



User Guide v.2021

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Purpose of these notes is to steer users towards an optimal use of EarthQuick. The website (www.earth-quick.com) also boasts a bunch of video tutorials to help users with daily use of EarthQuick.

Main key steps shall be detailed here through a workshop form with a project creation, data loading and interpretation. Extensive use of tips and tricks are essential to enable practical use of EarthQuick.

Side issues shall be addressed as advice, considering projects backup policy or data base handling.

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Introduction

That user guide stands as a collection of guidelines, mainly sorted per module of EarthQuick. Doing so, 15 chapters compose that document. Namely:




1. EarthQuick Software Installation
2. EarthQuick Launcher
3. Data Base
4. SegManager
5. Global Viewer
6. Wells Board
7. SyntheticsGen
8. GeoPosit
9. InterpMapper
10. ScanPaperLine
11. EM1D
12. Risked Eyesight
13. Projects transfer and content filtering
14. Mouse and Keyboard Shortcuts
15. Acronym and specific terms glossary

The idea is to provide a proficient way to define or remind functionalities during or after a training session.

At that point, the assumption that EarthQuick has not been already been installed on the users' PC is taken. Then, next chapter intends to let users or administrators follow installation workflow.

RMOTC dataset (Teapot Dome) shall be used to provide trainees with real case study. That dataset is courtesy of RMOTC and the U.S. Department of Energy.

Pictograms shall be used to let users find their way like a charm:

	: Identify exercises to be run with EarthQuick, working mainly with RMOTC – Tea Pot Dome data base.
	: Identify information EarthQuick DB specificities or tips and tricks to handle the latter.
	: Shows important information not to neglect.

1 EarthQuick Software Installation

1.1 Prerequisites


Installation must be run locally on each client machine of which characteristics must comply with:

- Minimum system requirements:
 - Free Space HD: 2 GB,
 - Amount of RAM: 4 GB RAM,
 - CPU speed: 1.2 GHz,
 - CPU Core count: 1,
 - Video Resolution: 1280x720,
 - Bits Color: 8.
- Preferred system requirements:
 - Free Space HD: 4 GB,
 - Amount of RAM: 8 GB RAM,
 - CPU speed: 2.2 GHz,
 - CPU Core count: 4,
 - Video Resolution: 1280*1024,
 - Bits Color: 32.
- Software prerequisites minimum requirements:
 - OS: Windows 7, 8, 8.1 and 10, 64-bits,
 - Java Runtime 1.6,
 - .NET Framework 4.0,
 - OpenGL,
 - Matlab runtime 64-bits (URL for download: <https://mathworks.com/products/compiler/mcr.html>). Installation comes along automatically with the EarthQuick installer,
 - MiKTeX 2.9 libraries 64-bits (OPTIONAL: if they intend to rely on 3D PDF facilities) (URL for download: <https://miktex.org/download>).

1.2 Installation proceeding

EarthQuick installation is made by running *EarthQuickInstaller.exe*, provided beforehand. That executable is created with an installation wizard and made of a self-extracting archive. Next page, Figure 3 shows steps to go through when launching installation.

In case of installer loss, a link for direct download is provided if sending a request to support@earth-quick.com. At first launch, EarthQuick asks for license number and activation code.

 In case user chose to add a shortcut to the desktop along installation, on some systems, an error message could occur at first launch, such as displayed on Figure 1.

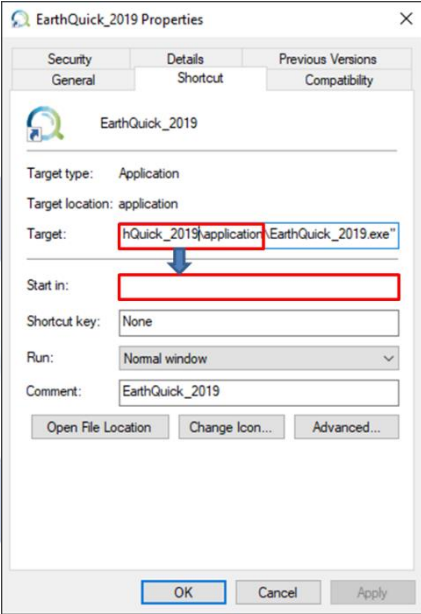
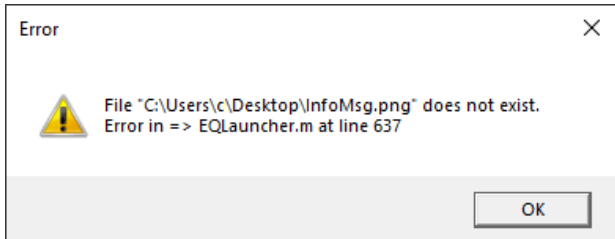


Figure 1: Error message due to shortcut creation by the installer wizard.



As a workaround, the following workflow is proposed:

1. Right click on the EarthQuick shortcut,
2. Choose *Properties* → *Shortcut* tab,
3. In the *Start in* command prompt, copy/paste the path of the EarthQuick Installer as contained above in the *Target* command prompt. For example, if in *Target* the string of characters is "*C:\Program_Files\EQ_2019\app\EarthQuick_2019.exe*", then "*C:\Program_Files\EQ_2019\app*" must be observed in *Start in*.

After complying with and applying these changes, a double click on the shortcut should lead users to a normal launch of EarthQuick.

Figure 2: Workaround associated to shortcut creation.

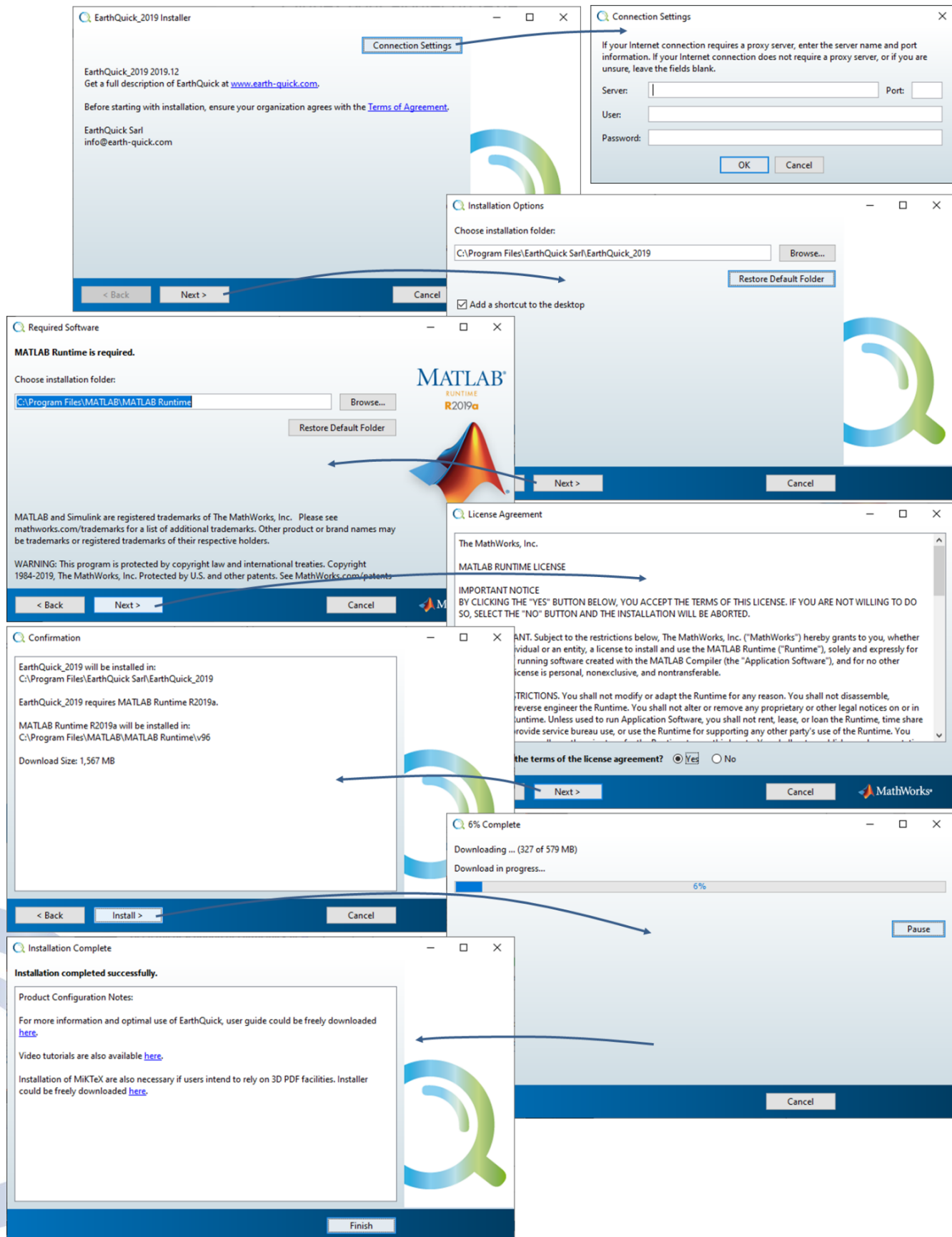


Figure 3: Installation workflow from top to bottom.

1.3 Pinnable icon onto Windows start menu

To enable EarthQuik to be pinned onto the Windows start menu, copy the application shortcut to %ProgramData%\Microsoft\Windows\Start Menu\Programs and %AppData%\Microsoft\Windows\Start Menu\Programs as illustrated by Figure 4.

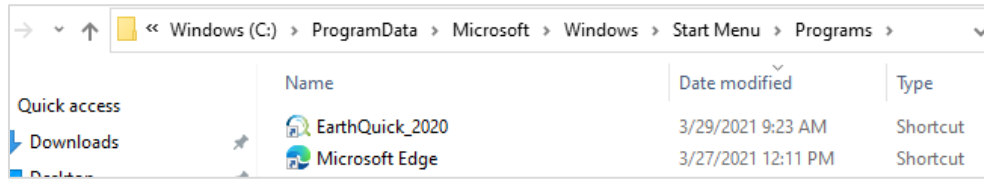


Figure 4: Use of Windows File Explorer to pin EarthQuik icon onto the start menu.

Then, drag the shortcut from the left-hand side panel of the startup menu to the right-hand side as shown on Figure 5.

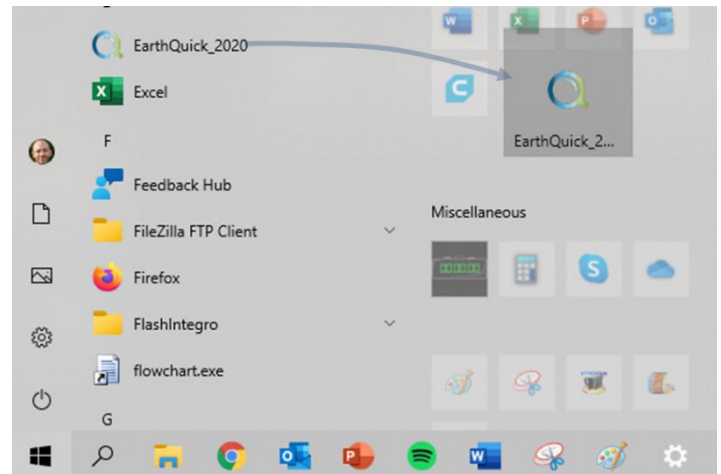


Figure 5: Drag and drop process in Windows startup menu.

1.4 Licensing system

Each license is a floating license, meaning that could be shared on several machines with a one single simultaneous use.

At first launch, user must type his/her license number and activation code to activate the license. To avoid having to type the license number and the activation code at each EarthQuik launch, the first launch must be performed by an administrator of the machine. Figure 6 and Figure 7 license number and activation code requests at first launch of EarthQuik.

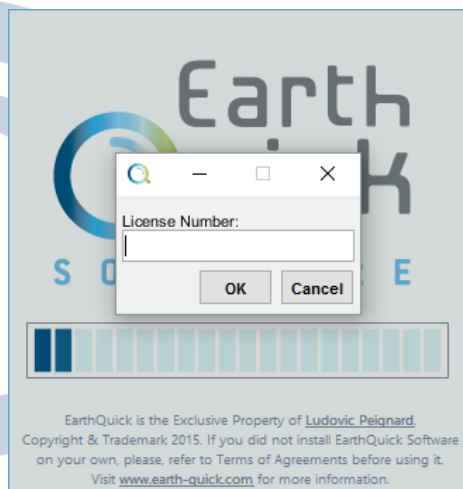


Figure 6: License number is made of 25 uppercased and lowercased characters as well as digits.

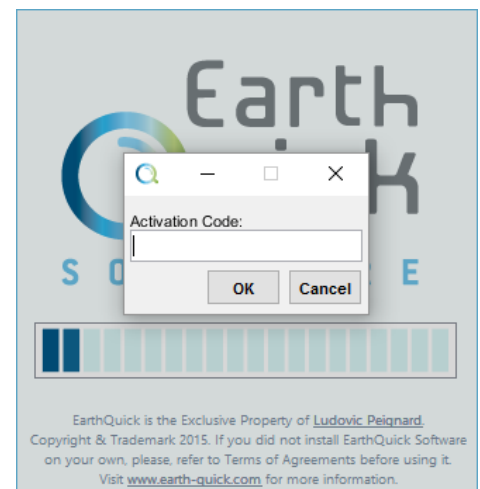


Figure 7: Activation code is made of 5 digits.

Licenses are granted through a secured SSH connection to a remote license server. The client machine exchanges a token with the license server and write a file with following characteristics on the server:

- Date and time;
- License number;
- Host name;
- Username;
- EarthQuick version in use.

No other information is communicated.

1.5 Third-party Software

Free-of-charge third party software products are required to let EarthQuick work properly. They are listed with their respective links for download as follows:

While installing the EarthQuick program, the EarthQuick installer wizard automatically check Matlab runtime occurrence on the machine and perform complete installation or updates if needed. That third-party software released by [MathWorks](#) is mandatory and free-of-charge. After complying with EarthQuick installation, the installer reminds users MiKTeX libraries are also necessary if intending to rely on 3D PDF facilities. MiKTeX is also free-of-charge although optional.

To install the complete package of MiKTeX (recommended if end users are not administrators of the machine they use), one must follow steps:

- Run basic-miktex-2.9.[k]-x64.exe as for basic installation.
- Then, relying on the Windows™ search bar, MiKTeX Package Manager could be found and launched (see Figure 8). The Package Manager (see Figure 9) enables advanced packages retrieving from the internet. EarthQuick relies on the packages below:
 - l3experimental
 - l3kernel
 - l3packages
 - media9
 - mptopdf
 - ocgx2
 - standalone

These are all to be installed.

The *Name* field enables to easily identify/filter packages in the list. Highlighted ones could then be installed by clicking the “+” sign in the upper left corner of the frame.

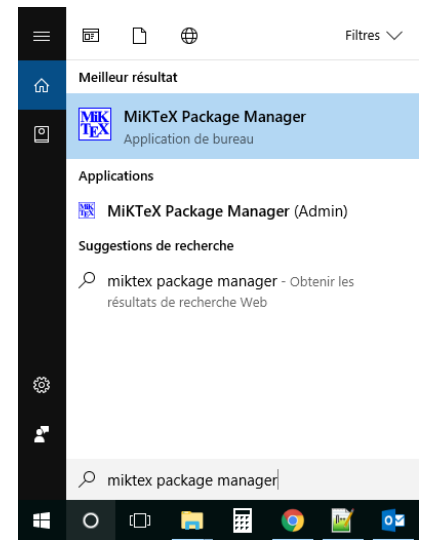


Figure 8: MiKTeX packages installation – Step 1.

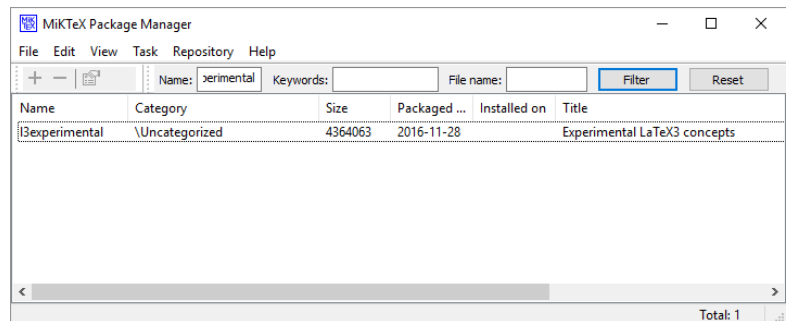


Figure 9: MiKTeX packages installation – Step 2.

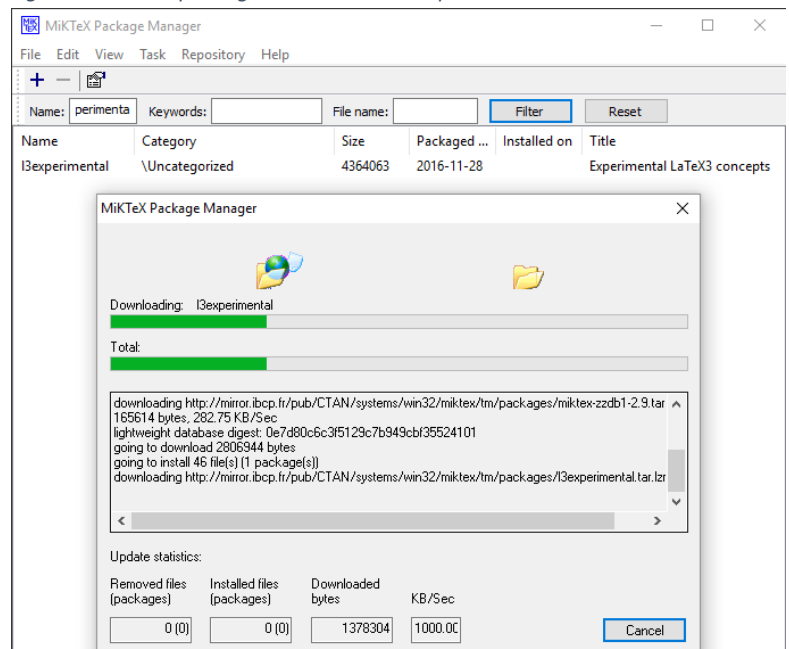


Figure 10: MiKTeX packages installation – Step 3.

Figure 10 to 10 show ongoing MiKTeX package installation.

1.6 Update

Users are aware a new version of EarthQuick has been released with a popup window at EarthQuick launch, as shown in Figure 11.

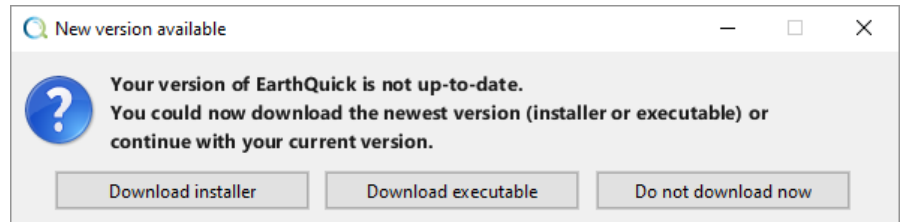


Figure 11: New version released warning.

Software update is then made with an uninstallation of the prior version first. Uninstallation could also be performed running *Programs and Features* Windows™ App as defined with Figure 12 in Chapter 1.7.

After downloading and execution of a new release, the installer wizard provided with each release could then be triggered. If a current active license on the machine has already been set, that is already automatically recognized as well as EarthQuick projects without any further handlings.

1.7 Uninstallation

Uninstallation could also be performed running *Apps-and-Features* Windows™ App and following uninstallation workflow as defined with Figure 12.

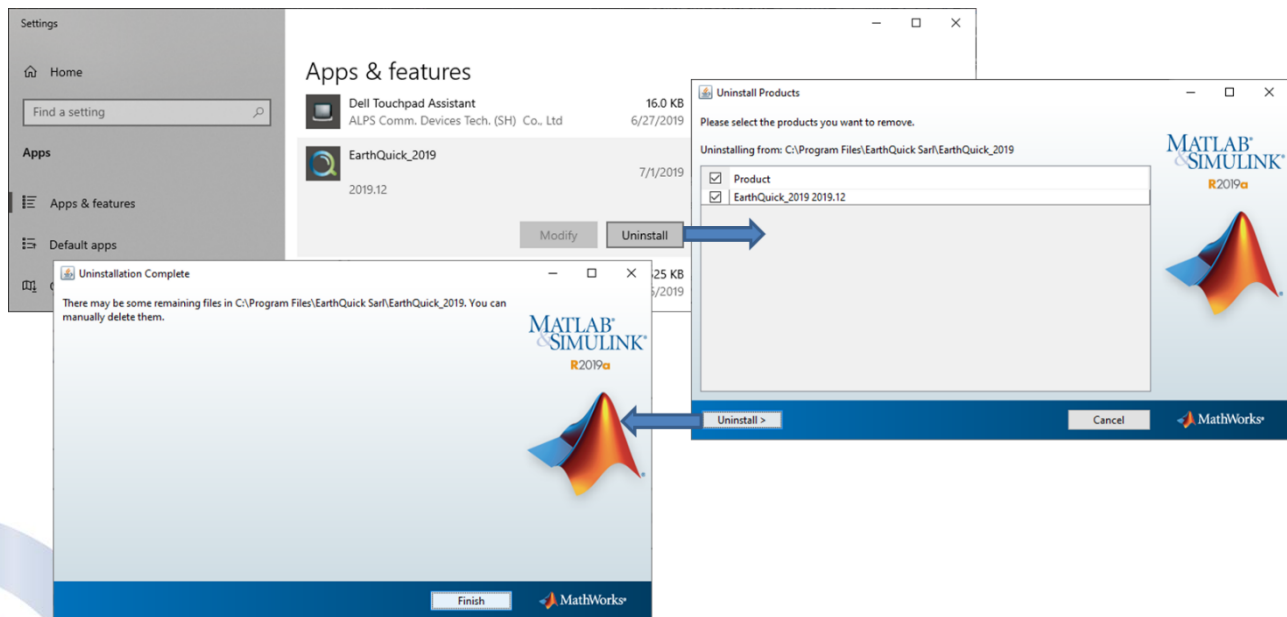


Figure 12: Uninstallation workflow.

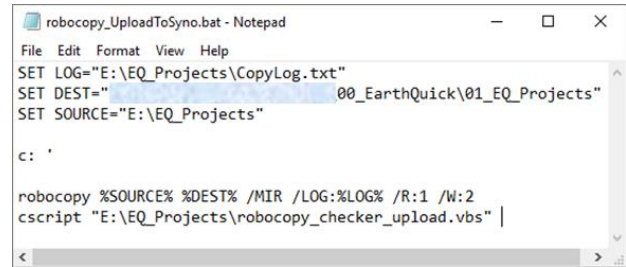
The executable of EarthQuick could also be downloaded to ease updates for users without administration rights on their machine.

1.8 Projects backup

That is strongly recommended to perform EarthQuick projects backup on a regular basis.

Task Scheduler from Windows™ is the proper tool to achieve such a burden since that support batch script relying on robocopy facility and triggers could be easily implemented.

Figure 13 shows an example of a script to update a copy of project on a remote location, that same script is then used to create a task, launched every day at 6 pm (see Figure 14).



```

robocopy UploadToSyno.bat - Notepad
File Edit Format View Help
SET LOG="E:\EQ_Projects\CopyLog.txt"
SET DEST="00_EarthQuik\01_EQ_Projects"
SET SOURCE="E:\EQ_Projects"

c: '

robocopy %SOURCE% %DEST% /MIR /LOG:%LOG% /R:1 /W:2
cscript "E:\EQ_Projects\robocopy_checker_upload.vbs"

```

Figure 13: Example of batch script to backup projects.

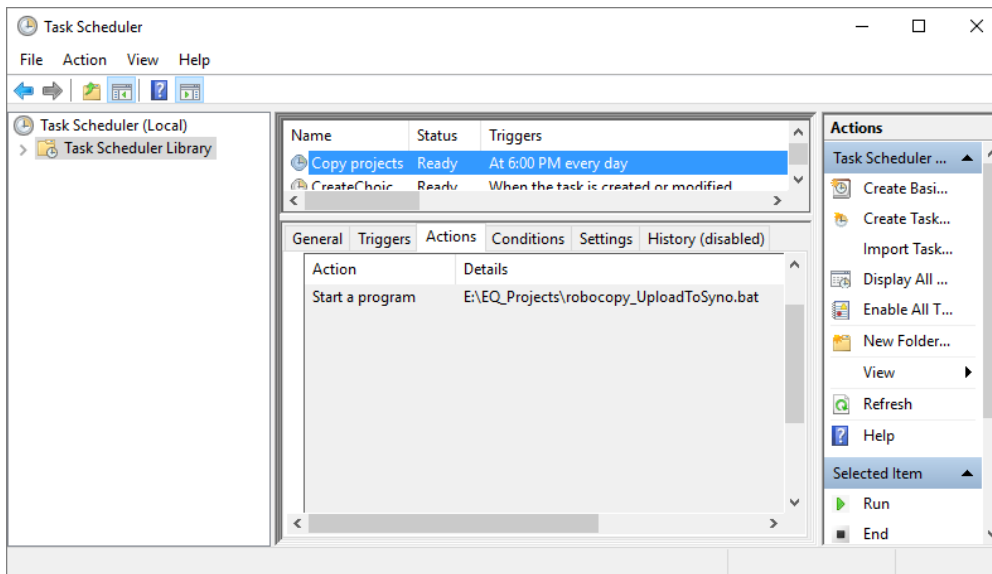


Figure 14: Task scheduler.

1.9 High resolution screens – DPI concerns

Computers using high resolution screens often rely on scale and layout in Windows™ settings which are not fixed to 100% to ease accessibility (see Figure 15). As a direct consequence, applications may suffer from blurry appearance and components geometry as well as fonts might be perturbed within the EarthQuik. To avoid these drawbacks, that is strongly recommended to change properties of the executable by a right-click on the shortcut icon, accessing application *Properties* → pushing *Change high DPI settings* → Choosing to *Override high DPI scaling behavior with System (Enhanced)*. See Figure 16 for an overview of that work-over process.

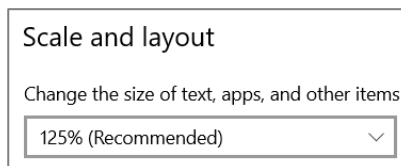


Figure 15: Example of scale value (in Windows™ Settings) ending to display concerns in EarthQuik.

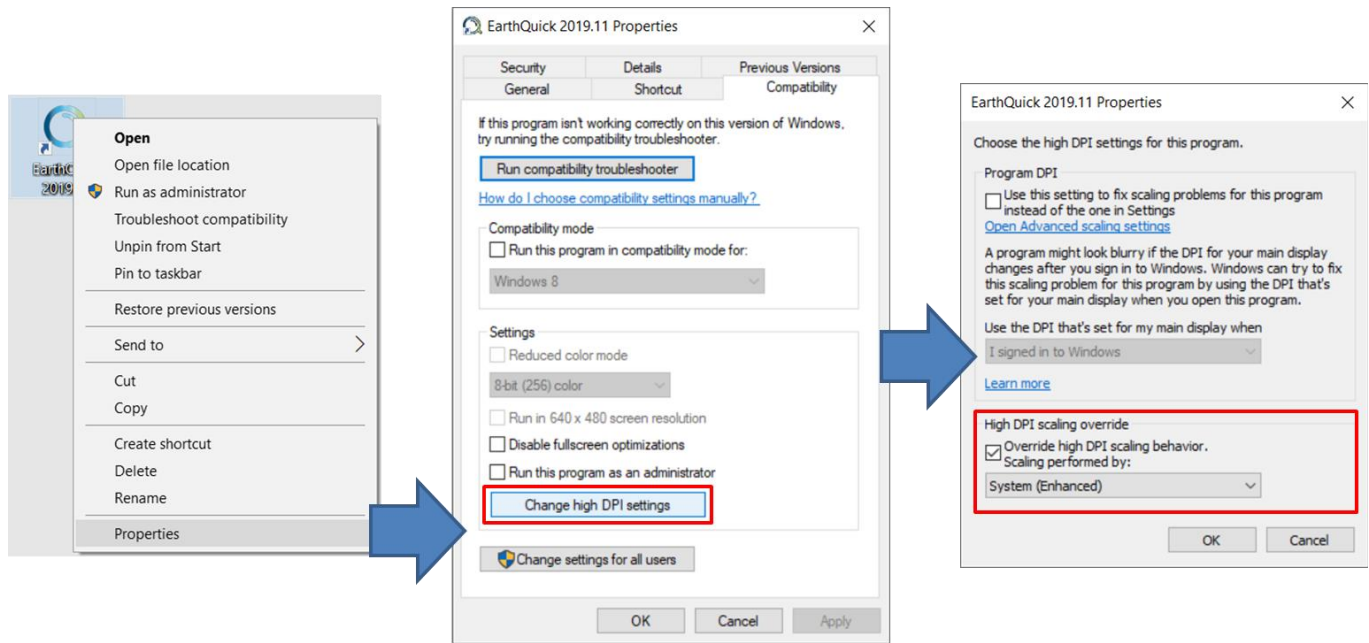


Figure 16: Work-over process for HD screens in Windows™.



2 EarthQuick Launcher

After complying with installation and license recognition, users could obtain the EarthQuick Launcher at start (see Figure 17).

Below are descriptions of the EarthQuick Launcher frame panel by panel, following numbers inserts on Figure 17.

(1) – List of the available **projects**

- Clicking on a row in the list enables project selection/activation.
 - Characteristics are then displayed on the top right-side panel (2).
 - Launch of modules shall rely on current project data base (DB).
 - Activated project could be deleted.
- New project could be created by clicking on *New Project...*. A project name and a location shall be requested.

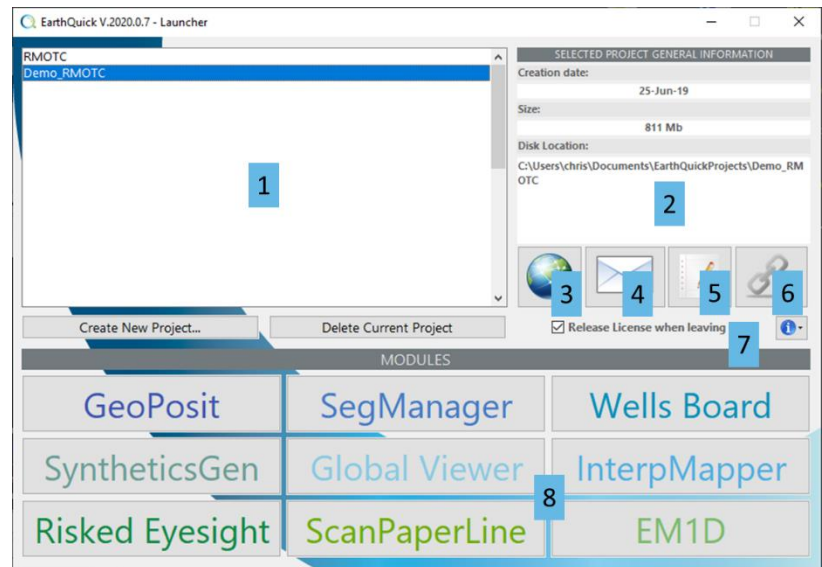


Figure 17: The EarthQuick Launcher.

(2) – **Attributes** (creation date, size, location path) of the selected/activated project.

(3) – Possibility to set **Geodetic Coordinate System (GCS)** or **Coordinate Reference System (CRS)**. That could remain blank.

Unit systems (Metric Vs Imperial) are informed there too.

See Figure 21 and comments aside.

(4) – **Mailing facilities**, used in Global Viewer and WellsBoard modules, to share on-the-fly reporting with a list of predefined recipients in 2 mouse clicks. See Figure 20 and comments aside.

- Full mail server settings available.
- Rolling mouse over question marks gets help.
- The *Test* button should be pushed to ensure parameters validity.

(5) – **Notes facilities** to be able to leave key information on a project. See Figure 19 and comments aside.

(6) – **Links** to other software platforms have been implemented.

- Isatis™: bidirectional (requires GTXserver™ installed).
- Kingdom™: unidirectional (from Kingdom™ to EarthQuick, limited to seismic, interpretation grids and wells in Microsoft Access™ DB).
- Petrel™: unidirectional (from Petrel™ to EarthQuick, limited to blocked seismic ZGY files).

(7) – **License** could be kept after shutting EarthQuick if it is usually shared between colleagues.

- If ticked on before leaving, other colleagues using same floating license shall be able to use it.
- Pushing the info button drops a panel with license information.
 - Must be communicated in every exchange with the support (support@earth-quick.com).

(8) – Each pushbutton of the bottom panel corresponds to a single module. When highlighted project appears to be valid, they could be triggered separately.

- the all-inclusive policy shall grant access to automatically all modules.
- All modules are detailed in following chapters. But shortly,
 - The main modules for interpretation are **Global Viewer** and **Wells Board**, respectively for Seismic and Wells interpretation. The **Global Viewer** enable to gather and vizualize all data types, attached to a project.
 - **SegManager** enables to load, concatenate, reformat, decimate, adapt amplitudes and compute attributes. Wide format compliance is taking in charge SEG-Y, SEG-2, Binary and ASCII formats.
 - **SyntheticsGen** is a module to get through the full-stack seismic-to-wells tie and AVO modeling processes, with the substantial creation of refined T/D laws at the well location and synthetic seismograms.
 - **InterpMapper** turns scatter data to continuous grids, relying on various interpolation methods.
 - **GeoPosit** is made to handle geographic and projected coordinates on a bunch of different media (single points, images, polygons...). That module stands at the crossroad of all operational duties when dealing with geosciences or even surface facilities.
 - **ScanPaperLine** turns images to SEG-Y files with the help of navigation information fetched in an ASCII file. Merger between image and navigation is easily made through a user-friendly interface.
 - **EM1D** models and prepares marine Controlled Source Electromagnetics acquisitions.
 - **Risked Eyesight** enables to assess a risked quantity by tuning parameters distributions and launching Monte-Carlo simulations.



1) Create a new project. Pay attention to access right to locate the project either on a disk or on any remote location.

2) Set the project CRS as follows:


Input Datum: North American 1927 (Alaska-Aleutian Ids East of 180W)

Projection: TM, Central Lat: 40.6667, Central Long: -107.3333, False East: 500000, False North: 0

Units: XY: Imperial, Z: Imperial.



3 Data Base

All along the *EarthQuick Training Notes*, when information on how data is handled within the EarthQuick DB, inserts shall be added, easily recognizable with the use of DB pictogram: . However, a quick introduction of the EarthQuick DB concept is necessary to understand the global idea.

3.1 The EarthQuick Data Base orientation

EarthQuick database is **transparent**, without recourse to third-party proprietary database format like Microsoft Access™, Oracle™, Sybase™... EarthQuick DB is made of simple directories and files (ASCII and Binary) could be explored off-the shell with a Windows™ file explorer.

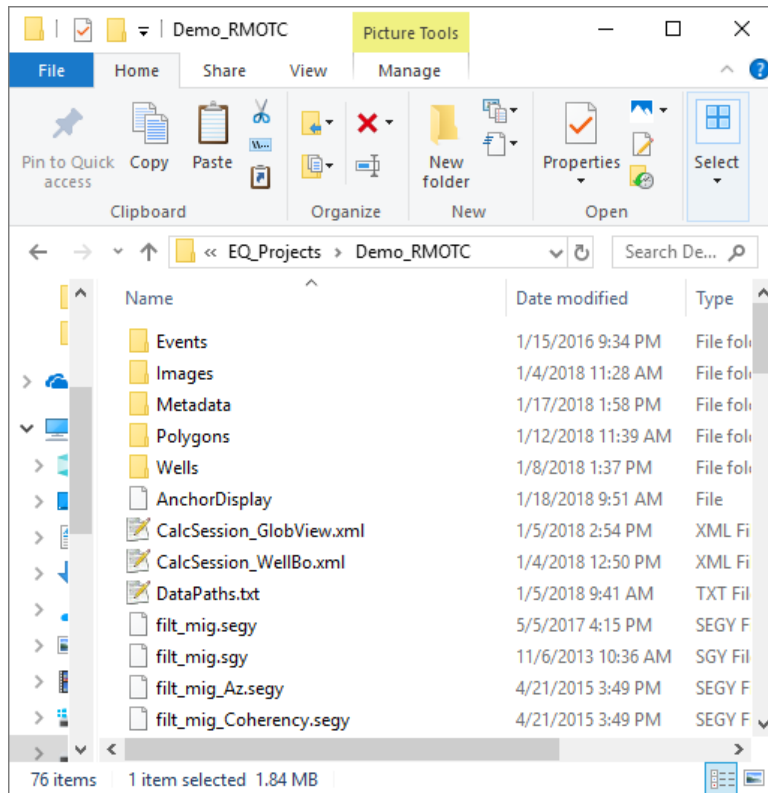


Figure 18: The Windows™ file explorer on the root folder of a project DB.

Practically, **responsibility** of users is higher but **freedom to handle DB** is also greater. That notion of responsibility constitutes a firm stance as well as a commitment to drive EarthQuick development. Users could filter data or share it with colleagues an easy way while one can corrupt a project by erasing brutally a whole folder. Chapter 1.8 details project backup implementation to avoid any data loss.

Key benefits of that policy:

- **Duplicating or creating files** in proprietary formats is avoided. That policy saves disk space and favor possibilities to exchange data with other software solutions.
- **Unique ID's** are usually implemented in many DB of G&G software. Transparent names are preferred. The idea is to let users exchange data from colleagues to colleagues or from project to project.
- Extensive use of CSV or ASCII formats with column separators let users perform changes on the DB directly in the Windows™ file

explorer.

- No need to implement any third-party solutions.

EarthQuick shows a wide scope of input data compliance, involving a wide bunch of formats:

- SEG-Y
- SEG-2
- LAS
- Shapefiles
- Images
- KML
- ASCII for seismic interpretation grids, faults, well logs, cultural data...
- ...

Key elements of DB per project:

- Launcher shows Disk location for each project, which could be copied and pasted in the Windows™ file explorer to access the root path of a project. Figure 18 shows what could be obtained by doing so.

3.2 Data tree structure

For each project, 5 folders (*Events*, *Polygons*, *Images*, *Metadata* and *Wells*), 2 subfolders (*Events\InterpretationGrids* and *Events\Faults*) and a bunch of files.

- Projects references are stocked in *EQProjects.csv* located in %userprofile%\documents\EarthQuick. *EQProjects.csv* stores all the different local projects references.
 - Any changes on that file away from EarthQuick must be done when it is closed.
 - That could then be handled directly in a table editor (e.g. Excel) to add a project by hand. For instance, if a colleague passed a project, one could make it visible by adding a row.
 - Warning: Table editors may leave unwanted column separator in csv files when handling them. Notepad++™ is recommended as a freeware to handle text files and avoid these side effects.
- Back on a project root folder, different types of files could be investigated:
 - **AnchorDisplay** contains grids definition for Global Viewer, binary file.
 - **DataPaths.txt** mentions paths to locate volumes and sections to avoid copying raw data in each project, minimizing disk space requirement.
 - **SubXEastNorth** files created when seismic data is loaded. They contain only information about where to retrieve wanted information in Section and Volume data (typically seismic or GPR). By no means, data is copied there.
 - **SectionsXssings_[...].csv** files created when pushing “Update sections Xssings” in the Global Viewer (See Chapter The root item and 1st-rank-leaf items 5.2.1 and Figure 49: Locations of intersections between displayed section and others available in a project. Figure 49) with some characteristics:
 - Files suffixes correspond to a Section name.
 - 1 file = gathering of all intersections with other section currently available on a project.
 - Information is sorted by column separated by commas (Sections names, Intersection X, Intersection Y, Trace of intersection in *mother* section, Trace of intersection in *daughter* section).
 - All SectionsXssings files are recomputed each time user push “Update sections Xssings” in the Global Viewer.

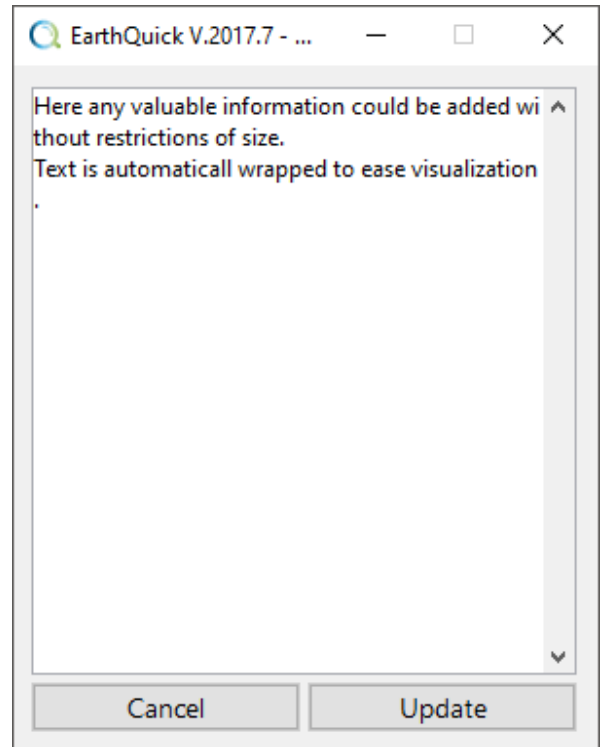


Figure 19: Management frame for notes.

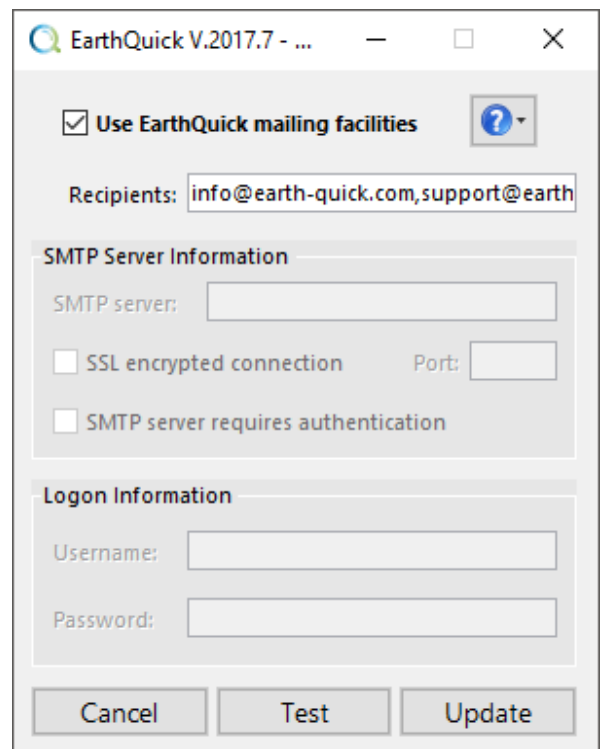


Figure 20: Management frame for Mailing settings.

- **VolumetricsParam.csv** file created when launching a Monte-Carlo simulation in the Risked Eyesight module. The latter contains parameters distributions.
- **ProjectNotes.xml** + **MailingSettings.xml** + **GCSandUnits.xml**. XML files contain metadata information on a project, available in the launcher.
 - **ProjectNotes.xml** contains notes attached to a project without any restriction of text size (see Figure 19).
 - **MailingSettings.xml** contains mailing settings to send Metadata pieces directly from *Data Folder Trees* of the Global Viewer and Wells Board. (See Figure 20 and Chapters 5 and 6).
 - **GCSandUnits.xml** contains a set of references regarding Geodetic Coordinate System (also named Coordinate Reference System). See Figure 11 and Chapter **Error! Reference source not found.** dedicated to GeoPosit. The latter provides more details about Geodetic Datums and Projections.
- **Other XML files** stand for session reminders on different modules.
- In the *Events* subfolder:
 - 2 subfolders occur (*Faults* and *Events*) and no files.
 - In the *Faults* subfolder, only files with the *EQ_FAULT_* prefix are expected with some characteristics:
 - 1 file = 1 fault.
 - Only binary files without extensions.
 - Special characters in the file names are not allowed.
 - Files contain fault picking (or sticks). Fault plans and boundaries are computed and rendered on the fly.
 - Other data kinds (i.e. without the *EQ_FAULT_* prefix) could be added but shall be ignored.
 - In the *Handsfree* subfolder, only files with the *HandsfreeDraw_* prefix are expected with some characteristics:
 - Files suffixes correspond to Volume or Section displayed when drawing has been performed.
 - 1 file = 1 set of drawing for either 1 section, or 1 volume inline, or 1 volume Xline.
 - ASCII files with *txt* extensions.
 - No header rows.
 - 1 row = 1 dots (i.e. 1 MB1 by user on the Sections Panel).
 - First column stands as traces reference, second column stands as vertical reference regarding underlying Section dimensions.
 - In the *InterpretationGrids* subfolder, only files with the *EQ_GRID_* prefix are expected with some characteristics:
 - 1 file = 1 grid.
 - Only binary files without extensions.
 - Special characters in the file names are not allowed.
 - Files contain information about grid dimensions (limits along [X,Y] axis and mesh size) and cells values.
 - Occurrence in folder trees (in GV and WB) depend on project grid parameters defined by mesh size and X and Y limits (from AnchorDisplay file).
 - Files could be renamed in the Windows™ file explorer (keeping the *EQ_GRID_* prefix) or interactively within EarthQuick by double-clicking on a grid in the folder trees of the *Global Viewer* and *Wells Board*.

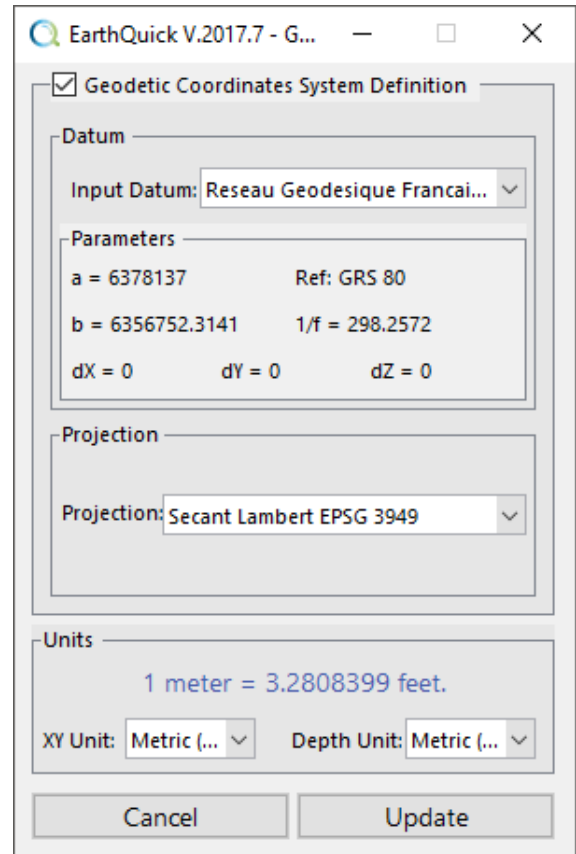


Figure 21: Management frame for GCS and lengths units.

