distance unit is meter*.
- Dec 7, 2018 : fixed forcing of *Grid cell size* in *Units* **feet** in *Header|Profile*
- Dec 7, 2018 : added buttons *OK/Cancel/Reset* to *WET Tomo|Coverage plot setup dialog*
- Dec 3, 2018 : added two controls to *WET Tomo|Coverage plot setup dialog* to ***sharpen wavepaths in coverage plot*** : edit *Raise wavepath weight to power* to any value between 0.0 and 100.0. Check box *Sharpen wavepaths active* to enable sharpening of wavepaths. With *Sharpen wavepaths active* unchecked we plot wavepaths as in previous versions of our software.
- Dec 3, 2018 : added two controls to *WET Tomo|WET Update weighting* to ***decrease WET velocity update in high-coverage areas*** of tomogram to ***reduce horizontal smearing artefacts*** : edit ***Velocity update power*** to any value between 0.0..1.0 with default 0.5. With box *Decrease update active* checked we determine the average hit count (wavepaths per pixel) over all tomogram pixels. Next we determine the difference between actual hit count and average hit count for each tomogram pixel. If the actual hit count exceeds the average hit count we then update the pixel's hit count to average hit count plus this difference raised to ***Velocity update power***. We then determine the ratio between updated hit count and original hit count. Finally the velocity update is multiplied by this ratio for each tomogram pixel.
- Nov 30, 2018 : updated 1_1D tutorial and added Fig. 14 showing ***WET Tomo|WET tomography Setting****s menu*. Uncheck option ***Scale wavepath width*** to prevent velocity artefacts just below topography (at strong topography curvature) and for less horizontal smearing at bottom of tomogram.
- Nov 28, 2018 : **SHIFT+Z** now deletes first break picks in all *Trace menu* gather types. Use e.g. to model gap in profile coverage when forward modeling shots. Delete picks for all traces recorded at receiver station number in gap, with **SHIFT+Z** in *Trace|Receiver station gather*.
- Nov 22, 2018 : tested our latest Standard version 3.36 with Golden Software Surfer version 16.0.330 released on Nov 7, 2018.
- Nov 21, 2018 : show Rayfract® version as v. 3.36 instead of Vers. 3.36 in Surfer plot title
- Nov 21, 2018 : our latest tutorial shows ***multiscale Conjugate-Gradient WET inversion using DeltatV+XTV starting model*** for NGU_2018_P1-1D synthetic fault zone model. We optimized WET inversion settings to more clearly image the 3 vertical fault zones.
- Nov 15, 2018 : check *WET Tomo|WET tomography Settings|Weight velocity update* to decrease velocity update in high-coverage areas of WET tomogram. Can help to avoid lateral smearing artefacts at bottom of tomogram.
- Nov 12, 2018 : Tassis et al. use *DeltatV+layered XTV* & *Plus-Minus* & *Wavefront* refraction methods to obtain an initial model for *WET inversion* of synthetic data modeled for layered subsurface with vertical fault zones (NGU Trondheim, 2018)
- Nov 12, 2018 : don't convert user-selected filenames to all-uppercase
- Nov 9, 2018 : completely read from **.PAR** file filenames with spaces
- Nov 9, 2018 : correctly display initial model filename in Surfer plot for filenames with spaces
- Nov 8, 2018 : to reduce Surfer Kriging artefacts try increasing the grid cell size in *Header|Profile*
- Nov 8, 2018 : we now allow creating and opening profiles using filenames up to 130 characters long, including drive character and directory plus **SEIS32.DBD** database filename
- Nov 8, 2018 : in *File|New Profile…* optionally click on the yellow folder icon at right-top to create a subdirectory. Hit **ENTER** key to enter this subdirectory. Set *File name* to your profile's name.
- Nov 8, 2018 : in *File|New Profile…* we now allow using spaces in *File name* & subdirectory names. Also *File name* can now be longer than 8 characters.
- Nov 6, 2018 : regard *File|Import data Settings|Select file in Profile directory* & *Keep current directory when selecting files* when selecting files in *Grid menu*, *WET Tomo|Interactive WET tomography* etc.
- Nov 6, 2018 : moved directory selection options *Select file in Profile directory* & *Keep current directory when selecting files* into *File|Import data Settings* submenu

- Nov 3, 2018 : fixed **.BAS** Surfer scripts so they work again with Scripter 9 coming with Surfer 9 up to Scripter 16 coming with Surfer 16 Beta. Download & run updated Ray335 Scripts.exe installer on your PC where you installed our version 3.35 or 3.36 software.
- Oct 24, 2018 : decreased lower limit for *DeltatV|Interactive DeltatV|Regression over offset stations* from 3 to 2. Allows better resolved imaging of layered velocity variation with DeltatV+XTV.
- Oct 21, 2018 : decreased smallest allowed values in *Refractor|Midpoint breaks|ALT+M mapping dialog* from 3 to 2, for *Regression Receiver Count*, *Direct Wave Delta [stations]* & *Refracted Wave Offset Delta*. Allows better resolved imaging of overburden layers with layered refraction methods.
- Oct 21, 2018 : Dangeard et al. use ERT, SRT, surface waves and Poisson's ratio for time-lapse imaging of water content in river banks (UPMC Paris, 2017)
- Wodajo et al. correlate SRT and ERT with borehole data to investigate and predict causes of sand boil formations including water seepage at an earthen dam (EEGS FastTIMES Vol 23, Number 3, 2018)
- Oct 20, 2018 : check *Model|Forward modeling Settings|Improved modeling at source* for alternative initialization of traveltime grid at source. May be more accurate but may slow down modeling.
- Oct 13, 2018 : for hard-rock basement such as granite try increasing *DeltatV|Interactive DeltatV|Max. valid velocity* to 6,200 m/s and increase *Export Options|Max. velocity exported* to 5,500 m/s
- apparent CMP velocity may exceed true velocity considerably in case of strong topography or strong refractor curvature. Check this in *Refractor|Midpoint breaks* : browse CMP curves with F7/F8. Browse offset within current curve with arrow down/arrow up cursor keys. Apparent velocity is shown at bottom in status bar, together with offset (Delta) and CMP (Midpoint).
- Oct 8, 2018 : *DeltatV|DeltatV Settings|Allow regression over two CMP traces* helps with *Reduced offset 0.0 is valid trace with time 0.0* unchecked for sample profile **LINE14**. Also check *Process every CMP offset* for improved vertical resolution.
- Oct 7, 2018 : improved prompt warning about *DeltatV* artefacts in case of strong refractor curvature and strong topography curvature and for lines shorter than 500m. Recommend using *Smooth inversion*.
- Oct 7, 2018 : *DeltatV|DeltatV Settings|Allow regression over two CMP traces* allows linear regression over just two CMP-stacked first breaks for velocity determination. Uncheck for regression over at least three CMP traces resulting in less detailed overburden imaging and less artefacts.
- Oct 5, 2018 : pick branch points at receivers in *Refractor|Shot breaks*. The first break at the branch point is used for both refractors. Improves overburden layer resolution.
- Oct 5, 2018 : check *Mapping|Pick branch points between Receivers* in *Refractor|Shot breaks* to pick branch points between receivers as in version 3.35 of our software.

Version 3.35 released in Sep 2018 :

- Sep 29, 2018 : rebuilt free trial installer with latest help file and updated **.BAS** Surfer scripts
- Sep 28, 2018 : updated **AUTOTOMO.BAS**&**DELTATV.BAS** scripts work with Surfer 16 beta. Download&run updated Ray335 Scripts.exe installer on your PC where you installed our version 3.35 software.
- Sep 23, 2018 : updated PowerPoint slide show TRA9002.PPT shows how to generate layered refraction starting model with Plus-Minus refraction method&run 2D WET with **PLUSMODL.GRD** starting model
- Sep 23, 2018 : updated PowerPoint slide show TRA9002.PPT shows how to generate pseudo-2D starting model with DeltatV+XTV refraction method&run 2D WET inversion with **DELTATVXTV.GRD** starting model. See tra9002.pdf for Adobe Acrobat .pdf version of the slide show.