- Other data kinds (i.e. without the *EQ_GRID_* prefix) could be added but shall be ignored.
- In the *Polygons* subfolder:
 - Only files with the *Polygon_* prefix are expected with some characteristics:
 - 1 file = 1 polygon.
 - ASCII files with *txt* extensions.
 - A header row exists for every Polygon file. “0” if open, “1” if closed.
 - Other data kinds (i.e. without the *Polygon_* prefix) could be added but shall be ignored.
- In the *Images* subfolder:
 - Only files with the *OvLp_* prefix are expected with some characteristics:
 - 1 file = 1 image.
 - Only binary files without extensions.
 - Created by GV or GeoPosit modules when georeferencing an image.
 - Other data kinds (i.e. without the *OvLp_* prefix) could be added but shall be ignored.
- In the *Metadata* subfolder:
 - That folder is used as a “depocenter” for screenshots reporting (PowerPoint presentations) and for 3D PDF.
 - All data kinds/formats could be added and shall be visible in folder trees of Global Viewer and Wells Board.
- In the *Wells* folder:
 - **ProjectWells.csv** – contains the library of all wells on a project. Information is sorted by column separated by commas (Wells names, X, Y, Kelly Bushing (KB), Terminal Depth (TD), Display, Comments). Display is related to library of graphical rendering defined in **WellKindsDisplay.csv**.
 - **WellKindsDisplay.csv** – contains the library of graphical rendering of well kinds. Information is sorted by column separated by commas (Well kinds, R, G, B, shape code [1: circle, 2: square, 3: diamond, 4: upward-pointing triangle, 5: downward-pointing triangle, 6: plus sign, 7: cross, 8: pentagram (five-pointed star)]).
 - **WellsMarkers.csv** – contains the library of all stratigraphic markers on a project. Information is sorted by column separated by commas (Wells names, Markers names, Measured depth, Display policy, R, G, B).
 - **WellsFacies.csv** – Enables to define lithostratigraphic facies library for the whole project. Information is sorted by column separated by commas (Facies names, R, G, B, Display policy).
 - **_Facies.csv suffixed files** – prefix corresponds to the name of a well. They rely on **WellsFacies.csv** file to distribute lithostratigraphic facies on a well path.
 - **_Dev suffixed files** – prefix corresponds to the name of the a well. Contain well trajectory deviation. Files are binary.
 - **_TD.csv suffixed files** – prefix corresponds to the name of a well. Contain well Time-to-depth laws. 1 law = 2 occupied columns in the file (1st for depth, 2nd for TWT). 1st row gives laws names. 2nd row is [0, NaN] if law is stored but inactive; [1, NaN] if law is the active law on the current well.
 - **_Logs_<log name> in-the-middle** – prefix corresponds to the name of a well and suffix to the log name. A special case is made with the ones with the suffix **EQSynthSeis**. They correspond to synthetic seismograms saved from the SyntheticsGen module.
 - **XML files** are again used as sessions reminders.



- 3) Identify folder by folder these items in your project already stored on your machine.
- 4) In the same project, launch the Global Viewer, select all Polygons for display, create a new one while observing effect on DB.

Recurrent errors:

- If a SEG-Y file is moved from a location to another, an error message is displayed in the status bar of the GV while trying to load the latter. Consequently, DataPaths.txt has to be modified.
- If DB is handled in back office, meaning away from EarthQuick, error message such the one illustrated by Figure 22 could pop up when launching GV or WB.

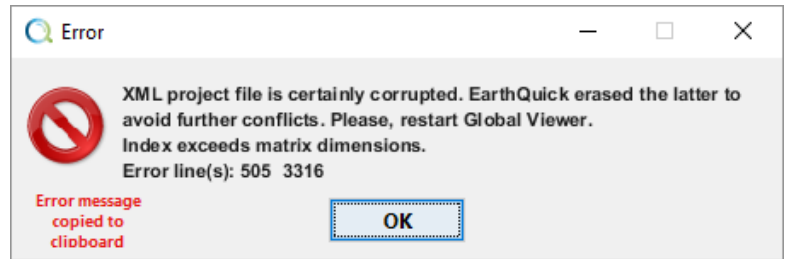


Figure 22: Typical error when deleting files in back office. Error lines could vary.

3.3 Dealing with error messages concerning DataPaths.txt

In case the message of Figure 23 pops up when trying to visualize some seismic or GPR data, EarthQuick simply needs users to intervene on the *DataPaths.txt* file located in the root folder of your project.

That concern may be encountered in case of project transfers, Volume and Section files moves, works on collaborative project...

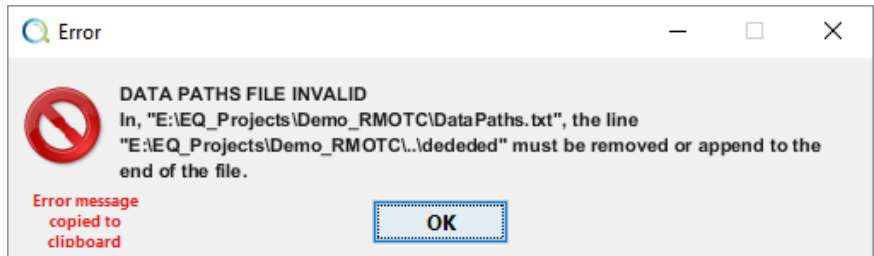


Figure 23: DataPaths.txt error message.

DataPaths.txt file is an ASCII file and the “anchor” which locates the SEG-Y files to be visible within an associated EarthQuick project. EarthQuick does not create copies of SEG-Y files in its own proprietary format when loading them. To access data originally contained in SEG-Y files, it always relies on these original SEG-Y files.

To go slightly further into details regarding how *DataPaths.txt* file operates:

- That is located in the root folder of a project.
- That is automatically updated when loading or creating SEG-Y files.
 - ➔ Good practice: Edition and modifications could be performed when EarthQuick is running. However, it is strongly recommended to close it after saving modifications.
- Each row refers to a path containing seismic data occurring in a project.
 - ➔ Good practice: To be updated when data is manually moved.
- Each row terminates with the backslash sign “\”.
 - ➔ Good practice: Not to be forgotten when copying/pasting paths in it.

It is strongly recommended to use the text file editor and freeware Notepad++™ (<https://notepad-plus-plus.org>) to modify or at least check all modifications made on all CSV files generated by EQ. See Figure 24 for example.

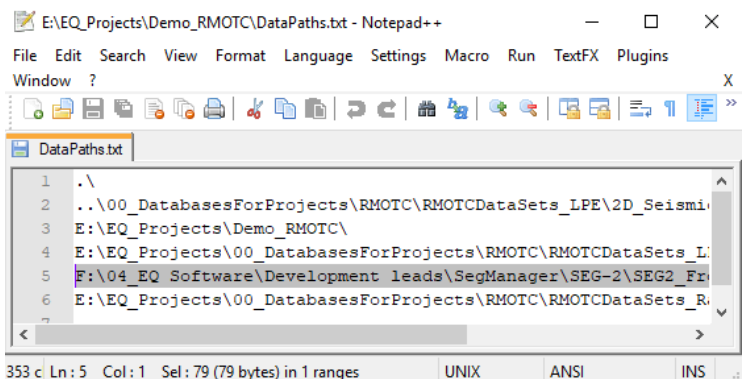


Figure 24: DataPaths.txt edited in a third-party text editor.

Users must be aware each folder quoted in *DataPaths.txt* are systematically scanned one by one to find summoned seismic data. When data is found, reading the *DataPaths.txt* is interrupted.

That means:

- If the first row refers to a non-existing folder, same error as shown in Figure 23 is obtained.
- If for example, the 5th row refers to a non-existing folder, but EarthQuick is asked to display seismic data contained in the folder quoted on the 3rd row, no error messages occur.

Below several cases are referenced to help dealing with frequent issues.

Case 1: Error message *DATA PATHS FILE INVALID [...]* must be removed or append to the end of the file (see Figure 23).

In case the quoted path refers to a non-existing folder, the associated row could be removed. Still, that is wiser to first cut it and append it at the end of the file.

Case 2: Error message *<data name> SEG-Y file is missing, or DataPaths.txt file is invalid* in the Global Viewer (see Figure 25).

SEG-Y files linked to SubXEastNorth-prefixed files could not be reached. *DataPaths.txt* must be updated.

Case 3: Back office DB has been reorganized. SEG-Y files have been moved to new or renamed folders.

Data migration must be tracked and recorded. Then, updated paths must be pasted in the *DataPaths.txt* file following strict rules: only one path per row and each path terminates with the backslash sign “\”.

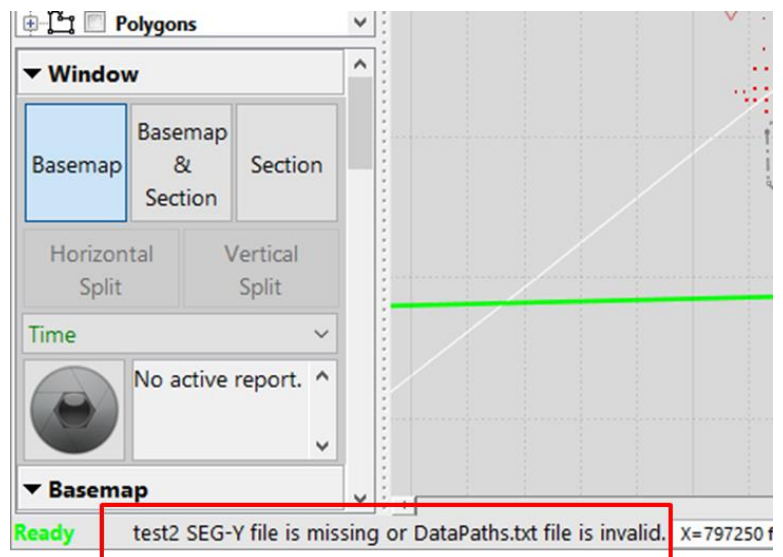


Figure 25: Error of loading in the Global Viewer.

Case 4: Project has been passed to a colleague, with all Volumes and Sections SEG-Y files located on the network.

Network locations must be checked and in case mapped disks or remote storages do not use the same naming on both local computers, *DataPaths.txt* must be updated.



When a remote folder is mounted (or mapped) as a drive on your computer, the letter to designate it may change from a computer to another. In that case, *DataPaths.txt* must be updated.

Case 6: A project is found without *DataPaths.txt* file in it.

That simply means that no Volumes or Sections data have been attached to the project. Once SEG-Y data is loaded or created for the very first time in a project, *DataPaths.txt* is automatically created.

4 SegManager

SegManager is a kind of nerve center of EarthQuick since it enables to handle data (typically seismic or GPR) in volumes or sections. Functionalities are numerous such as loading, concatenating, decimating, cropping, changing format, computing attributes or synthetic seismic sections...

4.1 Data conversion

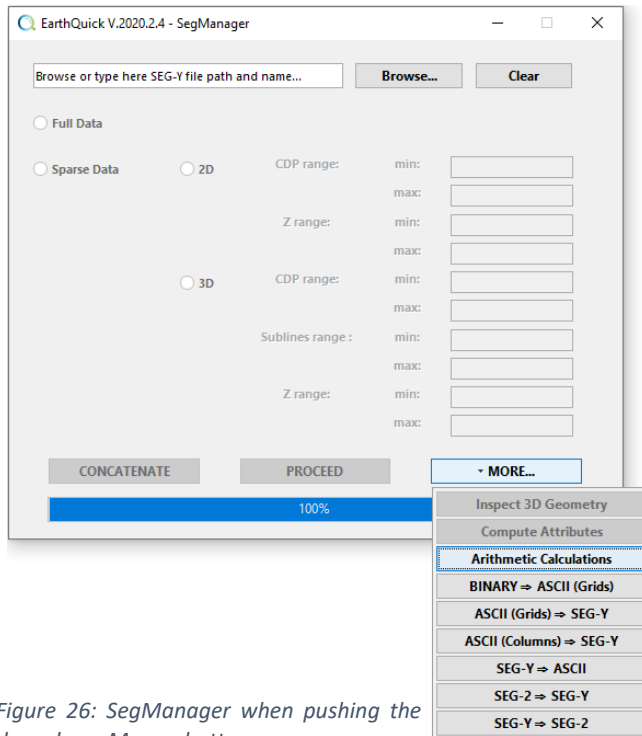


Figure 26: SegManager when pushing the drop-down More... button.

That is also the tool to use for data conversion with possible combinations shown on Figure 26 and below:

- Binary to ASCII (Grids)
- ASCII (Grids) to SEG-Y
- ASCII (Columns) to SEG-Y
- SEG-Y to ASCII
- SEG-2 to SEG-Y
- SEG-Y to SEG-2

Note conversion of ZGY files generated with Petrel™ from Schlumberger™ is available from the launcher.

4.1.1 From Binary to ASCII (Grids)

Some additional characteristics of the tool:

- Loads all the files at once in the RAM. Be careful with RAM overflowing.
- Works both for 2D and 3D data. 2D case disables "Inline Increment" and "Third Component" controls.
- No headerlines in the text file are permitted to proceed that type of conversion.

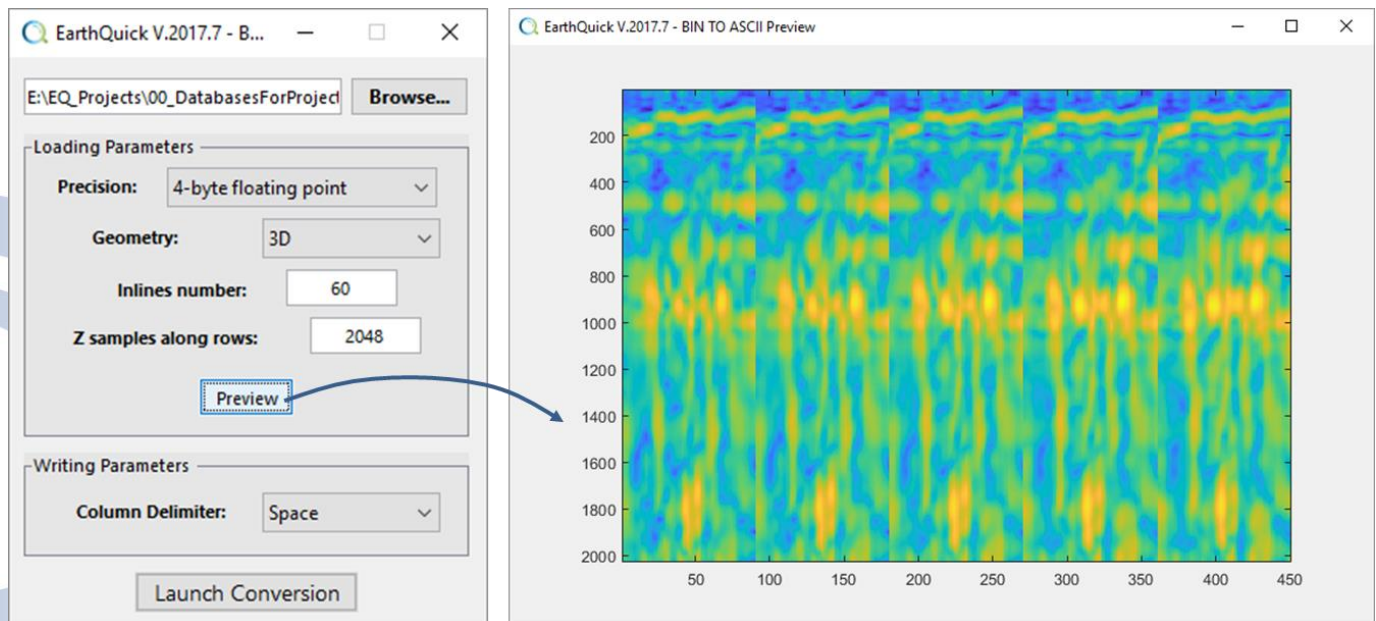
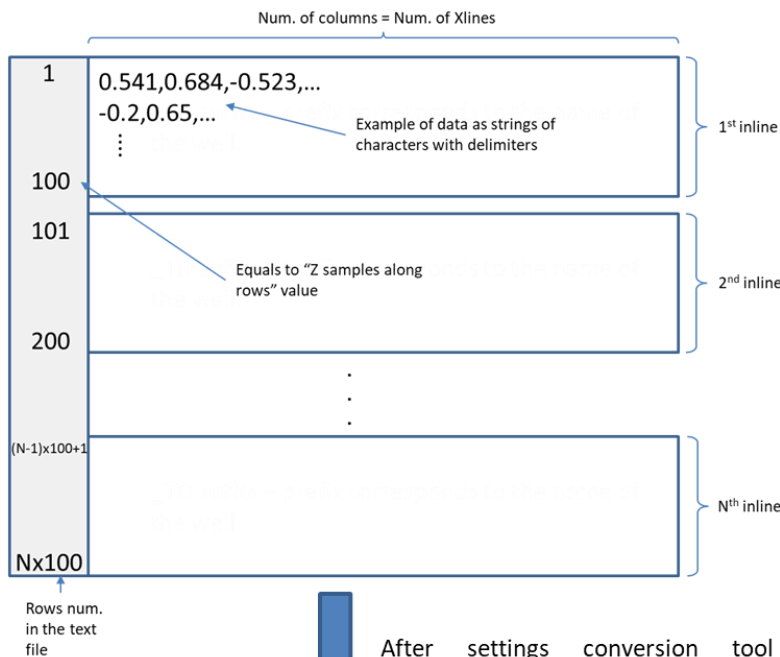


Figure 27: Use of Binary to ASCII (Grids) conversion tool. Preview of the 5 first inlines of 3D data to convert.

- Accepted precisions are 1-byte unsigned integer, 1-byte signed integer, 2-byte unsigned integer, 2-byte signed integer, 4-byte unsigned integer, 4-byte signed integer, 4-byte floating point, 8-byte floating point.
- The “Preview” button is made to verify geometry is correct before conversion.
- In a binary file, values are presented one after another. That could be seen as “data stored in 1D space”. Therefore, EarthQuick considers data is sorted along Z, Xlines and eventually Inlines if data is 3D. Meaning vertical dimension of data is primary, Xlines is secondary and Inlines is tertiary.
- Possible output delimiters are space, comma, semi-colon, tabulation, carriage return or new line character.

4.1.2 From ASCII (Grids) to SEG-Y

Example of compliant ASCII file structure



After settings conversion tool controls regarding file architecture, conversion could be launched.

EarthQuick V.2017.7 - A...

Type ASCII file path and name Browse...

Loading Parameters

Geometry: 3D

Column Delimiter: Comma

Inline Increment: Rows

Xline Increment: Columns

Third Component: Z

Z samples along rows: 100

Z domain: ☒ Time ☐ Depth

Xo: 0 Yo: 0 Zo: 0

InterXlines: 1 InterInlines: 1 Z step: 1

Angle of Inlines with North [°]: 0

Launch Conversion

Figure 28: Use of ASCII (Grids) to SEG-Y conversion tool.

Some additional characteristics of the tool:

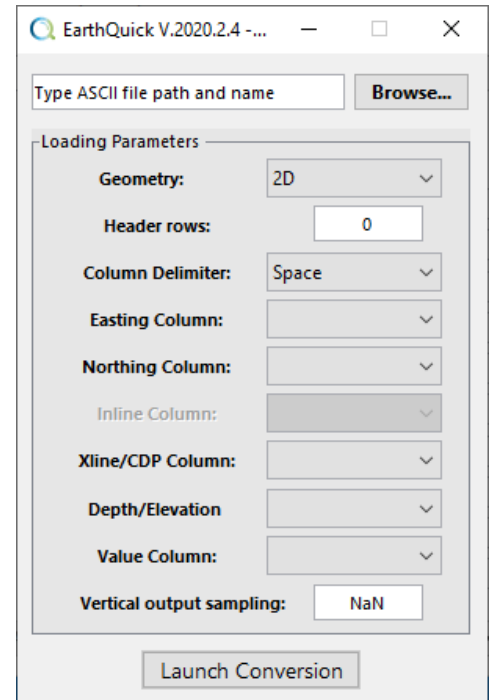
- Works both for 2D and 3D data. 2D case disables “Inline Increment” and “Third Component” controls.
- No header lines in the text file are permitted to proceed that type of conversion.
- Accepted delimiters are space, comma, semi-colon, tabulation, carriage return or new line character.
- Example of file structure is not the only accepted structure. “Inline increment” could be set to either “Rows” or “Columns” and “Xline increment” could be set to either “Rows” or “Columns”. Changes affect each other.
- “Third component” control is set to “Z” by default. Could be changed in case 3D data is sorted by time slices.
- (InterXlines, InterInlines, Z step) defines the data bin size.
- Depending on data geometry, InterXlines and InterInlines may be negative.
- Users have access to EBCDIC header tuning after clicking *Launch Conversion*.

4.1.3 ASCII (Columns) to SEG-Y

Column-sorted ASCII files with amplitudes along 2D sections or 3D volumes could be converted.

- 2D sections conversion relies on ASCII file inputs with 5 columns, namely Easting/Northing/CDP/Depth or Time/Amplitude. Intertrace distance and vertical sampling could be non-regular.
- 3D volumes conversion relies on ASCII file inputs with 6 columns, namely Easting/Northing/Inline/Xline/Depth or Time/Amplitude. Vertical sampling could be non-regular but geometry must be regularized in a completely filled rectangular parallelepiped and every trace must defined.
- Embedded interpolation algorithm enables to manage non-regular time/depth/elevation sampling.
- Specific order of columns is not required. Users are required to provide column indices.
- Vertical output sampling shall be given in mm or μ s.

Figure 29: Use of ASCII (Columns) to SEG-Y conversion tool.



4.1.4 From SEG-Y to ASCII

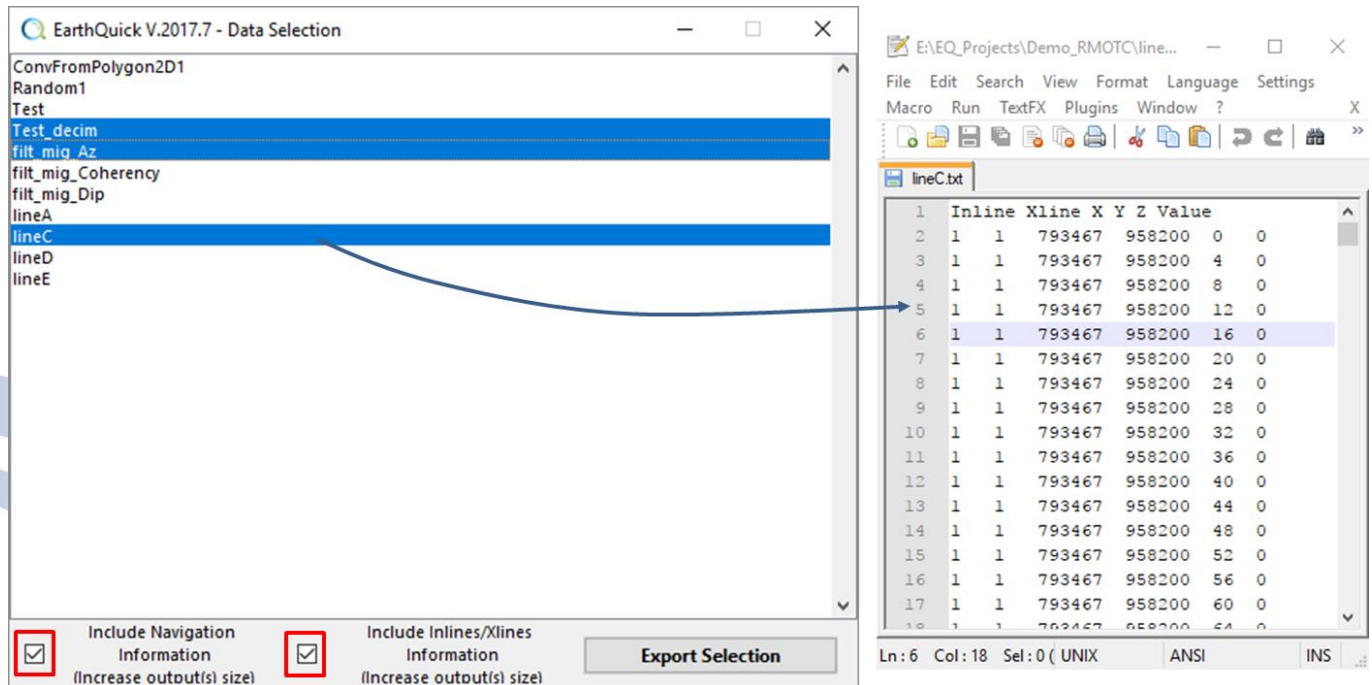


Figure 30: Use of SEG-Y to ASCII tool. On the right: Result of lineC export in a text editor. All options activated.

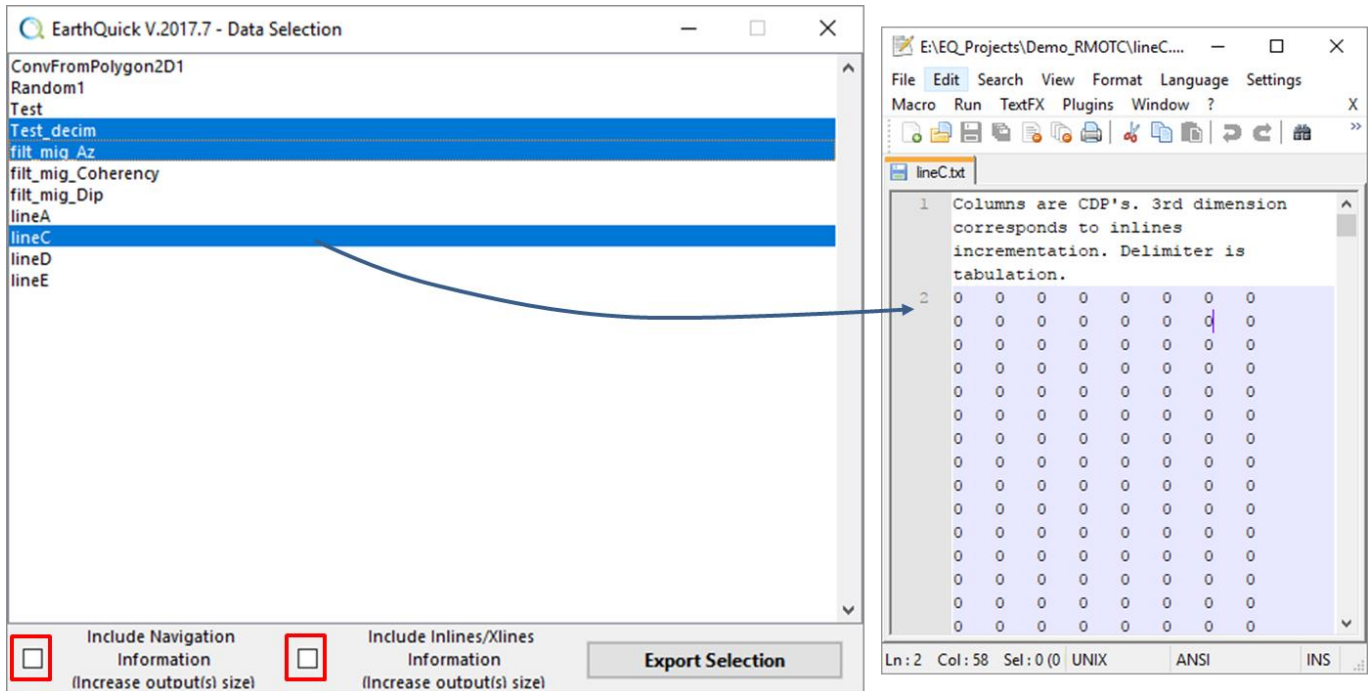


Figure 31: Use of SEG-Y to ASCII tool. On the right: Result of lineC export in a text editor. No options activated.

Some additional characteristics of the tool:

- 2D and 3D files could be turned to ASCII. Especially with 3D data, users must remain conscious ASCII files could be significantly bigger than SEG-Y files.
- Available SEG-Y's for conversion must be loaded in the project at first.
- There are as many output files as selected sections and volumes in the list.
- Ticking on/off options (bottom check boxes) shall drastically change output format.



- 5) From your project, export the line A containing loaded data and already stored on your machine, export a 2D line in ASCII format. Discuss the output format.

4.1.5 From SEG-2 to SEG-Y

Some additional characteristics of the tool:

- Works only for 2D sections.
- Shows a preview of section contained in the SEG-2 file before asking for a SEG-Y output file name (Figure 32).
- Navigation data in SEG-2 file is copied straight to SEG-Y file

4.1.6 From SEG-Y to SEG-2

That is the reverse of tool described in Chapter 4.1.5 but here preview is skipped instead.

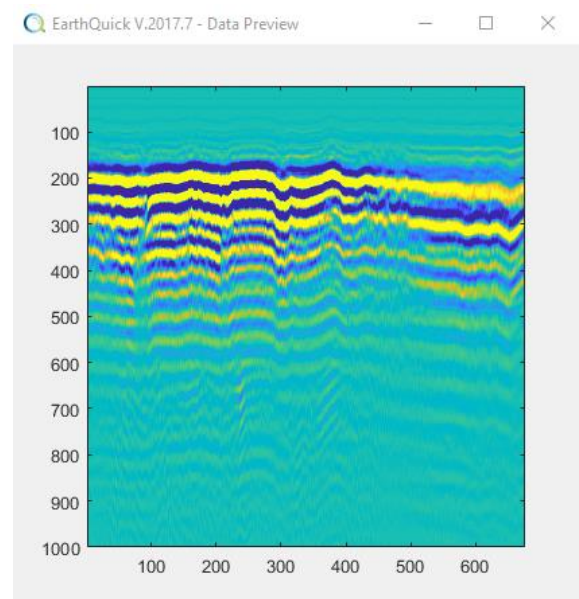


Figure 32: Section preview of SEG-2 to SEG-Y tool.

4.1.7 Arithmetic Calculations

Alongside Matlab™ scripts, performs computations on Volumes and Sections amplitudes, from simple arithmetic operations to iterative processes.

Different components could be described as follows on Figure 33:

- Left upper part correspond to available Volumes and Sections, selectable as variables for computation,
- Right upper part lists selected Volumes and Sections for computations. Each row defines one variable, named V{i}.
- Mid part contains the operations, defining the script,

Regular workflow:

- Launch the Volumes & Sections Amplitudes Calculator,
- Write scripts on selected Volumes & Sections keeping in mind all selected Volumes and Sections must share the same geometry and properties.
- To output results in a non-existing variable, use “NotDefinedOutput4Calc” variable. NotDefinedOutput4Calc.segy file shall be automatically created and loaded in the project after pushing the “Compute” button.

Note that tool loads all the files at once in the RAM. Be careful with RAM limits on your computer.

4.2 SEG-Y files full loading

By clicking on the *Browse...* pushbutton of the SegManager (see Figure 26), users could choose one or multiple SEG-Y files for loading in EarthQuick.

Before handling SEG-Y files for visualization or any computations (attributes, change of geodetic datums...) a proper loading step must be fulfilled. When loading a SEG-Y file for the 1st time, the radio button *Full Data* must be checked.

Related data with 2D or 3D geometry is indifferently loadable through a sequential loading described below. The two-next subchapters go through *Full Data* loading, step by step.

4.2.1 Sections

Here opposite in Figure 34 is the process to smoothly handle loading of 2D sections. Figure 35 illustrates the sequence while choosing to go for scan of trace headers.

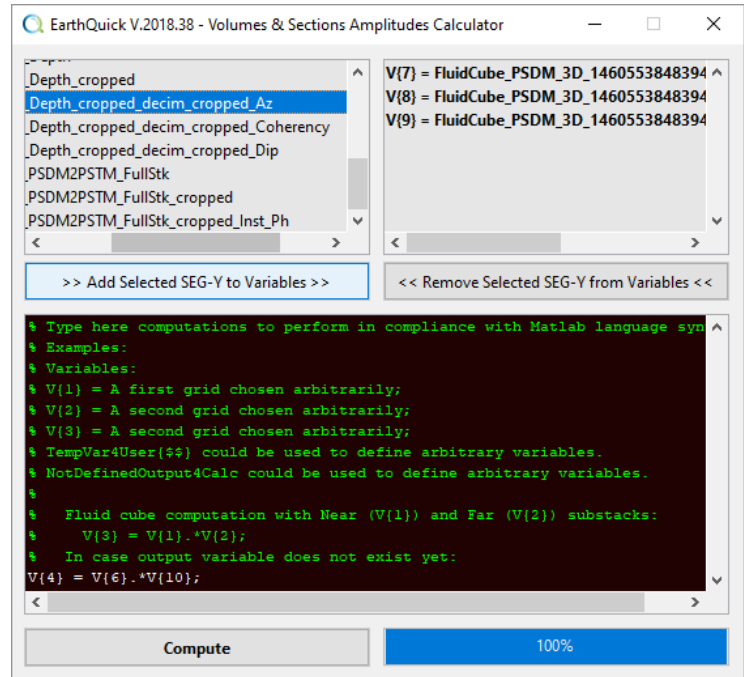


Figure 33: Volumes and Sections Amplitude Calculator.

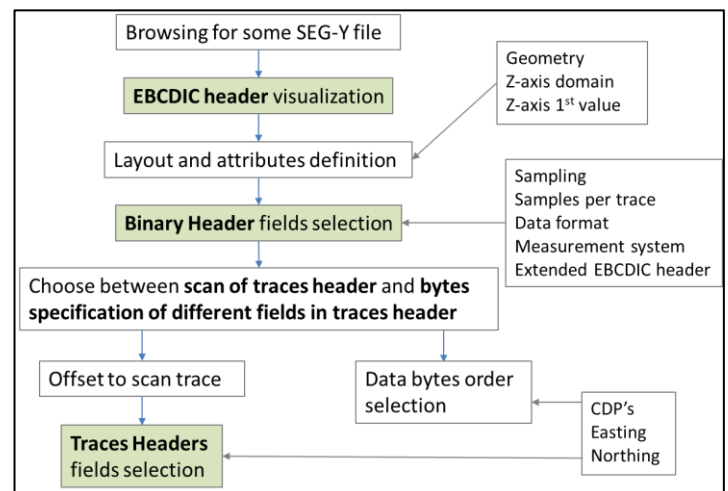


Figure 34: Sequence for 2D sections loading.

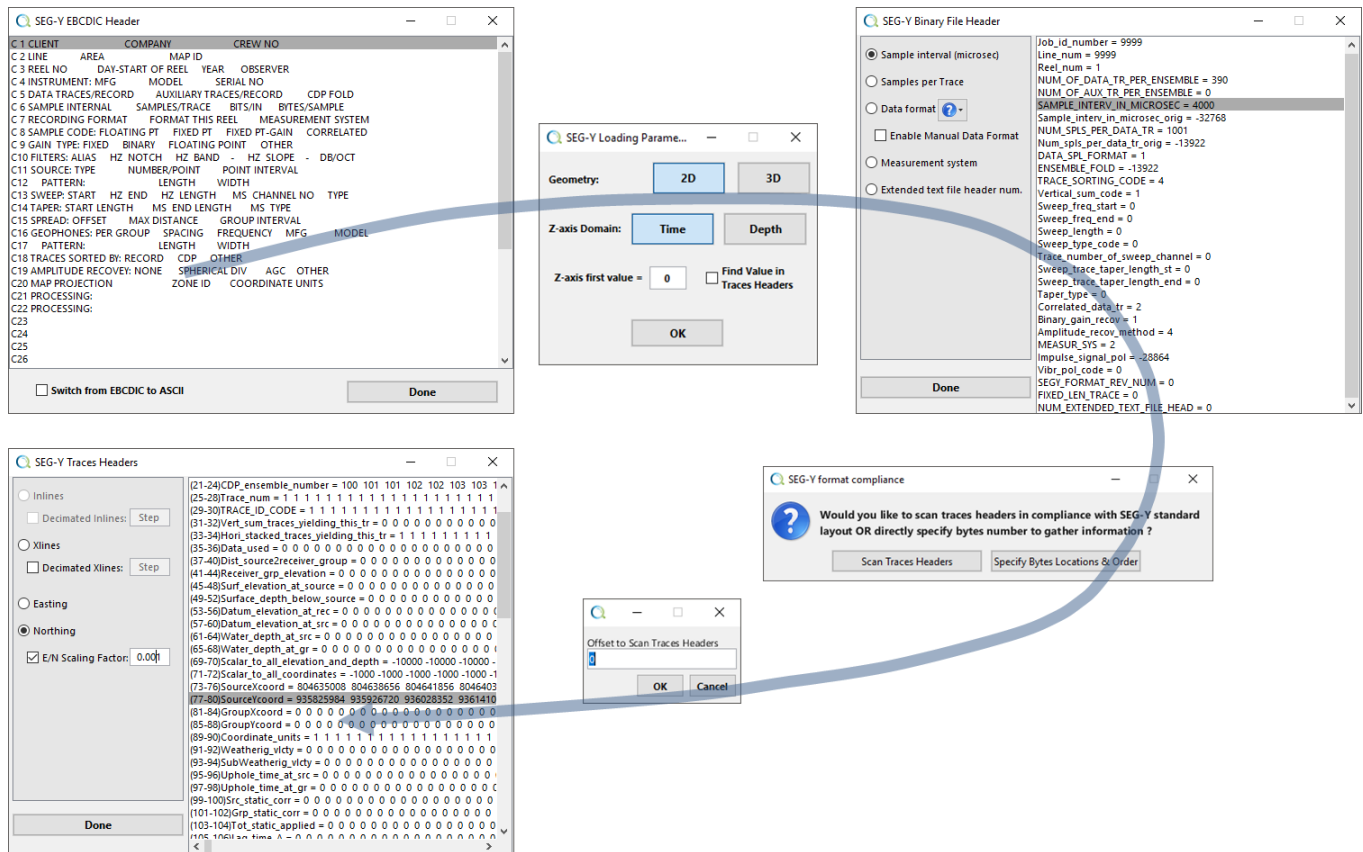


Figure 35: Screenshots all along the sequence while choosing to scan trace headers.

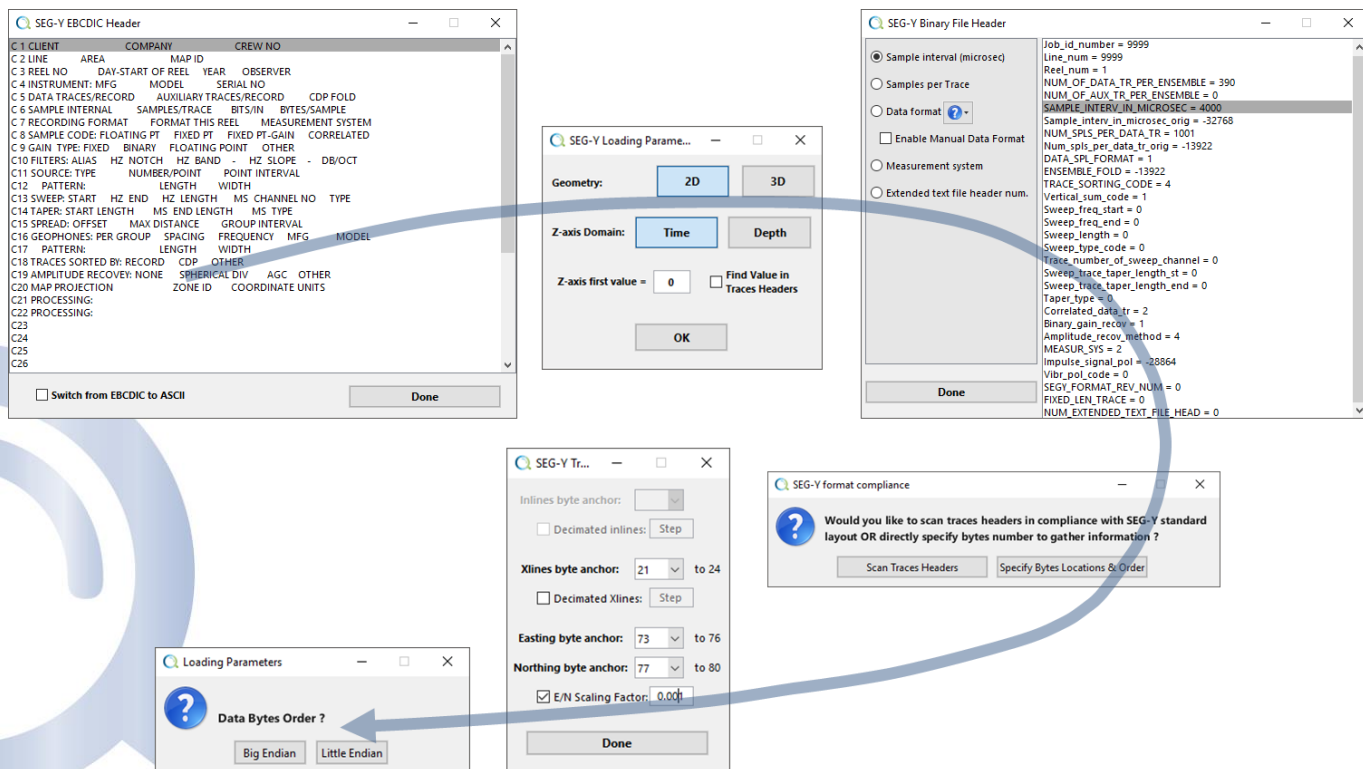


Figure 36: Screenshots all along the sequence while choosing to specify bytes locations.

When choosing to specify bytes locations instead, users have also the possibility to read trace data either in the big-endian order or in the little-endian order (Figure 36).

After loading is fulfilled, radio button sparse data is now active and could be selected.

4.2.2 Volumes

Volumes, or 3D data, are processed the same way except that the inline field is now required. When scanning trace headers, a plot showing organization of traces on a (Inlines, Xlines) crossplot is added (see Figure 37).

Ultimately, users have the possibility to generate movies (relying on the mpeg-4 format) which scroll the entire volumes in the 3 directions (i.e. inlines, xlines, time/depth slices). That option could help to scroll rapidly through volumes with the 3D viewer of the Global Viewer (see Figure 38). However, that is recommended not to perform that computation for Volumes above 3 GB in SEG-Y format.

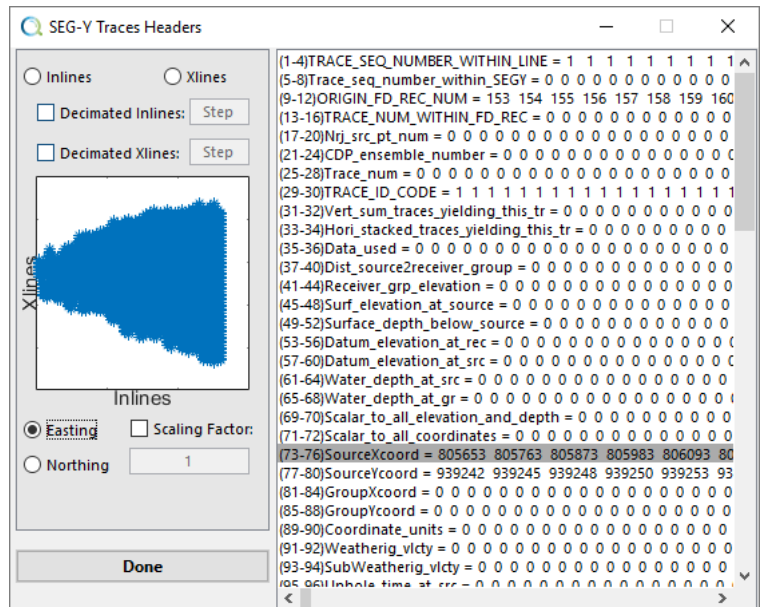


Figure 37: Traces headers scan for a volume.

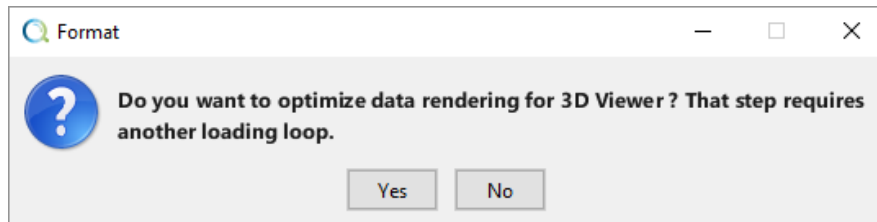


Figure 38: Optional ultimate step of 3D data loading.



- 6) Load the 3D seismic cube named *filt_mig.sgy* located in the *Original Data Folder*. Note *Original Data Folder* is provided for training sessions.

4.2.3 Multiple files loading

Multiple files could be performed by selected several files at once when browsing for SEG-Y files.

First alphabetically ordered file stands as a reference and loading is processed by screening headers of the latter. Then, other selected files are loaded with the same settings.

No limits exist regarding number of files to be simultaneously loaded.

After loading is fulfilled, radio button *Sparse Data* becomes active and could be selected.



- 7) Load all 2D seismic lines from A to D at once available in the *Original Data Folder*.

4.3 Data Concatenation

In case a section or a volume has been split in several parts, that might be fair to concatenate them in one single SEG-Y file. Once multiple files have been properly loaded first and secondly selected with the SegManager Browser, the CONCATENATE button could be pushed to launch concatenation.

As additional requirements, all files to be concatenated must show all same number of samples per trace, same precision format and no extended text file header. Then, a master file is selected by users to retrieve EBCDIC and Binary headers and copy them into the output SEG-Y file, gathering data of all selected files.



After concatenation is complete, product of that process (i.e. the SEG-Y output file) must be loaded has defined in chapter 4.1.7.



- 8) Concatenate all 2D lines in 1 single output SEG-Y file. Make observations with the Global Viewer. Note 110' is advised as the Grid Cell size parameter.

4.4 Data decimation and/or cropping

Except when selected several ones, once a SEG-Y file is loaded, users have access to *Sparse Data* radio button in the SegManager main frame.

EarthQuick recognizes SEG-Y files already loaded on a project. There is no need to reload a file each time some decimation or cropping has to be performed.

By clicking on the *Sparse Data* button, geometry of data is recognized (2D or 3D) and proper components of the frame are then activated.

Figure 39 below shows an example with some 3D data. By changing values in text fields, users could easily crop the volume.

4.5 Change of amplitudes and/or precision

After giving new values to CDP, Sublines and Z ranges, by clicking on PROCEED, users could choose between several options for the generated output SEG-Y file:

- **Decimation:** Independently, both in Inlines and Xlines directions.
- **Amplitude cropping:** Not to consider amplitudes beyond given limits.
- **Amplitude rescaling:** To adapt amplitudes in a range.
- **Encoding data format:** To write data on a specific format.

The overall process is illustrated with screenshots on Figure 40.

Figure 39: Cropping 3D data.

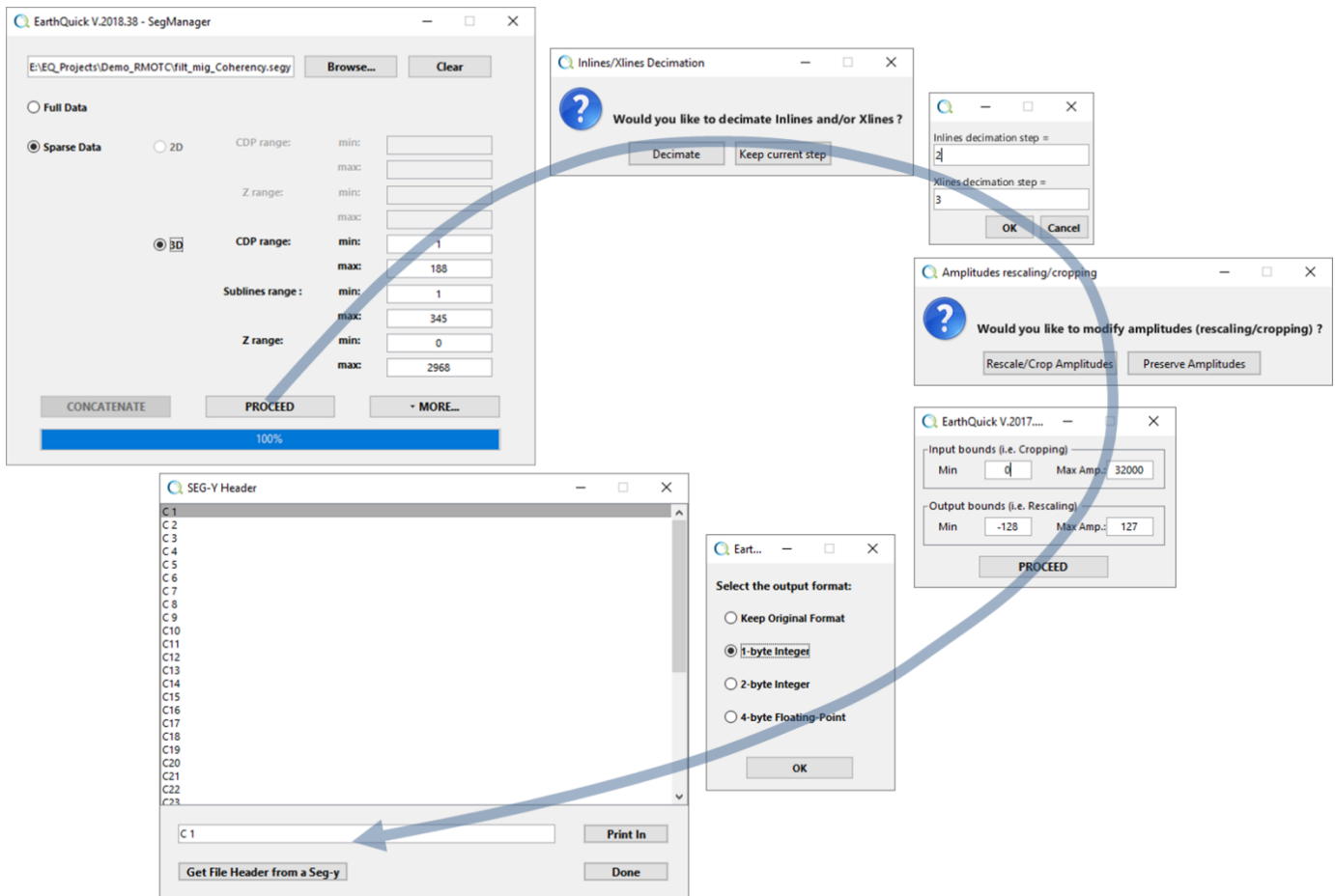


Figure 40: the overall process of decimation and amplitude rescaling & cropping.



Encoding data format must be wisely chosen to avoid unwanted cropping.



9) Get same display as on Figure 39 when browsing for 3D data loaded in Chapter 4.2.2, then, reshape 3D data to get in output:

- CDP range from 50 to 150, Sublines range from 100 to 200 and 2 range from 1000 to 2500.
- Only 1 in 2 Sublines and 1 in 3 Xlines for decimation.
- Regarding seismic amplitudes, keep only positive values remaining with a rescaling to fit a 1-byte integer output format.

Make observations with the Global Viewer.

4.6 Inspect geometry

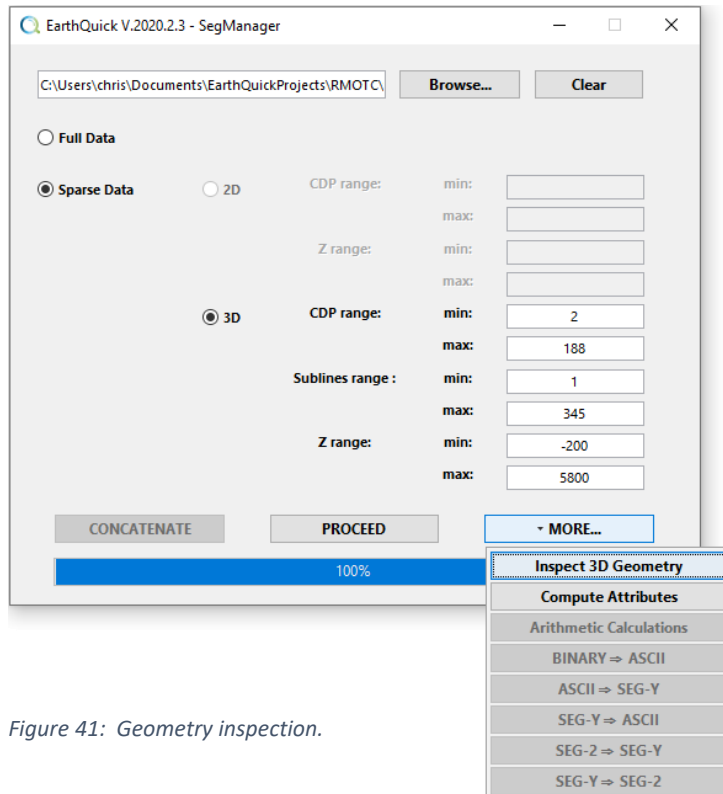


Figure 41: Geometry inspection.

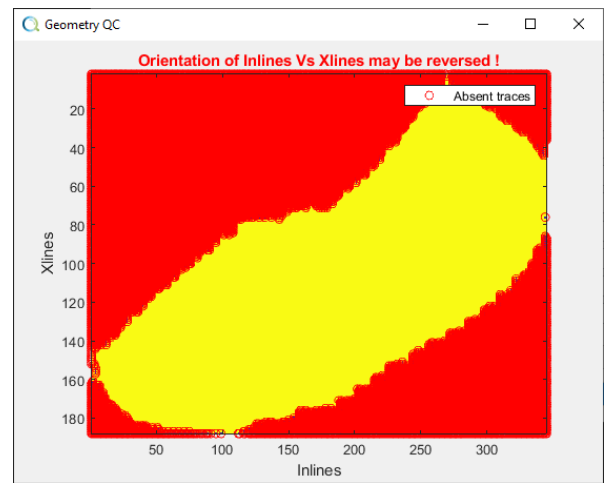


Figure 42: Graphical result of inspection.

Some unregular geometries of the volumes require an investigation tool to enable users to have a comprehensive insight of trace distribution.

The option *Inspect 3D Geometry* is a straightforward solution to do so. The graphical result illustrated by Figure 41 shows existing traces as yellow dots and non-existing traces as red dots.

4.7 Attribute computations

Only available for 3D data (if already loaded following proceeding defined in Chapter 4.2.2), pushing the COMPUTE ATTRIBUTES button enable to launch facility, illustrated by Figure 44, in charge of attributes creation (i.e. RMS amplitude, Envelope, Instantaneous Phase and Frequency, Dip and Azimuth, dip-steered Coherency).



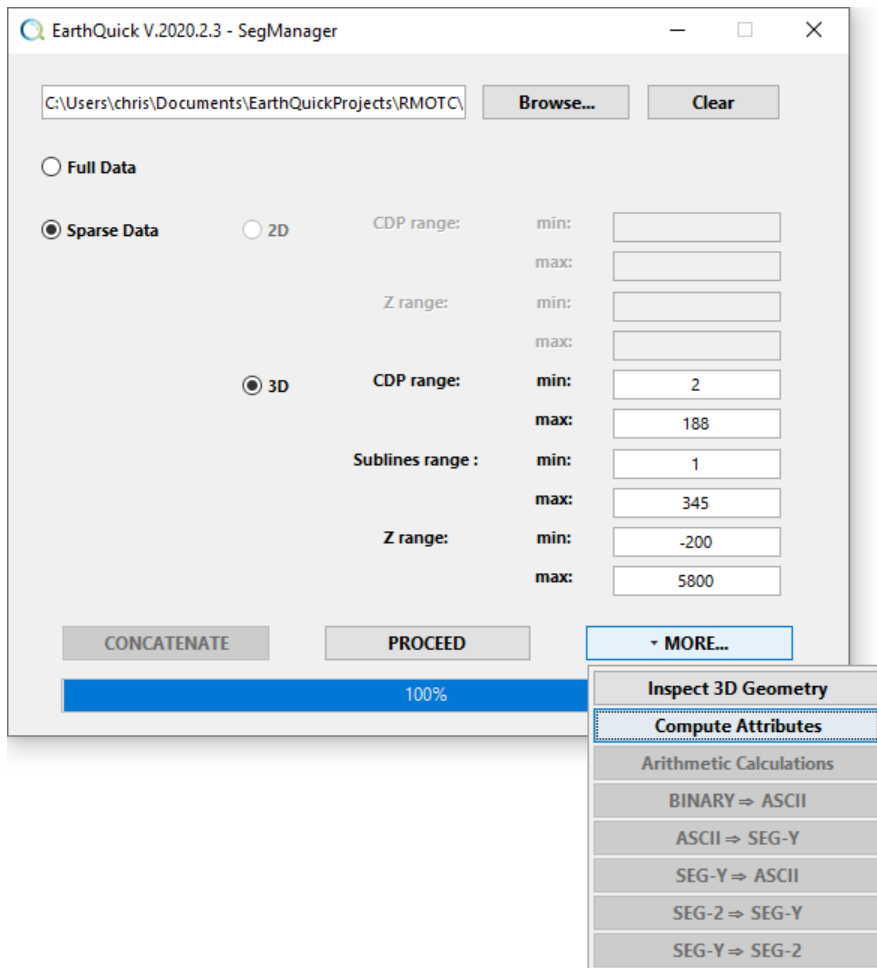


Figure 43: The way through attributes computations facility with the SegManager.

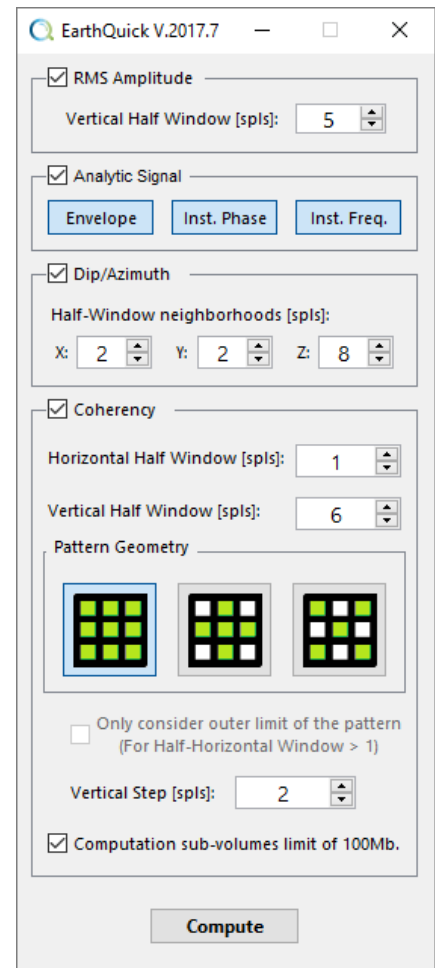


Figure 44: Settings for attributes creation.

For more geological and geophysical considerations regarding attributes, explanations and examples of EarthQuick results could be found on the internet at <http://books.ifpenergiesnouvelles.fr/ebooks/signal-processing/chap.php?id=10>.

Below are detailed all different settings for each attribute. Bold fonts refer to user inputs.

4.7.1 RMS amplitude

Vertical half window, required in samples, gives the length of the vertical window to compute Root Mean Square amplitude (i.e. the square root of the sum of the squared amplitudes divided by the number of samples).

4.7.2 Envelope, Instantaneous Phase and Frequency

No need of parameters to compute these 3 attributes.

The Envelope consists into the modulus of the analytic signal obtained with the Hilbert transform.

The Instantaneous Phase consists into the phase of the analytic signal.

The Instantaneous Frequency consists into the first derivative of the phase.

4.7.3 Dip & Azimuth

Dip and Azimuth are derived from local assessment of the gradient in amplitudes of data.

Half-window neighborhoods define the vicinity to perform local assessment of dip and azimuths in all directions of space.

Practically, computation is not very sensitive to these parameters. Default values shall fit many cases.

4.7.4 Dip-steered Coherency

Half-window neighborhoods define the vicinity to perform local computation of Coherency.

Pattern Geometry defines near traces to be considered, either all without restrictions, or along + and x shapes.

Vertical Step, required in samples, gives possibility to skip locations where Coherency is computed. That parameter could reduce computing time, but a too high value may result in a too discrepant result.

Computation sub-volumes limits check box, if ticked on, enables to distribute computations on several available CPU's.



Attributes computation requires first loading the define 3D volume in the RAM. Be careful with RAM limit of your computer.



10) Compute all attributes proposed by the facility on the previously cropped volume (see exercise in Chapter Change of amplitudes and/or precision4.5). Make observations with the Global Viewer.



5 Global Viewer

The Global Viewer stands as the core of EarthQuick, gathering all data/items in one module:

- 2D-3D seismic data (from SEG-Y files),
- Wells (logs, TD, KB, checkshot, deviation, stratigraphic markers and lithostratigraphic facies),
- Interpretation Grids and Faults,
- Images overlapping maps,
- Polygons/lines,
- Metadata.

Among a wide scope of functionalities, some could be quoted:

- EZ Selection is made by clicking on base map objects,
- Friendly color scales could be handled,
- 2D and 3D automatic or manual picking,
- Faults picking and automatic faults boundaries,
- Wells logs overlapping on seismic sections,
- Seismic attributes computation and optimized display,
- Different sections from both 2D and 3D dataset could be merged simply by 2 mouse clicks,
- Random lines could be generated through seismic cubes. All random lines could be dragged and dropped within seismic cube after being generated,
- Optical stack within 3D seismic data,
- 3D rendering with 3D seismic data, well data, grids (including amplitude extraction drapping facility),
- Frequency power spectrum and F-k power spectrum,
- Misties assessment,
- Images georeferencing,
- ...

Handy tools:

- Interactive ruler/scale bar to rapidly assess distance on basemap and seismic panel,
- Polygons to be drawn to assess area computation,
- Grids Calculator to perform all arithmetic and logical operations, up to layer-cake Time-to-Depth conversion for instance...,
- Seismic AVI-Movie generator from SEG-Y to have a quick glance through 3D seismic,
- Feed PowerPoint™ presentations with screenshots pushing one single button,
- Export 3D rendering to 3D PDF Files,
- GRV assessments from Top depth grid, target thickness and GWC/OWC,
- ...

Numerous possibilities of I/O exist to maximize compliance and ease redundant tasks.

5.1 Starting with the Global Viewer

Because of its “data gathering duty”, the GV hosts a quantity of different functions. Then, a sequential approach, i.e. from an overview to closer insight into functionalities, may help users to get familiar with that unavoidable component of EarthQuick.

Before launching the Global Viewer, grids definition (i.e. Easting and Northing limits and mesh size) is required. That process is identified as *layout settings* (see Figure 45). That rules the viewport on the basemap and the handling of interpretation grids and images. Information is contained in the binary file *AnchorDisplay*, located, on the root folder of each project.

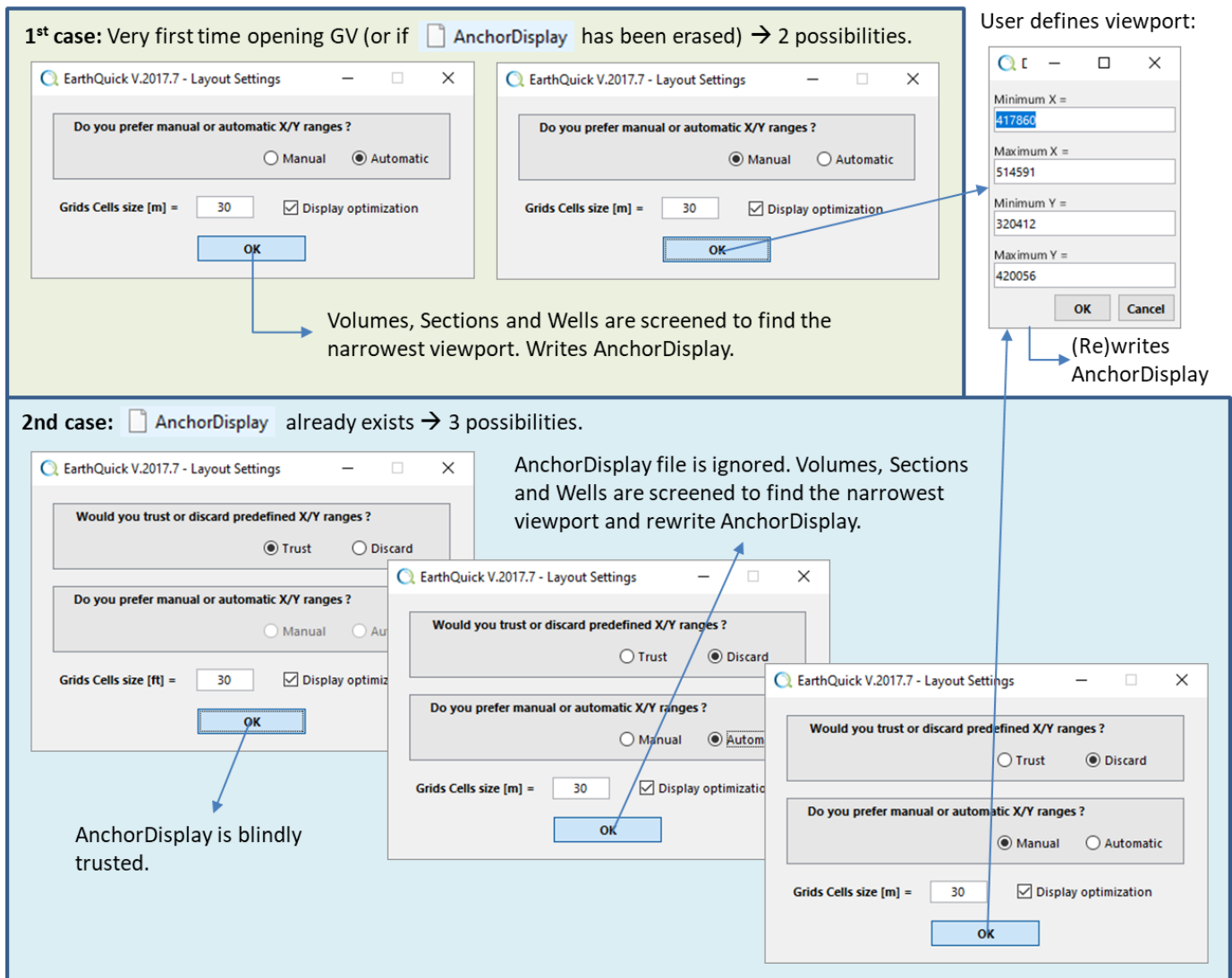


Figure 45: Layout settings policy mechanism.

A suggestion is still made if users prefer a manual definition. Then, Volumes, Sections and Wells, if any, are screened to find the narrowest rectangle viewport, oriented toward N-S direction, to enable a display of the exhaustive data base.

A focus could be made on seismic display optimization: 1. When ticked on if you have a bunch of 2D sections in your project and/or if it contains faults to intersect with 2D sections, you shall get faster rendering.



In EarthQuick, dual existence of horizons and grids as interpretation objects does not occur. Instead, users only handle grids for interpretation purposes.

Once geographic extensions and mesh size are defined in AnchorDisplay file, that information is stored in grids and images which are created afterwards. Consequently, if geographic extensions or mesh size are changed while grids or images are already created in the project, the GV shall not allow to use the latters. Therefore, that is strongly recommended users implement an iterative process to determine project

geographic boundaries once for good. Still, in case of mandatory changes, easy export facilities to ASCII format for grids are part of EarthQuick.

After that technical (but very handy) details, Figure 46 shows figure layout organization, namely:

- **Basemap Panel:** provides a sky-view facility to display projections of Volumes, Sections and Wells, Grids, Faults boundaries, Images and Polygons.
- **Seismic Panel:** provides a 2D-view facility to display Volumes and Sections data, projections of Wells, Grids, and Faults cuts.
- **Basemap Overview:** small replication of the basemap
- **Data Folder Tree:** enables selection and handling of data, sorted in 7 different folders (i.e. *Volumes, Sections, Wells, Grids, Faults, Images* and *Metadata*).
- **Accordion Tree:** gathers functions to display and interpret data.
- **Status Bar:** gives information about mouse pointer when rolling over *Basemap* and *Sections Panel* (inline, CDP, X, Y, Z, Amplitude value), status (processing or idle) and provides a calculator for simple arithmetic computations.



In *Data Folder Trees* of GV and WB, color codes of items are the same: **Red** for Depth, **Green** for Time and **Black** for Undefined.

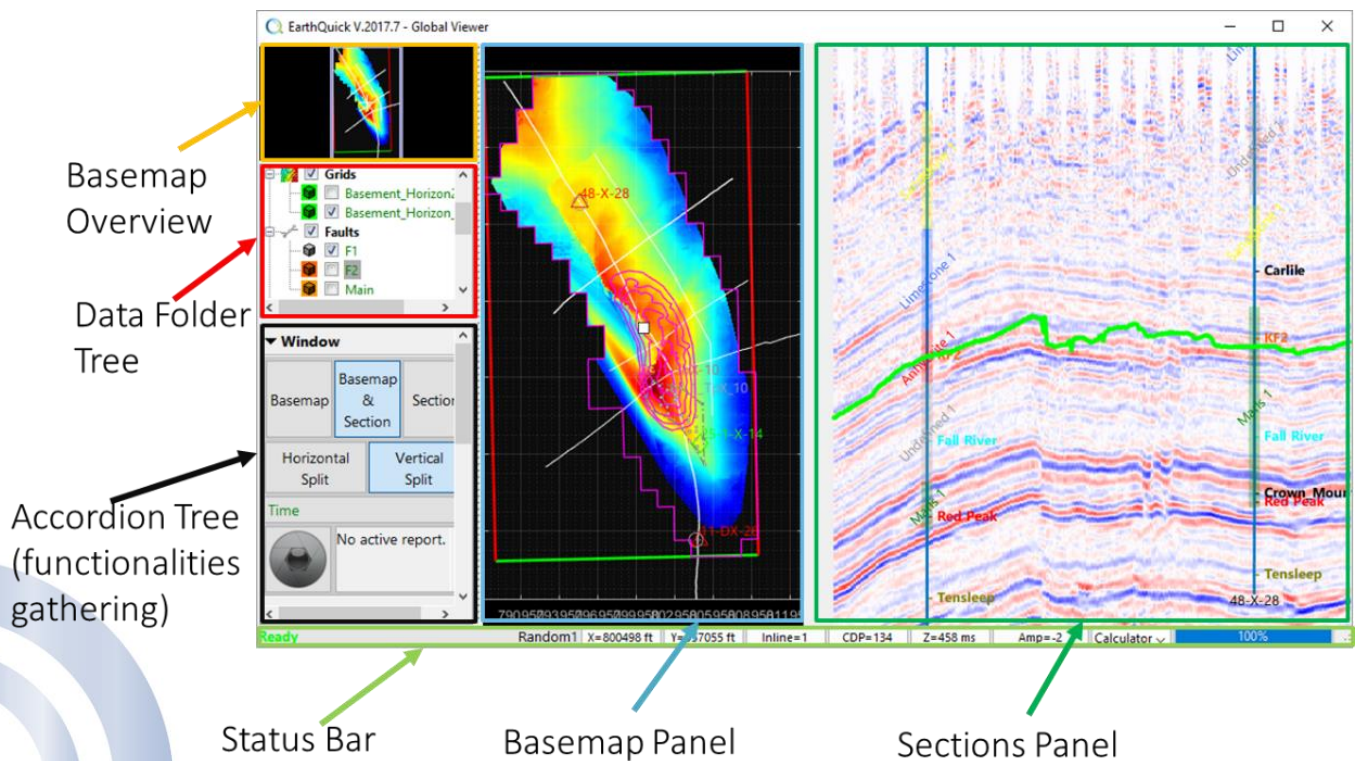


Figure 46: The Global Viewer layout.



Depending on settings in the Launcher (see Figure 21), lengths are given either in the metric (m, sq.m, cu.m, km) or imperial (ft, sq.ft, cu.ft, miles) system.



When leaving a GV session, selection of data and settings by the users is automatically stored in an XML file named GlobalViewerLayout.xml. If manually erased, launch of GV shall correspond to a fresh start, i.e. without preselected data. See recurrent errors in Chapter 3.2 for more details.



If users are eager to change names of data items, except for grids, that must be done off the shelf, directly in Windows™ File Explorer. The database has been built transparent to achieve that purpose. Again, Global viewer must remain closed during that operation.

5.2 Data Folder Tree

Data Folder Tree stands as a data selection centralization within the GV. Additionally, that enables a bunch of computations.

5.2.1 The root item and 1st-rank-leaf items

The root item shows the project name and allow some functionalities by right-clicking on the latter (see Figure 47).

All 1st-rank leaves correspond to folders in project DB where data is stored.

They all could be selected for display, except *Metadata*. Selection could have 2 different states: unselected (corresponding to ☐) meaning no data in the folder is selected and selected (corresponding to ☒) meaning data in the folder is selected.

When right-clicking on these items, a bunch of options and functionalities are offered, as shown on Figure 47.

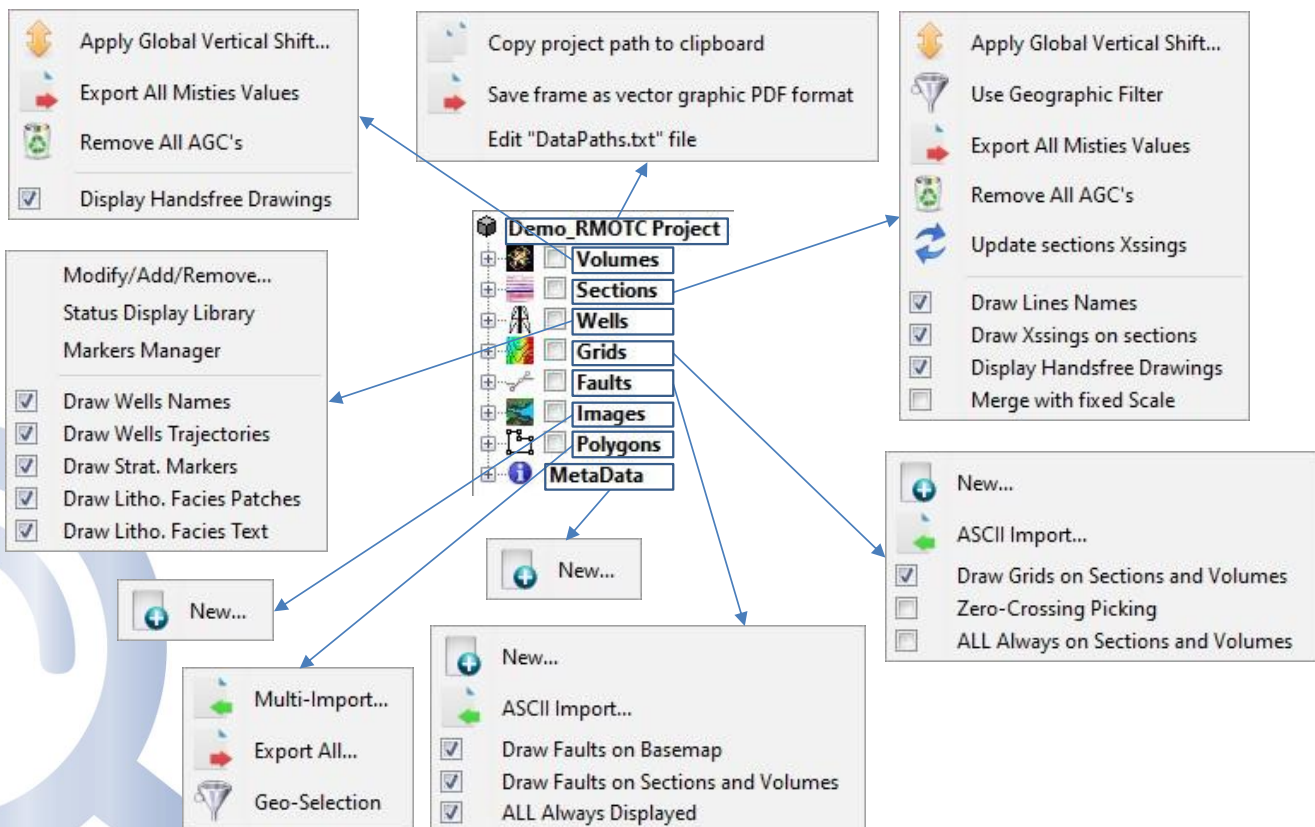


Figure 47: Right-clicking on the Data Folder Tree 1st-rank leaves.

Next pages give explanations of possibilities shown by Figure 47. Prefixes correspond to the item and suffix to the functionality/option denomination in the menus.

[Name of the project] Project / Copy project path to clipboard

Simply copy location path of the current project to the clipboard. Pasting with a simple Ctrl-V in the Windows™ File Explorer shall let users recover project physical location.

[Name of the project] Project / Save frame as vector graphic PDF format

Create a PDF file built with vectorial object for further use and content filtering of maps with third-party software.

[Name of the project] Project / Edit "DataPath.txt" file

Open through Windows™ the file "DataPath.txt" to enable users to change swiftly the paths to link loaded sections and volumes in the current project to effective locations of SEG-Y files (see Chapter 3.3).

Volumes / Apply Global Vertical Shift...

That function launches frame in Figure 48 and enables a global vertical tie on a selection of Volumes at once. Ideal tool to correct misties.

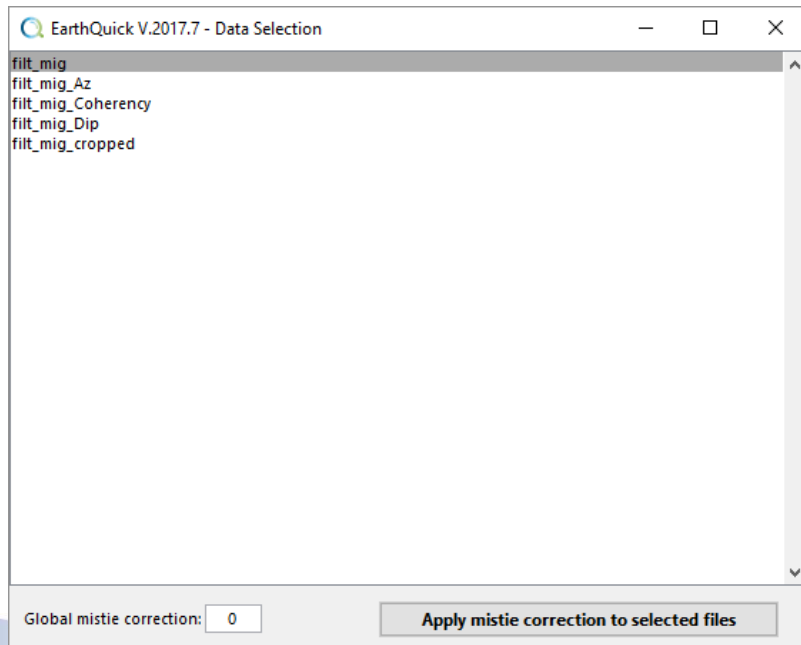


Figure 48: Applying global vertical shift on volumes.

Volumes / Remove All AGC's

Reset all AGC's windows to zero.

Volumes / Display Handsfree Drawings

If ticked on, available handsfree drawings are displayed on Sections Panel when applicable.

Sections / Apply Global Vertical Shift...

Same as equivalent for Volumes, adapted to Sections.

Sections / Use Geographic Filter

Let users restrain selection of 2D sections by giving a rectangular geographic boundary of selection with (X_{min} , X_{max} , Y_{min} , Y_{max}).

Volumes / Export All Misties Values

Export all misties values in an XLSX file (Excel™ proprietary format), named MistiesExport.xlsx, in the root folder of the related project.

First tab in the file corresponds to 3D data. Second tab corresponds to 2D data.

First tables columns correspond to data name. Second tables columns correspond to misties values.

MistiesExport.xlsx is only used for export. That could be arbitrary deleted without affecting EarthQuick. Therefore, any already generated MistiesExport.xlsx are not updated when changing misties values afterwards.

Sections / Export All Misties Values

Same as equivalent for Volumes.

Sections / Remove All AGC's

Same as equivalent for Volumes, adapted to Sections.

Sections / Update sections Xssings

Compute crossings with all currently available sections in a project. Must be triggered each time user change 2D section content.

Computation generates automatically 1 SectionsXssings_ - prefixed CSV file per section (see Chapter 3.2).

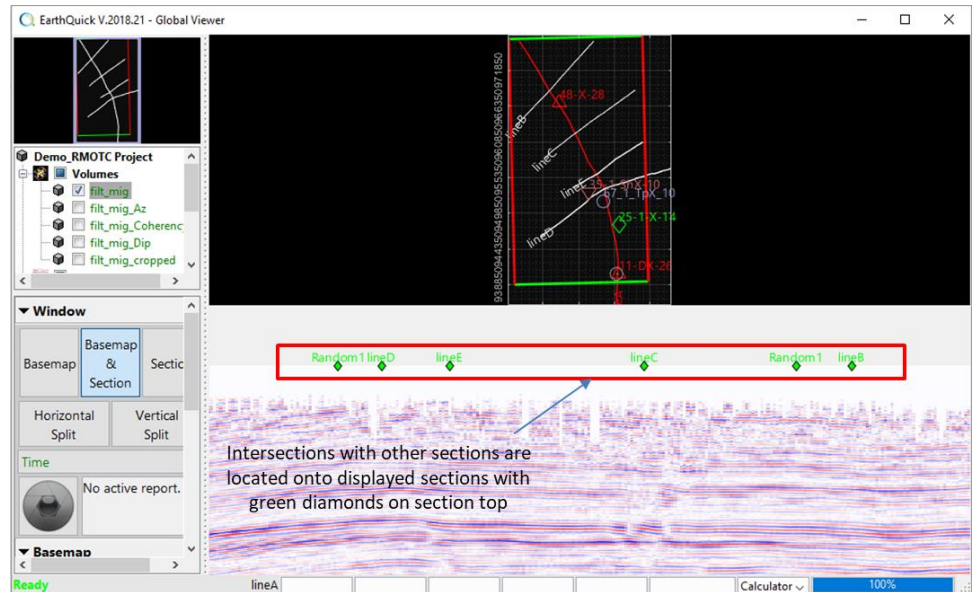


Figure 49: Locations of intersections between displayed section and others available in a project.

Sections / Draw Lines Names

Draw sections names on the Basemap when selected, near first CDP.

Sections / Draw Xssings on sections

If ticked on, intersections with other sections are located onto displayed sections with green diamonds on section top.

Sections / Display handsfree drawings

If ticked on, available handsfree drawings are displayed on Sections Panel when applicable.

Sections / Merge with fixed scale

If ticked on, when merging Sections, a fixed constant lateral scale is kept enabling use of screenshots, if any.

Wells / Modify/Add/Remove...

Modify/Add/Remove... item launches the frame in Figure 50.

To create a new well, users only have to write a Well Name which does not exist and push *Add/Apply changes*.

Any changes on a well must be followed by *Add/Apply changes* before pushing *OK*. Otherwise, changes shall not be stored.

If *Add/Apply changes* has been pushed but followed by a push on *Cancel*, all changes shall be lost.

Figure 50: Frame to modify, add or remove wells.



That frame on Figure 50 stands as a way to perform quick changes on wells database. However, to have an exhaustive access to all settings and data in wells, changes have to be performed through the Wells Board module.

In the aftermath of any changes, ProjectWells.csv and WellsMarkers.csv shall be updated.

Besides, for each removed well, its relative *_Dev*, *_TD.csv*, *_Facies*, *_SyntheticsGenAnchor.xml* and *_Logs* suffixed and infixed files shall be automatically removed.

Wells / Status Display Library

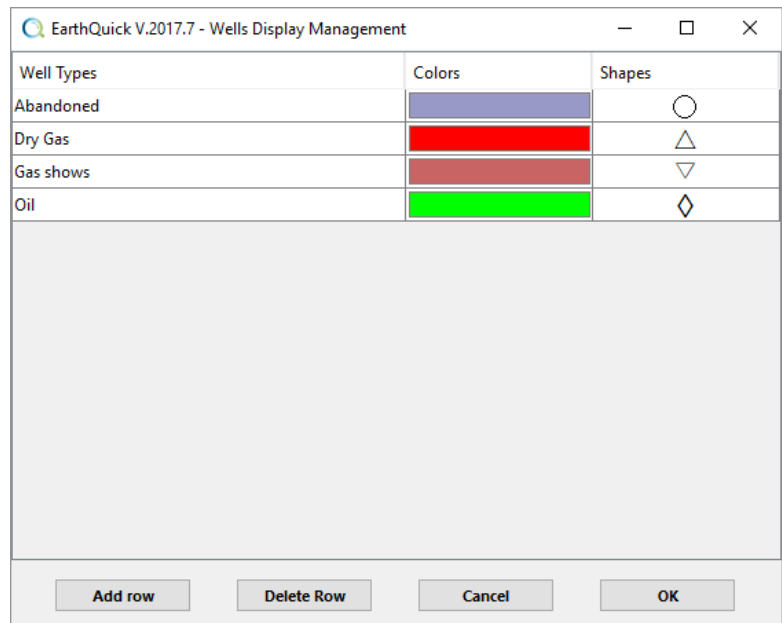
To manage display of wells on Basemap. Several millions of colors and up to 8 shapes (i.e. circle, square, diamond, upward-pointing triangle, downward-pointing triangle, plus sign, cross, pentagram (five-pointed star)) could be combined.

If users delete a status kind still in use by some wells, EarthQuick shall use first kind of the list after clicking *OK*.

If the list of kind is empty, EarthQuick apply default display (i.e. white circles).

The equivalent could be accessed through the Wells Board module.

Figure 51: Status Display Library frame.



Wells / Markers Manager

Figure 52 shows Markers Manager frame. Only the sixth column on the far right is editable in the Global Viewer. Display changes on a row (corresponding to 1 well and 1 marker) automatically affect all wells in the same time.

When ticked on, markers are shown on wells trajectories in Sections panel. When ticked off, markers are hidden instead.

The equivalent could be accessed through the Wells Board module, where MD and TVD are always editable. TWT is only editable when time-to-depth law exists on a well. The sixth column does not exist when launching Markers Manager from the Wells Board since display settings are then accessible directly from the folder tree.

Figure 52: Stratigraphic markers manager.

	Wells	Markers	MD from KB	TVD from SRD	TWT from SRD	Display
1	11-DX-26	Tensleep	6000	5357	NaN	<input checked="" type="checkbox"/>
2	11-DX-26	KF2	3121	3300	NaN	<input checked="" type="checkbox"/>
3	11-DX-26	Fall River	4996	5175	NaN	<input checked="" type="checkbox"/>
4	11-DX-26	Red Peak	4130	4309	NaN	<input checked="" type="checkbox"/>
5	11-DX-26	Carlile	NaN	NaN	NaN	<input checked="" type="checkbox"/>
6	11-DX-26	Crown Mountain	NaN	NaN	NaN	<input checked="" type="checkbox"/>
7	25-1-X-14	Tensleep	5788	6063	1.1060e+03	<input checked="" type="checkbox"/>
8	25-1-X-14	KF2	3213	3488	705.3973	<input checked="" type="checkbox"/>
9	25-1-X-14	Fall River	4.0923e+03	4.3673e+03	854.1224	<input checked="" type="checkbox"/>
10	25-1-X-14	Red Peak	4848	5123	974.8310	<input checked="" type="checkbox"/>
11	25-1-X-14	Carlile	NaN	NaN	NaN	<input checked="" type="checkbox"/>
12	25-1-X-14	Crown Mountain	NaN	NaN	NaN	<input checked="" type="checkbox"/>
13	35-1-ShX-10	Tensleep	NaN	NaN	NaN	<input checked="" type="checkbox"/>
14	35-1-ShX-10	KF2	NaN	NaN	NaN	<input checked="" type="checkbox"/>
15	35-1-ShX-10	Fall River	NaN	NaN	NaN	<input checked="" type="checkbox"/>
16	35-1-ShX-10	Red Peak	NaN	NaN	NaN	<input checked="" type="checkbox"/>
17	35-1-ShX-10	Carlile	NaN	NaN	NaN	<input checked="" type="checkbox"/>
18	35-1-ShX-10	Crown Mountain	NaN	NaN	NaN	<input checked="" type="checkbox"/>
19	48-X-28	Tensleep	5463	5.8484e+03	NaN	<input checked="" type="checkbox"/>
20	48-X-28	KF2	3848	2324	638.7441	<input checked="" type="checkbox"/>

Wells / Draw Wells Names

If ticked on, Wells name are drawn on Basemap and Sections Panel when applicable.

Wells / Draw Wells Trajectories

If ticked on, Wells trajectories projection are drawn on Basemap and Sections Panel when applicable.

If ticked off, *Draw Strat. Markers* menu item is automatically disabled.

Wells / Draw Strat. Markers

If ticked on, selected stratigraphic markers for display shall be shown when applicable (see Figure 46).

Wells / Draw Litho. Facies Patches

If ticked on, selected and available lithostratigraphic facies are drawn along wells trajectories on Sections Panel when applicable. Note selection for facies to be displayed could only be made through the Wells Board.

If ticked off, *Draw Litho. Facies Text* menu item is automatically disabled.

Wells / Draw Litho. Facies Text

If ticked on, names of selected and available lithostratigraphic facies shall be shown when applicable.

Grids / New...

Enables to create a new empty grid, ready for interpretation and computations. Users have just to provide a new name.

Grids / ASCII Import...

Grids import in EarthQuick works with scatter data, each point in the input ASCII file must contain (X, Y, Z) vector information. 1 row = 1 point, 1 column = 1 quantity among X, Y and Z. Workflow is shown on Figure 53.

Some abilities of the column-sorted ASCII file importers in all EarthQuick modules are such as:

- Order of column occurrence does not matter,
- File header could be interactively managed,
- Accepted delimiters are space, comma, semi-colon, tabulation, carriage return, new line.
- "Empty values" could be acknowledged.

EarthQuick considers that below SRD, depth values are expected to be positive, whereas they are expected to be negative the other way around. Then on top of previously mentioned abilities, grids importer could:

- Manage sign conversion of Z values.
- Z values could be either Time [ms], Time [s], Depth [m], Time [ft] or Undefined.

If the Global Viewer domain is tuned on a domain and current grid is to be loaded in another domain, Global Viewer adapt domain to newly loaded grid to enable immediate display of the latter.

By no means, two different grids could share the same name.



Double clicking on grids names in the *Data Folder Tree* allows renaming them.

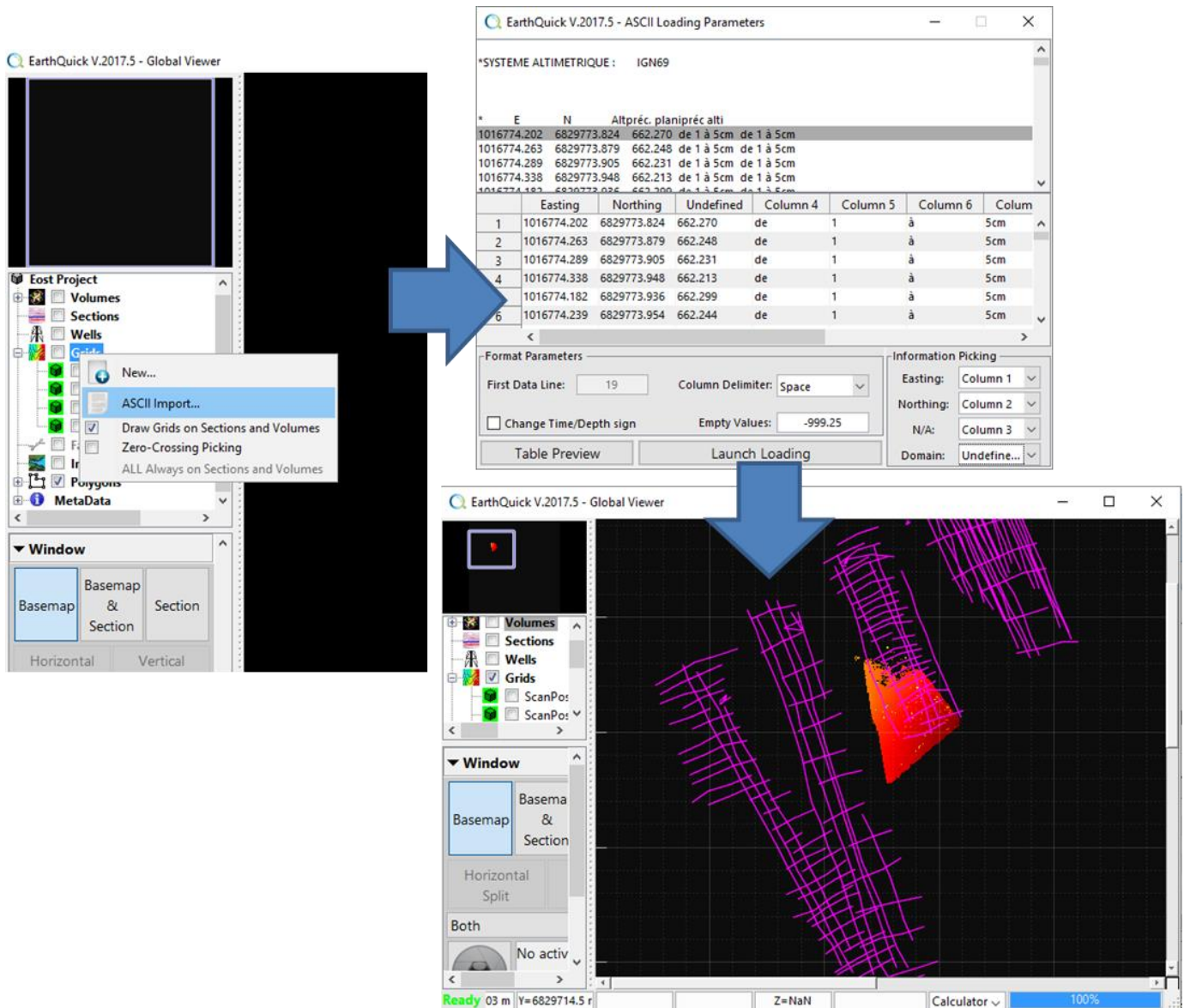


Figure 53: Workflow to import a grid in 3 steps.

Grids / Draw Grids on Sections and Volumes

If ticked on, the selected and active grids shall be displayed on Sections panel and the 3D Viewer, otherwise that is just hidden. See Grids interpretation facilities described in Chapter 5.3.3.

Grids / Zero-Crossing Picking

Enables automatic pickings (2D and 3D) to focus on Zero-Crossings instead of extrema.

Grids / ALL Always on Sections and Volumes

Enables to display multiple grids at once on Sections panel.

Note both on Basemap and with 3D Viewer (see Figure 74) only 1 single grid (the one which is actually selected) could be displayed at once.

Faults / New...

Enables to create a new empty fault, ready for interpretation. Users have just to provide a new name.

By no means, two different faults could share the same name.

Faults / ASCII Import...

ASCII import works just the same for faults than for grids (see Figure 53) except scatter data represents there the fault plan. Triangulation of the scatter to create the fault plan is automatic.

Faults / Draw Faults on Basemap

If ticked on, the selected and active faults shall be displayed on Basemap panel, otherwise that is just hidden.

Faults / Draw Faults on Sections and Volumes

If ticked on, the selected and active faults shall be displayed on Sections panel and the 3D Viewer, otherwise that is just hidden.

Faults / ALL Always Displayed

Enables to display multiple faults at once on Basemap and Sections panels.

Note both with 3D Viewer (see Figure 74) only 1 single fault (the one which is actually selected) could be displayed at once.