- Sep 5, 2018 : fixed bug in latest **AUTOTOMO.BAS** script. Download & run updated Ray335 Scripts.exe installer on your PC where you installed our version 3.35 software.
- Aug 25, 2018 : fixed assert in *DeltatV export*. Click *Ignore button* to skip Ass. **CMPHELPR.CPP** line #146.
- Aug 23, 2018 : *File|Update header data|Update Station Coordinates…* updates v0 in *Header|Station* if listed in the selected **COORDS.COR**
- Aug 23, 201 : check *File|Export data Settings|Export horizontal inline offset and v0 to .COR* to export v0 from *Header|Station* to **COORDS.COR** with *File|Export header data|Export Station Coordinates*
- Aug 22, 2018 : Ray335 Scripts.exe installs updated .BAS scripts into C:\RAY32\DAT . We now always position the Surfer plot title correctly.
- Aug 22, 2018 : with new option *WET Tomo|WET tomography Settings|Force RAM allocation* checked we now cache traveltime grids even in low-memory situations. This may result in apps swapping to disk including our own app and temporarily freeze your Windows PC especially during *WET processing* startup phase.
- Aug 19, 2018 : accept minimum velocity of 0.1 m/s in *WET starting model* **.GRD** instead of 10.0 m/s
- Aug 19, 2018 : updated help file chapter *WET tomography processing*. Use latest winhelp.exe installer.
- Aug 3, 2018 : if both *File|Import Data Settings|Allow missing traces for SEG-2* and *File|SEG-2 import settings|Receiver Coordinates specified in .DAT or .SG2 file* are checked and the SEG-2 files are missing **RECEIVER_STATION_NUMBER** or **RECEIVER_LOCATION** in the trace headers : prompt user about this, reset *File|Import Data Settings|Allow missing traces for SEG-2* and restart import
- Aug 2, 2018 : check ***File|SEG-2 import settings|Receiver Coordinates specified in .DAT or .SG2 file*** to enable import setting *File|Import Data Settings|Allow missing traces for SEG-2*
- Aug 1, 2018 : uncheck *File|Import Data Settings|Allow missing traces for SEG-2* so our SEG-2 import can deal with Seismic Source DAQLink **.SG2** files which do not specify **RECEIVER_STATION_NUMBER** or **RECEIVER_LOCATION** in the SEG-2 trace headers
- July 29, 2018 : support calling Surfer 8 and Surfer 9 again with our latest version 3.35. Unzip updated scripts in Surfer15 scripts for3 35.zip in your \RAY32\DAT directory. These updated **.BAS** scripts do not work with 3.34 or earlier versions of our software.
- July 29, 2018 : if ***CodeMeter service fails to start*** in *CodeMeter Control Center* with *Process|Start CodeMeter service* : try repairing **CodeMeter Runtime Kit** in *Windows Control Panel|Programs and Features*. If this does not help : run **regedit.exe** via *Windows Start menu*. Delete registry key **HKEY_LOCAL_MACHINE\SOFTWARE\WIBU-SYSTEMS\CodeMeter**. Leave *Registry Editor* via *File|Exit*.
- July 21, 2018 : *File|Export header data|Export refractor branches* writes refractor start/end in channel nos. to …**\LAYRTOMO\BRANCHES.BRN** ASCII file for all shots
- July 18, 2018 : for better vertical resolution check *DeltatV|DeltatV Settings|Taper velocity steps at layer interfaces*. This writes twice as many *CMP offset-elevation-velocity triples* to …**\TOMO\DELTATV.TXT** file and results in less artefacts when kriging in Surfer. Or use alternative *DeltatV|Interactive DeltatV|Export|Gridding Method* **Nearest Neighbor**. See our tutorials OT0608.pdf & jenny10.pdf .
- July 18, 2018 : write *station no.* to extra column in file written by *Grid|Export grid file to ASCII.TXT*
- July 17, 2018 : check ***Depth|Depth conversion Settings|Smooth Wavefronts*** with noisy first break picks. Uncheck for better resolution with *Wavefront method*, with exact first break picks.
- July 17, 2018 : improved *Wavefront method* interpretation with strong topography and strong refractor curvature. Allow for rays which emerge at an angle greater than 90 degrees to line topography.
- July 12, 2018 : prompt to smooth **DELTATV.GRD** starting model in Surfer if *WET inversion* fails due to invalid grid velocity
- July12, 2018 : improve prompt when shots have been extrapolated during time-to-depth conversion with *Depth|Wavefront* or *Depth|Plus-Minus* commands.

- July 12, 2018 : update forced grid cell size if changed in first three (3) decimal digits only. This happens if the grid cell count of 640,000 for Standard license or 1,280,000 for Pro license is exceeded.
- July 9, 2018 : export Plus-Minus characteristics determined during *Depth|Plus-Minus* computation, to …**\LAYRTOMO\PLUSMODL.FRN** ASCII file
- July 9, 2018 : export Plus-Minus times determined during *Depth|Plus-Minus* computation, to …**\LAYRTOMO\PLUSMODL.TMS** ASCII file
- July 7, 2018 : reduce size of Rayfract® **.EXE** executable by factoring out assert's into helper method
- July 7, 2018 : check *Depth|Depth conversion Settings|Keep extrapolated shots* to keep extrapolated **.ASC** shots in …**\EXTRAPOL** subdirectory instead of deleting them. Leave unchecked to avoid importing stale extrapolated shots during time-to-depth conversion with *Depth* menu commands.
- July 6, 2018 : when you select *Header|Profile* we now check that all added **Borehole spread/line** databases still exist on disk. If not we prompt you to restore the database from backup or reselect it.
- July 2, 2018 : more accurate, robust and repeatable *Wavefront method* computation. Don't regard previous depth interpretation for new interpretation : reset previous results in profile database.
- July 2, 2018 : export basement refractor wavefronts when running *Depth|Wavefront*, to …**\LAYRTOMO\WAVEFRONT.FRN** ASCII file
- July 2, 2018 : export overburden points determined during *Depth|Wavefront* computation, to …**\LAYRTOMO\WAVEFRNT.OVR** ASCII file
- June 18, 2018 : improved error prompt during *WET inversion* if too high or too low velocity in …**\LAYRTOMO\WAVEMODL.GRD** starting model. Recommend to increase lateral refractor smoothing in depth section window with **ALT+M** .
- June 15, 2018 : updated help file chapter *Time-to-depth conversion.* Use latest winhelp.exe installer.
- June 12, 2018 : improved error prompt if forward modeling detects invalid grid velocity due to invalid source/receiver coordinates and elevations. Prompt to fix elevations or force starting model grid limits.
- June 3, 2018 : updated help file chapter *Calling Surfer*. Use latest winhelp.exe installer.
- June 2, 2018 : updated search logic for finding **Scripter.EXE** now works with Surfer 15 and earlier Surfer versions 9 to Surfer 14. With Surfer 15 the **Scripter.EXE** is installed into Surfer 15 main directory. With earlier Surfer versions **Scripter.EXE** is installed into Scripter subdirectory.
- June 2, 2018 : for Surfer 15 select **Scripter.EXE** with ***Grid|Surfer invocation*** dialog. Press *Select* & navigate into `C:\Program Files\Golden Software\Surfer 15` & select **Scripter.EXE**. Click *Open* & *OK* buttons. Now our software can invoke Surfer 15 through our `.BAS` scripts and Scripter.
- May 26, 2018 : in *Refractor|Offset breaks display* regard line style settings in *Mapping menu* when plotting offset-sorted curves. Map traces to refractors with **ALT+M** in *Refractor|Midpoint breaks*.
- May 26, 2018 : when unmapping traces in *Refractor|Midpoint breaks* with **ALT+U** we now regard line style settings in *Mapping menu* : gray curves, force solid curves
- May 22, 2018 : if after opening an old profile database with our version 3.35 the trace signal does not display in *Trace|Shot gather* : press **ALT+M** and increase *Trace clip* from 0.0 to 1.0 or higher. Click *Filter button* to redisplay traces.
- May 19, 2018 : don't regard receiver x/y/z in SEG-2 .DAT or .SG2 file if *File|Import Data Settings|Allow missing traces* is unchecked. Get x from *Default spread type, Header|Profile|Station spacing* and *Layout start [station no.]* instead, as previously in version 3.34 and earlier.
- May 17, 2018 : we now regard ***File|Import Data Settings|Allow missing traces*** when importing SEG-2 files. Tested with our sample **LINE14** profile with *Default spread type* `10: 360 channels` and *Header|Profile|Station spacing* of 2.5m.

- May 17, 2018 : we prompt you when the *forced grid cell size* needed to be increased to stay below limit of 640,000 grid nodes for Standard license and 1,280,000 nodes for Pro license when generating the starting model
- May 16, 2018 : in *Refractor|Midpoint breaks display* we now regard the line style settings in *Mapping menu* when plotting CMP sorted curves before/after mapping traces to refractors with **ALT+M**
- May 16, 2018 : when you install multiple versions of Golden Software Surfer® on the same Windows PC then this may corrupt the previously installed Surfer version. To fix the previous installation select *Windows Control Panel|Programs and Features|Surfer ...* . Click *Repair radio button* and *Next button*.
- May 13, 2018 : more robust scanning of string format subblocks when importing SEG-2 files. Helps with non-standard **OYO CORPORATION INSTRUMENT PICKWIN95 .DAT** files.
- May 10, 2018 : ***Trace clip [traces]*** shown in *Trace processing parameters dialog* displayed with **ALT+M** in *Trace|Shot gather* etc. lets you specify over how many traces the current trace is plotted with ***Clip amplitude peaks*** checked. This helps with irregular *receiver spreads* e.g. for sample **LINE14** profile.
- May 7, 2018 : when adding **Borehole spread/line** profiles to main **Refraction spread/line** profile in *Header|Profile* : adjust *Profile start offset [m]* of main profile until the x axis coordinates shown on resulting starting model and tomogram plots match the x coordinates used for added **Borehole spread/line** profiles. Keep adjusting until shot point elevation for downhole shots or receiver elevation for uphole shots matches topography of main **Refraction spread/line** profile as shown in plots. See our tutorial 11REFR.
- May 5, 2018 : enable running *DeltatV|Interactive DeltatV* and mapping of traces in *Refractor|Midpoint breaks* with ALT+M for uphole refraction survey with just one borehole. Test with SUBS19.
- May 4, 2018 : our new tutorial SUBS19 shows import and processing of uphole refraction shots
- Apr 16, 2018 : if you recorded a profile with varying receiver spacing : set ***Header|Profile|Station spacing*** to Greatest Common Divisor GCD of your spacings used. E.g. if you planted some spreads with spacing of 5m and other spreads with 3m : set *Station spacing* to 1m. Now import your **Geometrics Plotrefa .VS** or **OPTIM LLC SeisOpt** or **Interpex GREMIX .GRM** or **GeoTomCG .3DD** with *File|Import Data...* and ***Default spread type*** **10: 360 channels** or **999: 999 channels** (available with Pro license only) as usual.
- Apr 16, 2018 : to download latest drivers for green WibuKey and silver/metallic CodeMeter USB dongle go to http://www.wibu.com/downloads-user-software.html
- Apr 6, 2018 : ***Grid|Convert .CSV layer model to Surfer .GRD*** now allows for maximum of 7 layers : 6 overburden layers & one basement half-space layer when converting the **.CSV** to **.GRD** format
- Apr 6, 2018 : better error prompt if *Smooth invert* fails for *Header|Profile|Line type* **Refraction spread/line** and all shots marked as *Header|Shot|Type* **Uphole shot**
- Mar 31, 2018 : more robust search for valid velocity grid cell at tomogram boundary. Search radius of 10 cells instead of just 5. Helps with extreme topography and activated *WET blanking* options.
- Mar 31, 2018 : check ***Refractor|Mapping|Force solid picked curves*** to always draw picked curves with a solid pen. Uncheck to use a dotted pen at gaps in curve (unpicked traces).
- Mar 27, 2018 : *File|Import Data...* writing of **.HDR** batch file : correct *Shot pos. [station no.]* for *Inline offset [m]* for *Header|Profile|Line type* **Refraction spread/line** only
- Mar 26, 2018 : more robust updating of shotpoints with *File|Update header data|Update Shotpoint coordinates...* and your **.SHO** file in case adjacent stations have the same x/y/z coordinates
- Feb 28, 2018 : for help regarding Surfer issues see our .pdf reference chapter ***Calling Surfer***
- Feb 28, 2018 : to automatically update your old **.BAS** scripts as described in next two bullets and as installed with earlier versions of our software into **C:\RAY32\DAT** directory : download our new .BAS updater and backup to permanent storage. Next run **BasConvrt.EXE** on your PC where you

installed these earlier versions of our software. We tested this with version 3.15 and later versions and Surfer 11/13/14/15. The updated **.BAS** scripts will continue to work with older Surfer versions.

- Feb 27, 2018 : to update **.BAS** scripts coming with version 3.21 or earlier versions of our software : replace **Overlays("Image Map")**, **Overlays("Contours")** and **Overlays("Classed Post")** with **Overlays(1)** in Windows Notepad editor. Also replace **IDocument** etc. with **Object**, see next bullet.
- Feb 25, 2018 : to make older **.BAS** scripts compatible with newer Scripter and Surfer versions : open the **.BAS** scripts in **C:\RAY32\DAT** in your favorite text editor e.g. Notepad and replace all occurrences of **IDocument, IWindow, IMapFrame, IColorMap, IContinuousColorScale, ILevels, ILevel, ILineFormat,** etc. with **Object**. This will not work with **.BAS** scripts for versions older than version 3.22 of our software.
- Feb 20, 2018 : Surfer 11 was released by Golden Software in 2012 and works fine under Window 7 64-bit. If Surfer 11 crashes under Windows 8 or Windows 10 when called from our app via **.BAS** script and Scripter : please install and use latest Surfer 15 free trial or full version instead. Select the Scripter **.EXE** in our ***Grid|Surfer invocation…*** dialog.
- Feb 13, 2018 : with opened *Refractor|Midpoint breaks display* we show a new option ***Mapping|Weigh CMP binned picks for mapping***. This option is unchecked per default, to cope with noisy traveltime picks or recording geometry errors. In earlier builds of our software we regard ***DeltatV|DeltatV Settings|Weigh picks in CMP curves*** instead. See below in Jan 29 bullet.
- Feb 2, 2018 : rebuilt winhelp.exe installer so it installs on non-U.S. English Windows versions
- Jan 31, 2018 : prompt user to delete or merge duplicate **.3DD** traces. Show duplicate rayID's in prompt.
- Jan 30, 2018 : before you import GeoTomCG **.3DD** files with *File|Import Data…* you need to merge or delete duplicate **.3DD** traces (consecutive lines with same source and same receiver coordinates). Otherwise our import routine has to assume that a new shot starts at the duplicate trace line since the **.3DD** format does not include the shot number.
- Jan 30, 2018 : when writing **.HDR** batch file in *File|Import Data…* we now add *shot inline offset* from *shot station* to *shot pos.* so our *Import Shot dialog* does not complain when running the **.HDR** batch file
- Jan 29, 2018 : export horizontal inline offset from first profile receiver to ASCII **.TXT** with *Grid|Export grid file to ASCII .TXT...* in additional column no. 5.
- Jan 29, 2018 : to get more robust traveltime field regression and better *Wavefront method* & *Plus-Minus method* output for tutorials GEOXMERC, OT0608, Val de Travers TRA02ASC and most other profiles :
  - check ***File|Import data Settings|Round shot station to nearest whole station number***
  - reimport the **.ASC** shots with *File|Import Data…*
  - reapply **.COR** station coordinate file with *File|Update header data|Update station coordinates…*
  - uncheck ***DeltatV|DeltatV Settings|Weigh picks in CMP curves***
  - remap traces to refractors in *Refractor|Midpoint breaks* with ALT+M mapping dialog
  - select *Depth|Wavefront* to rerun Wavefront refraction method
- Jan 27, 2018 : force using *spread type* with 999 channels with Pro license if required when importing extrapolated shots in *Depth|Plus-Minus* or *Depth|Wavefront* time-to-depth conversion. This helps with long lines e.g. with our GEOXMERC tutorial.
- Jan 23, 2018 : make *Header|Profile* fields *Job ID* and *Instrument* optional so you can leave them empty
- Jan 21, 2018 : instructions on how to uninstall&reinstall WibuKey driver for your green WibuKey USB dongle include screen shots with possible error messages and captions describing how to proceed
- Jan 21, 2018 : if you see error prompt ***Code Integrity check failed -> Application is terminated!*** e.g. with transparent green WibuKey USB dongle under Windows 10 64-bit with USB 3.0 port :
  - add exclusion in Windows Defender for file **C:\RAY32\BIN\RAYFRACT32.EXE**
  - add exclusion in Windows Defender for folder **C:\RAY32**
  - see our updated .pdf reference chapter *Installation and licensing*