Images / New...

Enables to import a new image.

Image import is compliant with following formats of graphics file: bmp, cur, gif, hdf, ico, jpg/jpeg, pbm, pcx, pgm, png, pnm, ppm, ras, tif/tiff. Users are then invited to provide *South West Corner X, South West Corner Y, East West width, North South width* and *Azimuth*.

By no means, two different images could share the same name.

Even though loading of images is possible in the Global Viewer, GeoPosit (see Chapter **Error! Reference source not found.**) module should be preferred for that task.

Polygons / Multi-Import...

Multi-import of polygons is performed from ASCII files, as for grids or faults, except that the Z value is replaced here by a polygon flag, as shown on Figure 54.

In a file to load, consecutive rows with the same flag correspond to one single Polygon. When flag changes, from a row to another, a new polygon to append to the project database is created.

Each polygon gets the name of its flag.

Delimiter could also correspond to *empty values* by ticking in the checkbox *No flag (delimiter = empty values)*. Then, expected ASCII input files must be composed of 2 columns.

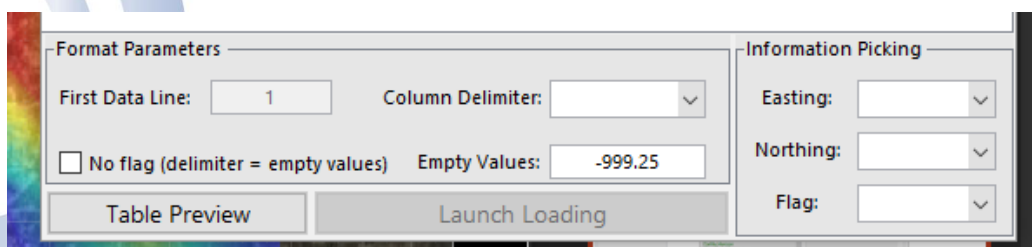


Figure 54: Bottom part of multi polygons import frame.

Polygons / Export All...

Export All... allow exports choosing between Flags or Not-a-Number values to differentiate polygons in the output file as seen on Figure 55.

The general idea is to remain compliant with a maximum number of platforms where the export from EarthQuick must be reimported.

Polygons / Geo-Selection

Geo-Selection works just the same as Geographic Filter for Sections but for Polygons. That let users restrain selection of Polygons by giving a rectangular geographic boundary of selection with (X_{min} , X_{max} , Y_{min} , Y_{max}).

Metadata / New...

Enables attachment of a file to the project, whatever the format. After attaching the file, it is physically copied in the Metadata folder of the project and add as a Metadata item of the folder tree. Double-clicking on the newly added folder tree item shall open the specified file in the Windows™ application associated with the extension of the file.

Users could also add any documents in the Metadata of the project, off the shelf. Global Viewer must remain closed during that operation. And by no means, two different metadata files could share the same name.

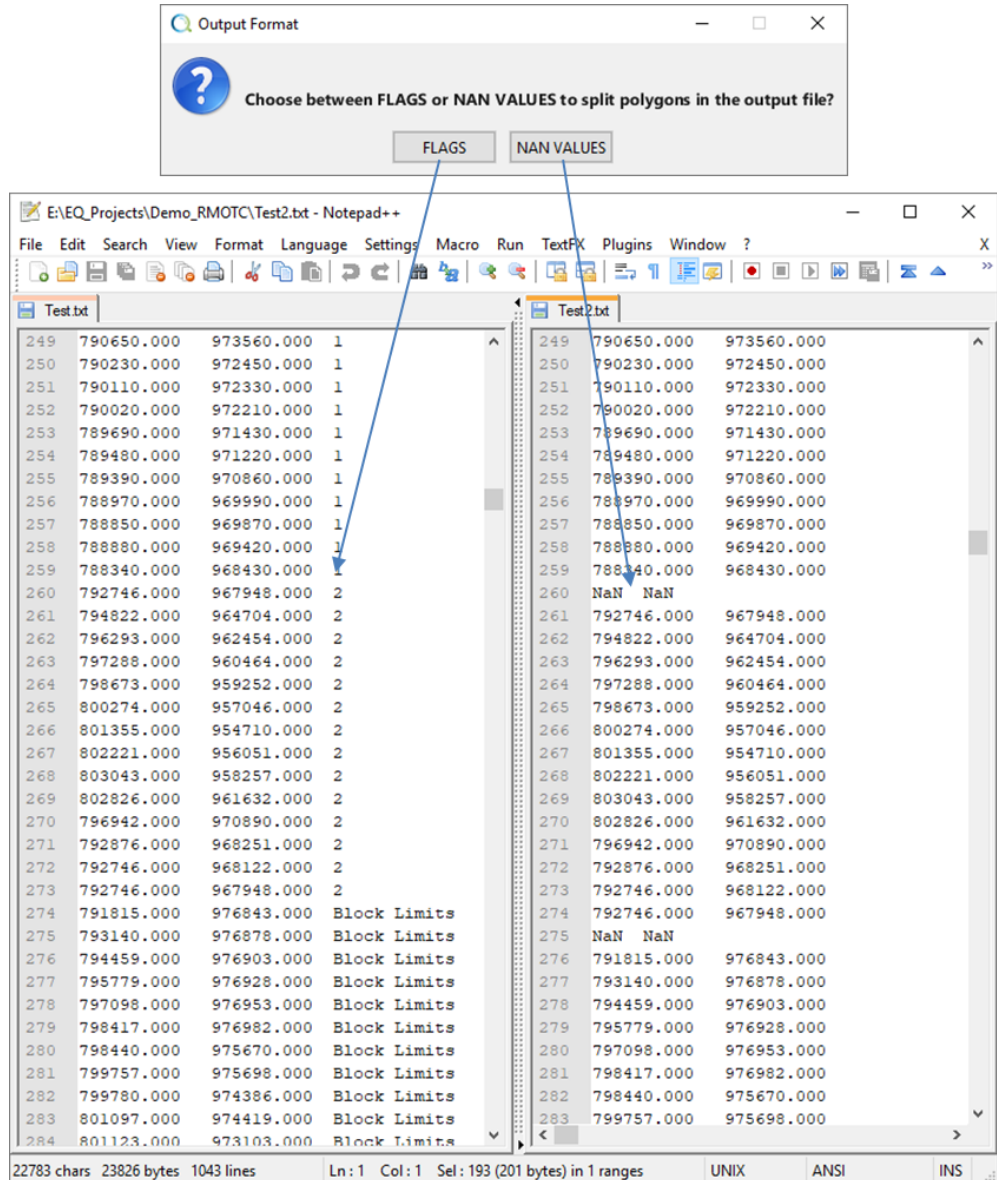


Figure 55: Massive export of Polygons and output files.

5.2.2 2nd-rank leaves

The 2nd-rank leaves are the direct “children” of the 1st-rank-leaf items in the *Data Folder Tree*.

They all could be selected for display, except Metadata items. Selection could have 3 different states: unselected (corresponding to ☐) meaning data is not selected, partially selected (corresponding to ☐) meaning data is selected for display but not for interpretation; and selected (corresponding to ☒) meaning data is selected.

When right-clicking on these items, a bunch of options and functionalities are offered, as shown on Figure 56.

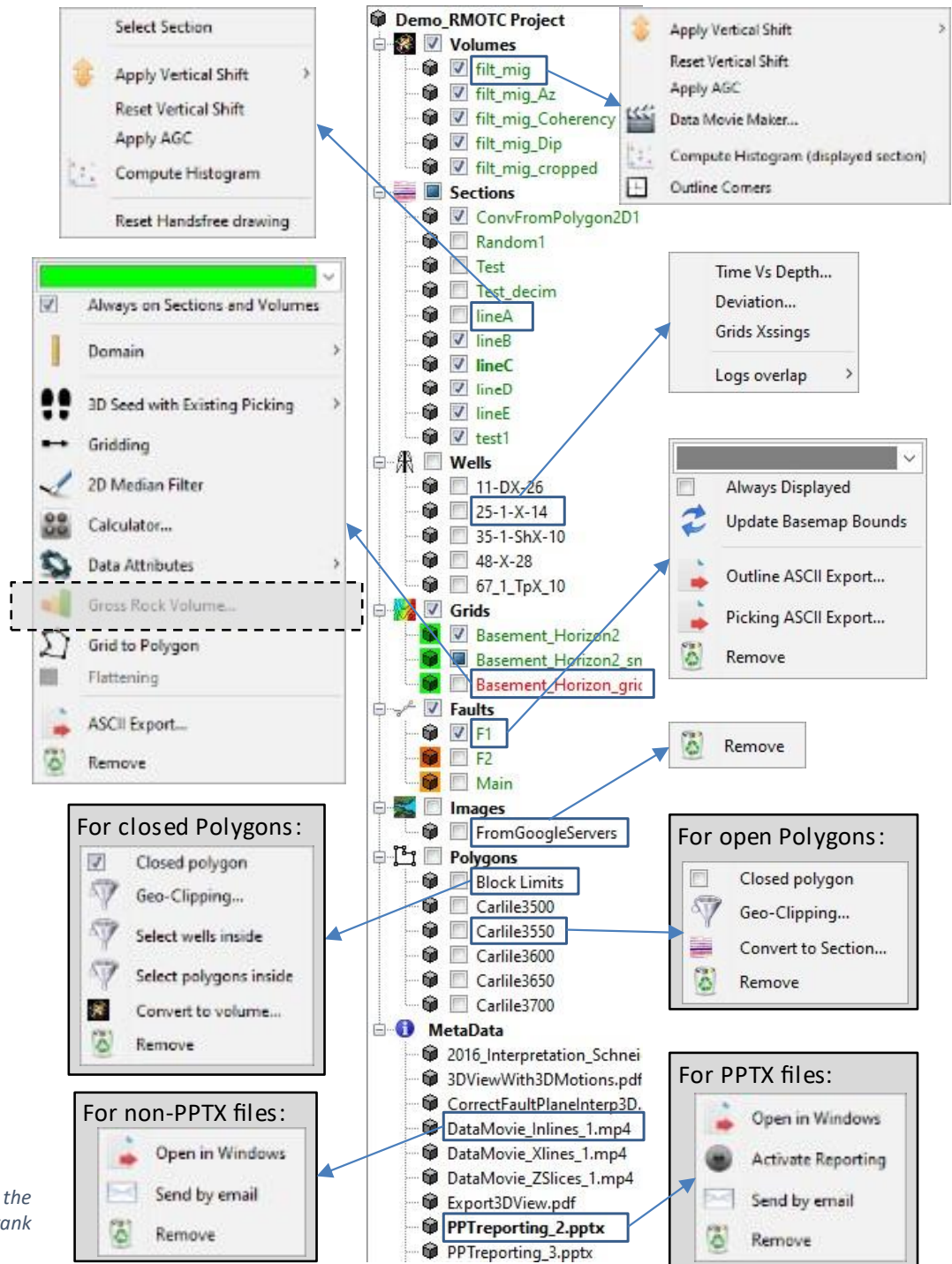


Figure 56: Right-clicking on the Data Folder Tree 2nd-rank leaves.

Below are explanations of possibilities shown by Figure 56. Prefix corresponds to the item’s parent and suffix to the functionality/option denomination in the menus:

Volumes / Apply Vertical Shift

Enables a vertical tie of a Volume. Ideal tool to correct misties.

Volumes / Reset Vertical Shift

Enables to reset vertical shift to 0 for a Volume.

Volumes / Apply AGC

AGC stands for Automatic Gain Control and is often used in presence of strong signal in the shallows and attenuated signal in depth.

That is tuned giving the length of the sliding window in samples. The more the window is wide, the more AGC is gentle.

The zero value corresponds to absence of AGC on the signal.

Volumes / Data Movie Maker...

Data Movie Maker... turns data in SEG-Y format to movies in the very popular MPEG-4 format, including interpretation.

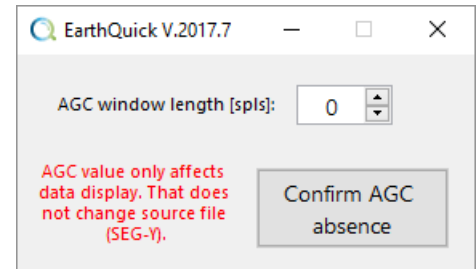


Figure 57: AGC tuning frame.

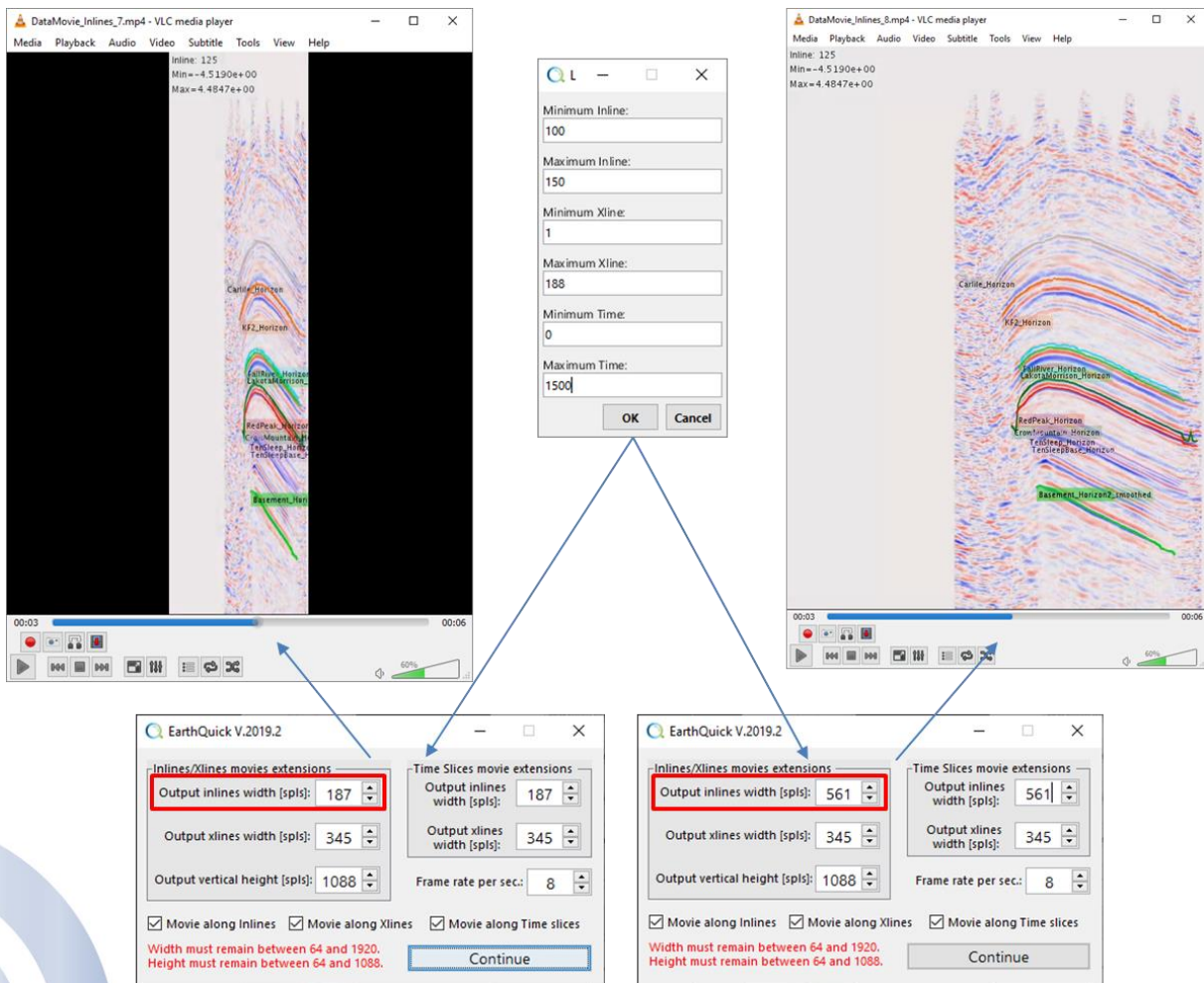


Figure 58: Data Movie Maker settings influence on results.

Below are specificities of that function:

- Selected grids and faults (in the folder tree) shall be automatically added to the movies with names annotations (see Figure 58).
- Current color scale in use for Volumes and Sections display shall be used (for example Blue-White-Red in Figure 58).
- Frames of the movies could correspond to only Inlines or Inlines, Xlines and Time/Depth slices.

- Aspect ratios of sections could not be easily changed in video readers. Hence, EarthQuick provides the possibility modify the aspect ratio when exporting.
- Figure 58 shows 2 cases:
 - On the left-hand side, ratio 1:1 is used. Output has been read and capture with VLC media reader.
 - On the right-hand side, ratio 1:3 is used. Output has been read and capture with VLC media reader.

Volumes / Compute Histogram (displayed section)

Histogram built on the amplitude of displayed section is generated with following characteristics:

- Histogram is made of dark blue bars.
- Vertical green line corresponds to the color scale center. It could be dragged to adapt the color scale to amplitudes.
- Reddish area corresponds to cropped amplitude values (linked to the color scale).
- AGC status is indicated since that processing has a significant effect on the amplitudes.

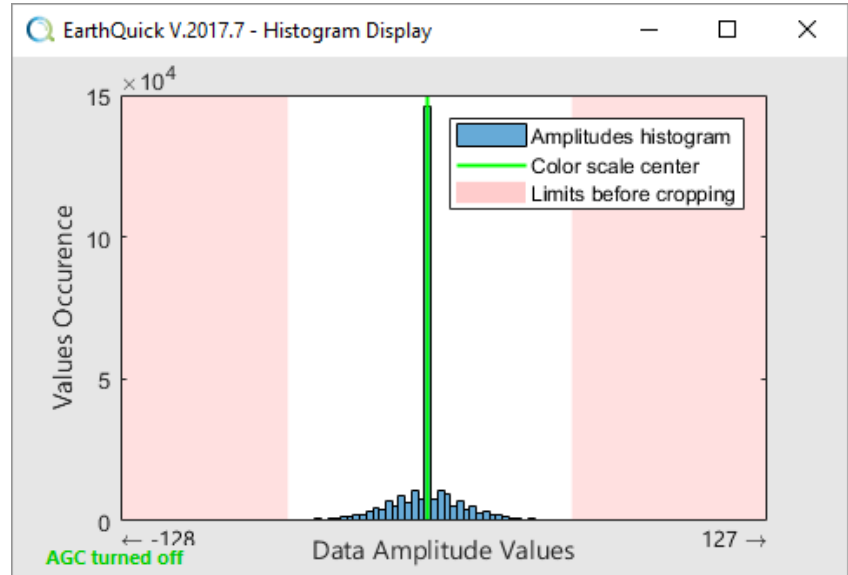


Figure 59: Histogram on amplitude values.

Volumes / Outline Corners

Outline corners of 3D data, corresponding to the geographic imprint, could be crucial to enable loading on some other platforms (see Figure 60).

Sections / Select Section

Enable to select a Section directly from the *Data Folder Tree* instead of clicking on its plot on the Basemap. Handy if Sections are numerous in a project to be easily find on a Basemap.

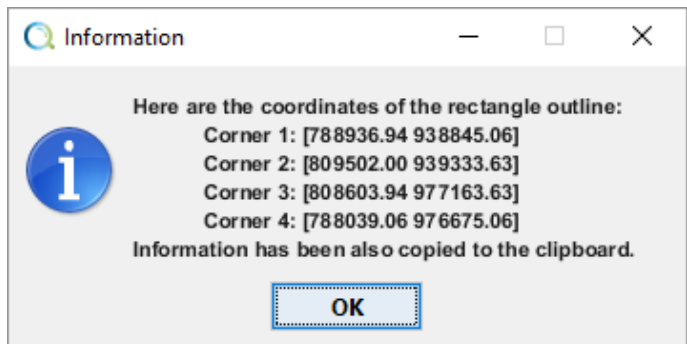


Figure 60: Popup message indicating corners.

Sections / Apply Vertical Shift or Sections / Reset Vertical Shift or Sections / Apply AGC or Sections / Compute Histogram

All these functions work just the same as for Volumes.

Wells / Time Vs Depth...

Figure 61 illustrates how Time-to-Depth (T/D) laws at wells are handled in the Global Viewer when pushing *Time Vs Depth*....

ASCII file loading process is compliant with ASCII file made of 2 columns, 1 for True Vertical Depth (TVD) from either the Kelly Bushing (KB) or the Seismic Reference Datum (SRD), 1 for Two-Way Time (TWT) from the Seismic Reference Datum (SRD), and separated by standard delimiters.

Multiple laws may coexist for the same well. Only one could be active (i.e. effectively in use).

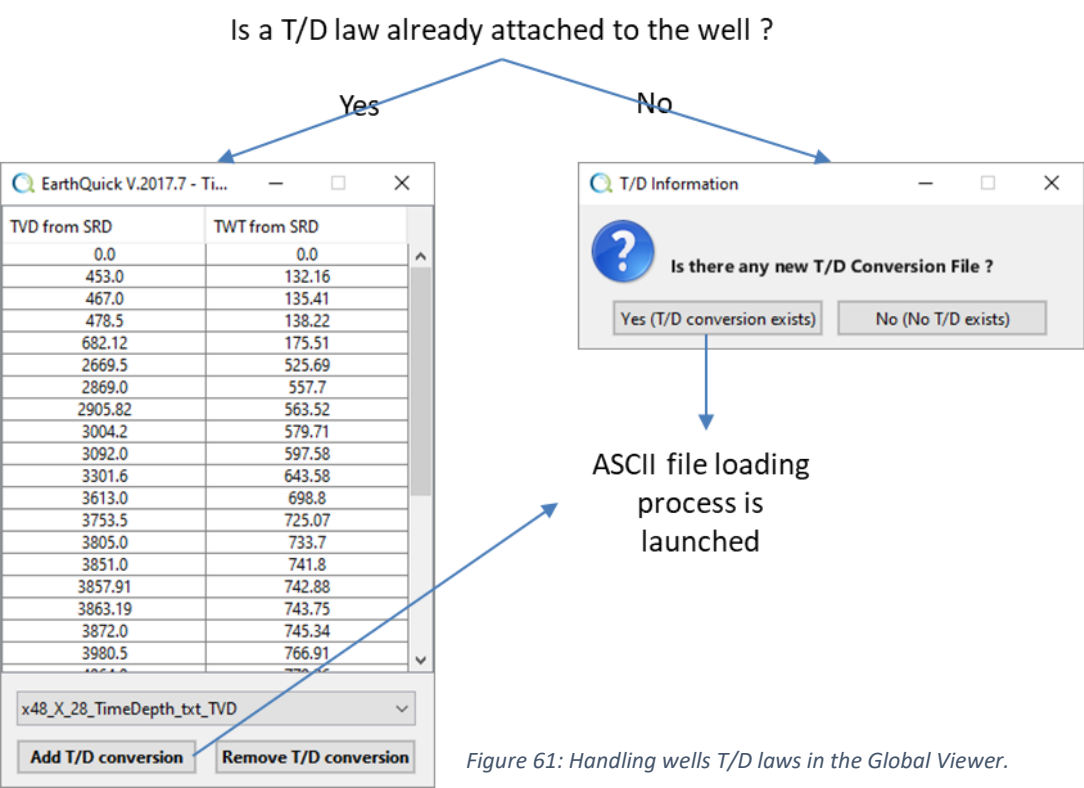


Figure 61: Handling wells T/D laws in the Global Viewer.

Wells / Deviation...

Figure 62 illustrates how wells deviations are handled in the Global Viewer when pushing Deviation....

ASCII file loading process is compliant with ASCII file made of 3 columns, 1 for Measured Depth (MD) from the Kelly Bushing, 1 for Azimuth clockwise in

degrees from the North, 1 for Incidence from the upright position, and separated by standard delimiters. The 3 columns could also be MD, offset along X (dX), offset along Y (dY).

Only 1 single deviation could exist at a time.

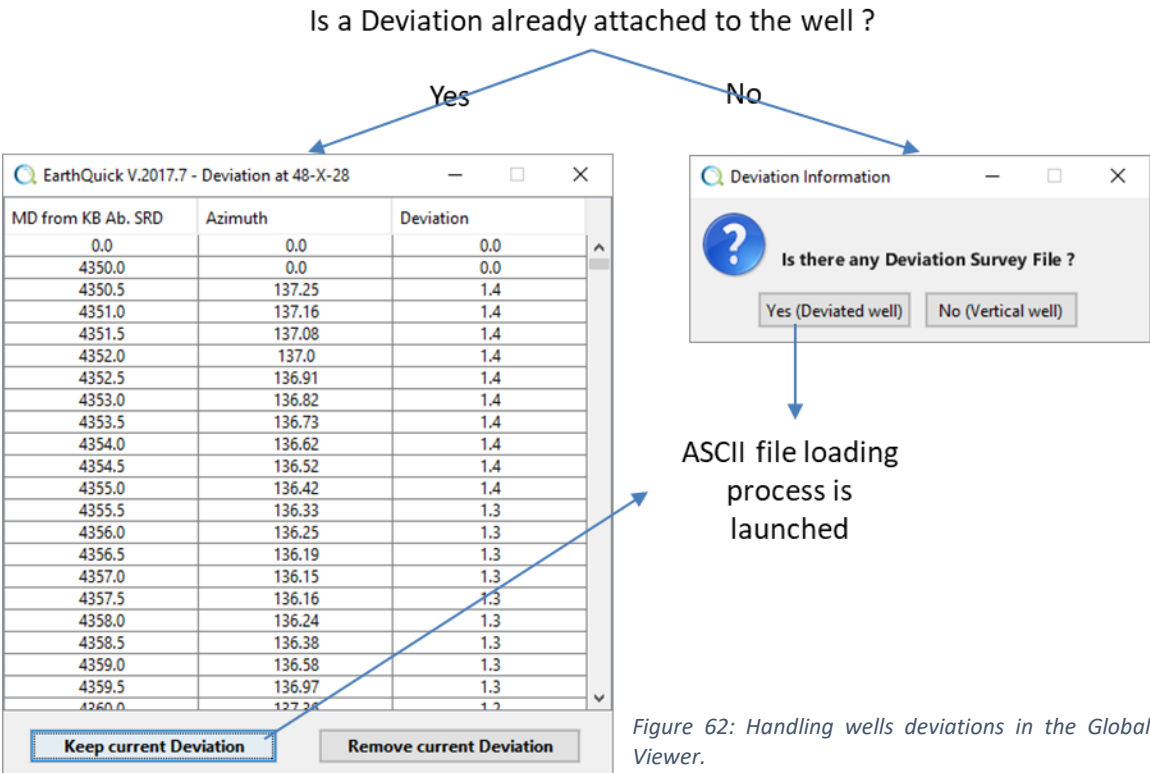


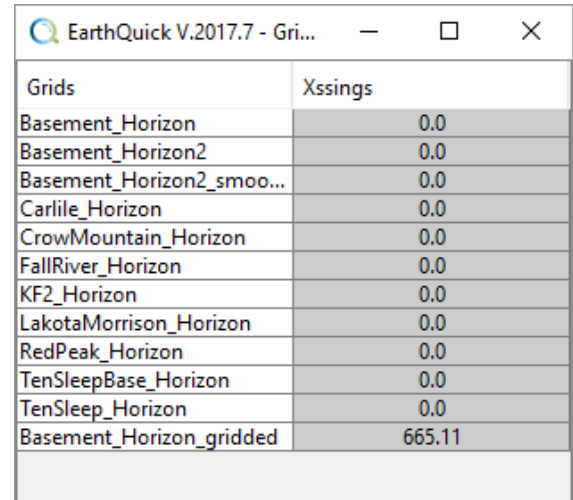
Figure 62: Handling wells deviations in the Global Viewer.

Wells / Grids Xssings

Grids Xssings enables use of a recurrent quick-look tool: computation of intersections between grids and a well path.

Intersection with time Grids is only possible if wells possess a T/D law, or if well is not deviated.

Cells of the table could be selected with the mouse, copied (Ctrl-C) and paste in a table editor.



Grids	Xssings
Basement_Horizon	0.0
Basement_Horizon2	0.0
Basement_Horizon2_smo...	0.0
Carlile_Horizon	0.0
CrowMountain_Horizon	0.0
FallRiver_Horizon	0.0
KF2_Horizon	0.0
LakotaMorrison_Horizon	0.0
RedPeak_Horizon	0.0
TenSleepBase_Horizon	0.0
TenSleep_Horizon	0.0
Basement_Horizon_gridded	665.11

Figure 63: Result of intersection between a well trajectory and Grids.

Wells / Logs overlap

If a well contains logs, they could be displayed on Sections, with some restrictions:

- Logs referenced in time require occurrence of a T/D law to be displayed on depth section and vice versa.
- Only 1 log at a time in the Section panel.
- Tuning of logs (i.e. scaling, cut-offs, ...) is only possible from the Wells Board (see Chapter 6).

Grids / Always on Sections and Volumes

Enable to display a grid on Sections panel, when not selected/active for interpretation.

Grids / Domain

To select the grid domain (Time, Depth, Undefined).

Grids / 3D Seed with Existing Picking

To launch automatic 3D seed picking on a selected Volume, considering each node of the selected grid as a seed. Automatic grid interpretation parameters (Step Tolerance, 3D Quality Criterion and 3D Seeds Range) must be considered.

Grids / Gridding

To interpolate a grid. 2 available interpolation algorithms:

- Triangulation-based cubic interpolation
 - “+”: Fast computation, with no needs of input parameters.
 - “-”: Do not allow discontinuities in the interpolated result.
- For advanced interpolation methods, refer to Chapter 8.

Output name correspond to input name with a “_gridded” suffix.

Grids / 2D Median Filter

2D median filter to smooth a grid. Output name correspond to input name with a “_smoothed” suffix.

Grids / Calculator...

Alongside Matlab™ scripts, performs computations on grids, from simple arithmetic operations to iterative processes (see Figure 65 with a script example of Time-to-depth conversion relying on a (Vo, k) layer cake).

Figure 64 shows calculator in use. Different components could be described as follows:

- Left upper part correspond to available grids, selectable as variables for computation,
- Right upper part lists selected grids for computations. Each row defines one variable, named V{i}.
- Mid part contains the operations, defining the script,
- Bottom part enables to restrict computations within a polygon, clean the script area, perform operations contained in the script.

Regular workflow:

- Create a new grid by right-click on Grids, named after original grids with _filt suffix,
- Launch the Grids Calculator,
- Write scripts on selected grids with possibility to limit computations within Polygons.

Basic scripts coding rules:

- TempVar4User{i} are temporary variables freely “summonable”,
- To reset V{i}, use V{i} = nan(size(V{i}));,
- V{i}(j) refers to index/indices j of variable V{i}.

Closing the calculator automatically saves the performed script in CalcSession_GlobalView.xml, located in the root folder of a project.

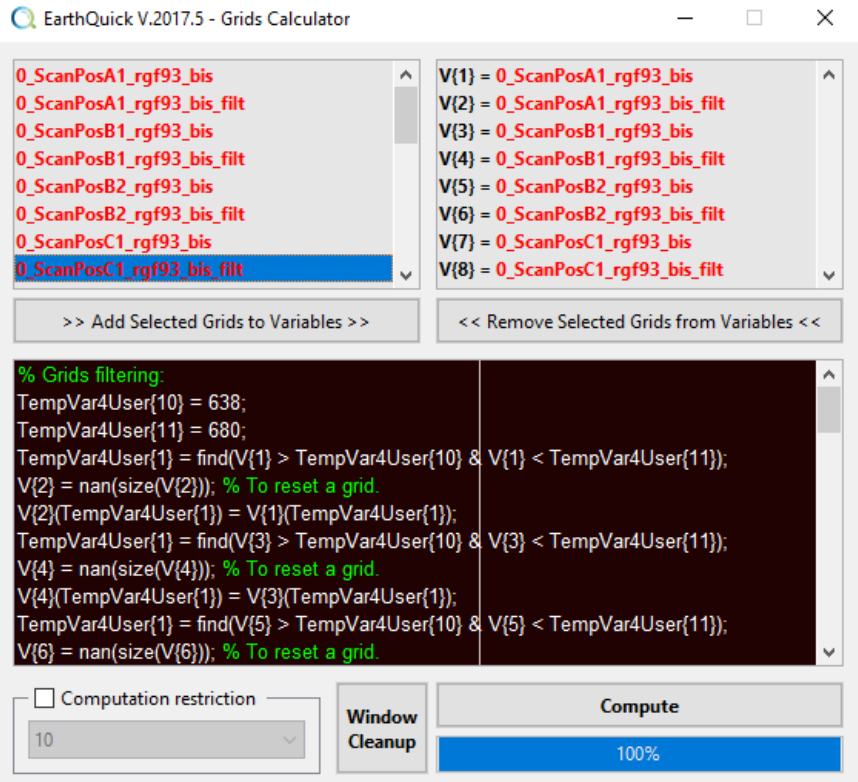


Figure 64: Grids calculator.



Figure 65: Example of a script to perform a T/D conversion with a (Vo,k)

Grids / Data Attributes

Unlike the SegManager, that way to compute attributes are quicker, since they are restrained to the grid vicinity.

Attributes possibilities are:

- Computed on a Volume, guided by a grid:
 - Amplitude extraction (surface attribute),
 - RMS amplitude (volume attribute),
 - Fracturation (volume attribute).
- Computed directly on the grid:
 - Dip
 - Azimuth

None of them require additional inputs from users.

Output is an Image, added in the folder tree.

Grids / Gross Rock Volume...

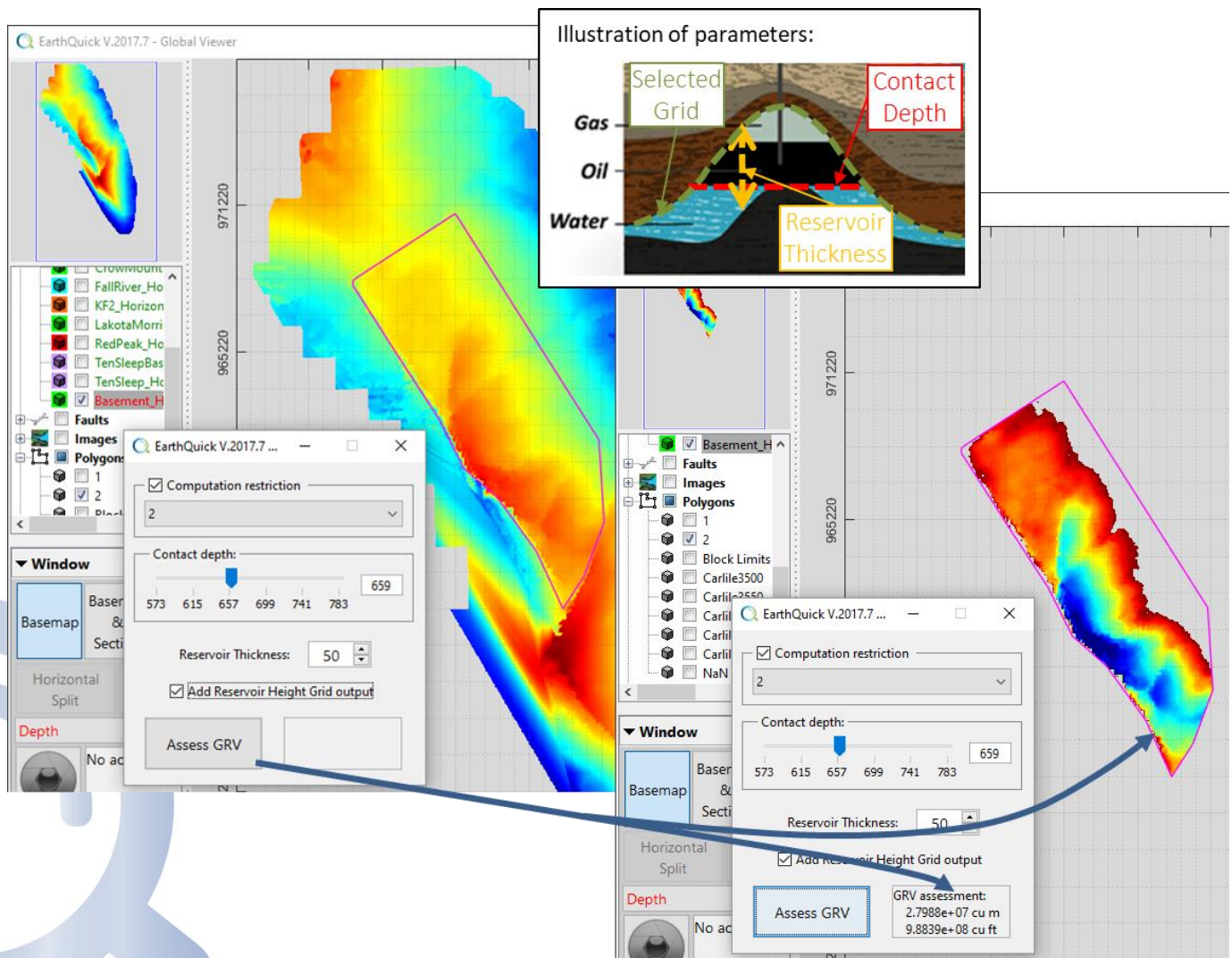


Figure 66: GRV computation.

Grids / Grid to polygon

Returns a Polygon representing a conforming 2-D boundary around points where the grid has defined values. Unlike the convex hull algorithm, the boundary can shrink towards the interior of the hull to envelop the points.

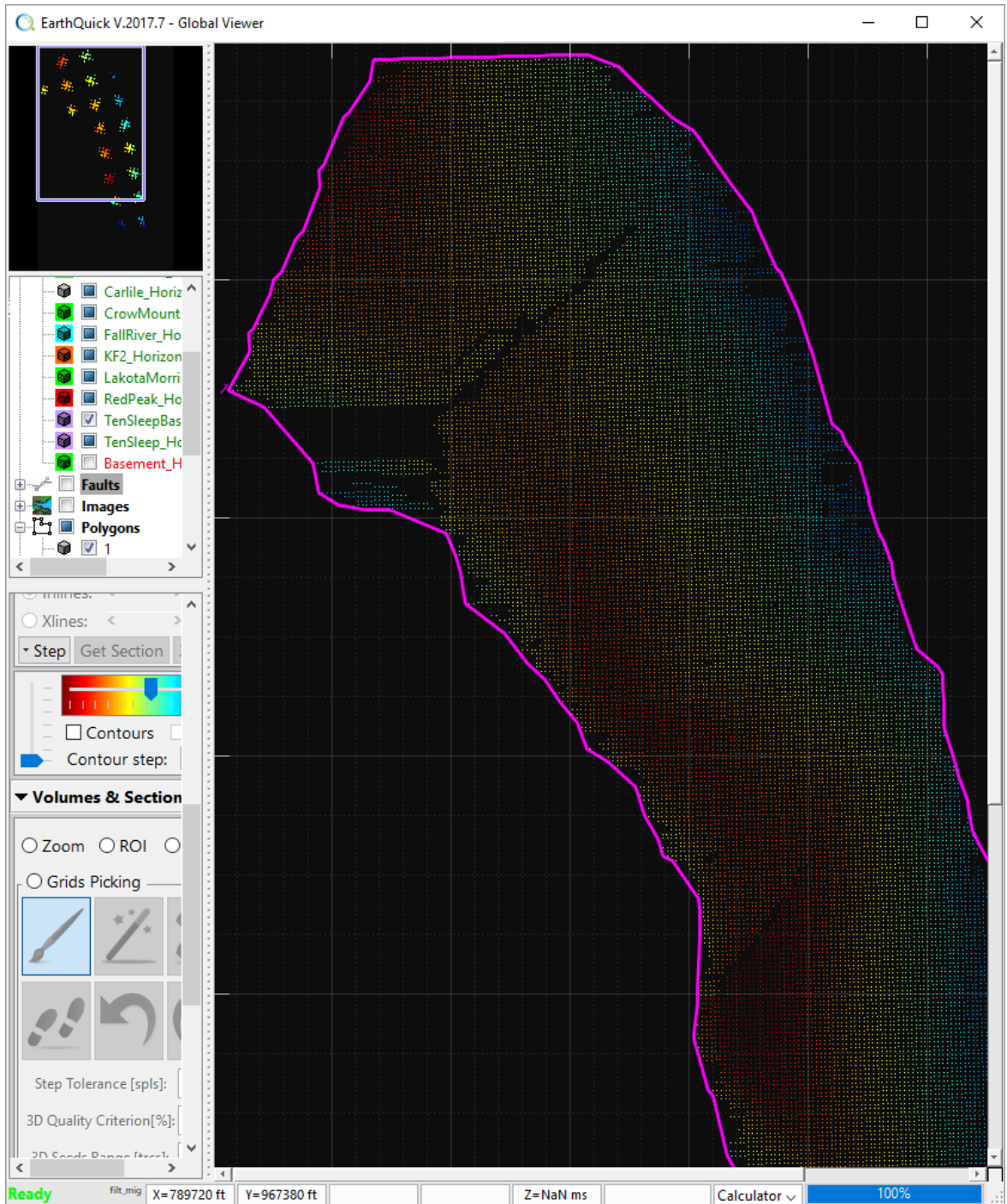


Figure 67: Grid-to-Polygon.

Grids / Flattening

Enables flattening of a selected grid on a Section. The level of flattening is also applied to other displayed grids and overlapped section.

For unselected or partially selected grids the menu item is disabled.

Grids / ASCII Export...

Export output is an ASCII file made of 3 columns (X, Y, Z) separated by tabulations.

Faults / Always Displayed

Enables to display a fault on Sections panel, when not selected/active for interpretation.

Faults / Update Basemap Bounds

Recompute fault lateral extensions and display them on the Basemap with a dashed line. If fault picking is done to pick fault contacts, evaluating the throw of the fault, extensions shall correspond to fault boundaries. An example is shown on Figure 68.

Manual update of basemap bounds has been preferred since automatic fault bounds update would affect EarthQuick performance when picking faults.

Faults / Outline ASCII Export...

Export output is an ASCII file made of 3 columns (X, Y, Z) separated by tabulations and corresponding to actual Basemap Bounds.

Faults / Picking ASCII Export...

Export output is an ASCII file made of 3 columns (X, Y, Z) separated by tabulations and corresponding to all picking dots.

Polygons / Closed polygon

If ticked on, Polygons are being closed. If ticked off, they become more "Polylines".

Polygons / Geo-Clipping...

Geo-Clipping works as a Geographic Filter for Polygons. That let users restrain imprints of a Polygon by giving a rectangular geographic boundary with (X_{min} , X_{max} , Y_{min} , Y_{max}), only dots within that boundary are then kept.

Polygons / Select wells inside

Restrain the selection of wells within a Polygon.

That tool also provides the list of select wells in a table which could be copied for a further use.

Polygons / Select polygons inside

Delete all the polygons which lays outside of the chosen closed polygon for selection. Polygons sitting aside the chosen closed polygon shall be kept.

Polygons / Convert to Section...

With that tool (see Figure 69), all open Polygons could be turned to a void Section (i.e. all samples values are zero).

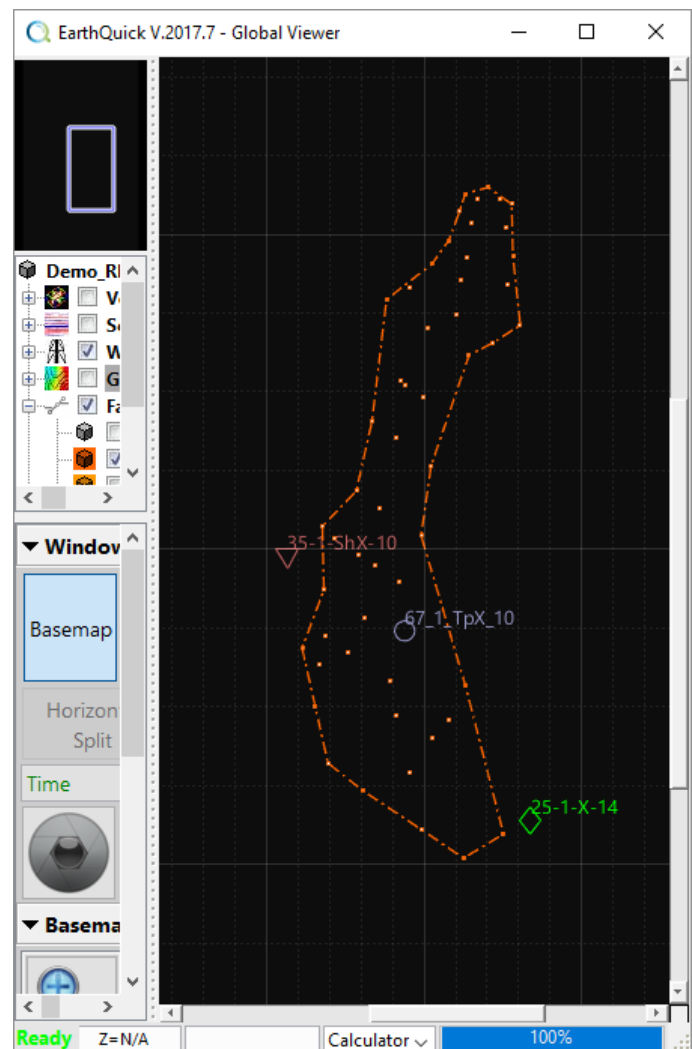


Figure 68: Updated Basemap Bounds.

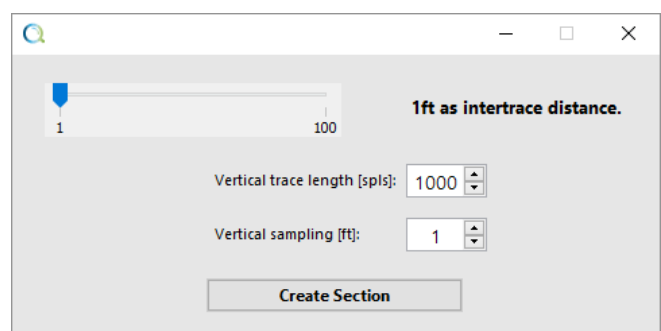


Figure 69: Creation of a Section from a Polygon.

The only required inputs from users are the intertrace distance, the number of vertical samples per data trace and the vertical sampling.

Clicking on *Create Section* shall launch SEG-Y file creation, automatically added to the *Data Folder Tree* in the *Sections* directory.

Polygons / Convert to Volume...

With that tool (see Figure 70), all closed Polygons could be turned to a void Volume (i.e. all samples values are zero).

The only required inputs from users are the number of inlines and Xlines, the number of vertical samples per data trace and the vertical sampling.

Clicking on *Create Section* shall launch SEG-Y file creation, automatically added to the *Data Folder Tree* in the *Volumes* directory.

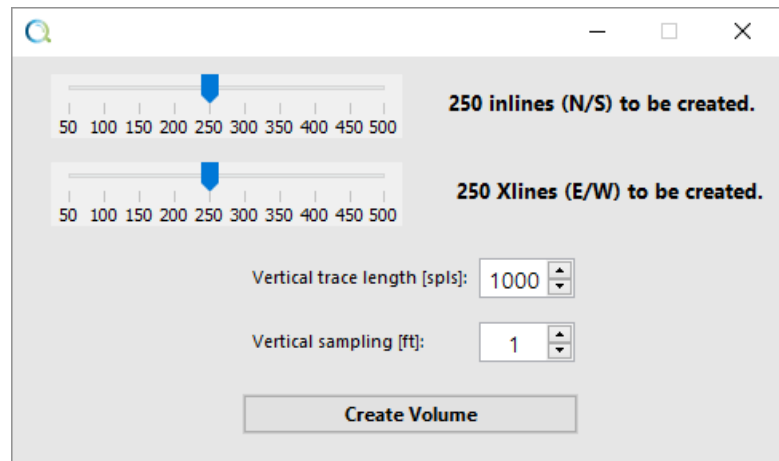


Figure 70: Creation of a Volume from a Polygon.