- Jan 7, 2018 : updated paragraph *Elevation specification* in help chapter *Editing header data*. Use latest winhelp.exe installer.
- Jan 4, 2018 : don't delete …**\GRADTOMO\GRADIENT.GRD,DLTAGRAD.GRD** when importing extrapolated shots in *Depth*|*Plus-Minus* or *Depth*|*Wavefront* time-to-depth conversion
- Jan 1, 2018 : fix automated updating of *Header*|*Station*|*v0* when mapping traces to refractors in *Refractor*|*Midpoint breaks* display with option *Direct wave first breaks recorded* unchecked
- Dec 31, 2017 : keep shotpoint dx/dy/dz offset from *shot station* in *Header*|*Shot* unchanged when interpolating v0 in *Header*|*Station* & when importing extrapolated shots with *Plus-Minus&Wavefront*
- Dec 31, 2017 : always reset shotpoint dx/dy/dz offset in *Header*|*Shot* for extrapolated shots
- Dec 31, 2017 : new option *File*|*Update header data*|*Keep current directory when selecting files*
- Dec 31, 2017 : new option *File*|*Update header data*|*Select file in Profile directory*
- Dec 26, 2017 : set starting directory for file selection to **\RAY32\<your profile name>\INPUT** when updating headers with **.COR/.SHO/.LST/.OYO/.GRM** files & when selecting **.HDR** batch file
- Dec 25, 2017 : always initialize *Header*|*Shot*|*Source elevation* for automatically imported extrapolated shots generated during *Depth*|*Plus-Minus* or *Depth*|*Wavefront* time-to-depth conversion
- Dec 25, 2017 : *Header*|*Station button Force interpolate coordinates* interpolates station coordinates and shotpoint dx/dy/dz offsets&*Source elevation* even when not changing any coordinate in *Header*|*Station*
- Dec 25, 2017 : to force interpolation of *Source elevation* for earlier builds : select *File*|*Export header data*|*Export Station Coordinates…* and *File*|*Update header data*|*Update Station coordinates* with **COORDS.COR** just exported
- Dec 22, 2017 : *Header*|*Station button Reset v0* does not reset shotpoint offsets as long as you did not change station x/y/z coordinates in same station editor session
- Dec 21, 2017 : prompt user that shotpoint offsets will be reset when user first edits station x/y/z coordinates in *Header*|*Station* and then clicks button *Interpolate v0 only*
- Dec 18, 2017 : added button *Interpolate v0 only* in *Header*|*Station*. Use to interpolate edited *v0* without recomputing shot dx/dy/dz from inline&lateral offset from *shot station* shown in *Header*|*Shot*.
- Dec 16, 2017 : rebuilt free trial installer with latest help file
- Dec 16, 2017 : don't force WET setting *Limit WET velocity to maximum velocity in initial model* when user clicks radio button *Conjugate Gradient* in *WET Tomo*|*Interactive WET tomography* main dialog
- Dec 12, 2017 : improved description of **.SHO** file format in help chapter *File formats*. *UpholeTime[ms]* is listed in column 6. *Correction[ms]* is listed in column 7. These are two separate columns.
- Dec 11, 2017 : clarify in help chapter *File formats* that shot point is source position vertically projected to topography along receiver spread. Use **.SHO file** column 5 to specify *shot hole depth* or edit *Header*|*Shot*|*Depth* after updating shotpoints with edited **.SHO** file. Use latest winhelp.exe installer.
- Dec 7, 2017 : update shotpoint dx/dy/dz with *File*|*Update header data*|*Update Shotpoint coordinates* and selected **.SHO** file or when user edits inline&lateral offset from *shot station* in *Header*|*Shot* or when user imports data files or updates geometry with *File*|*Update header data* submenu commands
- Dec 7, 2017 : recompute shot dx/dy/dz from inline&lateral shotpoint offset (offset from shot station shown in *Header*|*Shot*) when user edits *Station spacing* in *Header*|*Profile*
- Dec 4, 2017 : don't reset shotpoint dx/dy/dz (offset from shot station shown in *Header*|*Shot*) when interpolating station coordinates & v0 in *Header*|*Station*
- Dec 4, 2017 : don't reset shotpoint dx/dy/dz when automatically importing extrapolated shots generated during time-to-depth conversion with *Plus-Minus* or *Wavefront* method layered refraction
- Dec 2, 2017 : updated help chapters *Seismic and header data import* and *Crosshole survey interpretation*. Added subtitles to structure text. Use latest winhelp.exe installer.

- Dec 1, 2017 : removed references to outdated import option *Keep same Layout start for consecutive shot trace files* in help file.
- Dec 1, 2017 : add links to Bibliography section in help chapter *Introduction*
- Nov 28, 2017 : added more sub-titles and bookmarks to .pdf help. Expanded Table of Contents.
- Nov 26, 2017 : updated .pdf help. Added bookmarks for all chapters and important topics.
- Nov 25, 2017 : updated free trial installer with latest help file
- Nov 25, 2017 : more robust detection of end of free-format string section in SEG-2 trace descriptor block. Helps with import of ***MoHo SoilSpy Rosina*** seismograph `.SG2` trace files.
- Nov 22, 2017 : updated help chapter *Installation and licensing*. Use latest `winhelp.exe` installer.
- Nov 13, 2017 : layered refraction smoothing parameter *Base filter width [station nos.]* has again default value 10. We changed the default to 8 on Apr 15, 2017; see below. *Smoothing filter width* of 10 stations can give more robust imaging of basement fault zones with *Depth|Plus-Minus* and *Wavefront* refraction methods in case of ***strong undulation of refractor elevation***. Edit with `ALT+M` in *depth section window*.
- Nov 12, 2017 : more robust determination of trace data start during import of Geometrics SeisModules `.DAT SEG-2` trace files
- Nov 6, 2017 : regard forced grid limits in *Smooth invert|Custom 1D-gradient velocity profile* when generating `SEIS32.BLN` blanking file for *Grid|Grid and image DeltatV .TXT file*
- Nov 4, 2017 : regard forced starting model grid limits specified in dialog *Smooth invert|Custom 1D-gradient velocity profile* for constant-velocity starting model
- Nov 1, 2017 : reset internal status flags after displaying inversion output in Golden Software Surfer and when reopening the profile database
- Oct 31, 2017 : always write `.FIT` file for starting model even with *WET Tomo|WET tomography Settings|Write|Store modeled picks after last iteration only* checked
- Oct 23, 2017 : forward model traveltimes over *layered refraction starting model* before imaging `.GRD` file in Surfer so RMS error in plot title is up-to-date
- Oct 23, 2017 : more robust error handling when *WET inversion* fails to complete due to bad `.GRD` etc.
- Oct 21, 2017 : more robust *DeltatV* processing with bad recording geometry or bad first break picks
- Oct 20, 2017 : our latest free trial installer and help installer install our help file correctly under foreign language Windows installations. Tested on Italian language Windows 7 64-bit system.
- Oct 19, 2017 : fixed topography blanking for *DeltatV* starting model when forcing grid limits in *Smooth invert|Custom 1D-gradient velocity profile...*
- Oct 19, 2017 : regard forced *Grid top elevation* in *Smooth invert|Custom 1D-gradient velocity profile...* when determining and plotting *1D-gradient* and *DeltatV* starting model
- Oct 16, 2017 : fixed Ass. failure for narrow *CMP curve stack width* = 3 in *DeltatV|Interactive DeltatV*
- Oct 15, 2017 : to install our free trial under latest ***Windows 10 with Creators update*** you need to
  - disable *Real-time protection* in ***Windows Defender|Virus and threat protection settings***
  - download and run our free trial installer
  - add *Exclusion* in Windows Defender for file **`C:\RAY32\BIN\RAYFRACT32.EXE`**
  - add *Exclusion* in Windows Defender for folder **`C:\RAY32`**
  - reenable *Real-time protection* in Windows Defender
  - now test starting our free trial via Windows desktop link
  - you may need to do above routine multiple times, also after restarting Windows 10
- Oct 14, 2017 : updated free trial installer with latest help file
- Oct 14, 2017 : improved description of starting model in Surfer plot title. Warn about *DeltatV* artefacts.
- Oct 14, 2017 : tested under *Windows 10 Creators update* with *Surfer 15 Beta*. Works fine.
- Sep 29, 2017 : write *WET update weighting* parameters a&b to `.PAR` & restore from `.PAR` file
- Sep 29, 2017 : our latest tutorial NGUP1_1 shows *multiscale tomography* of NGU synthetic data using *Steepest Descent* method and *Cosine-Squared* WET update weighting across the wavepath

- Sep 29, 2017 : improved error prompts if *WET inversion* fails e.g. due to bad geometry specification
- Sep 27, 2017 : Georgios Tassis et al. show detection of fracture zones in bedrock using both modeled data and field refraction data
- Sep 25, 2017 : changed default *WET wavepath width* schedule for *multirun WET*
- Sep 25, 2017 : updated help chapter *Optimize Windows*. Use latest `winhelp.exe` installer.
- Sep 22, 2017 : recommend to decrease *WET velocity smoothing* in *traveltime misfit prompt*
- Sep 22, 2017 : updated help chapter *Uphole shots and uphole picks*. Use latest `winhelp.exe` installer.
- Sep 21, 2017 : Robert Illnar shows mapping of alpine permafrost with refraction seismic interpretation using weighted ground surface temperatures (wGST)
- Sep 16, 2017 : updated help chapter *WET tomography processing*. Use latest `winhelp.exe` installer.
- Sep 15, 2017 : Georgios Tassis et al. show *WET inversion* of refraction data using ***Plus-Minus starting model*** vs. ***1D-Gradient starting model***. See also our Norcal14 tutorial.
- Sep 12, 2017 : updated help chapters *Starting up Rayfract® and profile management* & *Editing header data* paragraph *Elevation specification*. Install updated help file with latest `winhelp.exe` installer.
- Sep 6, 2017 : to rename a tomogram subdirectory in your `C:\RAY32\<profile name>` profile directory :
  - close the profile database with *File|Exit*
  - open Windows Explorer and navigate into your profile directory `C:\RAY32\<profile name>`
  - right-click subdirectory `GRADTOMO`, `TOMO`, `LAYRTOMO` or `HOLETOMO` and select *Rename*
  - type in new subdirectory name e.g. `GRAD335` and press `ENTER/RETURN` key
  - when you reopen profile `C:\RAY32\<profile name>` with *File|Open Profile…* we will recreate all of these subdirectories `GRADTOMO`, `TOMO`, `LAYRTOMO` and `HOLETOMO` if you renamed them as above
- Aug 30, 2017 : write all flags in submenu *WET Tomo|WET tomography Settings|Write* to `.PAR` file
- Aug 29, 2017 : to import `GeoTomCG .3DD` files into `Refraction spread/line` profiles :
  - check *File|Import data Settings|Import horizontal borehole survey or .3DD refraction survey*
  - check *File|Import data Settings|X coordinate is corrected for topography already*
  - select *File|Import Data…* and set *Import data type* to `GeoTomCG .3DD`
  - `.3DD` import into `Refraction spread/line` or `Borehole spread/line` resets y coordinates to 0.0
- Aug 28, 2017 : we support calling into Golden Software Surfer 15 beta version
- Aug 18, 2017 : support import of `ASCII.ASC` with ***shot/receiver elevation in feet***. If any header line of `ASCII.ASC` contains string "`feet`" or "`(ft)`" or "[ft]" without enclosing "" then shot/receiver elevation is converted from feet to meters during import with *File|Import Data…* .
- Aug 17, 2017 : more robust calling into Surfer for tomogram plotting. Delete `.RUN` files & `.OK` files once the `DELTATV.BAS` or `AUTOTOMO.BAS` script doing the plotting has completed.
- Aug 14, 2017 : write new *WET settings* to `.PAR` file for corresponding `VELOITXY.GRD` file. Restore settings from `.PAR` file with ***Grid|Reset DeltatV and WET settings to .PAR file*** .
- Aug 10, 2017 : to force use of the correct shot point elevation for offset shots positioned outside your profile's receiver range :
  - *File|Export header data|Export Station Coordinates…* and save to `COORDS.COR`
  - *File|Export header data|Export Shot Point Coordinates…* and save to `SHOTPTS.SHO`
  - edit `elevation[m]` column of `COORDS.COR` for offset shot station(s) outside profile's receiver range
  - *File|Update header data|Update Station Coordinates…* with your edited `COORDS.COR`
  - edit `shotZ[m]` and `holeDepth[m]` columns in `SHOTPTS.SHO` for offset shot station(s)
  - *File|Update header data|Update Shot Point Coordinates…* with above `SHOTPTS.SHO`
- Aug 6, 2017 : *WET Tomo|WET tomography Settings|Enable multi-core heap* does not leak memory any longer. Don't enable this for earlier versions.
- July 23, 2017 : updated free trial and included latest Surfer 14 scripts in installer

- July 22, 2017 : always show color scale in Surfer 14 plots with our latest version 3.35. Unzip updated scripts in `Surfer14 scripts for3.35.zip` in your `\RAY32\DAT` directory. These updated scripts do not work with 3.34 or earlier versions of our software.
- July 12, 2017 : reset added borehole line database name when user clicks *Cancel button* in `seis32.dbd` selection dialog shown with *Select buttons* in *Header*|*Profile*
- July 12, 2017 : clear status bar at end of creation of new profile with *File*|*New Profile*...
- July 11, 2017 : new tutorial `KING17` shows interpretation of first breaks recorded with receivers located in three boreholes. This tutorial requires our Pro license.
- June 30, 2017 : added paragraph ***Installation of CodeMeter runtime/driver software*** in help file chapter *Installation and licensing*. Install updated help file with latest `winhelp.exe` installer.
- June 30, 2017 : check *WET Tomo*|*WET tomography Settings*|*Blank*|*Blank no coverage on top of borehole tomogram* in addition to blanking options *Blank no coverage after each iteration* or *Blank no coverage after last iteration* to blank on top of borehole tomogram. See updated `TUNNEL16` tutorial.
- June 28, 2017 : stop inversion early with clear error message if the starting model can't be generated due to conflict between forced grid limits and topography specified in *Header*|*Station*
- June 27, 2017 : don't accept *grid limits* in *Smooth invert*|*Custom 1D-gradient velocity profile* if these limits do not contain topography (station z coordinates) over whole profile
- June 19, 2017 : flags for ***WET blanking after last iteration*** (of current WET run) in *WET Tomo*|*WET tomography Settings*|*Blank submenu* are regarded during ***multirun WET inversion*** if *WET Tomo*|*Interactive WET tomography*|*Iterate*|*Blank checkbox* for respective *WET run no.* is checked only.
- June 16, 2017 : improved recovery and prompts if traces are not mapped to refractors correctly during time-to-depth conversion with *Depth menu* commands
- June 10, 2017 : in case of steep topography at line start/end you may want to configure WET blanking :
  - uncheck *WET Tomo*|*WET tomography Settings*|*Blank*|*Blank below envelope after last iteration*
  - optionally check or uncheck *Blank no coverage after last iteration* in same submenu
  - uncheck all other blanking options in same *WET Tomo*|*WET tomography Settings*|*Blank* submenu
  - above blanking settings may be required so shots positioned one station spacing outside first/last profile receiver are used for WET inversion

- June 10, 2017 : ***DeltatV*|*Interactive DeltatV*|*Regression over offset stations*** has new minimum value of 3 instead of former 5. A value of 3 can show more details or more noise in DeltatV inversion output in case of bad picks and geometry errors.
- June 9, 2017 : `Alt+B` shortcut in *Trace*|*Shot gather* shows *Automatic first break picking parameters dialog* with option *Processing*|*Solid color pick display* checked. For earlier builds uncheck this option.
- May 27, 2017 : describe use of SEGY trace header fields during import of `.SGY` files in new paragraph ***Use of SEGY trace header fields during import*** in help topic *Seismic and header data import*. Install updated help file with latest `winhelp.exe` installer.
- May 26, 2017 : use option *File*|*SEGY import settings*|*Force determine station numbers* if SEGY import with unchecked SEGY option *No receiver coordinates specified in .SGY file* fails due to inconsistent geometry specified in SEGY headers : e.g. varying elevation specified for same x/y coordinate pair.
- May 21, 2017 : determine *Layout start [station no.]* and *Shot pos. [station no.]* correctly when importing multiple `SEGY .SGY` trace files recorded with overlapping receiver spreads with option *File*|*SEGY import settings*|*No receiver coordinates specified in .SGY file* unchecked
- Apr 26, 2017 : *WET Tomo*|*WET tomography Settings*|*Blank*|*Blank no coverage after last iteration* is now checked per default
- Apr 25, 2017 : *WET Tomo*|*Interactive WET tomography*|*Edit velocity smoothing*|*Used width of Gaussian* has new range 0.1 .. 20.0 instead of 0.1 .. 6.0. Increase from default 1.0 for sharper filter.