Metadata / Open in Windows

Opens the specified file in the Windows™ application associated with the extension of the file.

Metadata / Deactivate Reporting or Activate Reporting

Only for PPTX files. New slides with screenshots shall be appended in the *activated* PPTX file. If none is activated for reporting, EarthQuick shall create a new presentation.

If item name is in bold fonts in the *Data Folder Tree*, item is activated for reporting.

Metadata / Send by email

Sends by email as an attached file, regarding email settings from the Launcher (i.e. recipient(s), SMTP server, ...).

Message of the email is always as follows:

That email is sent from EarthQuick.

The attachment is extracted from the [Project Name] project.

Please, do not answer that email.



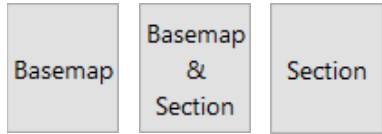

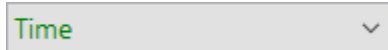
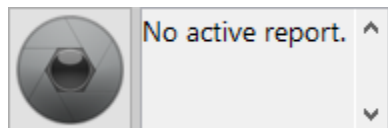
Depending on email servers, limit of attached files to emails is often between 10 MB and 20 MB. In case a presentation exceeds 15 slides, file size must be checked with the Windows File Explorer before sending.

5.3 Accordion Tree


Accordion tree hosts additional transversal functionalities.

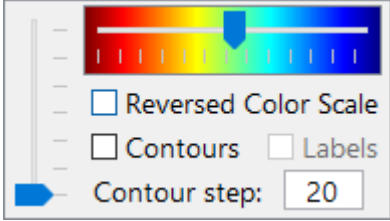
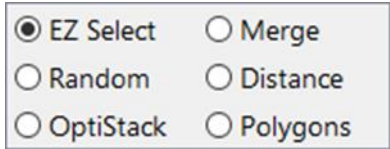
The accordion is made of 3 panels: *Window*, *Basemap*, *Volumes & Sections*, separately reviewed in the following subchapters.

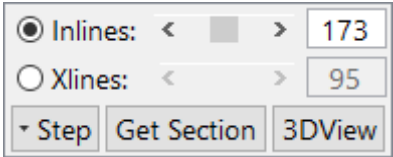
5.3.1 Window

	<p>3 Toggle Buttons. Only one of them could be pushed at a time.</p> <ul style="list-style-type: none"> • If <i>Basemap</i> is pushed, only the Basemap panel is displayed. • If <i>Basemap & Section</i> is pushed, the Basemap panel and the Sections panel are both displayed. The two toggle buttons <i>Horizontal Split</i> and <i>Vertical Split</i> are then enabled. • If <i>Section</i> is pushed, only the Section panel is displayed.
	<p>2 Toggle Buttons, only enabled when <i>Basemap & Section</i> is pushed above. Only one of them could be pushed at a time.</p> <ul style="list-style-type: none"> • If <i>Horizontal Split</i> is pushed, split between panels is horizontal. Could be preferred for long sections. • If <i>Vertical Split</i> is pushed, split between panels is vertical. Could be preferred for short sections and dual-screen computers.
	<p>Data could be sorted in 3 different domains: Time, Depth and Undefined. Then, restrictions of display offer 3 choices:</p> <ul style="list-style-type: none"> • <i>Time</i>: Only Time and Undefined data is displayable. • <i>Depth</i>: Only Depth and Undefined data is displayable. Spectra are not computable. • <i>Both</i>: All data is displayable, but some functions are deactivated (sections merge, power spectra, 3D Viewer, Faults, ...).
	<p>The Screenshot facility let users create reporting, enclosing EarthQuick frames into PowerPoint™ presentations by pushing the lens button or the F1 key.</p> <p>The text area on the right-hand side is not editable and gives screenshooting status information.</p> <ul style="list-style-type: none"> • Input parameters are: The slide name and the comments. • Output is located in the Metadata folder of the DB and in the <i>Data Folder Tree</i>. • When 3D viewer is on, screenshot is restricted to the latter. <p>Before screenshooting, background could be set lighter with the Ctrl-P shortcut (see Chapter 14 for shortcuts table).</p>

5.3.2 Basemap

	<p>3 Pushbuttons. Always enabled.</p> <ul style="list-style-type: none"> • <i>Zoom in</i> multiplies the current magnification by 1.2 factor. • <i>Zoom out</i> divides the current magnification by 1.2 factor. • <i>Zoom fit</i> reset the magnification to enable a complete display of the <i>basemap</i>. <p>Zoom level could also be set with the mouse wheel. However, when an image is displayed, the mouse wheel shall affect transparency of the latter and no</p>
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	<p>more the zoom level. If pressing the <i>Shift</i> key while rolling, zoom is lateral. If pressing the <i>Ctrl</i> key while rolling, zoom is vertical.</p>
	<p>A gathering of controls to manage grids color scale and contouring on the Basemap.</p> <ul style="list-style-type: none"> • Vertical slider controls compression of the color scale. • Horizontal slider controls translation of the color scale. Translating the color scale may have an effect on the compression. • The color scale could be reversed by ticking on the checkbox <i>Reverse Color Scale</i>. • <i>Contours</i> checkbox, <i>Labels</i> and <i>Contour step</i> editable text enable to add and manage contour levels. To improve performance, <i>Contours</i> must remain ticked off as often as possible.
	<p>6 tools to handle data and make measurements.</p> <ul style="list-style-type: none"> • EZ (“easy”) Select: <ul style="list-style-type: none"> ○ To display 2D Sections. Clicking on a 2D Section shall trigger loading and display in the Sections panel. ○ To select 3D Volumes. Clicking on a Volume boundary enables components described on the next row. ○ To get information about Polygons. Clicking on a Polygon gives access in the status bar to length, perimeter and area when applicable. • Merge: <ul style="list-style-type: none"> ○ To merge data from Sections and/or Volumes considering geometries and navigations. ○ Clicking on different Sections and Volumes, one after another, shall aggregate data to create a combination of data. ○ Right-clicking on basemap shall reset the selection of data. ○ That is recommended to merge data which are geographically crossing each other. However, the functionality takes in charge non-crossing Sections and Volumes. • Random: <ul style="list-style-type: none"> ○ Restricted to Volumes. ○ Users must first left click on a Volume boundary to select it. Then, a random line could be drawn in the limits of the volume. Last node of the random line corresponds a right click on the basemap. That selection is then extracted in the Volume and rendered as a Section in the Sections panel. ○ When random section has been created, that could be dragged and dropped with the mouse within the limits of the related Volume. ○ When random section has been created, right-clicking on basemap shall reset the selection of data. Users still have the possibility to save it as a Section. • OptiStack: <ul style="list-style-type: none"> ○ Restricted to Volumes. Used to stack several consecutive inlines or Xlines on top of each other. Commonly used highlight lateral continuity of events at same depths. • Distance:

	<ul style="list-style-type: none">○ Add a ruler on the Basemap with a dynamic measurement of distance and azimuth.○ If Imperial system has been chosen in the Launcher settings, distances shall be given in miles. If Metric system has been chosen, distances shall be given in kilometers instead.● Polygons:<ul style="list-style-type: none">○ To draw Polygons on the Basemap.○ Polygons are drawn by left-clicking and last node must correspond to a right-click. Polygon is then stored and added to the <i>Data Folder Tree</i>.
	<p>Activated when a Volume has been selected with the EZ Select functionality.</p> <p>Enables to:</p> <ul style="list-style-type: none">● Scroll for Inlines or Xlines to subsequently push <i>Get Section</i> load and display on the Sections panel.● Adapt <i>Step</i> of scroll bars to speed up navigation in the Volume data.● Launch the 3D Viewer described in Chapter 5.4.

5.3.3 Volumes & Sections

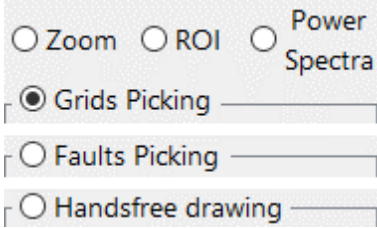
	<p>5 radio buttons. Only 1 could be selected at a time.</p> <ul style="list-style-type: none">● If <i>Zoom</i> is on, zoom is available on Sections by drawing a rectangle with the mouse and MB1. See Shortcuts in Chapter 14 for more hints with zooming.● <i>ROI</i> stands for <i>Region Of Interest</i>. If on, a rectangle could be drawn with the mouse and MB1 pushed. Rectangle could then be dragged & dropped, with a dynamic display of the vertical shift on the status bar.● If <i>Power Spectra</i> is on, 2 different spectra could be computed on mouse selections of a currently displayed Section:<ul style="list-style-type: none">○ Mean Power Spectrum
--	--

Figure 71: Mean Power Spectrum.

On Figure 71, green curve: The mean power spectrum of signal on all traces.
Red curve: The power power spectrum of noise of all traces.

All other curves: the power spectra of all traces, taken individually.

Mouse wheel enables dynamic zoom along the frequency axis. That level of zoom defines automatically a box car, used to filter in real-time the data selection.

- F-k Amplitude Spectrum

F-k spectrum enables real-time filtering (free-hand and dips) on frequency and wave number as shown on Figure 72.

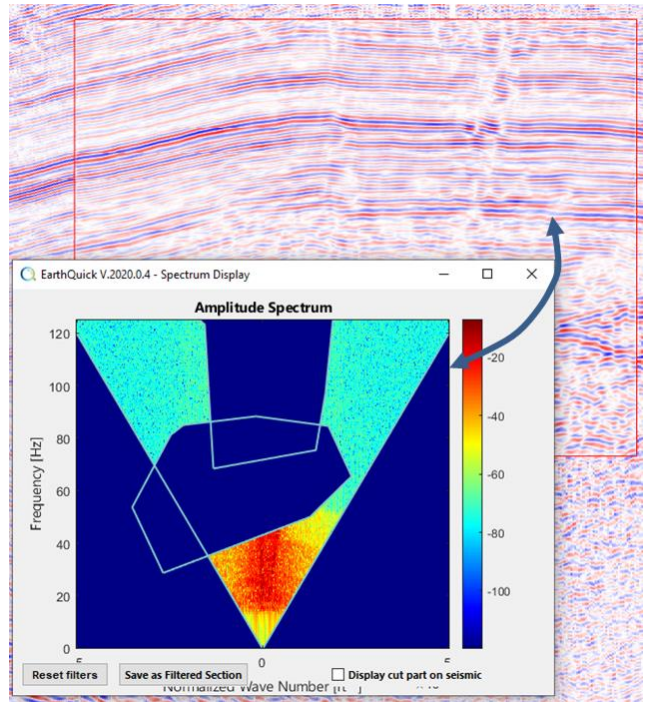


Figure 72: F-k Amplitude Spectrum.

Power Spectra facility is only available when domain is set on *Time*.

For both spectra, users could push *Save as Filtered Section* button to export current filtered section in an additional SEG-Y file. The newly generated section shall be automatically loaded in the current project and added under the Section leave of the Global Viewer folder tree.


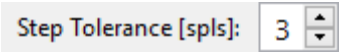

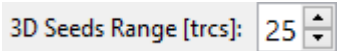
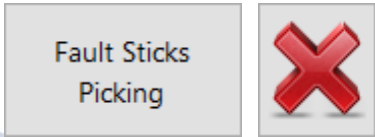




The checkbox *Display cut part on seismic* enables to retain only the cut part and to enable its real-time display on the seismic panel, both for Mean Power and F-k Amplitude Spectra.

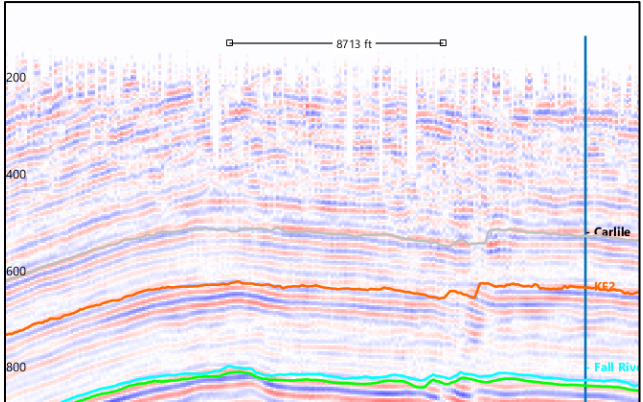
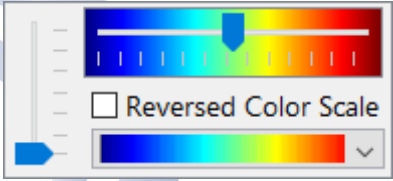
If *Grids Picking* is on, facilities for grids interpretation become enabled.

Grids interpretation facilities:

- Manual Picking (🖋️) for a freehand interpretation. MB1 to add interpretation dots and MB2 to stop interpreting.
- 2D Automatic Picking (🔍️) for an interpretation which follows extrema or zeros. MB1's to add dots, EarthQuick fill in between. MB2 to stop interpreting. 2D Automatic Picking is dependent on *Step Tolerance* criterion.
- 3D Automatic Picking (👣) for an interpretation which follows extrema or zeros. MB1 to add a seed, EarthQuick expands around. MB2 to stop interpreting. 3D Automatic Picking is dependent on *Step Tolerance*, *3D Quality Criterion* and *3D Seeds Range* criteria. Only possible with Volumes.
- Remove Picking (❌) to select interpretation with a lasso. MB1 must be pressed to begin tossing of the lasso. When MB1 is released, surrounded interpretation is highlighted. Then, if users press the *space bar* or *delete*



	keys, selected interpretation is removed. The tool works both on the Basemap and on the Sections panel.
	Grids interpretation facilities: Undo et Redo buttons to provide a 20-step backup. They are only enabled when applicable.
	Grids interpretation facilities: Control dedicated to 2D and 3D Automatic Picking facilities. The higher the value, the steeper could be the automatically interpreted surfaces. Value is given in samples.
	Grids interpretation facilities: Control dedicated to 3D Automatic Picking facilities. The higher the value, the more “demanding” is the propagation in terms of amplitudes continuity in the signal. Value is given in percentages.
	Grids interpretation facilities: Control dedicated to 3D Automatic Picking facilities. The higher the value, the wider could be the area of propagation. For a value of 25, users could expect a maximum square patch of interpretation on 51 by 51 nodes. Hence, the higher the value the more “demanding” is the propagation in terms of computation resources. Value is given in traces.
	If <i>Faults Picking</i> is on, facilities for faults interpretation become enabled. Faults interpretation facilities: <ul style="list-style-type: none"> • <i>Faults Sticks Picking</i> for a manual interpretation of fault sticks, made of dots. Triangulated fault planes are automatically recomputed for each additional fault dot. That is not the case for fault bounds. The fewer the number of dots per stick, the more pertinent the fault plane triangulation. • Remove Picking () to select interpretation with a lasso. MB1 must be pressed to begin tossing of the lasso. When MB1 is released, surrounded interpretation is highlighted. Then, if users press the <i>space bar</i> or <i>delete</i> keys, selected interpretation is removed. The tool works both on the Basemap and on the Sections panel.
	If <i>Handsfree drawing</i> is on, facilities for handsfree drawing become enabled. Handsfree drawing facilities: <ul style="list-style-type: none"> • The color chooser () enables to change color of all drawings all at once. Handsfree drawings are stored in EQ projects such that color is actually not saved. Then, color rendering only depends on that particular control. • Activation of Handsfree drawing () enables to make drawings on Sections panel without any shapes restrictions. MB1 must be pressed to

	<p>begin a drawing and MB2 must be pressed to finish the latter. A new drawing could then be added by iterating the process. There is no limit of drawings on a single section.</p> <ul style="list-style-type: none"> Remove drawing (✖) to select handsfree drawings with a lasso. MB1's must be pressed to begin tossing of the lasso. When MB1 is released, surrounded nodes of the drawings are highlighted. Then, if users press the <i>space bar</i> or <i>delete</i> keys, selected nodes are removed. The tool works on the Sections panel only.
<input type="button" value="Flip Section"/>	Flips horizontally a section on the Sections panel to help with geographic representation of data.
<input type="button" value="Data Movie"/>	Same as <i>Data Movie Maker...</i> described in Chapter 5.3.3.
Well Projection Limit: <input type="text" value="100"/>	<p>Sets a limit of tolerated offset between well location and its orthogonal projection on the section to display wells on Sections panel.</p> <p>Units of limit depend on what have been chosen in the Launcher settings: meters for metric system and feet for Imperial system.</p>
<input type="checkbox"/> Scales Display	<p>Gathering of an automatically tuned vertical scale and an adjustable horizontal scale, overlapped onto the Sections panel, as shown on Figure 73.</p>  <p><i>Figure 73: Illustration of scales on Sections panel.</i></p>
	<p>A gathering of components to manage sections color scale on the Sections panel.</p> <ul style="list-style-type: none"> Vertical slider controls compression of the color scale. Horizontal slider controls translation of the color scale. Translating the color scale may have an effect on the compression. The combobox lets users choose between 5 different color scales: <ul style="list-style-type: none"> Blue-White-Red (). Very common for signals centered on zero. Black & White (). To get closer to wiggles display with a color scale. Commonly used for some attributes and simply to rest the eyes. Jet (). Very common to display impedance inversion by-products. Black-Red-Yellow-White (). Pleasant to display amplitude values of amplitude-related attributes. HSV (). Circular color scale and very common to display angular values, especially the azimuth attribute. Every color scale could be reversed by ticking on the checkbox <i>Reversed Color Scale</i>.



- 11) Start the GV, preferring automatic screening of data to define grids layout. Bin size is 110 ft.
- 12) Import 2 TWT grids of your choice from the *Original Data Folder*. Perform gridding, smoothing and attributes extractions.
- 13) Assuming a constant velocity between the project SRD and a time grid, convert the latter to depth.
- 14) What about misties between different seismic sets?
- 15) Create new wells:
 - 1. Name: 48-X-28, X = 795788.4 ft (242556.3 m), Y = 966905.1 ft (294712.7 m), KB = -386 ft, TD = 5768 ft.
 - 2. Name: 25-1-X-14, X = 804965.5 ft (245353.5 m), Y = 948057.8 ft (288968 m), KB = -275 ft, TD = 5962 ft.
 - Measure the distance in between.
- 16) Load T/D laws and deviations on that well.
- 17) Display the well on the Sections panel and start reporting with embedded tools.
- 18) Deal with the file *NPR3_FieldBoundary.txt* to get the permit limits and make observations in the GV. Try to avoid use of GeoPosit. Keep reporting with well-chosen background and try share with a third party.

5.4 3D Viewer

3D viewer enables 3D rendering with Volumes. That includes display of wells (paths, logs, lithostratigraphic facies, stratigraphic markers), grids as either scatter plots or triangulated surfaces (including amplitude extraction draping facility), Images projected on triangulated grids and faults planes.

Examples of the 3D Viewer in use are shown in Figure 74 and Figure 75.

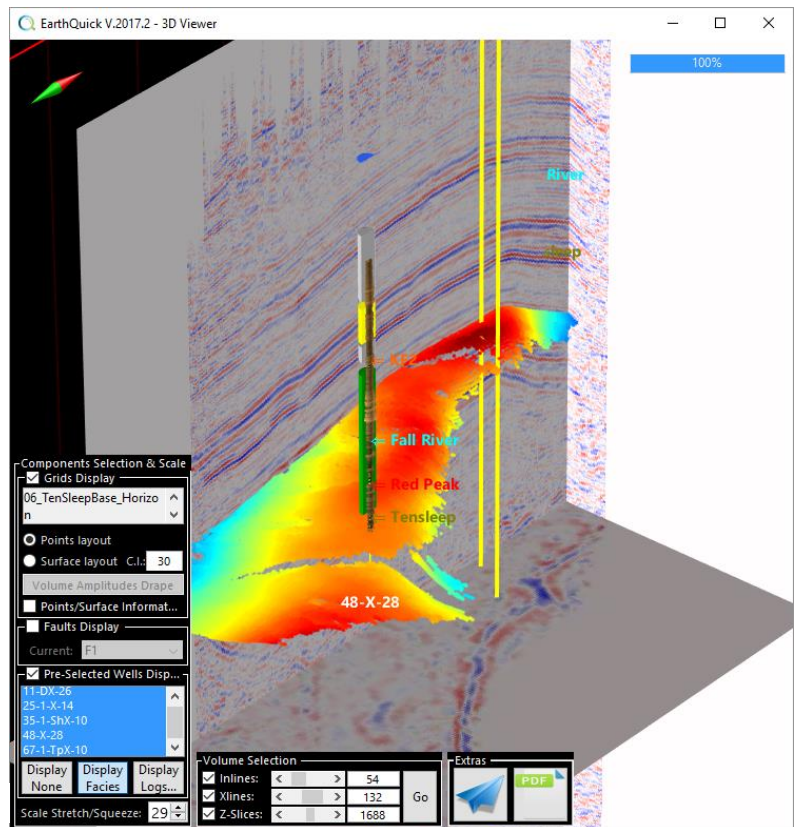


Figure 74: 3D Viewer – Well data.

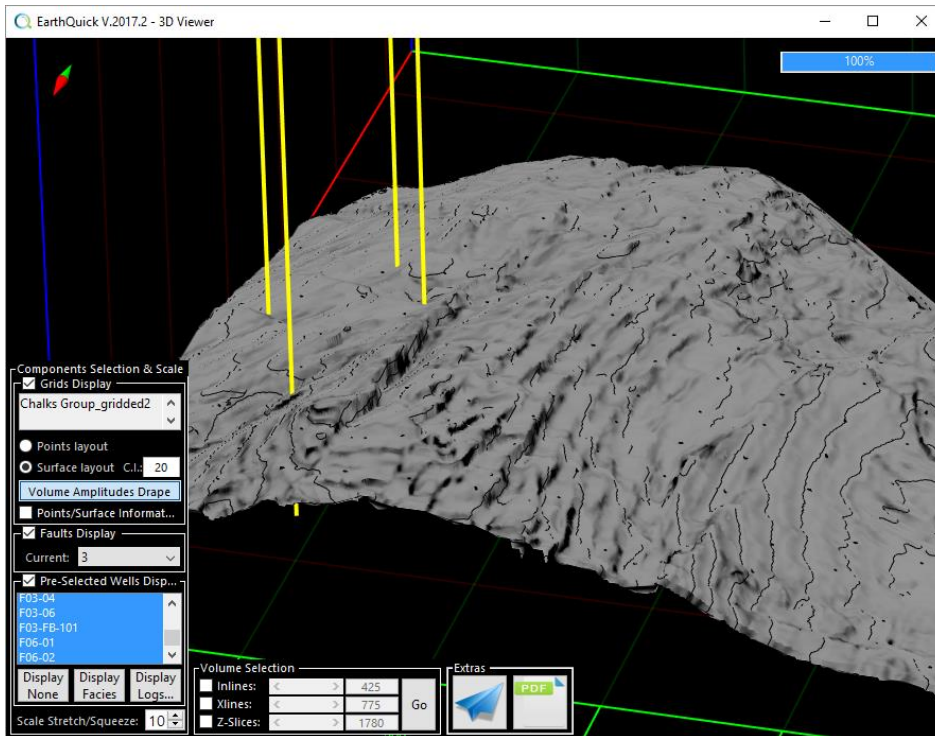



Figure 75: 3D Viewer – Amplitude extraction.

5.4.1 Basic rules to operate the 3D Viewer

That tool is to be launched from the Volumes data subpanel management in the accordion tree (), pushing the *3DView* button. A connection is then active between the GV main frame and 3D Viewer so that selection data is the same on both sides with some restrictions:

- MB1 + grab to rotate the volume, MB2 + grab to pan the Volume, Mouse Wheel to zoom in/out.
- Aspect ratio could be changed using *Scale Stretch/squeeze* spinner.
- When *Local Information* is ticked on, users could click on grids to get exact elevations, facies to get complete names, local exact log values (see Figure 76).
- Only one grid at a time could be displayed in the 3D Viewer corresponding to the one actually selected for interpretation in the main frame.
- A certain number of functionalities are deactivated when 3D Viewer is on. Trying to force them shall end up to the error message in Figure 77.
- When displaying logs along wells paths, width and colors of discs corresponds to logs values, globally normalized.

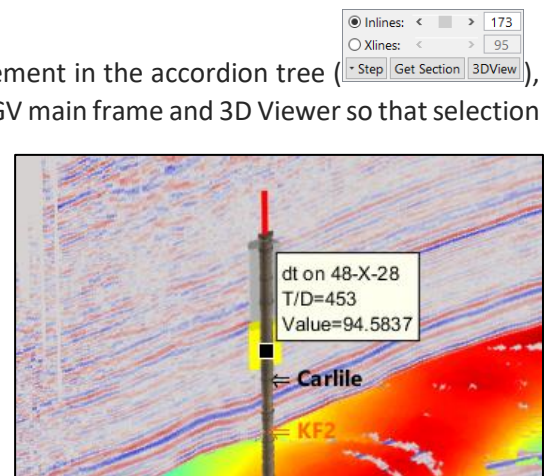


Figure 76: Extraction of local information.

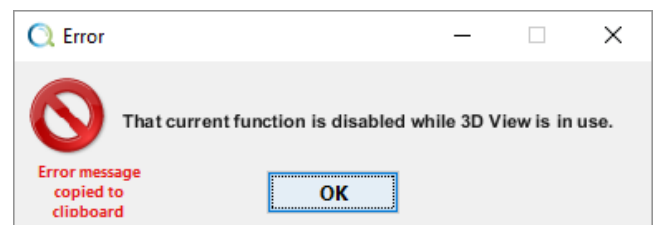


Figure 77: 3D Viewer error message.

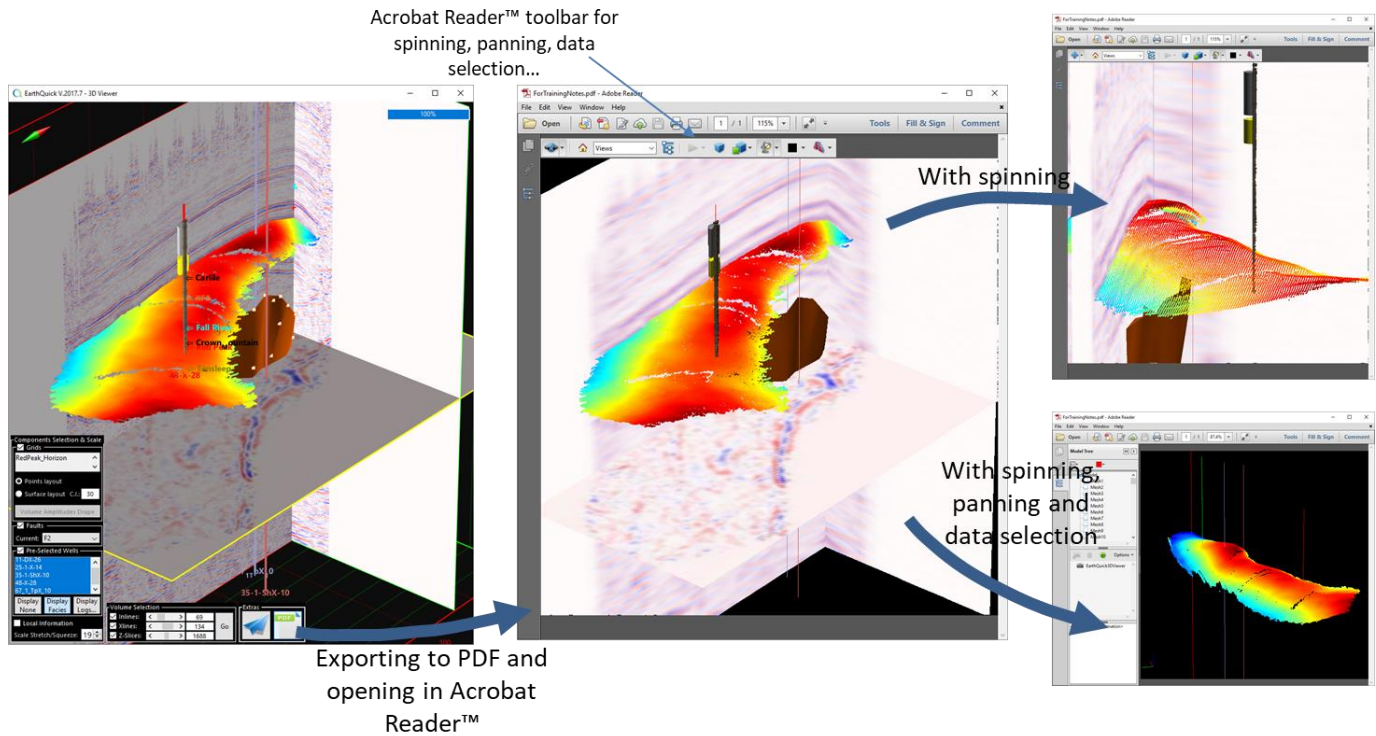


Figure 78: Common 3DPDF export workflow.

5.4.2 Complementary information

- If the complementary loop to optimize data rendering has been performed (see Figure 38), adding to the ability to get time/depth slices, users could click MB1 on inlines, Xlines or time/depth sections and then scroll & display sections on-the-fly (see Chapter 14 for shortcuts table). It is reminded performing that computation for Volumes above 3 GB is not recommended.
- The pushbutton with the paper plane enables permanent spinning of the Volume.
- Exports in 3DPDF format are also available (see Figure 78). These features could be opened with Acrobat Reader™ and spun, panned and recomposed in terms of items selection. All exports are added to the Metadata folder and their reduced size is in favor of sending them by email.



19) Make observations while interpreting on a new grid with the 3D Viewer launched.

6 Wells Board

The Wells Board enables geoscientists to QC, visualize and interpret well data the easy way. The user friendliness combined with a wide scope of compliance makes it a key element of the EarthQuick package.

Some key characteristics are quoted below.

I/O:

- Logs in ASCII, LAS 2.0 and LAS 3.0,
- T/D laws and deviations.

Functionalities:

- Arithmetic computations and statistics on logs,
- Filtering (despiking, interpolation, resampling, median/mean, blocking, cut offs application, bandwidth, ...),
- Log editing in tables,
- Log ghosting for overlapping,
- Stratigraphic/geological markers correlation,
- X-plots display with interactive dots selection,
- Reporting in Power Point™ on the fly,
- Seismic grids projection.

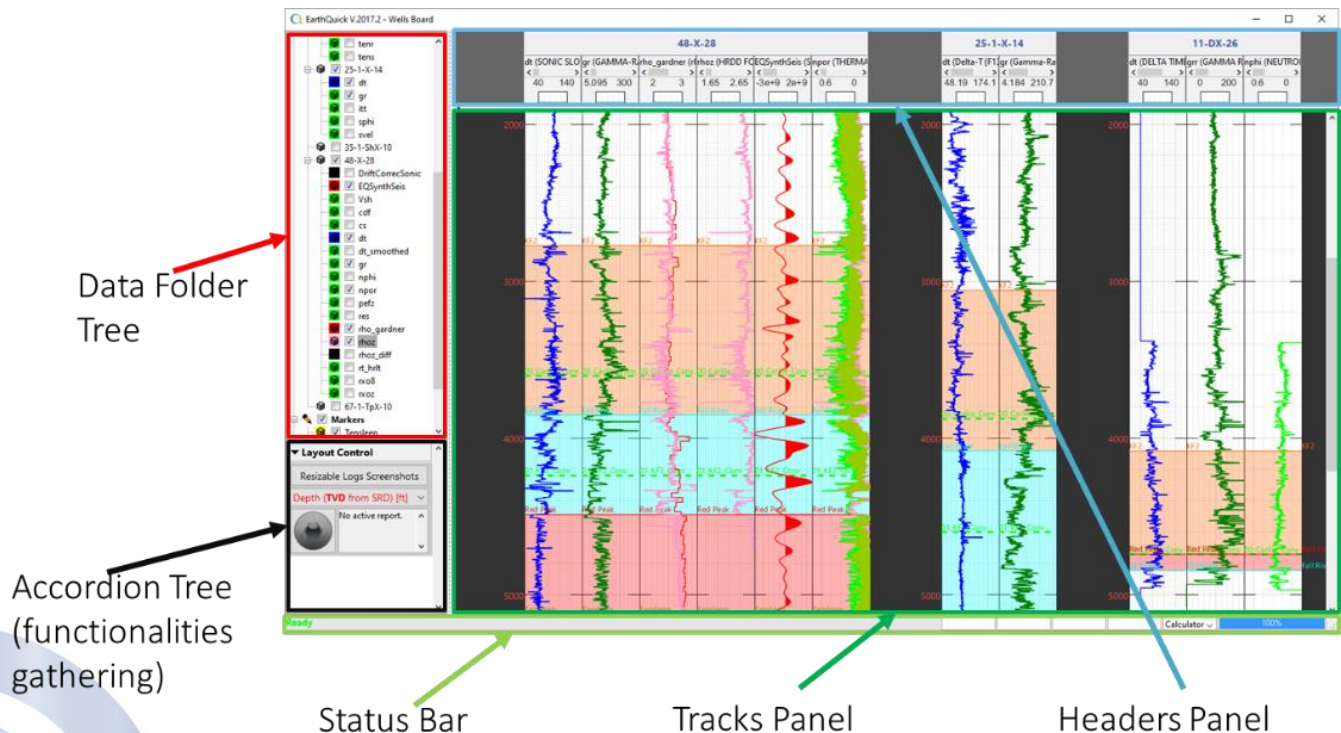


Figure 79: The Wells Board layout.

6.1 Starting with the Wells Board

Figure 79 shows figure layout organization, namely:

- **Headers Panel:** provides a view on wells names, logs names and scales.
- **Tracks Panel:** provides a view of log plots, including markers, facies, grids and color filling.
- **Data Folder Tree:** enables selection and handling of data, sorted in 4 different folders (i.e. Wells, Markers, Grids, and Metadata).
- **Accordion Tree:** gathers functions to display and interpret data.

- **Status Bar:** gives information about mouse pointer when rolling over Tracks Panel (X, Y, Z, Amplitude value), status (processing or idle) and provides a calculator for simple arithmetic computations.



In *Data Folder Trees* of GV and WB, color codes of items are the same: **Red** for Depth, **Green** for Time and **Black** for Undefined.

6.2 Data Folder Tree

Data Folder Tree stands as a data selection centralization within the Wells Board. Additionally, that enables a bunch of computations.



If users are eager to change names of data items, except for grids, that must be done off the shelf, directly in Windows™ File Explorer. The database has been built transparent to achieve that purpose. Again, Wells Board must remain closed during that operation.

6.2.1 The root item and 1st-rank-leaf items

The root item shows the project name and allow some functionalities by right-clicking on the latter (see Figure 80).

All 1st-rank leaves correspond to folders in project DB where data is stored.

They all could be selected for display, except *Metadata*. Selection could have 2 different states: unselected (corresponding to ☐) meaning no data in the folder is selected and selected (corresponding to ☒) meaning data in the folder is selected.

When right-clicking on these items, a bunch of options and functionalities are offered, as shown on Figure 80.

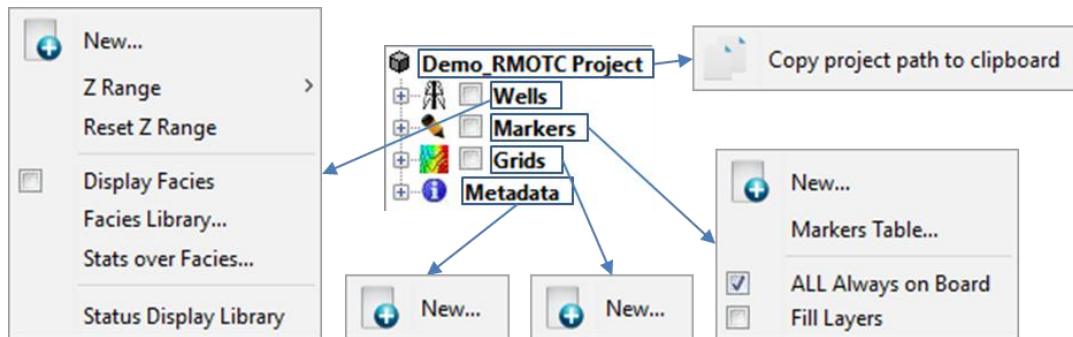


Figure 80: Right-clicking on the Data Folder Tree 1st-rank leaves.

Below are explanations of possibilities shown by Figure 80. Prefix corresponds to the item and suffix to the functionality/option denomination in the menus:

[Name of the project] Project / Copy project path to clipboard

Simply copy location path of the current project to the clipboard. Pasting with a simple Ctrl-V in the Windows™ File Explorer shall let users recover project physical location.

Wells / New...

Enables to create a new empty well. Users have just to provide a new name.

Wells / Z Range

Enables to reconsider the global scale of observation for all tracks of logs and every well.

Wells / Reset Z Range

Enables to reset a global scale of observation for all logs tracks of every well. EarthQuick screen all logs of every well and new range correspond to an all-inclusive boundary.

Wells / Display Facies

If ticked on, selected and available lithostratigraphic facies are drawn along wells trajectories on Tracks Panel when applicable.

Wells / Facies Library...

Enables to define a library of lithostratigraphic facies. At a project scale, each facies has a unique name, a color code and a display parameter (See Figure 81).

Display parameter enables to make a selection of shown and hidden items without inclusion of facies in the *Data Folder Tree*.

Facies are stored in *WellsFacies.csv* in the *Wells* folder of a project. More details could be found in Chapter 3 dedicated to EarthQuick database.

Wells / Stats over facies...

See chapter 6.5 below for explanations.

Wells / Status Display Library...

Enables to define a library of kinds for Wells with frame shown on Figure 82. Each kind is defined by a unique name, a color code and a shape.

Wells kinds are stored in *WellsKindsDisplay.csv* in the *Wells* folder of a project. More details could be found in Chapter 3 dedicated to EarthQuick database.

Markers / New...

Enables to create a new marker. Users have just to provide a new name.

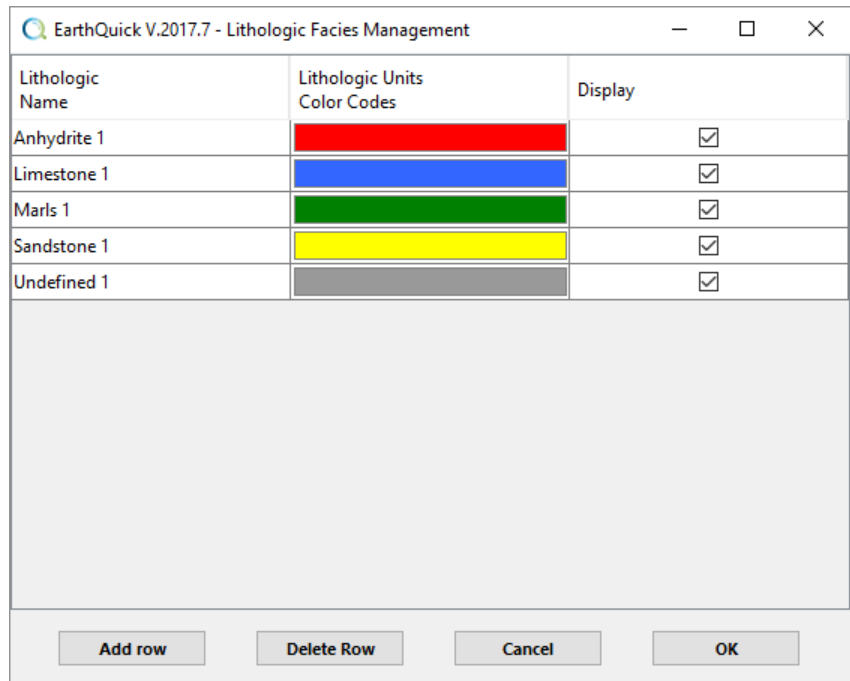


Figure 81: Lithostratigraphic facies Management frame.

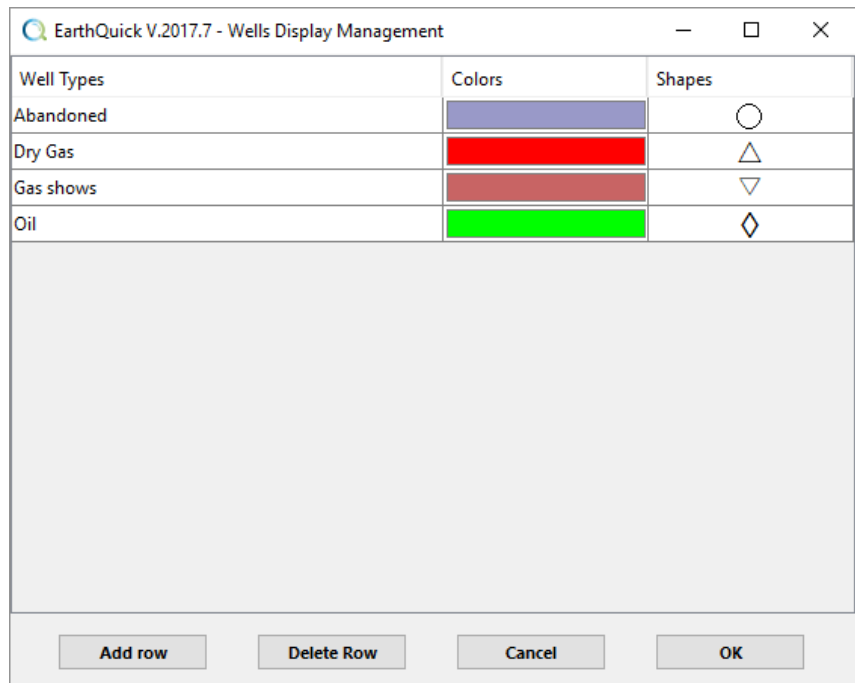
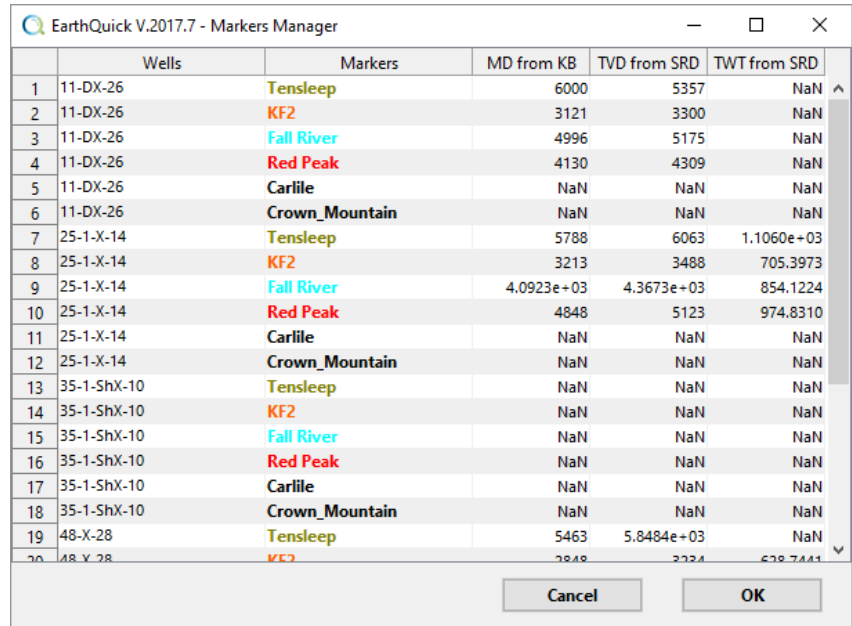


Figure 82: Wells Display Management frame.

Markers / Markers Table...

Figure 83 shows Markers Manager frame. Unlike the Global Viewer, the Wells Board offers the ability to edit the three last columns on the right-hand side.

MD and TVD are always editable. TWT is only editable when time-to-depth law exists on a well.



	Wells	Markers	MD from KB	TVD from SRD	TWT from SRD
1	11-DX-26	Tensleep	6000	5357	NaN
2	11-DX-26	KF2	3121	3300	NaN
3	11-DX-26	Fall River	4996	5175	NaN
4	11-DX-26	Red Peak	4130	4309	NaN
5	11-DX-26	Carlile	NaN	NaN	NaN
6	11-DX-26	Crown Mountain	NaN	NaN	NaN
7	25-1-X-14	Tensleep	5788	6063	1.1060e+03
8	25-1-X-14	KF2	3213	3488	705.3973
9	25-1-X-14	Fall River	4.0923e+03	4.3673e+03	854.1224
10	25-1-X-14	Red Peak	4848	5123	974.8310
11	25-1-X-14	Carlile	NaN	NaN	NaN
12	25-1-X-14	Crown Mountain	NaN	NaN	NaN
13	35-1-ShX-10	Tensleep	NaN	NaN	NaN
14	35-1-ShX-10	KF2	NaN	NaN	NaN
15	35-1-ShX-10	Fall River	NaN	NaN	NaN
16	35-1-ShX-10	Red Peak	NaN	NaN	NaN
17	35-1-ShX-10	Carlile	NaN	NaN	NaN
18	35-1-ShX-10	Crown Mountain	NaN	NaN	NaN
19	48-X-28	Tensleep	5463	5.8484e+03	NaN
20	48-X-28	KF2	2848	2324	638.7441

Figure 83: Markers Management frame.

Markers / ALL Always on Board

Enables to display multiple markers at once on Tracks panel.

Only 1 single Marker (the one which is actually selected) could be interactively moved on the tracks, by dragging that latter with the mouse.

Markers / Fill layers

If ticked on, Markers are highlighted by a color filling between 2 consecutive markers displayed on a track. Color corresponds to the top marker color.

A change on Markers selection automatically trigger an update on color filling.

Grids / New...

Enables to create a new empty grid, ready for visualization. Users have just to provide a new name.

Metadata / New...

Enables attachment of a file to the project, whatever the format. After attaching the file, it is physically copied in the Metadata folder of the project and add as a Metadata item of the folder tree. Double-clicking on the newly added folder tree item shall open the specified file in the Windows™ application associated with the extension of the file.

Users could also add any documents in the Metadata of the project, off the shelf. Wells Board must remain closed during that operation. And by no means, two different metadata files could share the same name.

6.2.2 2nd-rank leaves

The 2nd rank leaves are the direct “children” of the 1st-rank-leaf items in the *Data Folder Tree*.

They all could be selected for display, except Metadata items. Selection could have 3 different states: (corresponding to ☐) meaning data is not selected, partially selected (corresponding to ☐) meaning data is selected for display but not for interpretation; and selected (corresponding to ☒) meaning data is selected.

When right-clicking on these items a bunch of options and functionalities are offered, as shown on Figure 84.