- Apr 15, 2017 : layered refraction smoothing parameter *Base filter width [station nos.]* has new default value 8 instead of former 10. This can improve lateral resolution when detecting basement fault zones with *Depth|Plus-Minus* and *Wavefront* refraction methods. Edit with ALT+M in *depth section window*.
- Apr 8, 2017 : describe *Cosine-Squared WET update weighting* in help topic *WET tomography processing*. Install updated help file with latest winhelp.exe installer.
- Apr 3, 2017 : our new *WET Tomo|WET Update weighting dialog* lets you edit parameters a&b for ***Cosine-Squared weighting function***. See Chen and Zelt AGU 2012 poster Fig. 5 (a) .
- Apr 3, 2017 : set *WET Tomo|Interactive WET tomography|Ricker differentiation* to -2 to ***weight WET velocity updates with Cosine-Squared function*** instead of default -1 meaning *Gaussian weighting*
- Apr 1, 2017 : detect missing 2nd header line in GeoTomCG .3DD files
- Mar 31, 2017 : show *rayId* in error prompt when importing GeoTomCG .3DD file with bad geometry
- Mar 30, 2017 : a 2016 report by NGU (Geological Survey of Norway) compares using our *Plus-Minus method layered refraction starting model* vs. *1D-gradient starting model* for *WET inversion*.
- Mar 30, 2017 : ***vary/decrease basement refractor smoothing for our Plus-Minus method*** by 1. clicking *No button* in our *Continue with WET tomography prompt* and 2. pressing ALT+M in *Plus-Minus Depth Section window* to display our *Plus-Minus Model Parameters dialog*.
- Mar 30, 2017 : ***adapt our 1D-gradient starting model to layered subsurface*** by checking options *Smooth invert|Smooth inversion Settings|Allow XTV inversion for 1D initial model* and *Optimize XTV for layered starting model* before selecting *Smooth invert|WET with 1D-gradient initial model*
- Mar 30, 2017 : before importing a GeoTomCG .3DD survey file involving multiple boreholes (with all y coordinates = 0.0) you need to split the .3DD such that all traces contained in one .3DD are recorded with receivers located in the same Borehole spread/line or along the same Refraction line . See e.g. our tutorial 11REFR plus 1611HOLE tutorial.
- Mar 30, 2017 : *WET Tomo|Interactive WET tomography|Edit velocity smoothing|Maximum velocity update* now has valid range 0.01% to 30% instead of former 1% to 30%
- Mar 28, 2017 : ***WET Tomo|WET Velocity constraints|Pad polygon border*** extends the polygon border by one pixel (grid cell) in each direction when blanking velocity tomogram during *WET inversion* . This option is enabled per default to make it easier to pick the .BLN *blanking polygon* in Surfer.
- Mar 23, 2017 : added more figures to tutorial tunnel16 and improved instructions
- Mar 22, 2017 : updated free trial and included latest help file in installer
- Mar 18, 2017 : describe new controls in *WET velocity constraints* and *Custom 1D-gradient velocity profile* dialogs. Install updated help file with latest winhelp.exe installer.
- Mar 15, 2017 : focus on *Select button* in *WET Tomo|Interactive WET tomography dialog* if no or invalid *starting model* (initial velocity model) specified
- Mar 14, 2017 : tutorial tunnel16 shows ***imaging of tunnel excavation disturbed zone*** (EDZ) with version 3.35 of our software
- Mar 13, 2017 : unmapping traces in *Refractor|Midpoint breaks display* with ALT+U shortcut does not reset *CMP Stack Width* edited with ALT+M to default width any longer
- Mar 13, 2017 : we have changed defaults for display of first break picks in *Trace|Shot gather*. Change display settings in *Processing menu*.
- Mar 13, 2017 : obtain ***smoother DeltatV starting models with less noise/artefacts*** with non-default *DeltatV settings* as described in tutorials OT0608 on page 3 and GEOXMERC on page 1. These non-default *DeltatV settings* work best for long refraction spreads/lines and dense shot spacing.
- Mar 10, 2017 : ***Depth|Depth conversion Settings|Prefer geometric velocity for Wavefront*** computes the basement refractor velocity as described by (Jones and Jovanovich, 1985). Uncheck to set basement velocity to average of forward and reverse velocity obtained from traveltimes reduced to basement refractor level (E. Brueckl, 1987). This new option is checked per default. Uncheck for lines with steep topography for more robust velocity determination.

- Mar 8, 2017 : ***WET Tomo|WET velocity constraints|Smooth polygon border*** smooths over blanking polygon border during *WET inversion*. Uncheck to strictly enforce the blanking polygon border.
- Mar 6, 2017 : more robust determination of velocity at source/receiver during *WET inversion*
- Mar 3, 2017 : *File|Export header data|Export Traces to GeoTomCG .3DD* with *File|Export data Settings|Gather traces by common receiver station* checked : regard *File|Import Data Settings|Import horizontal borehole survey or .3DD refraction survey* & *Import circular borehole survey* settings to determine `.3DD` trace sort
- Mar 3, 2017 : more robust determination of *Shot pos.[station no.]* during import of `GeotomCG .3DD` with *File|Import Data Settings|Import circular borehole survey* checked
- Feb 27, 2017 : extrapolate velocity to polygon boundary from outside when blanking inside polygon as specified in *WET Tomo|WET Velocity constraints dialog*
- Feb 26, 2017 : *WET Tomo|WET tomography Settings|Blanking|Blank no coverage after each iteration* & *Blank no coverage after last iteration* blank below covered tomogram area for *Line type* `Refraction spread/line`. For *Line type* `Borehole spread/line` we also blank above covered area.
- Feb 25, 2017 : don't plot source symbol (red triangle) on tomogram if no traces picked for that shot
- Feb 24, 2017 : `SHIFT+Z` in *Trace|Shot gather* deletes first break picks & modeled picks for current shot
- Feb 24, 2017 : `ALt+Z` in *Trace|Shot gather* deletes first break pick & modeled pick for current trace
- Feb 23, 2017 : *File|Import Data* `.HDR` file creation : write *Delay Time* and *Sample Interval* with 6 digits precision to `.HDR` . Write actual number of samples in input file to `.HDR` column *Sample Count*.
- Feb 22, 2017 : if *WET inversion* can't allocate enough RAM memory to cache all source and receiver station traveltime grids we now prompt you to install more RAM and use our Pro version
- Feb 22, 2017 : `ALT+M` in *Trace|Shot gather* etc. brings up *Trace processing parameters dialog*. Box ***Remove systematic dc offset from traces*** is now unchecked per default.
- Feb 21, 2017 : *Smooth invert|Smooth inversion Settings|Output inversion results in Feet* now prompts you to confirm toggling this setting and deletes `...\GRADTOMO GRADIENT.GRD&DLTAGRAD.GRD`
- Feb 21, 2017 : display shotpoint and receiver coordinates with 4 digits after decimal point instead of 3. Also write coordinates to `SHOTPTS.SHO` and `GeoTomCG .3DD` with 4 digits past decimal point.
- Feb 20, 2017 : check *File|Import Data Settings| .3DD shot traces sorted by receiver offset* to improve detection of shots when importing `GeoTomCG .3DD` with multiple shots recorded at same shot point but with shifted receiver spread. Otherwise such shots are merged into one shot during `.3DD` import.
- Feb 15, 2107 : ***File|Import data Settings|Import circular borehole survey*** disables receiver spread geometry checks and does not make any assumption regarding shape of borehole spread. Use when borehole spread line loops back on itself. Check source&receiver positions on tomogram plots. Update source&receiver coordinates via *File|Update header data|Update Station coordinates* and *Update Shotpoint coordinates*. See ***Help|Contents|File formats***.
- Feb 15, 2017 : for WET inversion of data recorded with circular spread (see above bullet) you need to digitize the tunnel void boundary on our starting model plot in Surfer to generate a `.BLN` blanking file. Now select this `.BLN` in our *WET Tomo|WET Velocity constraints dialog*. Now run Smooth inversion with constant-velocity starting model. Next run *WET Tomo|Interactive WET tomography* and vary WET parameters. See ***Help|Contents|WET tomography processing***.
- Feb 15, 2017 : *WET Tomo|Interactive WET tomography|CG iterations* has new default of 10 instead of 15. *Line Search iters.* has new default of 2 instead of 3. This may make *Conjgate Gradient* more robust.
- Feb 15, 2017 : regard all databases added in *Header|Profile* when determining max. picked time needed to determine RMS error in percent

- Feb 15, 2017 : more robust import of `GeoTomCG .3DD` traces when receivers are sorted by decreasing x coordinate (horizontal hole) or decreasing z coordinate (vertical hole) in the `.3DD` file
- Feb 14, 2017 : *Smooth invert*|*Custom 1D-gradient velocity profile*|*Forced velocity* allows editing of initial velocity for constant-velocity starting model. Check box *Force constant velocity* to enforce this.
- Feb 13, 2017 : correctly display *Header*|*Shot*|*Source elevation* for *Line type* `Borehole spread/line`
- Feb 13, 2017 : allow forcing of left grid limit in *Smooth invert*|*Custom 1D-gradient velocity profile*
- Feb 13, 2017 : write forced grid limits to `.PAR` file when creating starting model
- Feb 10, 2017 : *Grid*|*Vertical plot title* plots the tomogram title vertically on tomogram. Uncheck to plot title horizontally on top of tomogram.
- Feb 9, 2017 : *File*|*Open Profile…* checks all borehole `SEIS32.DBD` added in *Header*|*Profile* if they are up-to-date. We prompt you to open any added out-of-date borehole line database with *File*|*Open Profile…* to revise the database.
- Feb 6, 2017 : regard for *DeltatV starting model grid* the grid limits forced in *Smooth invert*|*Custom 1D-gradient velocity profile*
- Feb 6, 2017 : prompt user to run Rayfract® Pro as Admin if AWE memory allocation fails
- Jan 30, 2017 : *Grid*|*Export grid file to ASCII.TXT…* now terminate lines in `.TXT` with <cr><lf>
- Jan 28, 2017 : ***File*|*Shorten stored trace length…*|*New trace length stored in db [ms]*** lets you specify a shorter trace length for an existing profile to reduce disk size of the database. Click *button Update traces* to revise the database. This new dialog is available for our Pro license only. *Shot delay* and *Trigger delay* are not regarded when shortening the database traces on disk.
- Jan 27, 2017 : our PowerPoint slide show shows how to interactively improve your first break picks
- Jan 27, 2017 : fixed issue with forcing grid limits in *Smooth invert*|*Custom 1D-gradient velocity profile*
- Jan 23, 2017 : updated help chapters *Introduction* and *Calling Surfer*. Install updated help file with our latest `winhelp.exe` installer .
- Jan 4, 2017 : support main profile *Line type* `Borehole spread/line` when adding borehole(s) with *Select button(s)* in *Header*|*Profile* . All profiles selected are regarded to determine tomogram limits.
- Jan 4, 2017 : regard for *Line type* `Borehole spread/line` the grid limits forced in *Smooth invert*|*Custom 1D-gradient velocity profile*
- Jan 4, 2017 : convert grid limits forced in *Custom 1D-gradient velocity profile* to feet with *Smooth invert*|*Smooth inversion Settings*|*Output inversion results in Feet* checked
- Jan 4, 2017 : the *Custom 1D-gradient velocity profile* selected is used for *Line type* `Refraction spread/line` only at this time
- Jan 4, 2017 : support joint inversion of main profile shots with borehole profile(s) shots added in *Header*|*Profile* with *Output inversion results in Feet* checked
- Dec 28, 2016 : *Smooth invert*|*Custom 1D-gradient velocity profile*|*Grid bottom elevation* can be increased to at least 40% of depth range of *DeltatV 1D-gradient starting model*
- Dec 28, 2016 : *WET inversion* shows better error message in status bar if starting model too shallow
- Dec 27, 2016 : describe ***how to obtain elastic constants*** based on P-wave & S-wave surveys along same line in help chapter *Dynamic Poisson's ratio imaging*. Install updated help file with latest `winhelp.exe` .
- Dec 27, 2016 : don't allow selection of `1DVELO.TXT` & `1DUSER.TXT` files in *Smooth invert*|*WET with 1D-gradient initial model*. Prompt to copy `1DVELO.TXT` to `MYVELO.TXT` and to select `MYVELO.TXT` .
- Dec 26, 2016 : don't overwrite `1DVELO.TXT` and `1DUSER.TXT` files in *Smooth invert*|*WET with 1D-gradient initial model* if user selected these in *Smooth invert*|*Custom 1D-gradient velocity profile dialog*

- Dec 26, 2016 : let user click *OK/Cancel/Reset etc. buttons* in *Smooth invert|Custom 1D-gradient velocity profile dialog*, *WET Tomo|Interactive WET tomography dialog* and *Grid|Surfer plot Limits dialog* even if numeric field with current focus has invalid/empty value
- Dec 22, 2016 : new help file chapter ***Calling Surfer*** lists steps to try if Golden Software Scripter can't find Surfer. Install updated help file with latest `winhelp.exe` installer.
- Dec 19, 2016 : *interpolate x coordinate at stations without any picked traces* when importing Geometrics PlotRefa, Optim SeisOpt, Interpex Gremix and GeoTomCG .3DD shots
- Dec 14, 2016 : more accurate interpolation of forward modeled traveltime at receivers. Helps especially with large cell size.
- Dec 10, 2016 : Joana Santos uses SRT to obtain initial model for MASW (Univ. Lisboa, 2016)
- Dec 10, 2016 : decrease ***Refractor count*** from 2 to 1 for short lines (24 channels) in *Refractor|Midpoint breaks* with ALT+M to map basement with *Depth|Plus-Minus* or *Wavefront* layered refraction
- Dec 10, 2016 : decrease ***Base filter width*** from default 10 to 5 stations for short lines in *Depth|Plus-Minus* or *Wavefront* depth sections with ALT+M so the basement refractor can be mapped
- Dec 10, 2016 : check *Smooth invert|Smooth inversion Settings|Allow XTV inversion for 1D initial model & Optimize XTV for layered starting model* for compromise between deeper diving waves & more shallow layered refraction starting model. See our tutorial jenny10.pdf .
- Dec 5, 2016 : make error message prompts modal to dialogs so you have to confirm prompts before you can continue working with the dialog
- Nov 30, 2016 : regard *File|Export data Settings|Export coordinates in feet* when writing `.HDR` batch file in *File|Import Data…* . Unit `[m]` or `[ft]` is written to 2nd header line of `.HDR` batch file.
- Nov 30, 2016 : *File|Import Data…* regards unit `[m]` or `[ft]` in 2nd header line of `.HDR` when importing shots listed in `.HDR` batch file
- Nov 24, 2016 : improved description of *Conjugate Gradient method controls* in help file chapter ***WET tomography processing***. Install updated help file with latest `winhelp.exe` installer.
- Nov 19, 2016 : help file chapter ***Seismic and header data import*** describes our new *File|Import Data dialog*. Install updated help file with latest `winhelp.exe` installer.
- Nov 18, 2016 : disallow forcing of grid cell size for free trial in *Header|Profile* & disable option *Smooth invert|Smooth inversion Settings|Edit cell size* for free trial
- Nov 17, 2016 : fixed free trial. *Header|Profile dialog* is working again. Adding *borehole lines* to main profile is not possible in our limited functionality free trial version.
- Nov 16, 2016 : *File|Import Data…* offers new controls to ***generate a `.HDR` batch file for all matching input files in selected input directory***. Review and edit this `.HDR` batch and use for batch import.
- Nov 11, 2016 : help file chapter ***File formats*** describes our new *File|Export grid file to ASCII .TXT dialog*. Install updated help file with latest `winhelp.exe` installer.
- Nov 10, 2016 : *File|New Profile…* & *File|Open Profile…* both reset fields in *Grid|Surfer plot Limits dialog* if plot limits have not yet been saved to disk with *OK button* for this profile
- Nov 10, 2016 : reset *Grid|Export grid file dialog to ASCII .TXT dialog* as in above bullet
- Nov 10, 2016 : reset *Smooth invert|Custom 1D-gradient velocity profile dialog* as above
- Nov 9, 2016 : *Smooth invert|Smooth inversion Settings|Output inversion results in Feet* now correctly determines the ***grid cell size in feet*** (same as Surfer *X spacing* & *Y spacing*) with checked option *Header|Profile|Force grid cell size* and using field *Header|Profile|Cell size*
- Nov 8, 2016 : *Grid|Export grid file to ASCII .TXT…* opens a new dialog which lets you select the `.GRD` input file, `.TXT` output file and optionally ***export x/y/z/velocity for cells with velocities in a specified velocity range***. This lets you easily ***build a basement contour map*** from multiple crossing 2D profiles showing elevation of "basement" with velocities in this range. Just paste all exported `.TXT` files into one `.TXT` and grid and contour with Golden Software Surfer.
- Nov 6, 2016 : added *checkbox Proportional XY Scaling* to *Grid|Surfer plot Limits dialog*. If this is checked we do not regard *X Scale* & *Y Scale* values. Edit these in *Surfer Map|Scale tab* instead.
- Nov 6, 2016 : regard *Grid|Surfer plot Limits* for *Line type* `Borehole spread/line`