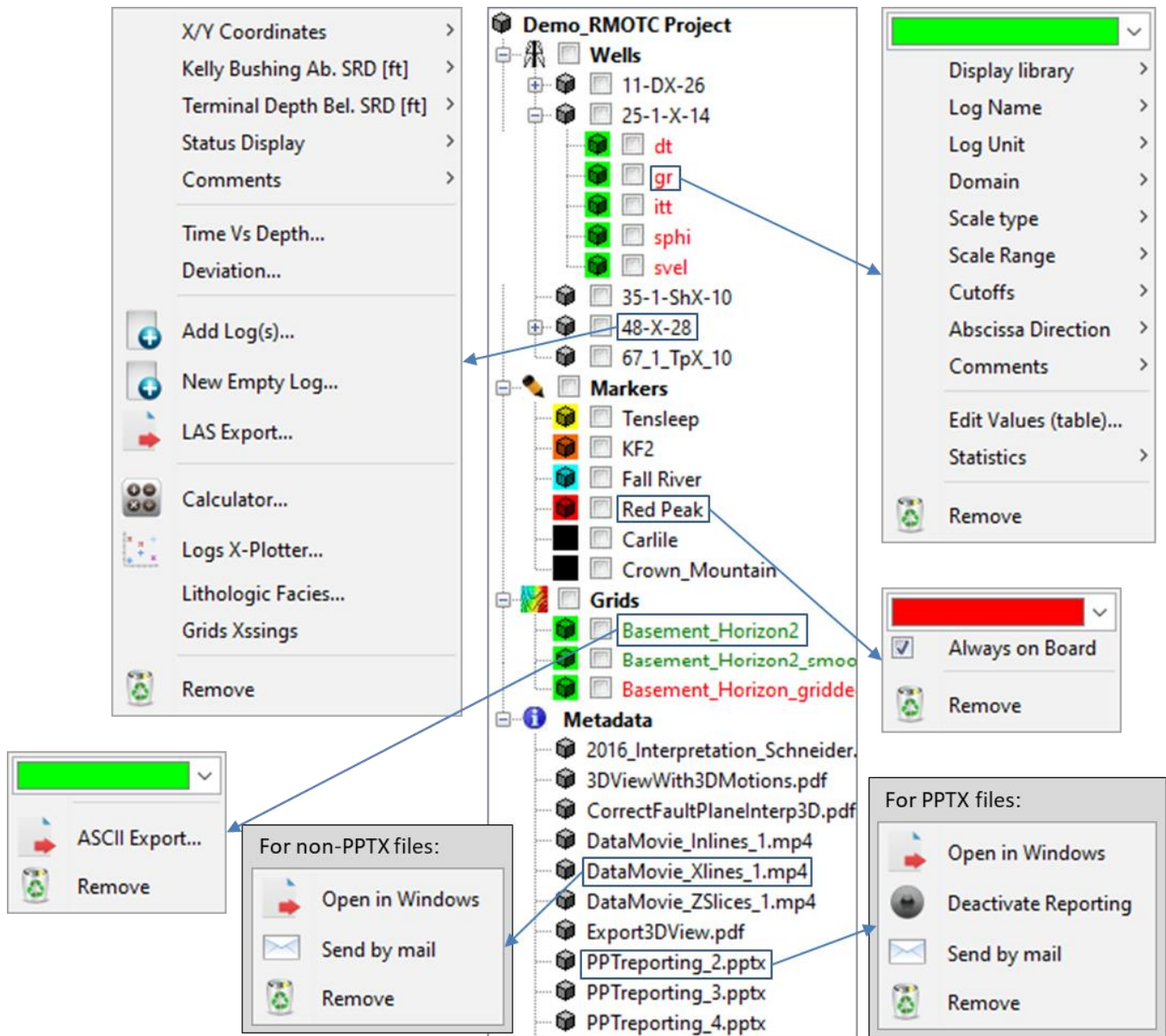


Figure 84: Right-clicking on the Data Folder Tree 2nd-rank leaves.

Below are explanations of possibilities shown by Figure 84. Prefix corresponds to the item's parent and suffix to the functionality/option denomination in the menus:

Wells / [Name of a well] / ...

Well logs options are defined below with Figure 89 and comments coming next.

Wells / X/Y Coordinates

Enables to modify Easting and Northing associated to a well head.

Changes are stored in *ProjectWells.csv*. More details could be found in Chapter 3 dedicated to EarthQuick database.

Wells / Kelly Bushing Ab.SRD

Enables to modify Kelly Bushing (KB) above the so-called Seismic Reference Datum (SRD), considered as the elevation reference (i.e. the zero value) shared between different sources of data in all projects. KB is the actual reference for Measured Depth (MD) measurements.

Sign of KB is positive if above the SRD, negative if below the SRD.

Changes are stored in *ProjectWells.csv*. More details could be found in Chapter 3 dedicated to EarthQuick database.

Wells / Terminal Depth Bel.SRD

Enables to modify Terminal Depth (TD) below the so-called Seismic Reference Datum (SRD), considered as the elevation reference (i.e. the zero value) shared between different sources of data in all projects. If TD value is unknown, a sufficiently arbitrary data is recommended.

Sign of TD is negative if above the SRD, positive if below the SRD.

Changes are stored in *ProjectWells.csv*. More details could be found in Chapter 3 dedicated to EarthQuick database.

Wells / Status Display

Enables to change display of wells, choosing among different kinds defined in the Status Display Library.

Changes are stored in *ProjectWells.csv*, 6th column. They only affect the wells display on the basemap of the Global Viewer.

Wells / Comments

Enables to add comments on a well.

Changes are stored in *ProjectWells.csv*, 7th and last column. Some special characters are not allowed and shall be automatically replaced by blanks if typed by users.

Wells / Time Vs Depth...

Figure 61, in Chapter 5.2.2, illustrates how Time-to-Depth (T/D) laws at wells are handled in the Global Viewer when pushing *Time Vs Depth...*

ASCII file loading process is compliant with ASCII file made of 2 columns, 1 for True Vertical Depth (TVD) from either the Kelly Bushing (KB) or the Seismic Reference Datum (SRD), 1 for Two-Way Time (TWT) from the Seismic Reference Datum (SRD), and separated by standard delimiters.

Multiple laws may coexist for the same well, only one could be active (i.e. effectively in use), though.

Wells / Add Log(s)...

Enables import of logs from an ASCII file with automatic recognition of LAS format or logs mnemonics.

The workflow is detailed in Figure 85.

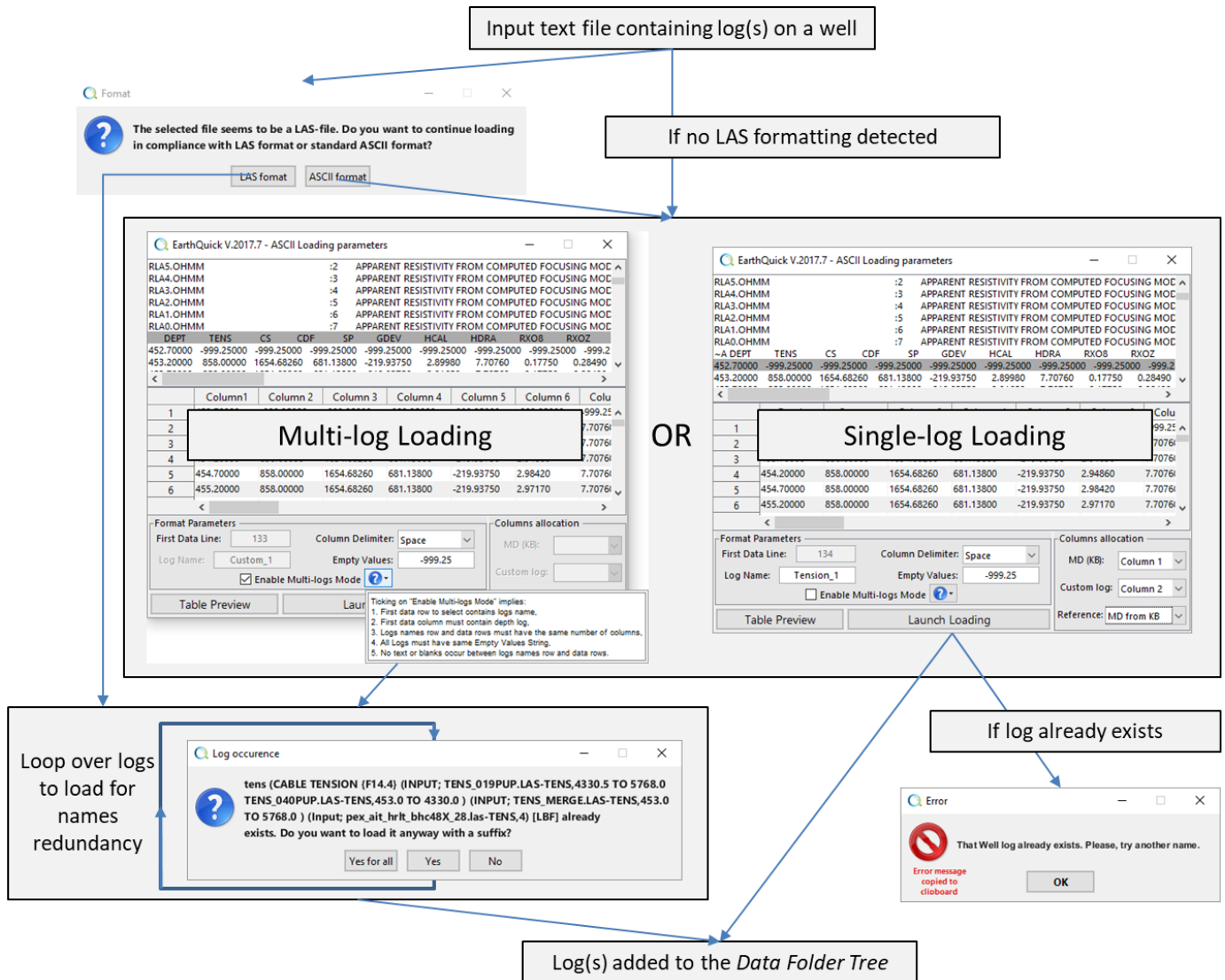


Figure 85: Log(s) import workflow.

Wells / New Empty Log...

Enables to create a new empty log. Users have just to provide a new name.

Use of Calculator often requires relying on that functionality.

Wells / LAS Export...

Export output is compliant with the LAS format and contains all logs of the well.

Wells / Calculator...

Alongside Matlab™ scripts, performs computations on logs, from simple arithmetic operations to iterative processes (see Figure 87 with a script example to estimate and filter logs).

Figure 86 shows calculator in use. Different components could be described as follows:

- Left upper part correspond to available logs, selectable as variables for computation,
- Right upper part lists selected grids for computations. Each row defines one variable, named V{i}.
- Mid part contains the operations, defining the script,
- Bottom part enables to perform operations contained in the script.

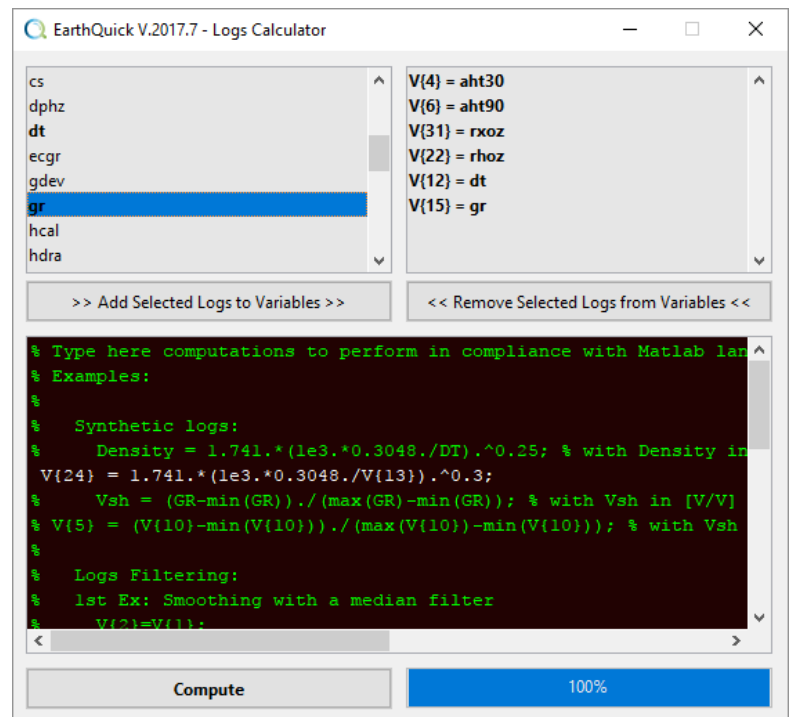


Figure 86: Logs calculator.

```
% Type here computations to perform in compliance with Matlab language syntax.
% Examples:

% Synthetic logs:
Density = 1.741.*(1e3.*0.3048./DT).^0.25; % with Density in [g/cm3] and DT in [us/ft] (Gardner's law)
Vsh = (GR-min(GR))./(max(GR)-min(GR)); % with Vsh in [V/V]

% Logs Filtering:
% 1st Ex: Smoothing with a median filter
V{$$+1}=V{$$};
TempVar4User{1} = 1;
for i = 3:length(V{$$})-2
    TempVar4User{1} = V{$$}(i-2:i+2);
    TempVar4User{2} = median(TempVar4User{1});
    V{$$+1}(i) = TempVar4User{2};
end
% 2nd Ex: 100 ft or m Blocking
TempVar4User{1} = 1;
TempVar4User{2} = 100; % to stand as the blocking window size.
while TempVar4User{1} < length(V{$$})
    if V_Zlogs{$$}(TempVar4User{1})+TempVar4User{2} <= V_Zlogs{$$}(end)
        % Find samples concerned by window span:
        Temp = find(V_Zlogs{$$} >= V_Zlogs{$$}(TempVar4User{1}) & V_Zlogs{$$} <
V_Zlogs{$$}(TempVar4User{1})+TempVar4User{2});
        V{$$}(Temp) = mean(V{$$}(Temp));
        TempVar4User{1} = 1+Temp(end);
    else
        break;
    end
end
end
```

Figure 87: Example of a script to estimate and filter logs. “\$\$” string must be replaced by genuine indices.

Wells / Logs X-Plotter...

See Chapter 6.4 below for explanations.

Wells / Lithologic facies...

On each well, users have the ability to define facies occurrence on depth ranges.

Predefined facies library constitutes a pool of facies at disposal of users for each well of a project. On Figure 88, each row of the table corresponds to a facies continuous occurrence. 1st column is made of drop-down menus (combo boxes) to let users pick some facies. 2nd column is directly linked to 1st column choice and therefore is not editable. Ranges are defined with tops and bases, corresponding to 3rd and 4th columns.

Wells / Grids Xssings (crossings)

Same function as for the Global Viewer.

Markers / Always on Board

Enable to display a marker on Tracks panel, when not selected/active for interpretation.

Grids / ASCII Export...

Export output is an ASCII file made of 3 columns (X, Y, Z) separated by tabulations.

Metadata / Open in Windows

Opens the specified file in the Microsoft™ Windows™ application associated with the extension of the file.

Metadata / Deactivate Reporting or Activate Reporting

Only for PPTX files. New slides with screenshots shall be appended in the *activated* PPTX file. If none is activated for reporting, EarthQuick shall create a new presentation.

If item name is in bold fonts in the *Data Folder Tree*, item is activated for reporting.

Metadata / Send by email

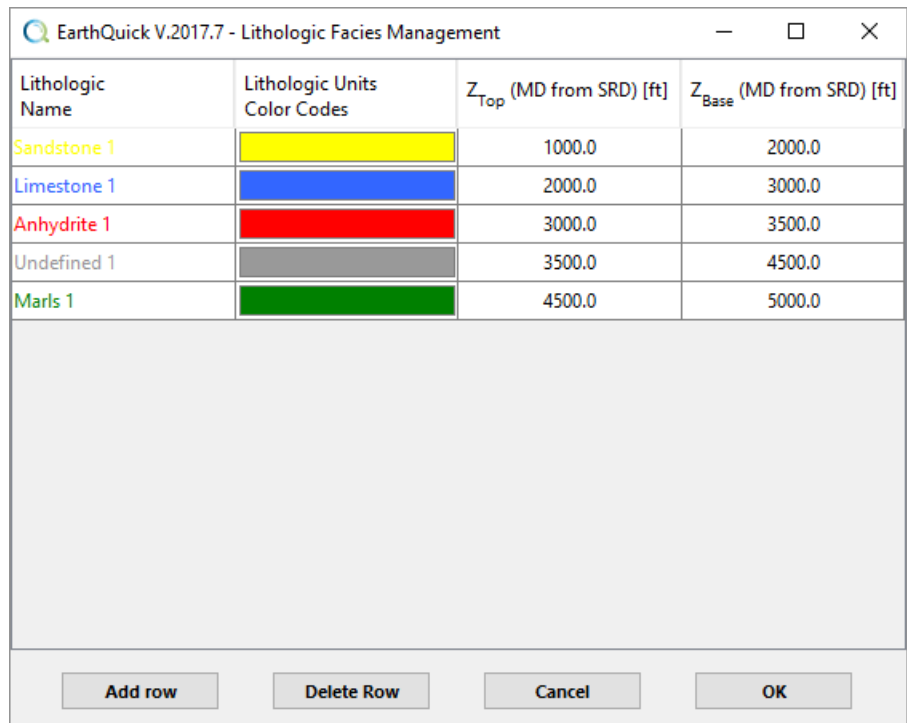
Sends by email as an attached file, regarding email settings from the Launcher (i.e. recipient(s), SMTP server, ...).

Message of the email is always as follows:

That email is sent from EarthQuick.

The attachment is extracted from the [Project Name] project.

Please, do not answer that email.



Lithologic Name	Lithologic Units Color Codes	Z _{Top} (MD from SRD) [ft]	Z _{Base} (MD from SRD) [ft]
Sandstone 1		1000.0	2000.0
Limestone 1		2000.0	3000.0
Anhydrite 1		3000.0	3500.0
Undefined 1		3500.0	4500.0
Marls 1		4500.0	5000.0

Figure 88: Lithostratigraphic facies definition on a well.



Depending on email servers, limit of attached files to emails is often between 10 MB and 20 MB. In case a presentation exceeds 15 slides, file size must be checked with the Windows File Explorer before sending.

6.2.3 3rd-rank leaves

The 3rd rank leaves exclusively correspond to well logs in the *Data Folder Tree*.

They all could be selected for display. Selection could have 2 different states: unselected (corresponding to ☐) meaning data is not selected and selected (corresponding to ☒) meaning data is selected for display.

When right-clicking on these items, a bunch of options and functionalities are offered, as shown on Figure 89, corresponding to an example of right-click on a resistivity log.

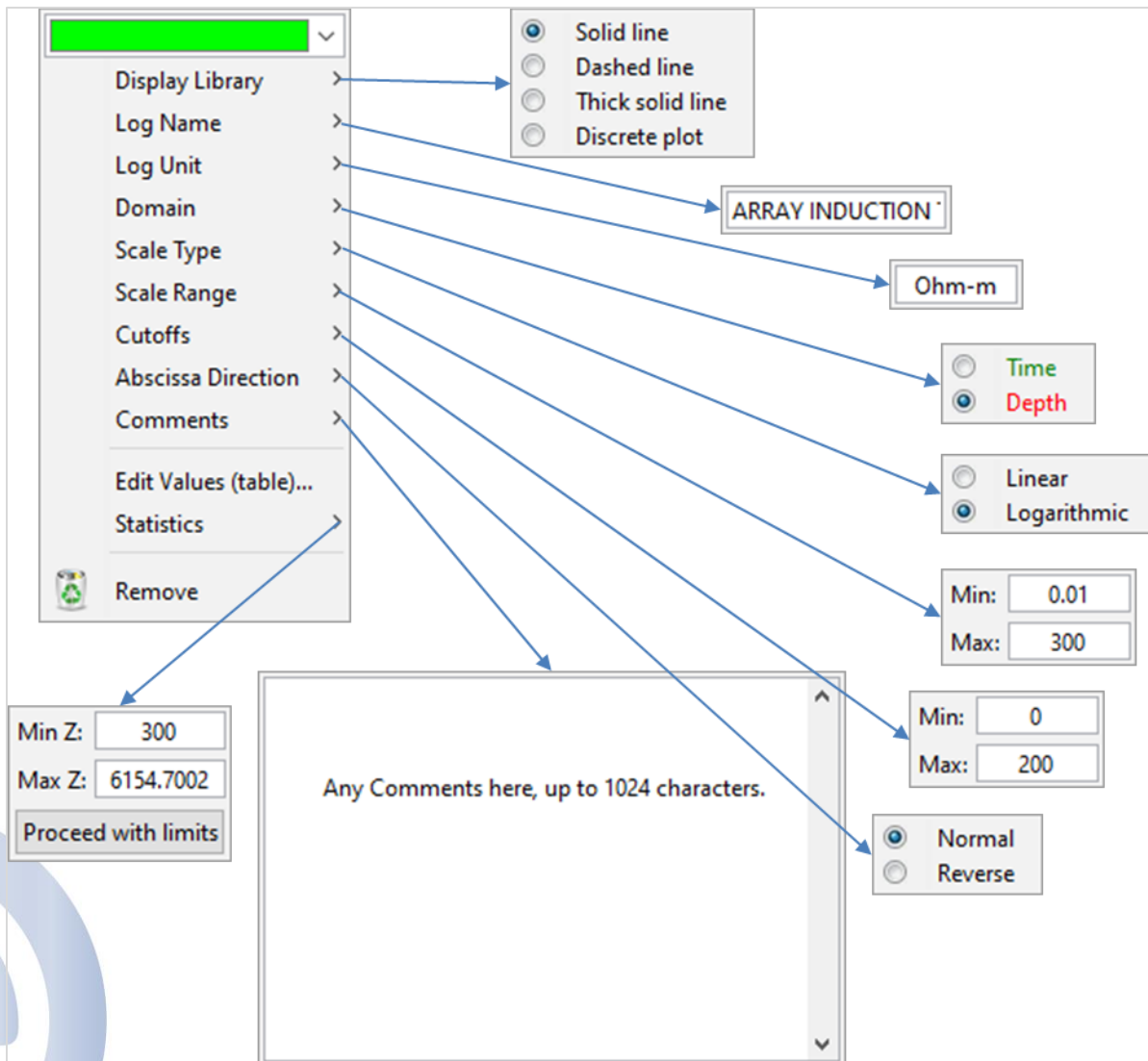


Figure 89: Logs parameters through menu items in Data Folder Tree.

Below are explanations of possibilities shown by Figure 89, sorted by order of appearance in the menus:

Display Library

Offers possibility to display curves on tracks with 4 different renderings.

Default values correspond to *Solid line*.

Log Name

Provides 256 characters to name a log. Strings beyond 256 characters are simply cut.

Default values correspond to *<empty string>*.

Log Unit

Provides 256 characters to define the log unit. Strings beyond 256 characters are simply cut.

Default values correspond to *<empty string>*.

Domain

2 domains are possible: Time (i.e. Two-way time) and Depth.

Default values correspond to *Depth*.

Scale Type

Corresponds to the horizontal axis and is applied to samples amplitudes.

Default values correspond to *Linear*.

Scale Range

Defines the horizontal axis limits. No effects on data.

Scale is only validated if users press the “return” key.

Default values correspond to samples amplitudes extrema.

Cutoffs

Defines extrema of samples values and has a reversible effect on them. Computations on cutoff logs pay attention to cutoffs definition.

Cutoffs are only validated if users press the “return” key.

Default values correspond to samples amplitudes extrema.

Abscissa Direction

Defines the horizontal axis direction. No effects on data.

Default values correspond to *Normal*.

Comments

Provides 1024 characters to make a free comment. Strings beyond 1024 characters are simply cut.

Default values correspond to *<empty string>*.

Edit Values (table)

Enables to display samples amplitudes, function of depth/time in an embedded table editor. Rows could be copied and pasted afterwards.

Statistics

After pushing on *Proceed with limits*, users have the possibility to investigate data distribution/statistics in a log, as shown on Figure 90.

See Chapter 6.5 below for statistics on several wells at once.

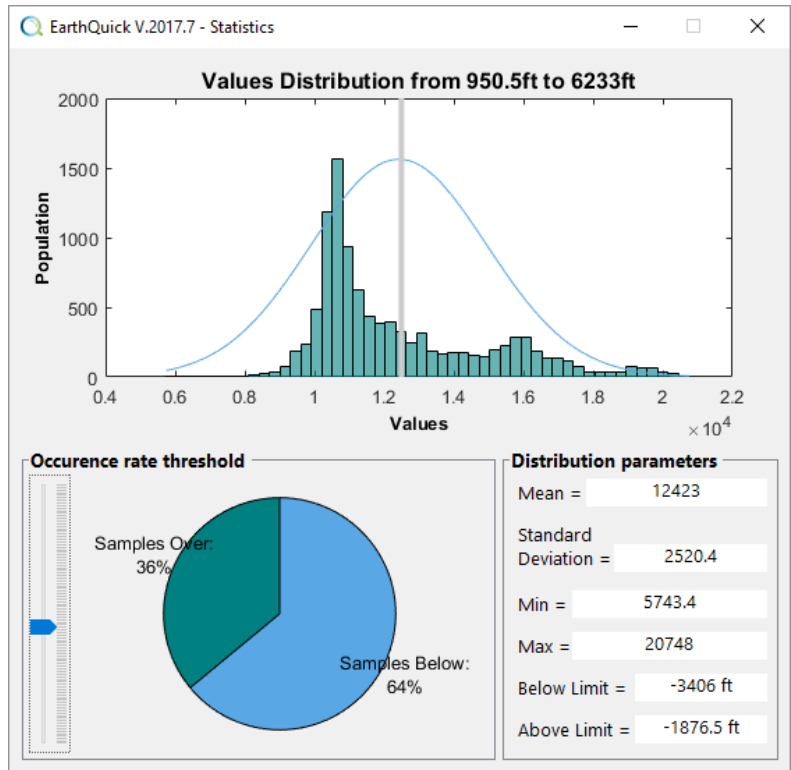


Figure 90: Statistics on a log.

6.3 Accordion Tree

Accordion tree hosts additional transversal functionalities.

The accordion is made of 1 panel: Layout Control, reviewed in what follows.

Resizable Logs Screenshots


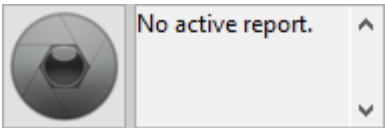
That tool is especially made to help with markers interpretation.

After clicking on a track, the latter is replicated and draggable on any other displayed tracks for comparison, by grabbing replication with the mouse.

Mouse wheel enables to stretch/squeeze the replication.

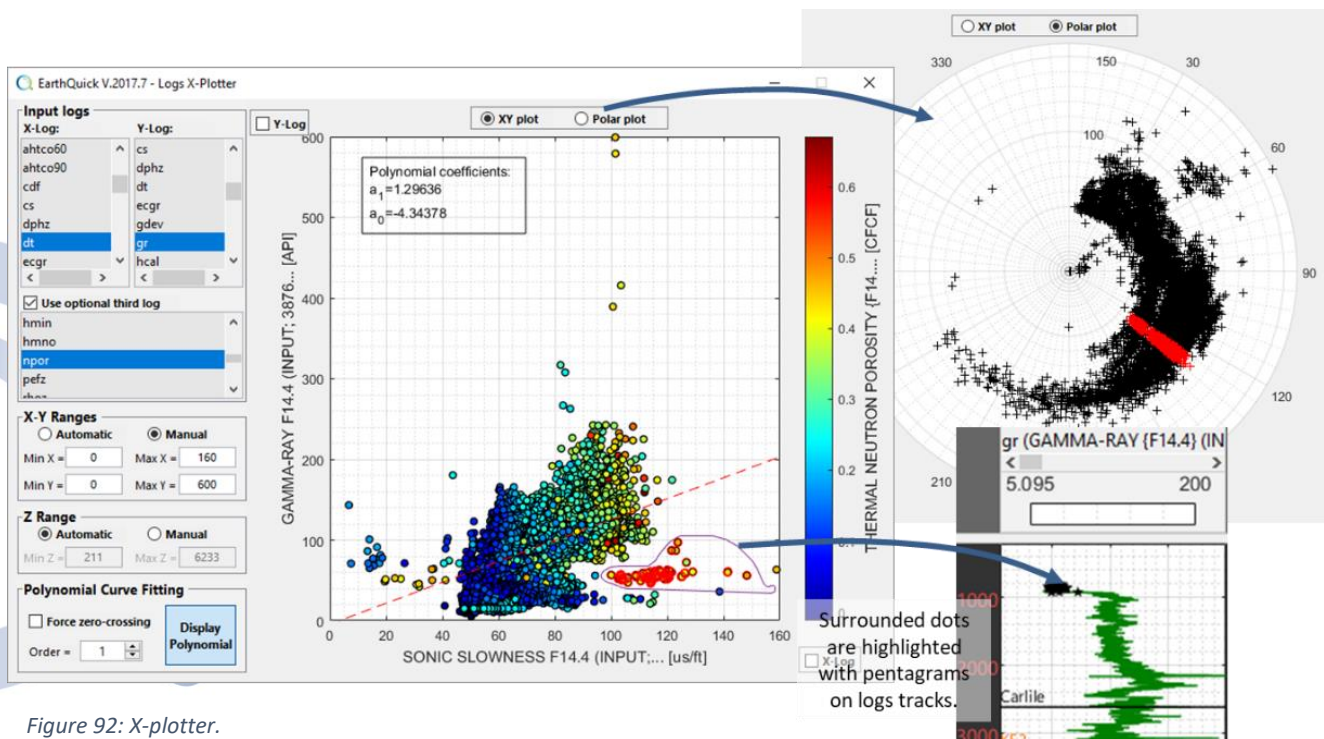
Ctrl + Mouse wheel enables to change transparency of the replication.

Figure 91: Resizable logs screenshots.

	<p>Data could be sorted in 3 different domains: Time, Depth and Undefined. However, the Wells Board only considers Time and Depth.</p> <p>Then, restrictions of display offer 3 choices:</p> <ul style="list-style-type: none"> • <i>Time (TWT from SRD)</i>: Two-Way Time from Seismic Reference Datum. Only wells with a T/D law could display their logs tracks in depth. • <i>Depth (TVD from SRD)</i>: True Vertical Depth from Seismic Reference Datum. Only wells with a T/D law could display their logs tracks in time. • <i>Depth (MD from SRD)</i>: Measured Depth from Seismic Reference Datum. Only wells with a T/D law could display their logs tracks in time. <p>A difference occurs between <i>TVD from SRD</i> and <i>MD from SRD</i> only for deviated wells.</p>
	<p>The Screenshot facility let users create reporting, enclosing EarthQuick frames into PowerPoint™ presentations by pushing the lens button or the F1 key.</p> <p>The text area on the right-hand side is not editable and gives screenshotting status information.</p> <ul style="list-style-type: none"> • Input parameters are: The slide name and the comments. • Output is located in the Metadata folder of the DB and in the <i>Data Folder Tree</i>. <p>Before screenshooting, background could be set lighter with the Ctrl-P shortcut (see Chapter 14 for shortcuts table).</p>

6.4 X-plotter

The X-plotter (to be pronounced “cross-plotter”) is a fair introduction tool to every reservoir characterization study.



The X-plotter allows:

- Crossplots involving 2 or 3 logs
- Filtering data in depth range
- Dots selection and corresponding log curve portions highlighted on Tracks panel.
- Polynomial regression (possibility to force zero-crossing)
- X-Y linear or logarithmic scales
- Polar plot

Figure 92 illustrates X-plotter abilities with a crossplot involving P-wave sonic Vs Gamma-ray Vs Neutron Porosity.

When right-clicking on selected dots (marked with red circles), users could also copy highlighted dots to clipboard to subsequently paste values in a table editor.

6.5 Multi-well statistics

Multi-well statistics performs average and standard deviation computations on intervals defined by lithostratigraphic (i.e. lithologic and/or stratigraphic) facies. To do so, users must select a list of wells and facies and a log. Naming of chosen log must be consistent from a well to another to allow “multi”-well approach.

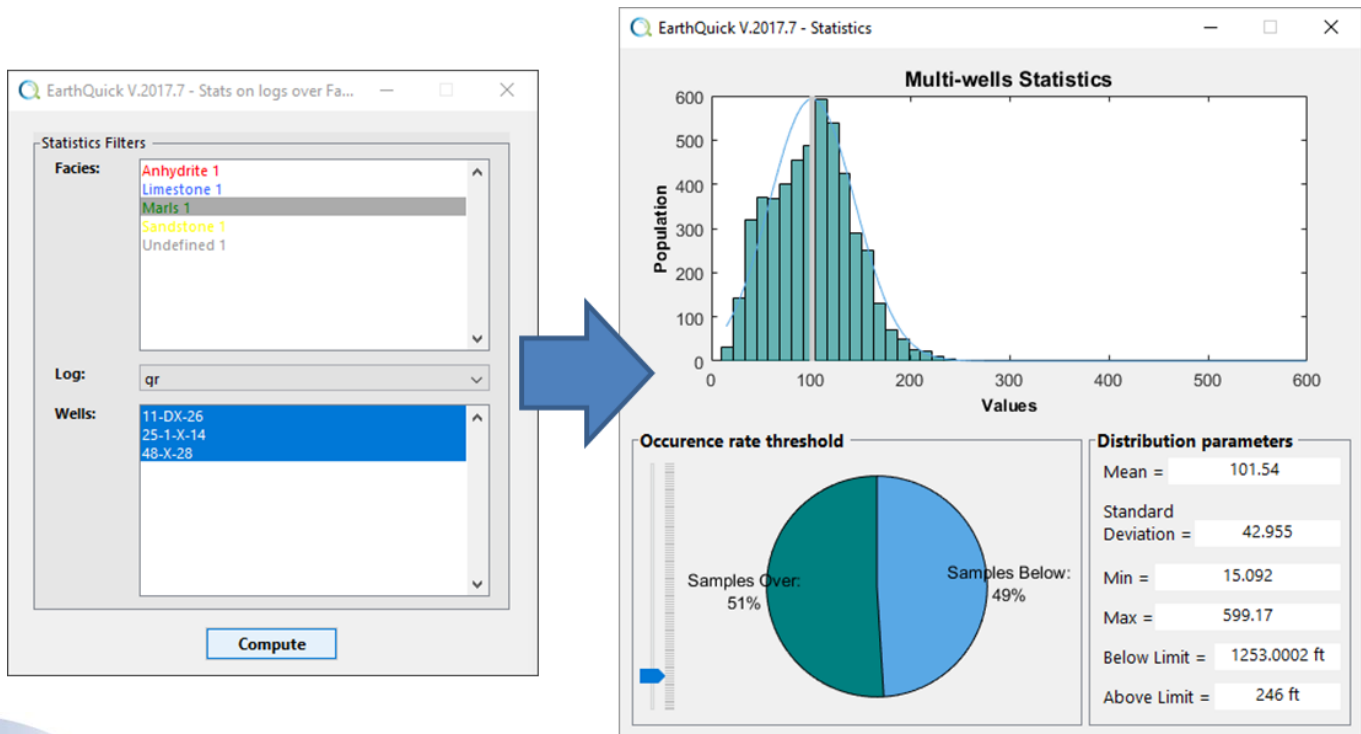


Figure 93: Multi-well statistics approach.

6.6 Color filling and copy/paste of log curves

Interpretation of well logs often requires ability to graphically combine logs and fill logs tracks with colors, linked to samples amplitudes. That chapter shows easy workflows to do so.

Figure 94 is a “living” example of what could be achieved with such functionalities. Here, up to HC bearing sand packages detection, corresponding to yellowish patches added on tracks.

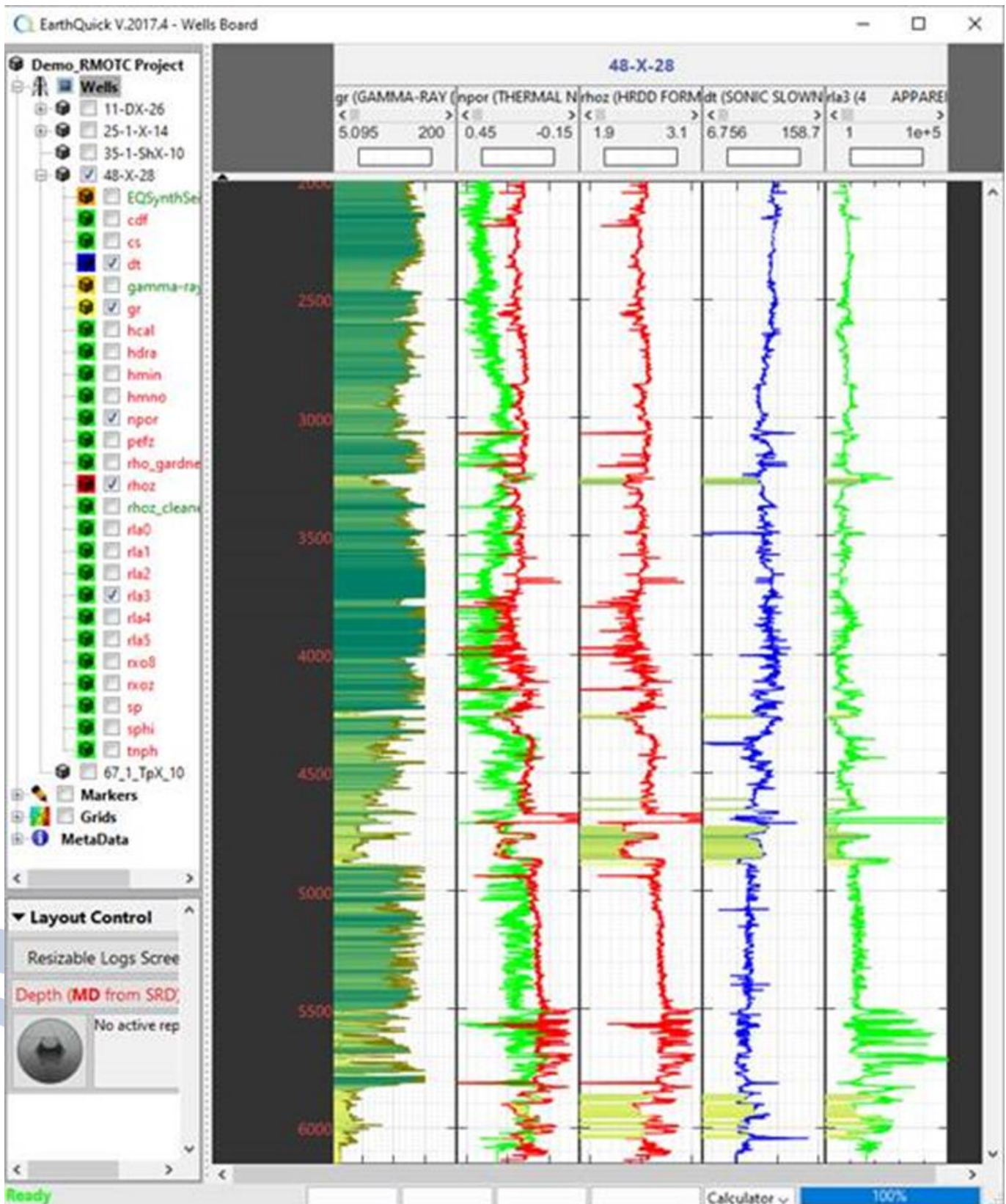


Figure 94: Example of well logs color filling.

6.6.1 Color filling – Unique color

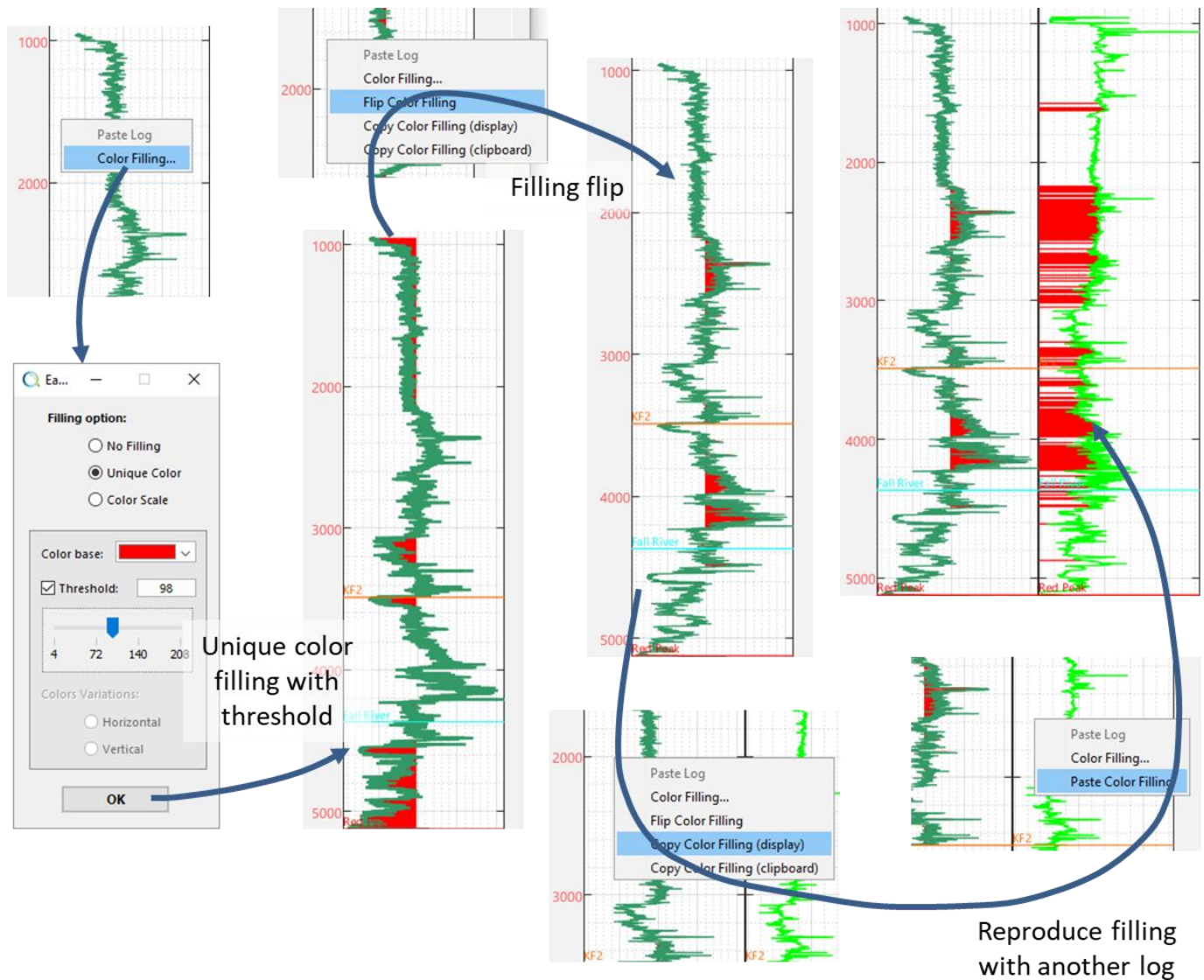


Figure 95: Color filling workflow - Unique color.

Color filling could also be copied to the clipboard (*Copy Color Filling (clipboard)* is a menu item when right-clicking on tracks). Subsequently, pasting clipboard into a table editor enables to export it (see Figure 96).

Figure 96: Pasting color filling in a table editor.

Z [m, ft or ms]	Patches width [log units]
6023	18.847801
6012.5	36.441597
6012.5	17.252304
6002	18.847801
6002	13.576599
5991.5	17.252304
5991.5	2.8034016
5991	13.576599

6.6.2 Color filling – Color scale

Figure 97 shows the equivalent of unique color filling workflow with a color scale.

The central part of the workflow, missing in Figure 97, could be retrieve from Figure 95.

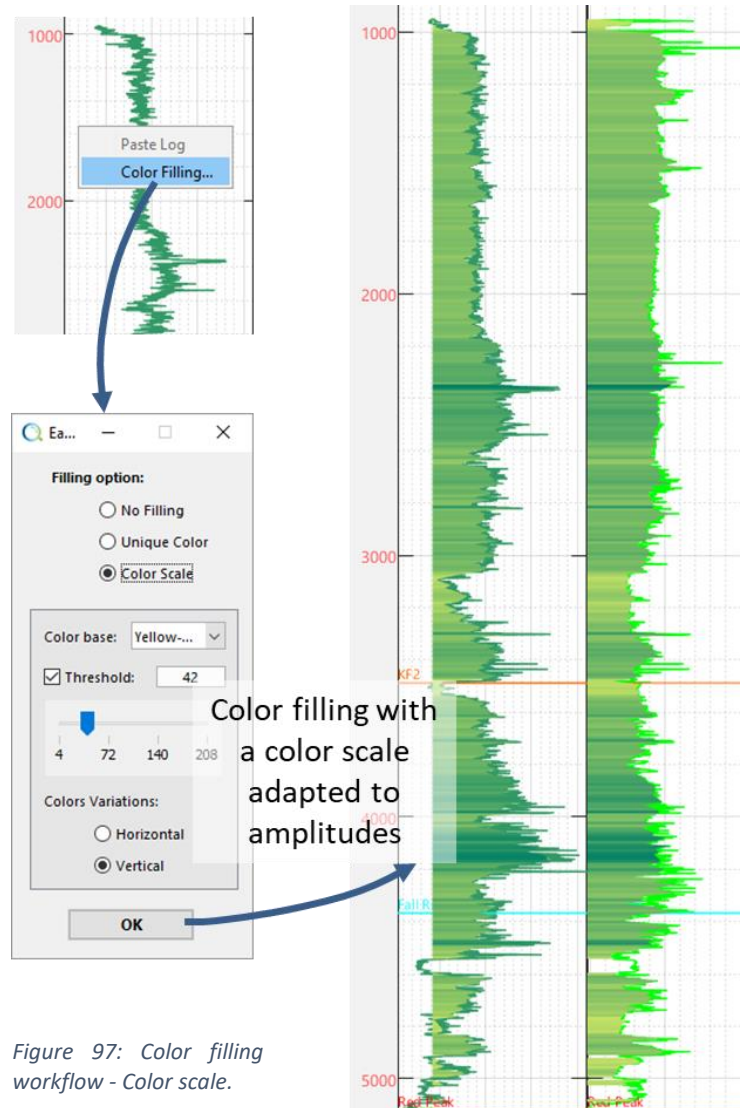


Figure 97: Color filling workflow - Color scale.

6.6.3 Copy/Paste curves on other tracks

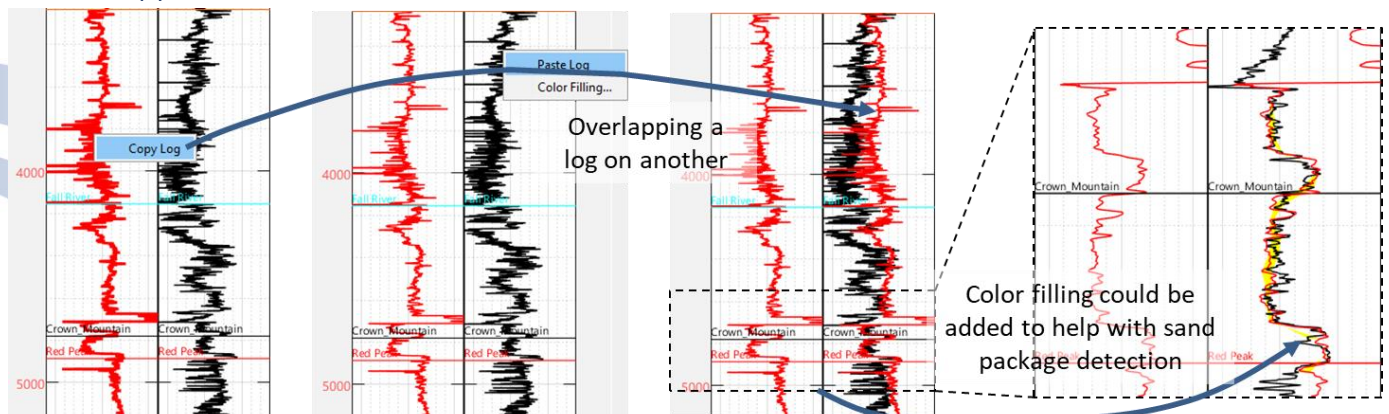


Figure 98: Copy/paste curves workflow.