- Nov 3, 2016 : install updated help file with latest `winhelp.exe` installer. Added topics for new controls in *WET velocity constraints dialog*, *Custom 1D-gradient velocity profile dialog* and *Header|Profile* .
- Nov 2, 2016 : our updated ad will be printed in EAGE NSG Dec 2016 issue
- Oct 27, 2016 : *WET Tomo|WET velocity constraints|Blank outside polygon* checkbox forces blanking outside polygon specified in selected *Surfer* `.BLN` *blanking file* overriding the *blanking flag* in header line (2nd column) of the `.BLN` . Also check box *Polygon blanking active*.
- Oct 27, 2016 : *WET Tomo|WET velocity constraints dialog* offers 4 new checkboxes for extrapolation of velocity to `.BLN` *blanking file* boundary when blanking outside polygon : *Extrapolate to top&bottom*, *Extrapolate to left&right*. Use with low velocity at shots or receivers to avoid gaps in coverage.
- Oct 21, 2016 : *File|Export header data|Export First Breaks…* writes value of -1.0 into columns *synthetic*, *residual[ms]* and *abs(residual)* if the trace has not been modeled with WET inversion
- Oct 12, 2016 : ***borehole-recorded shots can be positioned outside the receiver spread***. But the *Shot pos.[station no.]* specified during import into profile with *Line type* `Borehole spread/line` has to match an active receiver station no. used to record this shot. Once all shots have been imported go into *Header|Shot* and review&optionally edit fields *dx* and *dz* in frame *Offset from Shot Station* . Tab through dialog controls until absolute coordinate fields *x* and *z* in frame *Source Coords*. are updated. See e.g. our new `1611HOLE` tutorial. Walkaway VSP shots are recorded with 3 spreads in one borehole.
- Oct 12, 2016 : upper *File|Import Data|Select button* now shows contents of `INPUT` subdirectory of *profile directory* for current profile database.
- Oct 6, 2016 : *Smooth invert|Custom 1D-gradient velocity profile|Grid bottom elevation[m]* lets you specify the lower limit of the starting model grid. Check *Force grid limits* & click *OK* to activate this.
- Oct 6, 2016 : *Smooth invert|Custom 1D-gradient velocity profile|Left limit of grid[m] & Right limit of grid[m]* fields are enabled for our Pro license only. Check *Force grid limits box* & click *OK* to activate.
- Oct 6, 2016 : *Smooth invert|Custom 1D-gradient velocity profile|Reset limits to grid* lets you select a `VELOITXY.GRD` velocity tomogram in directories `…\LAYRTOMO` or `…\GRADTOMO` and reset above grid limits
- Sep 28, 2016 : to edit limits and scale of ***Surfer plots***
  - select our *Grid|Surfer plot Limits*
  - click *button Reset to grid* and select your final `VELOIT20.GRD` tomogram in `…\GRADTOMO` or `…\HOLETOMO` subdirectories
  - edit plot limits, min./max. velocity and x/y scale as desired
  - check box *Plot limits active* and click *OK button*
  - select *Grid|Image and contour velocity and coverage grids…* and above `VELOIT20.GRD`

- Sep 23, 2016 : our new tutorial `11REFR` shows how to easily ***constrain surface-refraction tomography with VSP shots***. `1611HOLE` shows *WET inversion* of the VSP shots only without refraction shots.
- Sep 23, 2016 : tutorial `11REFR` compares multiscale tomography with single-run *WET inversion*.
- Sep 19, 2016 : our Pro license allows easy adding of up to four (4) *Borehole line* profiles to main profile in *Header|Profile*. The main profile can have either *Line type* `Refraction spread/line` or `Borehole spread/line` . First breaks picked for main and added profiles are used for ***joint WET inversion***.
- Sep 19, 2016 : Added *Ok/Cancel/Reset buttons* to *Header|Profile dialog*.
- Sep 16, 2016 : when adding *Borehole spread(s)* to your main profile with *Header|Profile|Select button(s)* as described below in Sep 15, 2016 bullets you may want to uncheck *WET Tomo|WET tomography Settings|Blank outside borehole tomogram*. Instead pick blanking polygon (*tomogram boundary*) in Surfer as below and use our *WET velocity constraints* option.
- Sep 16, 2016 : create the Surfer `.BLN` blanking file needed for above bullet as described in http://www.goldensoftware.com/knowledge-base/surfer/1095-how-can-i-create-a-bln-file : digitize

the boundary on velocity tomogram with ***Map|Digitize*** and save to a `.BLN` file. Optionally first draw the polygon on the tomogram in an empty base layer with Surfer ***Draw|Polygon command***. See above link.

- Sep 16, 2016 : toggle the *blanking flag* in the saved `.BLN` file e.g. with Microsoft WordPad. E.g. first line `31,1` in `.BLN` means polygon with 31 points (corners), blank inside polygon. Change this to `31,0` to blank outside polygon after each WET iteration.
- Sep 16, 2016 : ***WET Tomo|WET Velocity constraints...|Select blanking file*** lets you select above Surfer `.BLN` *blanking file* after editing the `.BLN` and toggling the *blanking flag* as above.
- Sep 15, 2016 : *Header|Profile|Select button* lets you easily ***add one Borehole spread/line profile*** to main profile. Our Pro license allows adding up to four (4) *Borehole spread/line* profiles to main profile.
- Sep 15, 2016 : adding *Borehole spread/line* profile(s) to main profile as in above bullet is possible for true 2D profile databases where y coordinates are all zero 0.0 only.
- Sep 15, 2016 : when adding *Borehole spread/line* profile(s) adjust *Header|Profile|Profile start offset[m]* for main refraction profile so the horizontal X axis shown with starting model and WET tomograms matches the X axis shown for borehole tomograms.
- Sep 15, 2016 : *WET inversion* uses first breaks picked for main and all added *Borehole spread* profiles. *DeltatV* and layered refraction methods use first breaks picked for the main refraction profile only.
- Sep 15, 2016 : Smooth inversion with *constant-velocity starting model* uses first breaks picked for main profile and for added *Borehole spreads* profile(s).
- Sep 15, 2016 : plot shot and receiver symbols for added *Borehole spreads* on WET tomograms
- Sep 15, 2016 : better error prompt during *WET inversion* if velocity grid has invalid velocity values.
- Sep 15, 2016 : more robust extrapolation of velocity at top/bottom of tomogram during *WET inversion*.
- Aug 31, 2016 : write residuals to `BREAKS.LST` with *File|Export header data|Export First Breaks*
- Aug 31, 2016 : *File|Export data Settings|Write empty line to .LST after each shot* option writes blank line separating shots into `BREAKS.LST` with *File|Export header data|Export First Breaks*
- Aug 31, 2016 : *File|Update header data|Update First Breaks* skips blank lines between shots in `.LST`
- Aug 31, 2016 : complete the transaction when importing shots even if update with `IMPSHOTS.SHO` fails
- Aug 31, 2016 : updated tutorial `coffey04` : how to import reversed VSP shots into refraction profile
- Aug 21, 2016 : limit WET parameter *Width of Gaussian for one period [sigma]* to max. 100.0
- Aug 19, 2016 : *File|Export data Settings|Export horizontal inline offset to .COR* optionally exports *horizontal inline offset* (from first profile receiver station) to `COORDS.COR`. Also export *weathering velocity* (v0 in *Header|Station*) and *DeltatV v0* at topography if available.
- Aug 19, 2016 : do not reset interactive WET parameters *Ricker differentiation* and *Width of Gaussian for one period [sigma]* when reopening a profile database with *Line type Borehole spread/line*
- Aug 18, 2016 : export *horizontal inline offset* (from first profile receiver station) to `COORDS.COR` .
- Aug 18, 2016 : extrapolate *custom velocity profile* to top/bottom of `GRADIENT.GRD`
- Aug 12, 2016 : install updated help file with latest `winhelp.exe` installer. Added a paragraph at end of chapter *Smooth inversion* explaining our new *Custom 1D-gradient velocity profile dialog*.
- Aug 10, 2016 : *multirun WET inversion* now works with *Wavepath frequency* above 200 Hz and *Wavepath width[ms]* smaller than 0.1 ms
- Aug 10, 2016 : when you click *Conjugate Gradient radio button* in *WET Tomo|Interactive WET tomography* we now prompt you to confirm or keep using the safer *Steepest Descent* search method
- Aug 10, 2016 : *Smooth invert|WET with 1D-gradient initial model* writes the averaged velocity vs. depth profile to `C:\Ray32\<your profile name>\GRADTOMO\1DVELO.TXT`

- Aug 10, 2016 : *Smooth invert|Custom 1D-gradient velocity profile* dialog lets you select a ***custom velocity profile*** in `.TXT` file with two columns : depth below topography and velocity. Copy above `1DVELO.TXT` to `MYVELO.TXT` and edit with Microsoft WordPad. Now select the `.TXT` file in this dialog.
  Check box *Replace velocity active* and select *Smooth invert|WET with 1D-gradient initial model* to

  - write the averaged DeltatV velocity vs. depth profile to file `…\GRADTOMO\1DVELO.TXT`
  - read in your custom `.TXT` velocity profile specified above
  - interpolate your velocity profile to all depths & use this to compute the `GRADIENT.GRD` with topography
  - write the interpolated custom velocity vs. depth profile to file `…\GRADTOMO\1DUSER.TXT`
  - plot the generated `GRADIENT.GRD` in Surfer as usual