- 20) QC the 48-X-28 well attributes (i.e. X, Y TD and KB) relying on documents at your disposal.
- 21) Import logs for 48-X-28.
- 22) With 48-X-28, observe X-plot between P-wave slowness and gamma-ray logs, eventually add the neutron porosity log as a colored component. Make observations about outliers on X-plot.
- 23) Restrain X-plot to Frontier end Wall Creek.
- 24) Compare 25-1-X-14 and 48-X-28. Any idea to locate KF2 stratigraphic marker onto 25-1-X-14 ?
- 25) Compute a synthetic density log from the sonic log with the Calculator. Compare synthetic and real data.
- 26) Merge calipers from resistivity and density measurements.
- 27) Assess distribution of gamma-ray values in the Crow Mountain formation. The multi-well statistics tool could help...



7 SyntheticsGen

SyntheticsGen is dedicated to operations which requires to yield some synthetic seismic data, for different purposes and through different workflows.

7.1 Seismic-to-well tie

Typical workflow (Figure 99) is always reminded when launching the Seismic-to-well tie module.

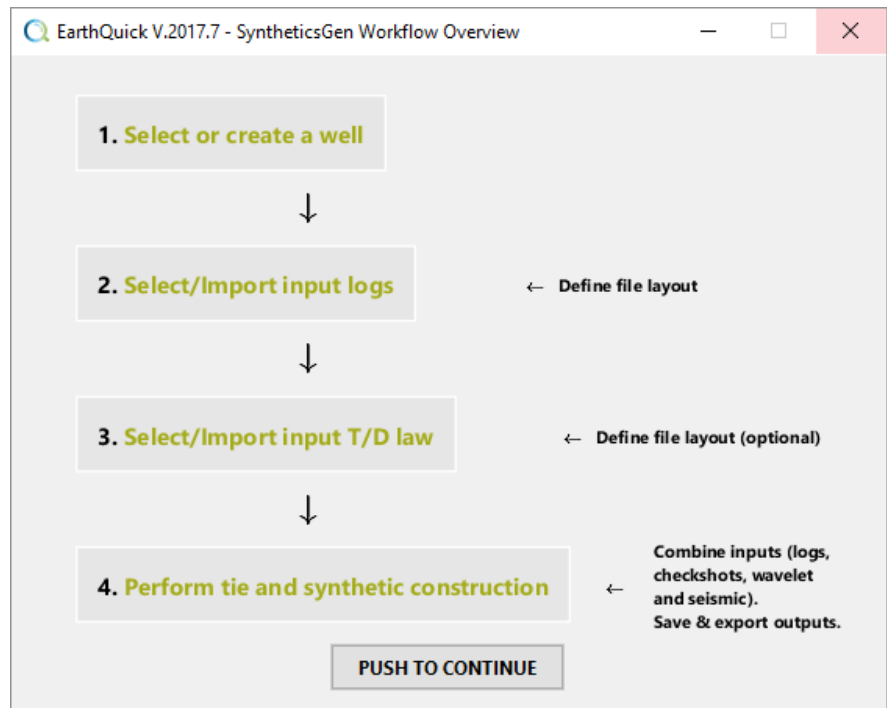


Figure 99: Seismic-to-well tie workflow.

7.1.1 Well Data selection

7.1.1.1 Sonic Log

Required for the workflow.

If pre-processing is required (e.g. despiking), that must be handled with the Wells Board calculator.

7.1.1.2 Density Log

Optional for the workflow.

If pre-processing is required (e.g. despiking), that must be handled with the Wells Board calculator.

7.1.1.3 T/D law or Checkshot/VSP

Could be missing in a well. If so, the seismic-to-well tie process shall be "lighter", without any drift correction, but with a likely need of bulk shift correction.

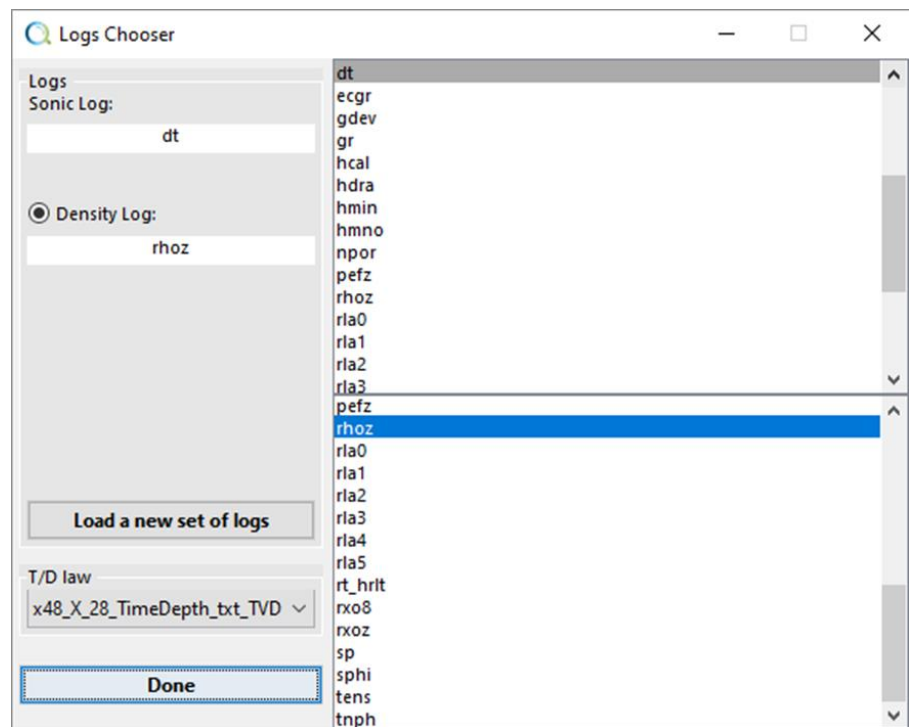


Figure 100: Input data chooser.



Users must be aware when integrating the sonic without Checkshot/VSP, bulk shift is likely to occur so as to compensate the lack of the constant of integration.

7.1.2 Drift Correction

After data selection, users enter main frame. Below is what users obtain by clicking on bottom left *Extend* button when *T/D Graphics* has been selected.

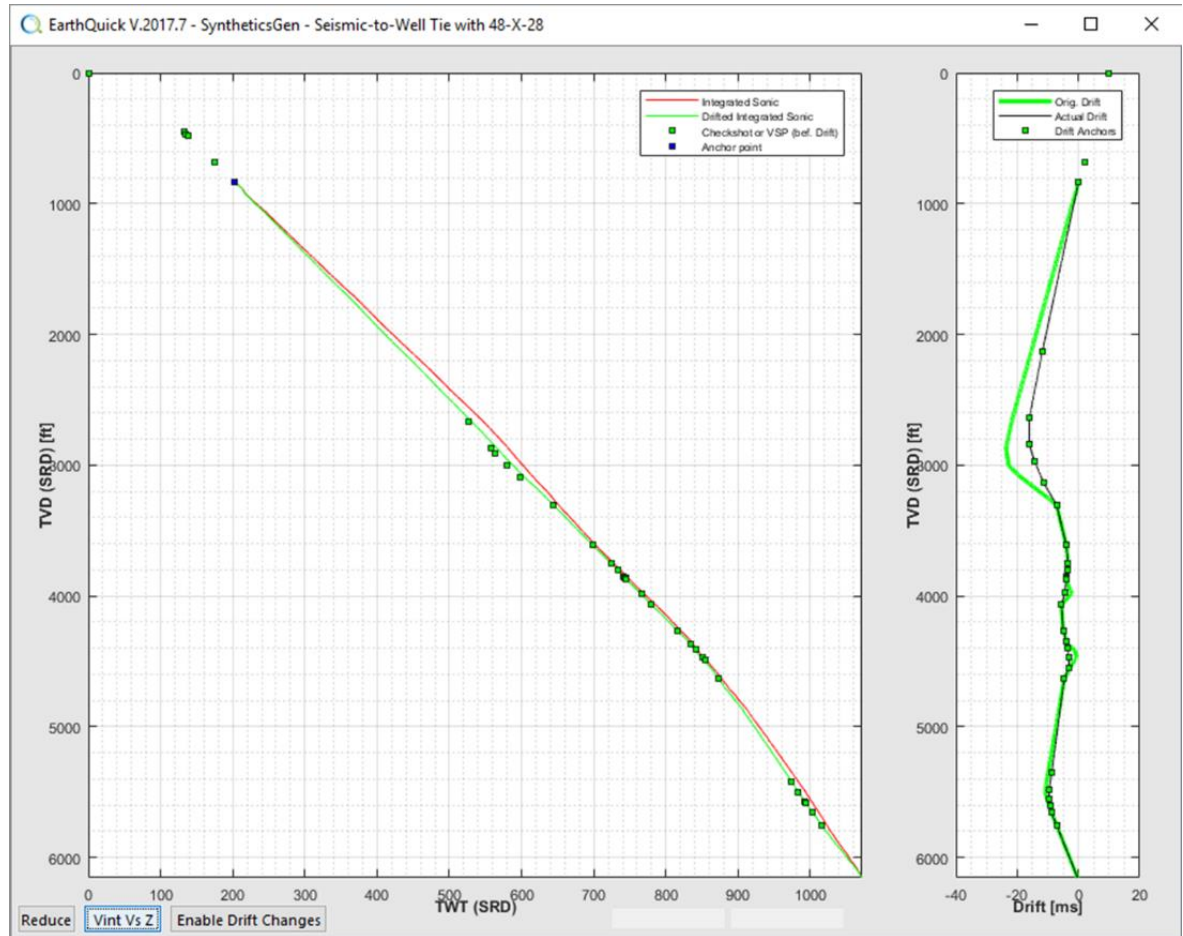


Figure 101: Depth Vs Time (Two-way time) and manually controlled drift correction.

7.1.2.1 Raw drift – automatically computed

If T/D law coming from a Checkshot or a VSP measurement has been added to the well, Sonic drift correction is automatically processed by default to make integrated sonic fit the T/D law (see Figure 101).

However, the process has an impact on Sonic values and subsequently on Reflectivity Coefficient values. Indeed, drift correction change the final T/D law, gathering pros from sonic and Checkshot/VSP. That final T/D law is derived to build the *Drift Corr. Sonic*, in its turn, derived to build the reflectivity log.

7.1.2.2 Manual control of the drift correction

By clicking on the *Enable Drift Changes* toggle button, users may control the drift correction by moving drift anchors (green squares) in the right-hand side panel (see Figure 101).



It is also recommended to activate Depth Vs Vint in the same time to better understand how changes on drift correction influence Sonic values.

7.1.3 Reflectivity log

After complying with drift correction, if any, users could observe main frame as shown in Figure 102.

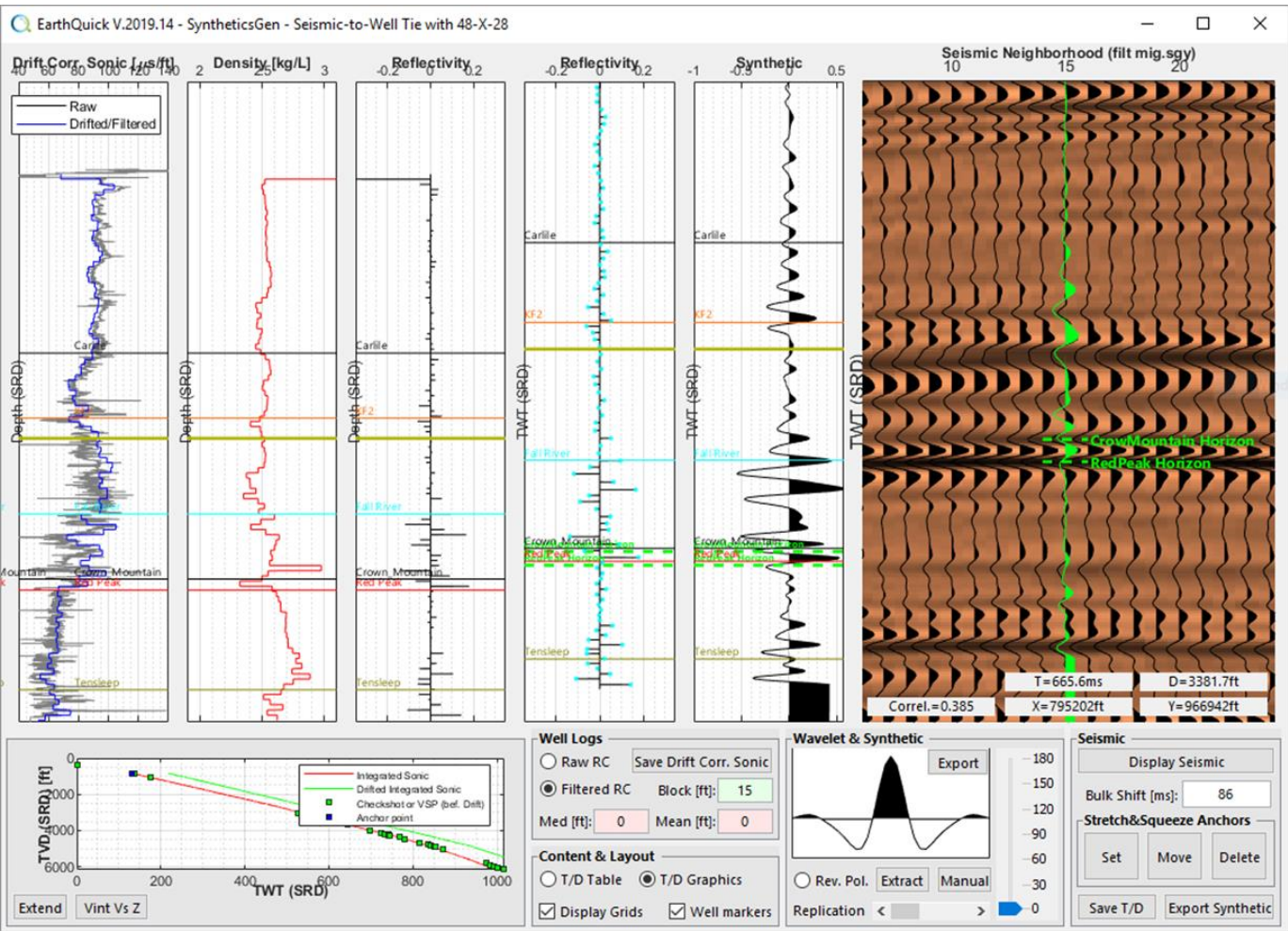


Figure 102: Main frame of SyntheticsGen - Seismic-to-Well Tie

- In the upper part, from left to right:

Track 1	Track 2	Track 3	Track 4	Track 5	Track 6
Drifted corrected Sonic or Raw Sonic if no available Checkshot/VSP,	Density if any,	Reflectivity in Depth,	Reflectivity in TWT,	Synthetic Seismogram in Time,	Seismic Neighborhood, in TWT.

- In the lower part, from left to right:

Table with T/D conversion information (Depth, TWT, Vint, Drift Correction, ...) or Plots with same information (See Figures 2 and 3).	Wavelet Design	Logs filtering facilities	Content and Layout management	Seismic and export facilities	Display Results
--	-------------------	---------------------------------	-------------------------------------	-------------------------------------	--------------------

Then, users may observe the Reflectivity logs (tracks 3 and 4) as an intermediate step between well logs in depth and synthetic seismogram in time.

SyntheticsGen module enables editing/filtering of well logs, before computing automatic conversion of the reflectivity log from depth to time domain.

7.1.3.1 Data conditioning – logs editing/filtering

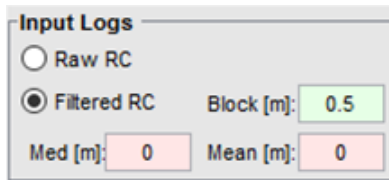


Figure 103: Logs Panel

Well logs editing could be performed before computing (see Figure 103).

Blocking

Create a staircase signal. Length of the steps is equal to the distance given in the text edit box from users.



A systematic blocking is recommended because of resampling from depth to time domain. Window length is objective-dependent.

Mean

Smooths the signal. Length of the smoothing sliding window is equal to the distance given in the text edit box from users. The more the window is large, the more the signal is smoothed.

Median

Removes erratic values with a median filter. Length of the median sliding window is equal to the distance given in the text edit box from users. The more the window is large, the more the signal is smoothed.

7.1.3.1 From Depth to Time Domain

From Track 3 to Track 4 (see Figure 102), the Reflectivity log is converted from depth to time domain. Because of the further need to compute a convolution by the wavelet, Reflectivity log in time is processed to end up with a constant sampling rate of 0.1 ms.

Samples which are taken into account for convolution are highlighted as blue dots on track 4 (see Figure 102).

7.1.4 Wavelet

Synthetic seismogram is the result of the convolution between the Reflectivity log and the wavelet, both in time.

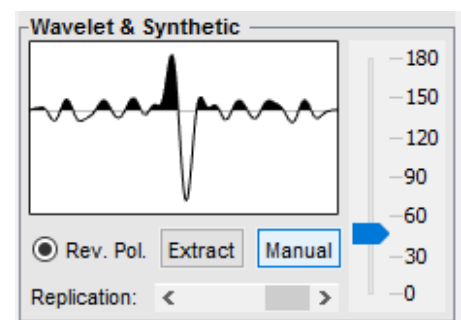


Figure 104: Wavelet & synthetic seismogram panel.

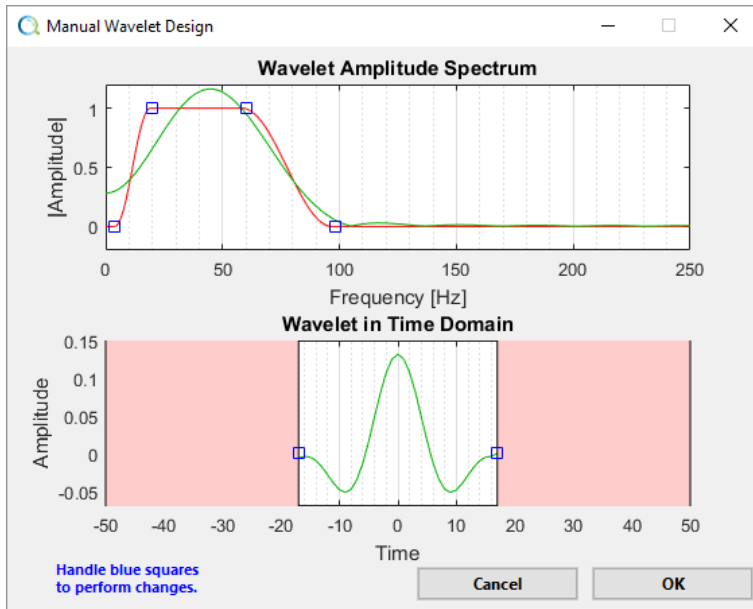
7.1.4.1 Automatic Extraction

Automatic wavelet extraction enables to extract the wavelet from the seismic frequency content.

7.1.4.2 Manual design

Manual wavelet design enables users to define a zero-phase wavelet, controlling its frequency bandwidth and its duration in time.

Frequency content goes from 0 Hz to the Nyquist frequency, taking displayed seismic into account.



Phase rotation and Polarity

Phase could be rotated with a slider (see Figure 104) from 0° to 180°, 180° being the same as ticking on Reverse Polarity (Rev. Pol.).

Both work for manual designed and automatically extracted wavelets.

Figure 105: Manual wavelet builder.

7.1.4.3 Convolution

For convolution purposes with the Reflectivity log, the wavelet is automatically resampled to 0.1 ms sampling rate, to enable automatic resets of the synthetic seismogram when updating the latter.

7.1.5 Seismic-to-Well Tie

Visual tie QC is made directly onto the Seismic Panel since the synthetic seismogram is overlapped onto the seismic section, which is displayed both as wiggles and colored plots.

7.1.5.1 Seismic section display

Seismic section may come from 2D or 3D data, previously loaded with the SegManager module.

7.1.5.2 Adjustment facilities

SyntheticsGen embeds usual “bulk shift” and “stretch & squeeze” functionalities.

When adjustment facilities (bulk shift and/or stretch and squeeze) are used, drift correction is disabled.

Bulk shift

A scalar value. Negative value moves the synthetic upward. Positive value moves the synthetic downward.

If null or left blank, no bulk shift is applied.

Stretch and squeeze

To apply stretch and squeeze, the following workflow could be run:

- 1- Push the Set toggle button to activate the possibility to locate moving anchors on the synthetic, in the seismic panel.
- 2- Click MB1 on the seismic section to locate anchors. Intercept of the left-click shall be the intercept of the anchor.
- 3- Push the Move toggle button to activate the possibility to move each moving, added at step 2.



Figure 106: Seismic section panel.

- 4- Click MB1 on an anchor and drag it while pressing MB1. Reflectivity log in time shall be updated on the fly. MB1 release shall update the synthetic seismogram.
- 5- Push the Delete toggle button to activate the possibility to delete anchors.
- 6- Click MB1 on an anchor to delete it.

After moving anchors, it is not permitted to add new anchors.

If users delete all anchors, no stretch and squeeze is applied.



Stretch and squeeze functionalities shall always be handled with much care and must be documented. But still, interesting if a well-projection distance is important or if a well is actually deviated but without the deviation log at disposal of users.



A screenshot after complying with seismic-to-well tie process is always worth...

7.1.6 Results

7.1.6.1 Synthetic seismogram

Synthetic seismogram could be exported by clicking the Export Synthetic pushbutton. Then, it shall be available for display in the GV and WB modules.

Only one Synthetic seismogram could be saved per well.



In the database, synthetic seismogram at wells occurs as a well log, prefixed *EQSynthSeis* the *Wells* folder.

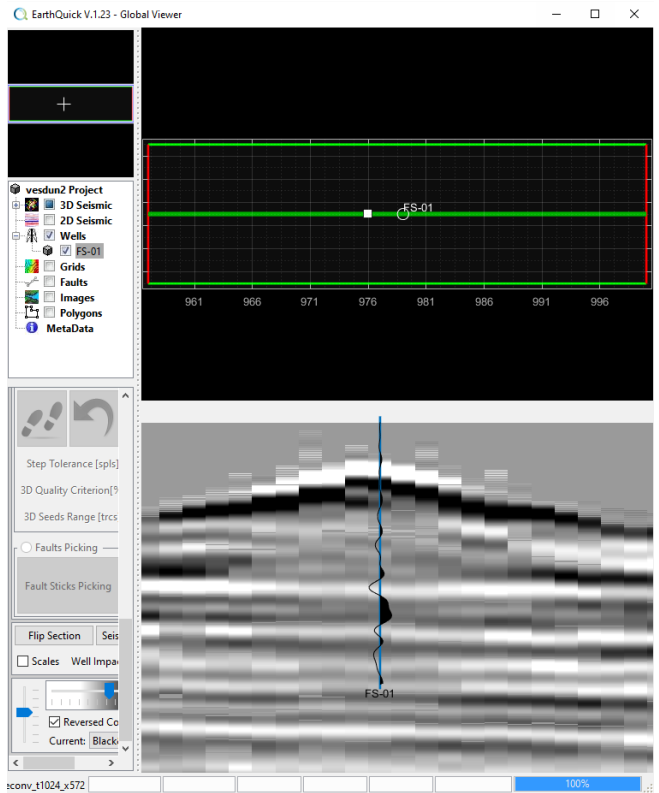


Figure 107: Observing the synthetic seismogram in the GV.

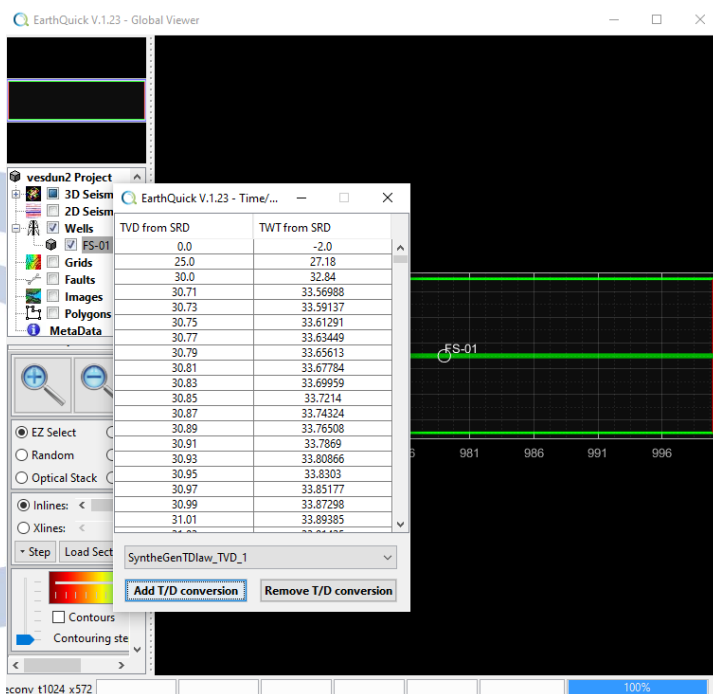


Figure 108: Observing and selecting the actual T/D law in a well.

7.1.6.2 T/D law

Final T/D law could be saved by clicking the Save T/D pushbutton. Then, it shall be available through the GV and WB modules.

Several T/D laws may coexist in one well. Users have the possibility to set a T/D law as reference in the GV and the WB as shown aside.

7.1.7 Angle/Offset considerations

SyntheticsGen handles angles and offsets for synthetic seismograms construction in next Chapter 7.2.



- 28) Ensure 48-X-28 well data has been loaded (logs, T/D law, deviation, stratigraphic markers).
- 29) Perform the complete workflow described in Figure 99 to end up with Figure 102. Your observations should be close to Figure 102. Use the *filt_mig* seismic volume.

7.2 AVO Modeling

AVO Modeling is the proper component of SyntheticsGen to handle angles and offsets for creation of 2D synthetic seismograms. Observations of reflectivity amplitudes dependency on angles and offsets are made on offsets and angles gathers.

AVO modeling workflow is made of 4 steps quoted on Figure 109.

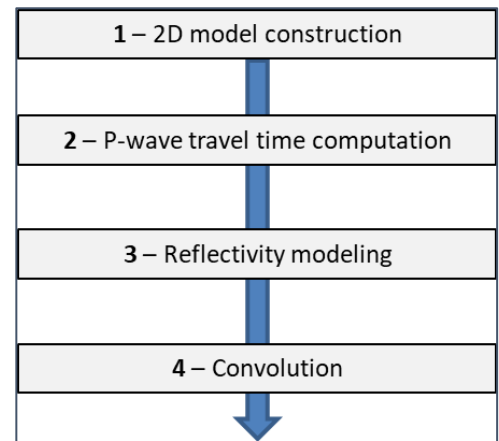


Figure 109: AVO Modeling workflow.

7.2.1 Starting with AVO Modeling

Figure 110 shows figure layout organization, namely:

- **Global controls** offer the ability to save a modeling project (📁), load a modeling project (📁) or completely reset the module (🔄) to start over. The text area is not editable and is just to provide information, just like the progress bar.
- **2D model View** displays 2D P-wave velocities and densities modeling.
- Functionalities tabs enable to follow the modeling workflow defined in Figure 109.
- **Gather View** shows either reflectivity or seismic reflected amplitudes at one single location, function of offsets or angles.
- **Amplitudes graph** shows amplitudes at one single depth/time (determined by mouse location on the Gather View) as a curve depending on offsets or angles.

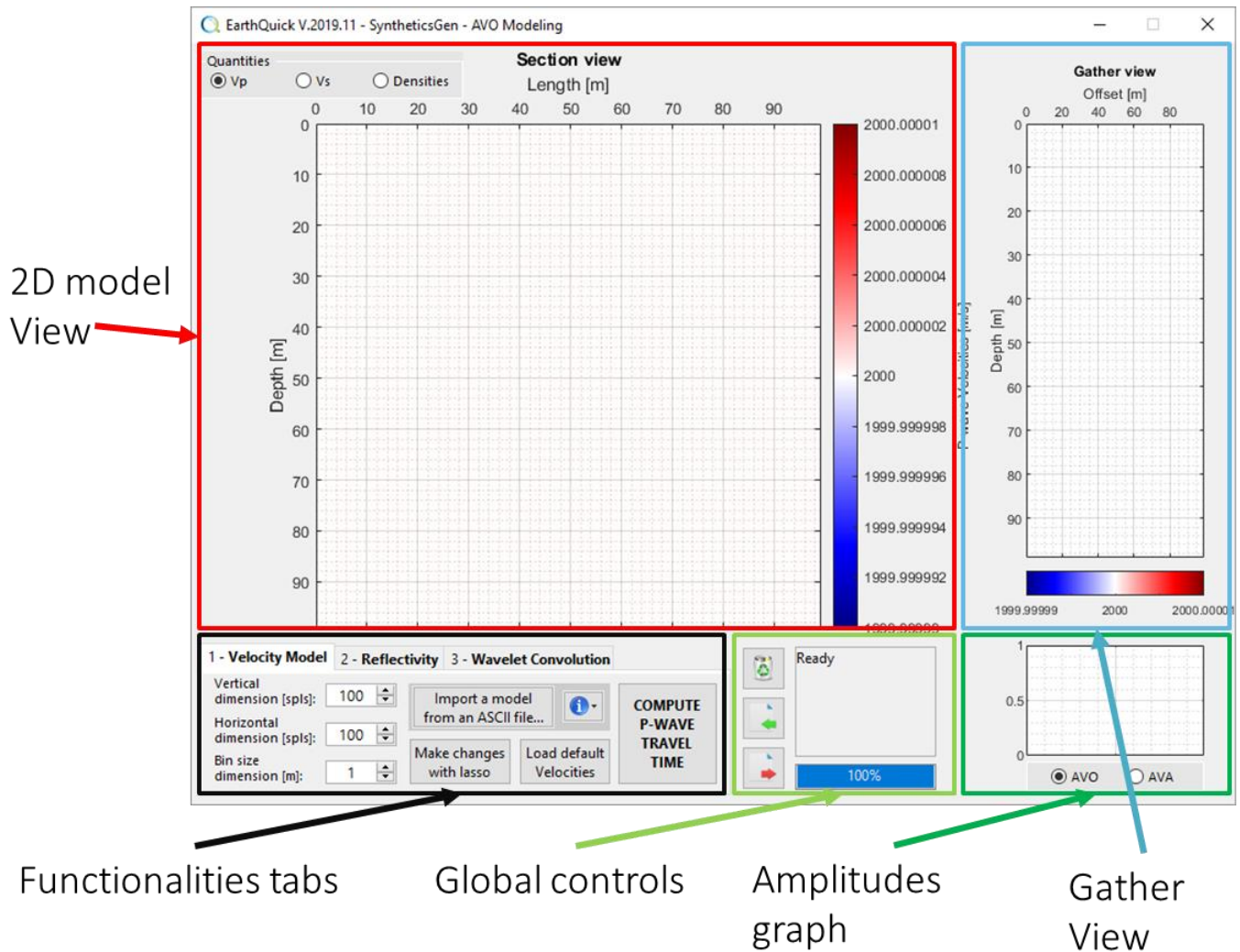


Figure 110: The AVO Modeling tool layout.

7.2.2 2D model construction

- 2D models are made of grids containing squared cells with 3 physical quantities in them: P-wave velocities, S-wave velocities and densities.
- In the *Velocity Model* tab (see Figure 111), users have the possibility to change:
 - Vertical and horizontal dimension in samples
 - Bin/cell size dimension in the depth unit selected for the project (meters or feet).

Each time these components are handled to change the grid, filling of cells is flushed.

Vertical dimension [spls]:	130
Horizontal dimension [spls]:	151
Bin size dimension [ft]:	328



The more numerous the cells, the heavier the upcoming computations.

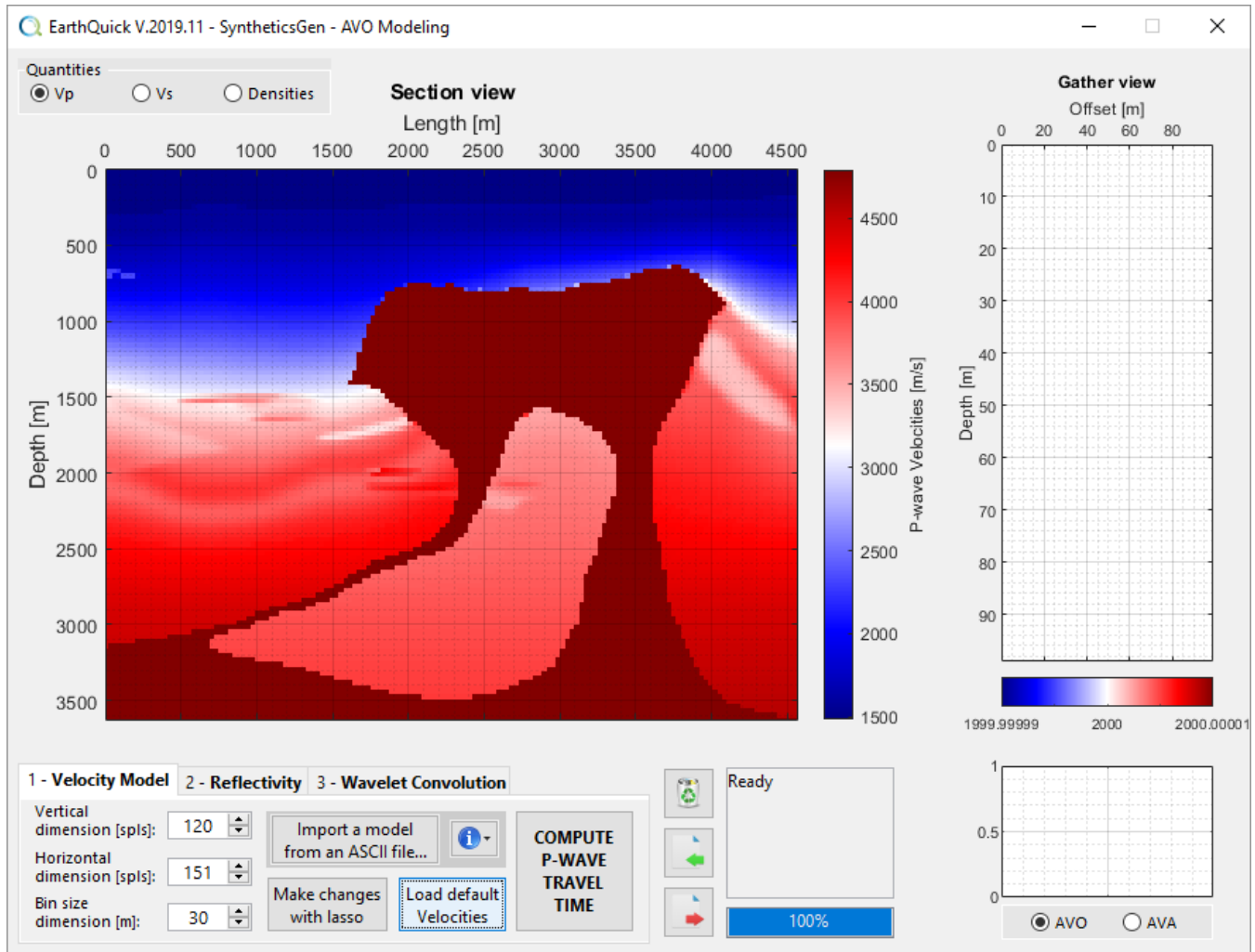
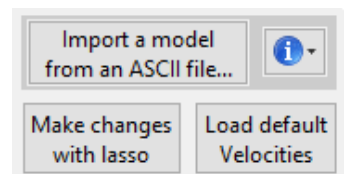


Figure 111: AVO Modeling - Loading default velocities. Model courtesy of BP (Billette, F., Brandsberg-Dahl, S., 2005, The 2004 BP velocity benchmark, 67th Annual Internat. Mtg., EAGE, Expanded Abstracts).

Users have 3 options at their disposal to set 2D model of P-wave velocities, S-wave velocities and densities (see Figure 111):

- *Load default Velocities* (density model remaining constant). That option is mostly dedicated to users intending to practice.
- Draw a free-hand model with the mouse, pushing *Make changes with lasso*. MB1's must be pressed to begin tossing the lasso to surround cells and change their velocities and densities. When MB1 is released, a prompt pops up and ask for a P-wave velocity, S-wave velocities and a density.
- Import a model contained in an ASCII file by pushing *Import a model from an ASCII file...* and being compliant with restrictions quoted by the drop-down button with an information sign:
 - 1st row contain a scalar value = mesh size.
 - Data is organized as 2 regular tables. 1st = P-wave velocities, 2nd = S-wave velocities, 3rd = densities.
 - A single table's row corresponds to quantities values along a single depth level.
 - A single table's column corresponds to quantities values along a single trace.
 - Two consecutive rows are separated by the "newline" ASCII character.
 - Two consecutive columns are separated by the "space" ASCII character.
 - Velocities and densities are stored on top of each other in the ASCII file.
 - Velocities and densities tables have the same dimensions.





The toggle button *Make changes with lasso* must be released before stepping up. Otherwise, other functionalities like zooming could be blocked.

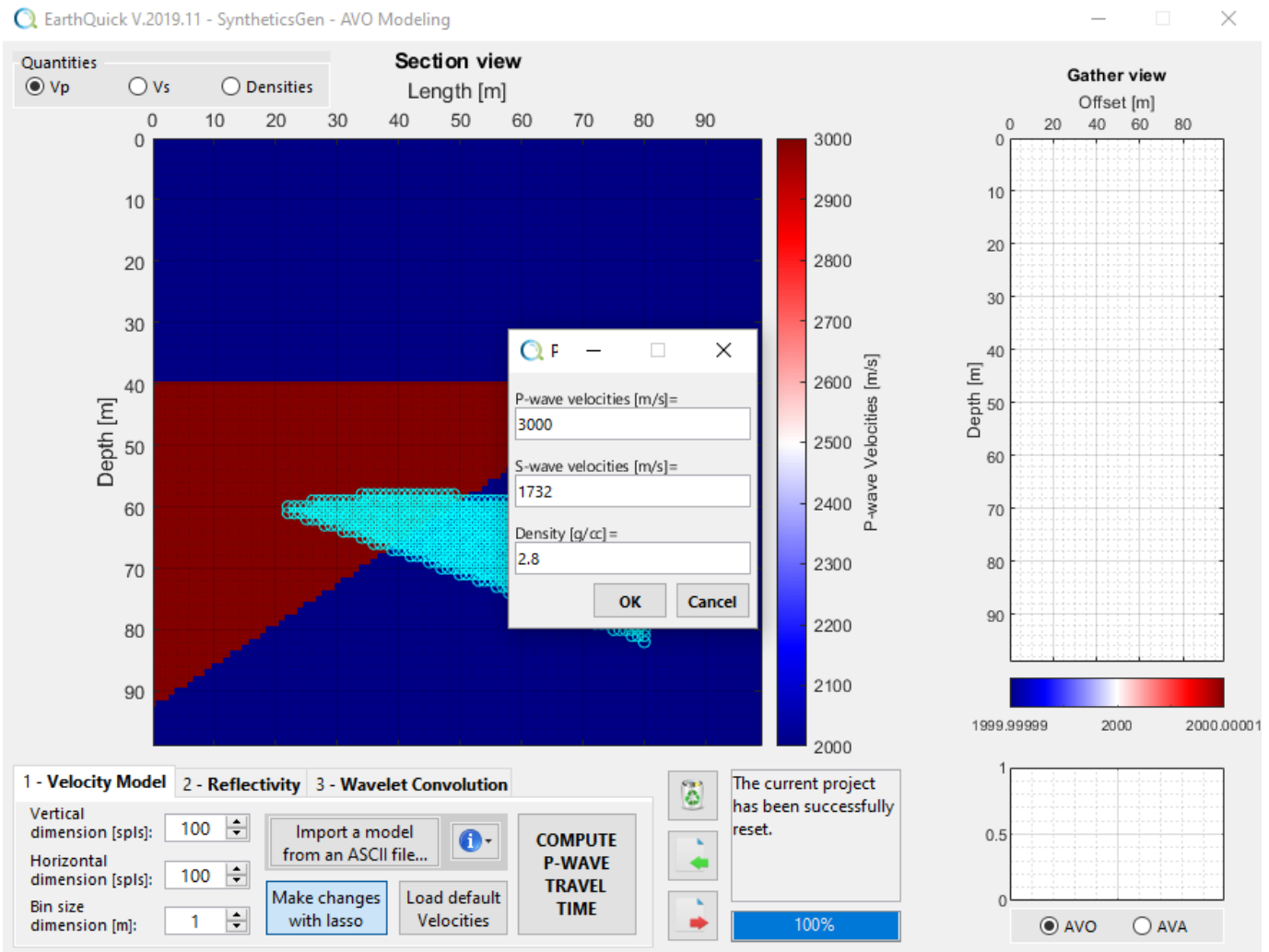


Figure 112: Example of free-hand P-wave velocities model construction.

7.2.3 P-wave travel time computation

Once model design has been completed, pushing *COMPUTE P-WAVE TRAVEL TIME* in the *Velocity Model* tab, users may launch the P-wave travel time computation, (see Figure 112 and Figure 113).

Computing P-wave travel time enables to launch ray tracing avoiding turning waves considerations, with following characteristics:

- That step identifies the rays coming from every zero-depth location down to every location in depth, if any. Crucial information obtained there is the relationship between offsets and angles of rays at every location in depth.
- The result of ray tracing is temporarily stored on the machine. Each time a new model is about to be used, ray tracing must be relaunched.
- In case EarthQuick is installed on a machine with several CPU's, ray tracing shall rely on parallel computing to accelerate computation.



By default, S-waves are supposed to equal $V_p/\sqrt{3}$ in EarthQuik. That assumption considers equality of Lamé coefficients.

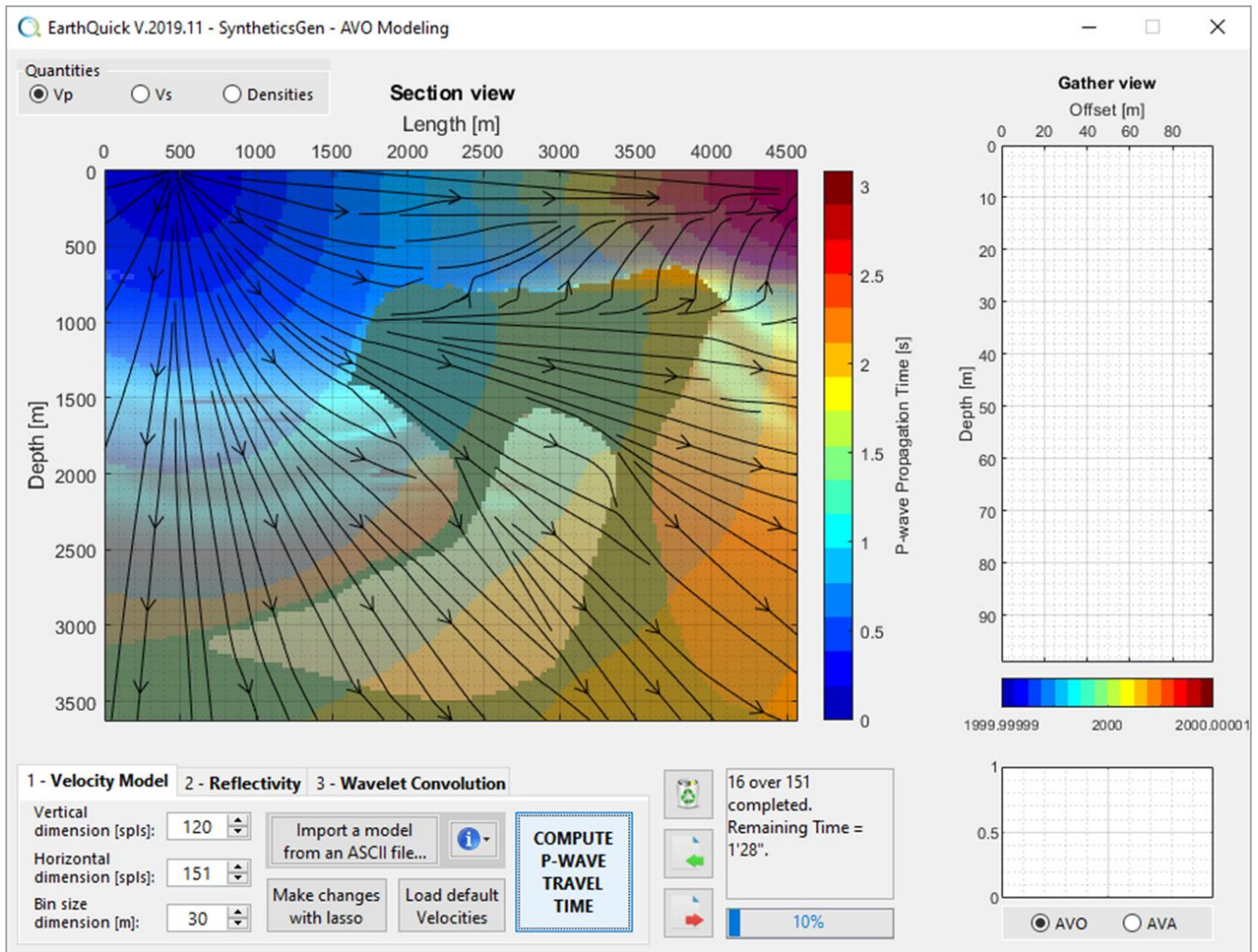


Figure 113: Ongoing P-wave travel time computation.

7.2.4 Reflectivity modeling

Once complying with P-wave travel time computation, clicking on tab 2 – *Reflectivity* gives access to Reflectivity modeling with the ability to choose the modeling algorithm among:

- Zoeppritz, only for P-waves
- 3-term aki & richards
- 2-term aki & Richards, also named 2-term approximation of Shuey
- Bortfeld
- Hilterman

That step uses result of ray tracing (relationship between offsets and rays angles at every location in depth) and add amplitude of reflections on top of that.

To do so, users have chosen *Selection* in the *Axes Controls* panel and then click MB1 on the *Section view*. The light blue vertical line corresponds to the selected location to subsequently compute reflectivity modeling at all depths. Figure 114 shows a living example.

Users could also have an idea of rays contributions for every cell by ticking on the *Plot Rays* checkbox and clicking MB1 on the *Section view*.

Once a location and algorithm have been chosen, reflectivity modeling could be launched by clicking the *COMPUTE REFLECTIVITY MODELING* button.

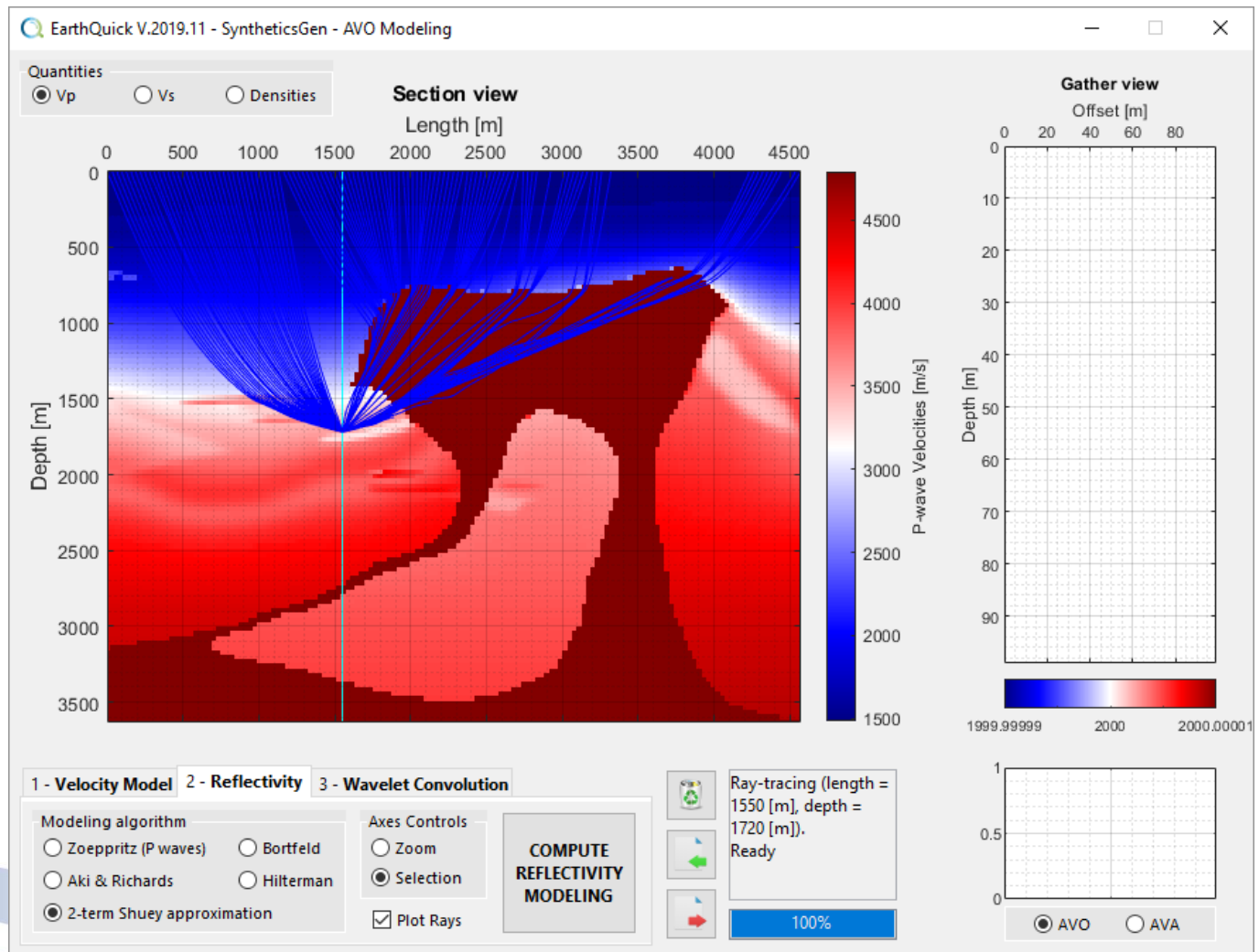


Figure 114: Reflectivity modeling and rays plotting.

Prior to results seen in the *Gather view* (see Figure 115), users are informed of mute, automatically applied by EarthQuick on modeling results to avoid turning rays.

The mute step simply seeks inversions in ray angles when moving away from the zero-offset (location of the light blue vertical line in Figure 114).

In Figure 116, dark blue zones on right panel shows exclusions operated by the mute. The dashed rectangles show reflectivity amplitudes at the same point where rays were plotted on Figure 114.

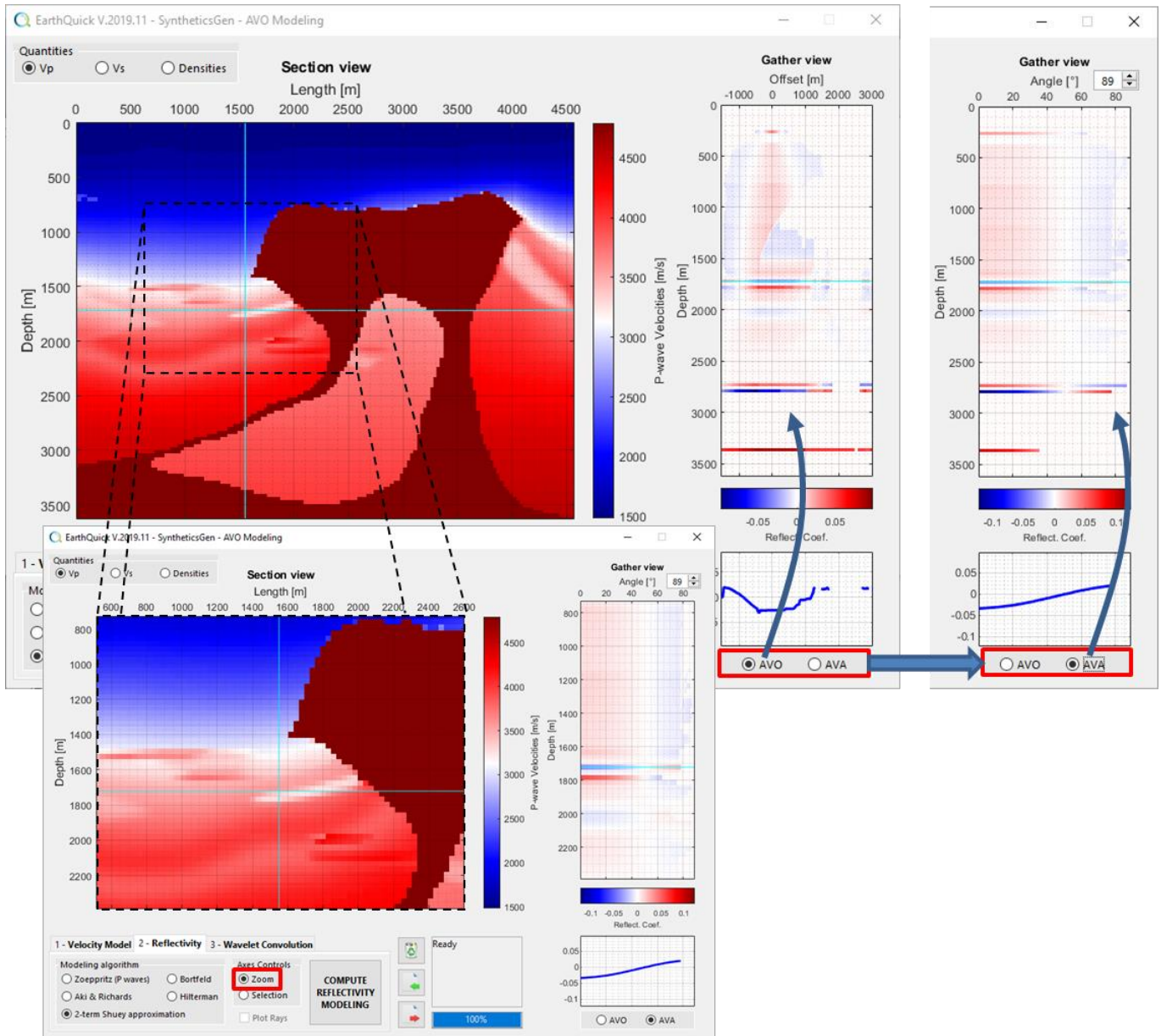


Figure 115: Results of reflectivity modeling.

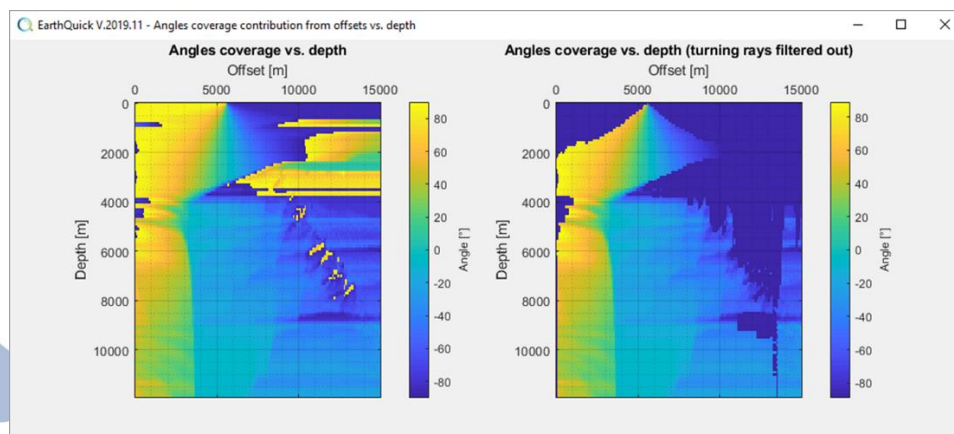


Figure 116: QC frame for automatic mute.

7.2.5 Convolution

Once complying with P-wave travel time computation, clicking on tab 3 – *Wavelet Convolution* gives access to Synthetic seismogram (see Figure 117).

Design of the wavelet is as described in Chapter 7.1.4.

In the *Convolution* panel, a flip-flop could be operated between reflectivity and seismic signal. To be noted each time the radio button *Time Wavelet Convolution* is pushed, the synthetic seismogram is reevaluated. On the contrary, after performing changes on the wavelet, users must push *UPDATE TIME CONVOLUTION* to make these changes effective.

Before convolution, a blind depth-to-time conversion of the reflectivity is performed by EarthQuick using depth model at the zero-offset location.

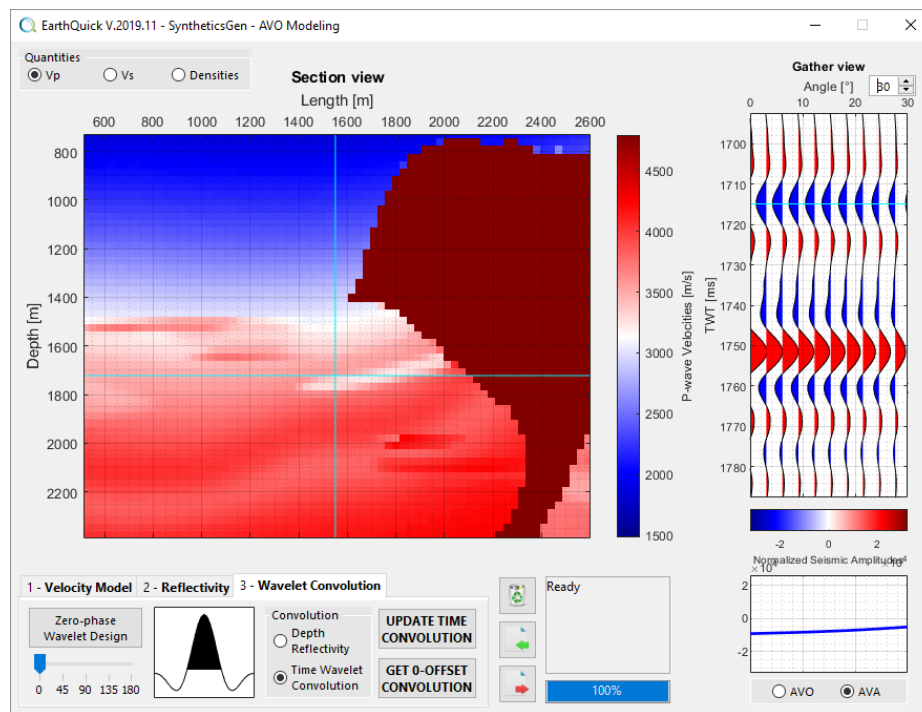


Figure 117: Result of convolution between reflectivity and wavelet.

7.2.6 Zero-offset and full-offset convoluted section

In the end, to help with assessment of vertical stretch and squeeze of stacked sections in time alongside with tuning effect, a zero-offset convolution of the 2D zero-offset model is proposed by pushing the *GET 0-OFFSET CONVOLUTION* button (see Figure 117).

A full-offset (also named full-stack) section could then be obtained with the ability to control the maximum angle for stack consideration. Full-stack section is processed after clicking the *Update Stack* button (see Figure fffff). When moving mouse pointer over 0-offset and full-offset sections, reticles are automatically pointing relating location on other graphs in real time. Gather view is also automatically linked to mouse pointer with full-offset section.

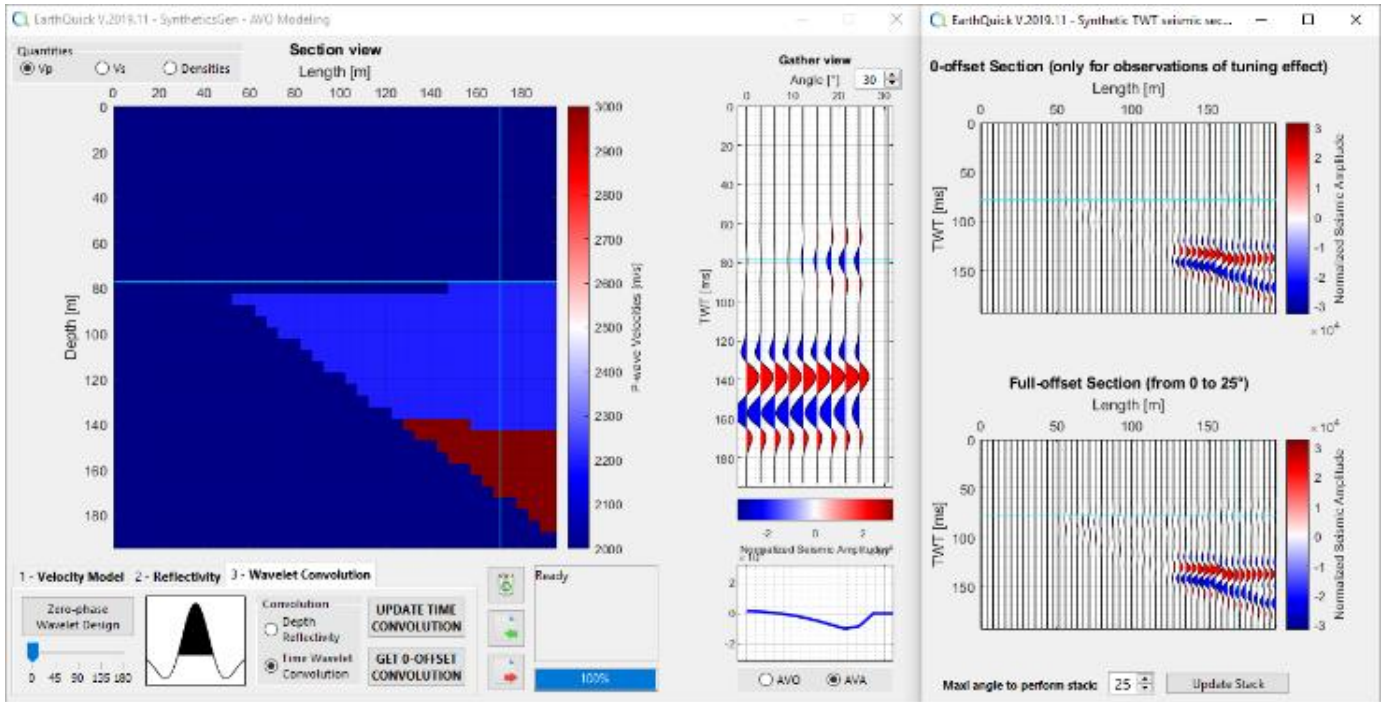


Figure 118: zero-offset and full-stack synthetic sections on a handsfree-constructed model.



- 30) Fulfil the complete workflow described in Figure 109 to characterize expected effects of such a salt tongue occurrence on seismic amplitudes. Loading of the salt tongue model could be achieved simply by clicking on the *Load default Velocities* button in the *Velocity Model* tab.

8 InterMapper


InterMapper turns scatter data to continuous grids, relying on various interpolation methods. That also lets users perform data analysis and filtering.

Like with the Global Viewer, InterMapper launches with asking users to define grid settings. See Chapter 5.1 for a complete insight. If any, last settings are proposed.


Opening of the module gives a direct access to the main frame (see Figure 119: The InterMapper main frame. Figure 119) where all steps of processing are actually performed.

4 zones compose the frame:

- The **Input Selection** panel (top left) to select either an *Existing EarthQuick Grid* or to *import* a new set of scatter data from an *ASCII file*. The *Import ASCII file* facility acts as explained in Chapter 5.2.2 - *Grids / ASCII Import...*
- The **Interpolation Method Selection** panel (top central) to choose an interpolation method.
- The buttons **A – Process** to launch interpolation followed by **B – Save Results** to backup and export (top right).
- The graphical panel where input data, intermediate and final results are displayed.
3 tabs compose the panel:
 - **Pre-conditioning** vows to analyse and filter input data,
 - **Variogram Analysis**, only with Ordinary Kriging, to display experimental variogram and assess variogram model,
 - **Interpolation results** to display and QC interpolation results.

Users could find dropdown  button in the upper left corners of some axes in the module. They correspond to settings or actions to easily interact with data. Typically, from there, outliers could be eliminated or variogram models could be set.

8.1 Data analysis and Filtering

After selecting input data, the dropdown  button enables to have access to filtering tools from the related axes, named *Scattered Input* in the *Pre-conditioning* tab. See Figure 120.

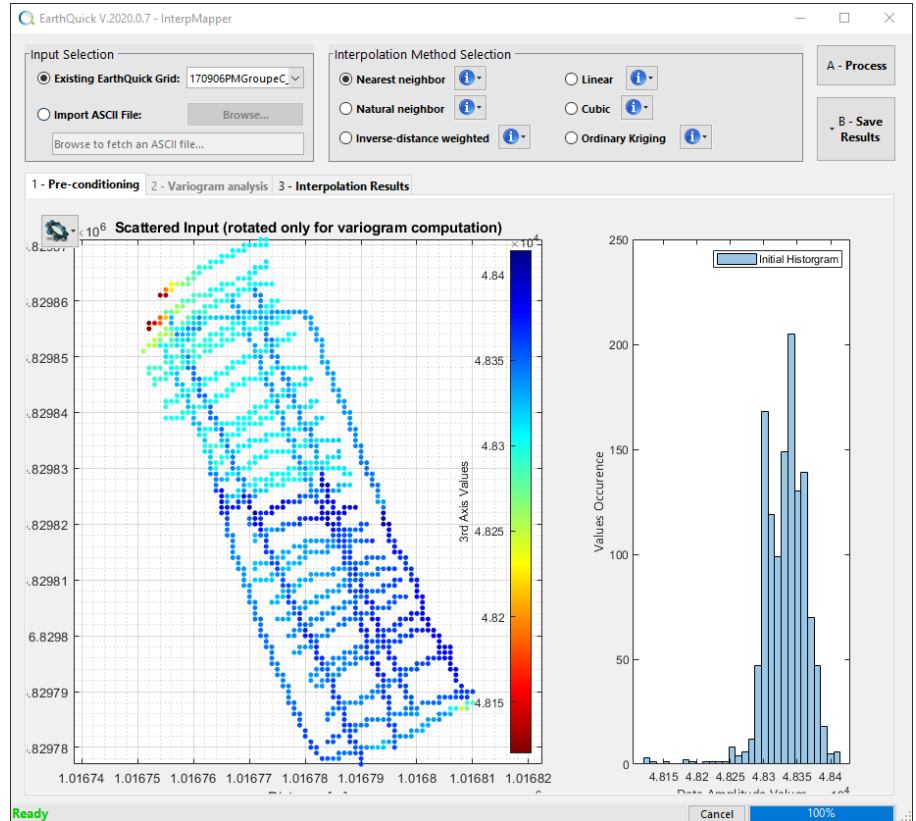


Figure 119: The InterMapper main frame.

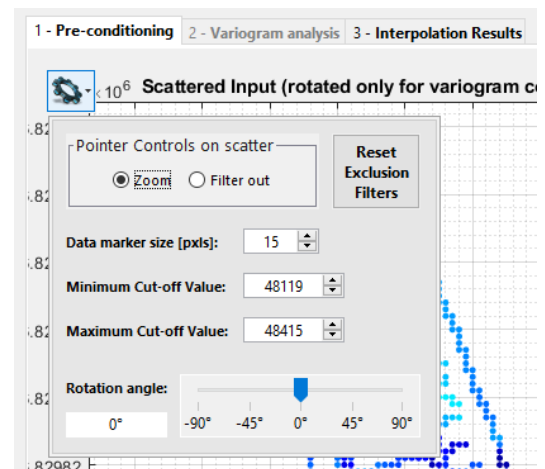


Figure 120: Normal data filtering tools.

Users could:

- Zoom in the data with mouse controls over the axes,
- Draw exclusion polygons to evict outliers (see Figure 120 – *Filter out* check box),
- Define minimum and maximum cut-offs to filter out extreme values,
- Change data marker size, specified as number of pixels in use to display each point of the scatter,
- Rotate the scatter (especially designed for Inverse-Distance Weighted interpolation to save computation power, and for Ordinary Kriging to enable handling of anisotropy),
- (Select polygon to be used as interpolation barriers when dealing with Inverse-Distance Weighted interpolation only).


8.2 Interpolation methods

8.2.1 Non-parametric methods

Available non-parametric interpolation methods are:

- Nearest neighbor, relying on triangulation-based nearest neighbor interpolation and bringing discontinuities,
- Natural neighbor, relying on triangulation-based natural neighbor interpolation. This method is an efficient tradeoff between linear and cubic.
- Linear, relying on triangulation-based linear interpolation.
- Cubic, relying on triangulation-based cubic Interpolation.

8.2.2 Inverse-distance weighting

After data analysis and filtering, in the *Interpolation Results* tab, users are invited to push the dropdown button  and select (see Figure 121):

- 1 – The distance weight factor (e.g. -2 correspond to a weight varying as the inverse of the squared radius length),
- 2 – The radius length (i.e. largest distance to consider data).

In other words, the method allows the distance weight to vary and to consider a certain number of neighbors through a fixed radius distance. Unit of the radius distance is as per the project unit system.

That interpolation method tries to maximize use of parallel computing facilities (CPU's).

8.2.3 Ordinary Kriging

After data analysis and filtering, enables isotropic or anisotropic ordinary kriging, with access to:

- 1 – Variographic analysis (including drift correction),
- 2 – Ordinary kriging interpolation.

Note kriging is the only proposed interpolation methods which take nugget effect into account, considering noise content, meaning input points are not necessarily honored in the interpolation result.

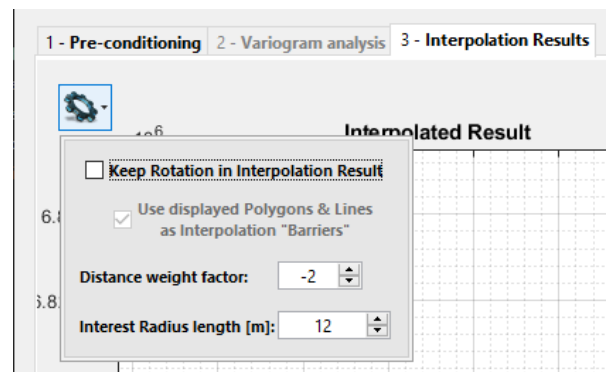


Figure 121: Inverse-distance weighted interpolation options.

8.2.3.1 Variographic analysis

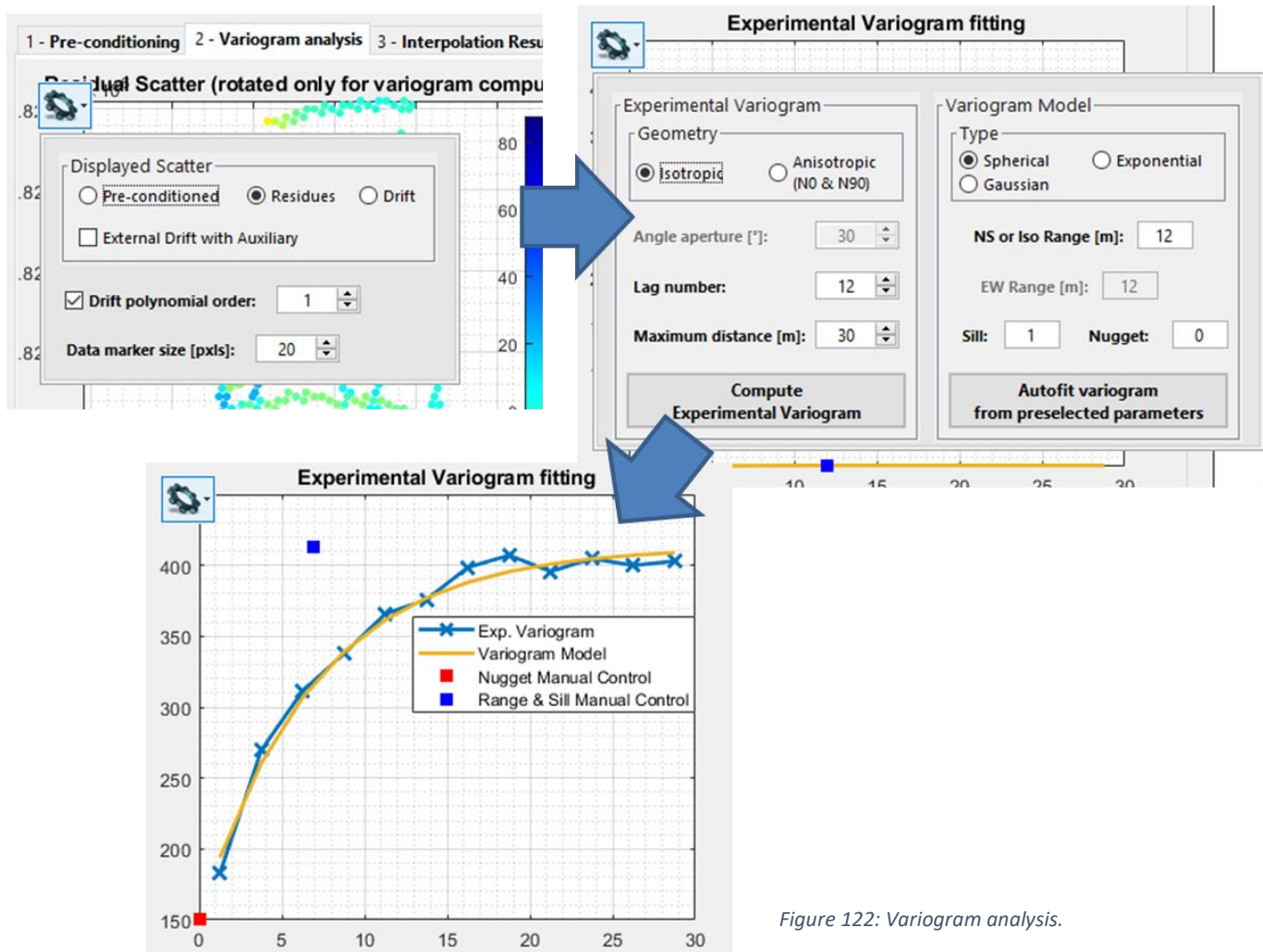


Figure 122: Variogram analysis.

Performing variographic analysis, in any case, as described by Figure 122, users must comply with the following workflow:

- 1 – Estimate the drift correction by tuning the drift order (upper-left corner),
- 2 – Estimate the experimental variogram of the residues (upper-right corner and lower corner),
- 3 – Estimate the variogram model of the residues (upper-right corner and lower corner).

Options enables to:

- Automatically fit variogram model after choosing its type, pushing the *Autofit variogram from preselected parameters* button,
- Perform kriging with external drift (KED). See checkbox *External Drift with Auxiliary* in Figure 122 upper-left corner. Order of the regression between drift and data points could be tuned. KED is different than cokriging since covariance between inputs is not required. Additional facilities shall let users determine correlation between external drift and kriged variable.



Anisotropic kriging could be performed by ticking on the *Anisotropic (NO & N90)* radio button and adjusting *Angle aperture* value. See radio button *Anisotropic (NO & N90)* in Figure 122 upper-right corner. Users have then 2 variogram models to adjust on 2 experimental variograms. After tuning both variogram models, as per with the isotropic case, the *A – Process* button has simply to be pushed to run the interpolation (see Chapter 8.2.3.2).

Note prior rotation of input data, as mentioned in Chapter 8.1, might be opportune to orientate minimum and maximum variability along N-S and E-W directions, alongside directions of experimental variograms.

8.2.3.2 Ordinary kriging interpolation

Before pushing the *A- Process Button*, in the *Interpolation Results* tab (see Figure 123), *Neighbors per estimation* must be set with care. The more the value approaches the total number of input points, the more computing time shall be increased.

Assessment of uncertainties could be also performed through kriging variance display, ticking on the *Display Error/Confidence* check box.

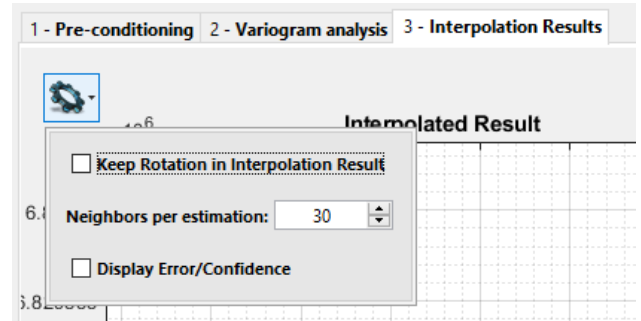
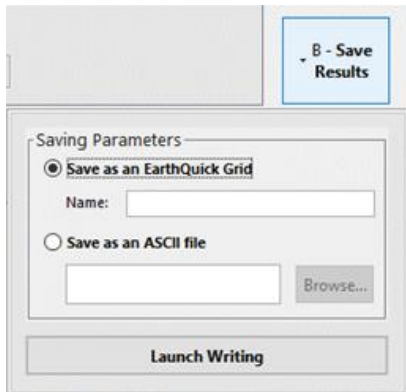


Figure 123: kriging interpolation parameters.

8.3 Backup



After processing interpolation, backup of 2 kinds are possible:

- Save as an EarthQuick Grid. Saved grids automatically ready for use with other EarthQuick modules.
- Save as a column-oriented (Easting, Northing, Value) ASCII file. That possibility enables export and share with third-party software solutions.

Names of backed up grids or files could be set by users after selection of the saving mode. Several pushes on the *Launch Writing* button without changing the output name shall overwrite last backup.

Figure 124: Interpolation backup possibilities.



- 31) In the Global Viewer, perform seismic interpretation of KF2 horizon, exclusively on 2D seismic lines. Getting back to the InterpMapper, interpolate seismic picking with all available methods. Comment on “geological” credibility of each result.

9 GeoPosit

GeoPosit enables to cope with Geodetic Coordinate Systems concerns, dealing with single locations, ASCII files, SEGY files, images, satellite pictures, shapefiles and KML files.

The main frame of GeoPosit (see Figure 125) is made such as that is split in 2 parts:

- On the left-hand side, all information concerning the input.
- On the right-hand side, all information concerning the output.
- Then, these 2 parts are equally divided in 3 elements:
- In the top, definition of kinds for input and output.
- In the middle, definition of the geodetic datums.
- In the bottom, definition of the projection system, if applicable.

Figure 125: GeoPosit frame for single locations conversion.

The table below gives the library of the 223-predefined geodetic datums in EarthQuick, divided in 3 columns. However, clicking on the drop-down menus, users could select *CUSTOM BY USER* (1st choice in the list) and create their own geodetic datum.

Predefined Geodetic Datums		
Abidjan 1987 (Ivory Coast)	Guam 1963 (Guam)	Old Hawaiian (Mean for Hawaii; Kauai; Maui; Oahu)
Adindan (Burkina Faso)	Gunung Segara (Indonesia-Kalimantan)	Old Hawaiian (Oahu)
Adindan (Cameroon)	GUX 1 Astro (Guadalcanal Island)	Oman (Oman)
Adindan (Ethiopia)	Herat North (Afghanistan)	Ordnance Survey Great Britain 1936 (England)
Adindan (Mali)	Hermannskogel Datum (Croatia-Serbia, Bosnia-Herzegovina)	Ordnance Survey Great Britain 1936 (England; Isle of Man; Wales)
Adindan (Mean for Ethiopia&Sudan)	Hjorsey 1955 (Iceland)	Ordnance Survey Great Britain 1936 (Mean for Eng; Isle of Man; Scotland; Shetland Ids; Wales)
Adindan (Senegal)	Hong Kong 1963 (Hong Kong)	Ordnance Survey Great Britain 1936 (Scotland; Shetland Islands)
Adindan (Sudan)	Hu-Tzu-Shan (Taiwan)	Ordnance Survey Great Britain 1936 (Wales)
Afgooye (Somalia)	Indian (Bangladesh)	Pico de las Nieves (Canary Islands)
Ain el Abd 1970 (Bahrain)	Indian (India; Nepal)	Pitcairn Astro 1967 (Pitcairn Island)
Ain el Abd 1970 (Saudi Arabia)	Indian (Pakistan)	Point 58 (Mean for Burkina Faso & Niger)
American Samoa 1962 (American Samoa)	Indian 1954 (Thailand)	Pointe Noire 1948 (Congo)

Anna 1 Astro 1965 (Cocos Islands)	Indian 1960 (Vietnam-Con Son Island)	Porto Santo 1936 (Porto Santo; Madeira Islands)
Antigua Island Astro 1943 (Antigua-Leeward Islands)	Indian 1960 (Vietnam-Near 16°N)	Provisional South American 1956 (Bolivia)
Arc 1950 (Botswana)	Indian 1975 (Thailand)	Provisional South American 1956 (Chile-Northern; Near 19°S)
Arc 1950 (Burundi)	Indonesian 1974 (Indonesia)	Provisional South American 1956 (Chile-Southern; Near 43°S)
Arc 1950 (Lesotho)	Ireland 1965 (Ireland)	Provisional South American 1956 (Colombia)
Arc 1950 (Malawi)	ISTS 061 Astro 1968 (South Georgia Islands)	Provisional South American 1956 (Ecuador)
Arc 1950 (Mean for BoLeMaSwZaiZamZi)	ISTS 073 Astro 1969 (Diego Garcia)	Provisional South American 1956 (Guyana)
Arc 1950 (Swaziland)	Johnston Island 1961 (Johnston Island)	Provisional South American 1956 (Mean for BolChiColEcuGuyPerVen)
Arc 1950 (Zaire)	Kandawala (Sri Lanka)	Provisional South American 1956 (Peru)
Arc 1950 (Zambia)	Kerguelen Island 1949 (Kerguelen Island)	Provisional South American 1956 (Venezuela)
Arc 1950 (Zimbabwe)	Kertau 1948 (West Malaysia & Singapore)	Provisional South Chilean 1956 (Chile-Near 53°S-Hito XVIII)
Arc 1960 (Mean for Kenya & Tanzania)	Kusaie Astro 1951 (Caroline Islands)	Puerto Rico (Puerto Rico; Virgin Islands)
Arc 1960 (Kenya)	Korean Geodetic System (South Korea)	Pulkovo 1942 (Russia)
Arc 1960 (Tanzania)	L. C. 5 Astro 1961 (Cayman Brac Island)	Qatar National (Qatar)
Ascension Island 1958 (Ascension Island)	Leigon (Ghana)	Qornoq (Southern Greenland)
Astro Beacon E 1945 (Iwo Jima)	Liberia 1964 (Liberia)	Reunion (Mascarene Islands)
Astro DOS 71/4 (St Helena Island)	Luzon (Philippines-Excluding Mindanao)	Reseau Geodesique Francais 1993 (France)
Astro Tern Island (FRIG) 1961 (Tern Island)	Luzon (Philippines-Mindanao)	Rome 1940 (Italy-Sardinia)
Astronomical Station 1952 (Marcus Island)	MPoraloko (Gabon)	S-42 Pulkovo 1942 (Hungary)
Australian Geodetic 1966 (Australia Tasmania)	Mahe 1971 (Mahe Island)	S-42 Pulkovo 1942 (Poland)
Australian Geodetic 1984 (Australia Tasmania)	Massawa (Ethiopia-Eritrea)	S-42 Pulkovo 1942 (Czechoslovakia)
Australian Geocentric 1994 (Australia Tasmania)	Merchich (Morocco)	S-42 Pulkovo 1942 (Latvia)
Ayabelle Lighthouse (Djibouti)	Midway Astro 1961 (Midway Islands)	S-42 Pulkovo 1942 (Kazakhstan)
Bellevue (IGN) (Efate & Erromango Islands)	Minna (Cameroon)	S-42 Pulkovo 1942 (Albania)
Bermuda 1957 (Bermuda)	Minna (Nigeria)	S-42 Pulkovo 1942 (Romania)
Bissau (Guinea-Bissau)	Montserrat Island Astro 1958 (Montserrat-Leeward Islands)	S-JTSK (Czechoslovakia-Prior 1 JAN 1993)
Bogota Observatory (Colombia)	Nahrwan (Oman-Masirah Island)	Santo (DOS) 1965 (Espirito Santo Island)
Bukit Rimpah (Indonesia-Bangka & Belitung Ids)	Nahrwan (Saudi Arabia)	Sao Braz (Azores-Sao Miguel; Santa Maria Ids)
Camp Area Astro (Antarctica-McMurdo Camp Area)	Nahrwan (United Arab Emirates)	Sapper Hill 1943 (East Falkland Island)
Campo Inchauspe (Argentina)	Naparima BWI (Trinidad & Tobago)	Schwarzeck (Namibia)
Canton Astro 1966 (Phoenix Islands)	North American 1927 (Alaska-Excluding Aleutian Ids)	Selvagem Grande 1938 (Salvage Islands)
Cape (South Africa)	North American 1927 (Alaska-Aleutian Ids East of 180°W)	Sierra Leone 1960 (Sierra Leone)
Cape Canaveral (Bahamas Florida)	North American 1927 (Alaska-Aleutian Ids West of 180°W)	South American 1969 (Argentina)
Carthage (Tunisia)	North American 1927 (Bahamas-Except San Salvador Id)	South American 1969 (Bolivia)

Chatham Island Astro 1971 (New Zealand-Chatham Island)	North American 1927 (Bahamas-San Salvador Island)	South American 1969 (Brazil)
Chua Astro (Paraguay)	North American 1927 (Canada-Alberta; British Columbia)	South American 1969 (Chile)
Corrego Alegre (Brazil)	North American 1927 (Canada-Manitoba; Ontario)	South American 1969 (Colombia)
Dabola (Guinea)	North American 1927 (Canada-New Brunswick; Newfoundland; Nova Scotia; Quebec)	South American 1969 (Ecuador)
Deception Island (Deception Island; Antarctica)	North American 1927 (Canada-Northwest Territories; Saskatchewan)	South American 1969 (Ecuador-Balra; Galapagos)
Djakarta-Batavia (Indonesia-Sumatra)	North American 1927 (Canada-Yukon)	South American 1969 (Guyana)
DOS 1968 (New Georgia Islands-Gizo Island)	North American 1927 (Canal Zone)	South American 1969 (Mean for Arg/Bol/Bra/Chi/Ecu/Guy/Par/Per/Tri&To/Ven)
Easter Island 1967 (Easter Island)	North American 1927 (Cuba)	South American 1969 (Paraguay)
Estonia Coordinate System 1937 (Estonia)	North American 1927 (Greenland-Hayes Peninsula)	South American 1969 (Peru)
European 1950 (Cyprus)	North American 1927 (Mean for Ids)	South American 1969 (Trinidad & Tobago)
European 1950 (Egypt)	North American 1927 (Mean for BelCosRicElSalGuaHonNic)	South American 1969 (Venezuela)
European 1950 (Eng; Channel Islands; Scotld; Shetland Ids)	North American 1927 (Mean for Canada)	South Asia (Singapore)
European 1950 (Eng; Irlld; Sctld; Shetland Ids)	North American 1927 (Mean for Conus)	Tananarive Observatory 1925 (Madagascar)
European 1950 (Finland; Norway)	North American 1927 (Mean for Conus-East of Mississippi Riv.)	Timbalai 1948 (E. Malaysia-Sabah Sarawak)
European 1950 (Greece)	North American 1927 (Mean for Conus-West of Mississippi Riv.)	Tokyo (Japan)
European 1950 (Iran)	North American 1927 (Mexico)	Tokyo (Mean for Japan; South Korea; Okinawa)
European 1950 (Italy-Sardinia)	North American 1983 (Alaska-Excluding Aleutian Ids)	Tokyo (Okinawa)
European 1950 (Italy-Sicily)	North American 1983 (Aleutian Ids)	Tokyo (South Korea)
European 1950 (Malta)	North American 1983 (Canada)	Tristan Astro 1968 (Tristan da Cunha)
European 1950 (Mean for Aus Bel Den Fin Fr Ger Grc It Lux Ned Nor Por Sp Swd Swt)	North American 1983 (CONUS)	Viti Levu 1916 (Fiji-Viti Levu Island)
European 1950 (Mean for AusDenFrGerNedSwt)	North American 1983 (Hawaii)	Voirol 1960 (Algeria)
European 1950 (Mean for Isr Iraq Leb Kuw Sau Arab Syr)	North American 1983 (Mexico; Central America)	Wake Island Astro 1952 (Wake Atoll)
European 1950 (Portugal Spain)	North Sahara 1959 (Algeria)	Wake-Eniwetok 1960 (Marshall Islands)
European 1950 (Tunisia)	Nouvelle Triangularisation Francaise (NTF)	WGS 1972 (Global Definition)
European 1979 (Mean for AusFinNedNorSwdSwt)	Observatorio Meteorologico 1939 (Azores-Corvo & Flores Islands)	WGS 1984 (Global Definition)
Fort Thomas 1955 (Nevis; St. Kitts-Leeward Islands)	Old Egyptian 1907 (Egypt)	Yacare (Uruguay)
Gan 1979 (Republic of Maldives)	Old Hawaiian (Hawaii)	Zanderij (Suriname)
Geodetic Datum 1949 (New Zealand)	Old Hawaiian (Kauai)	
Graciosa Base SW 1948 (Azores (Faial; Graciosa; Pico; Sao Jorge; Terceira))	Old Hawaiian (Maui)	

As for the table opposite, that gives the library of the 16-predefined projections in EarthQuick, divided in 2 columns. However, clicking on the drop-down menus, users could select *CUSTOM BY USER* (1st choice in the list) and create their own geodetic datum.

In case users have assigned a GCS to the project from the Launcher (see Figure 21 and comments aside), the input side default state of the GeoPosit module shall correspond to that assigned GCS.

Contrary to other modules, GeoPosit requires lengths and distances expressed in the metric system.

In the *DATUMS PARAMETERS* panel, the pushbutton *Input Datum = Output Datum* equalizes Output Datum to the Input Datum.

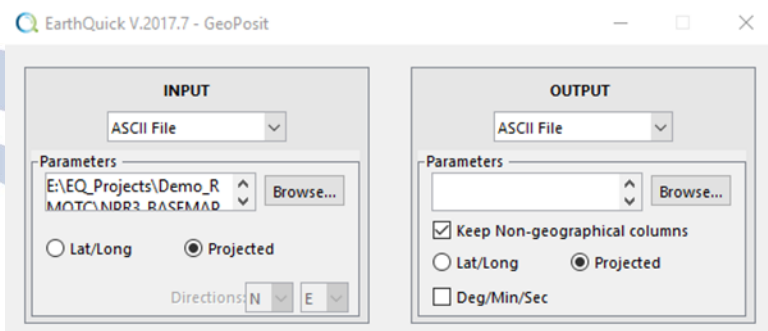
Predefined Projections	
Names	Parameters
Transverse Mercator (Gauss Kruger)	- Central latitude and longitude - False easting and northing
Universal Transverse Mercator	- UTM zone - Hemisphere
Lambert I (Secant)	None
Lambert I (Tangent)	None
Lambert II (Secant)	None
Lambert II (Tangent)	None
Lambert II étendu (Secant)	None
Lambert II étendu (Tangent)	None
Lambert III (Secant)	None
Lambert III (Tangent)	None
Lambert IV (Secant)	None
Lambert IV (Tangent)	None
Lambert 93	None
Secant Lambert EPSG 3949	None
Tangent Lambert EPSG 22391	None
Tangent Lambert EPSG 27572	None

9.1 Single location transforms

Transforms a single location directly typed in the EarthQuick frame. I/O could be projected coordinates (Easting/Northing) or geographic coordinates (Latitude/Longitude in Deg/Min/Sec or decimal modes).

See Figure 125 for example.

9.2 ASCII file navigation transforms



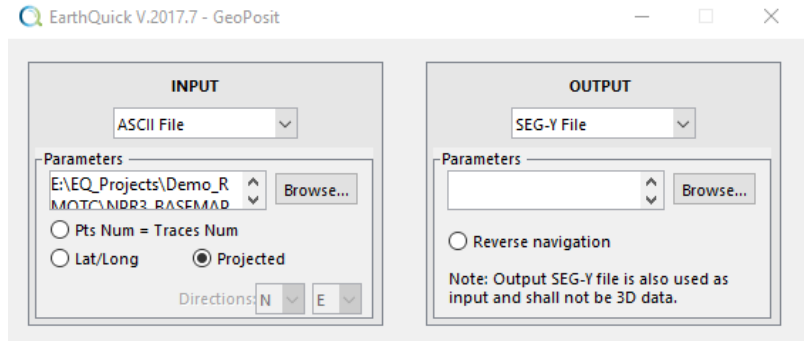
Converts columns of ASCII file. With the typical ASCII file loader in EarthQuick, users could select columns which matter in an ASCII file and decide to keep or not non-geographical columns.

Figure 126: Upper part of the GeoPosit frame for ASCII file to ASCII file conversion.

9.3 Navigation import into a SEG-Y file

Imports navigation into trace headers of a SEG-Y file from an ASCII file containing navigation, with or without column delimiters. Navigation points number from ASCII file could be different than SEG-Y traces number.

Figure 127: Upper part of the GeoPosit frame for ASCII file to SEG-Y file conversion.



9.4 Navigation export from a SEG-Y file

Extracts navigation from a SEG-Y file and put it within an ASCII file.

9.5 SEG-Y file navigation change

Simply converts navigation in a SEG-Y file. I/O are the same file.

That functionality is addressed to SEG-Y files containing 2D sections or 3D volumes. Before being an input, every SEG-Y file must be loaded first with the SegManager. Output here is created from a copy of the input before updating its coordinates. Therefore, the output does not have to be preexisting and loaded before navigation conversion.

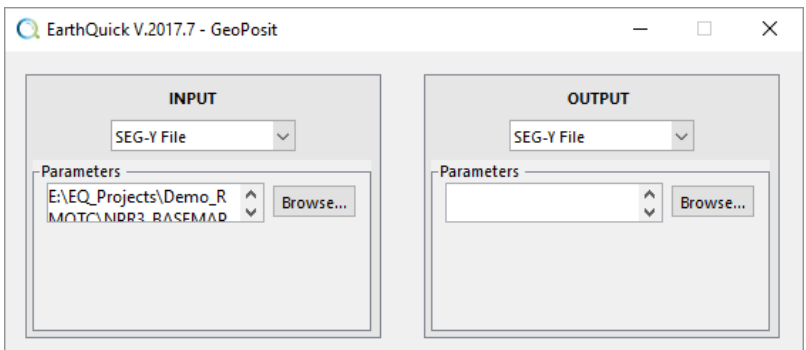


Figure 128: Upper part of the GeoPosit frame for SEG-Y to SEG-Y file conversion.

9.6 Images georeferencing

Inputs could either come from third party pictures with anchor points or be loaded from *Google™ Apps* services. Optional control consists in interactive deformation/calibration of the picture to cope with lateral distortions. Processing a picture with GeoPosit automatically enables display of the latter in the Global Viewer module with a node added to *Images* in the *Data Folder Tree*.



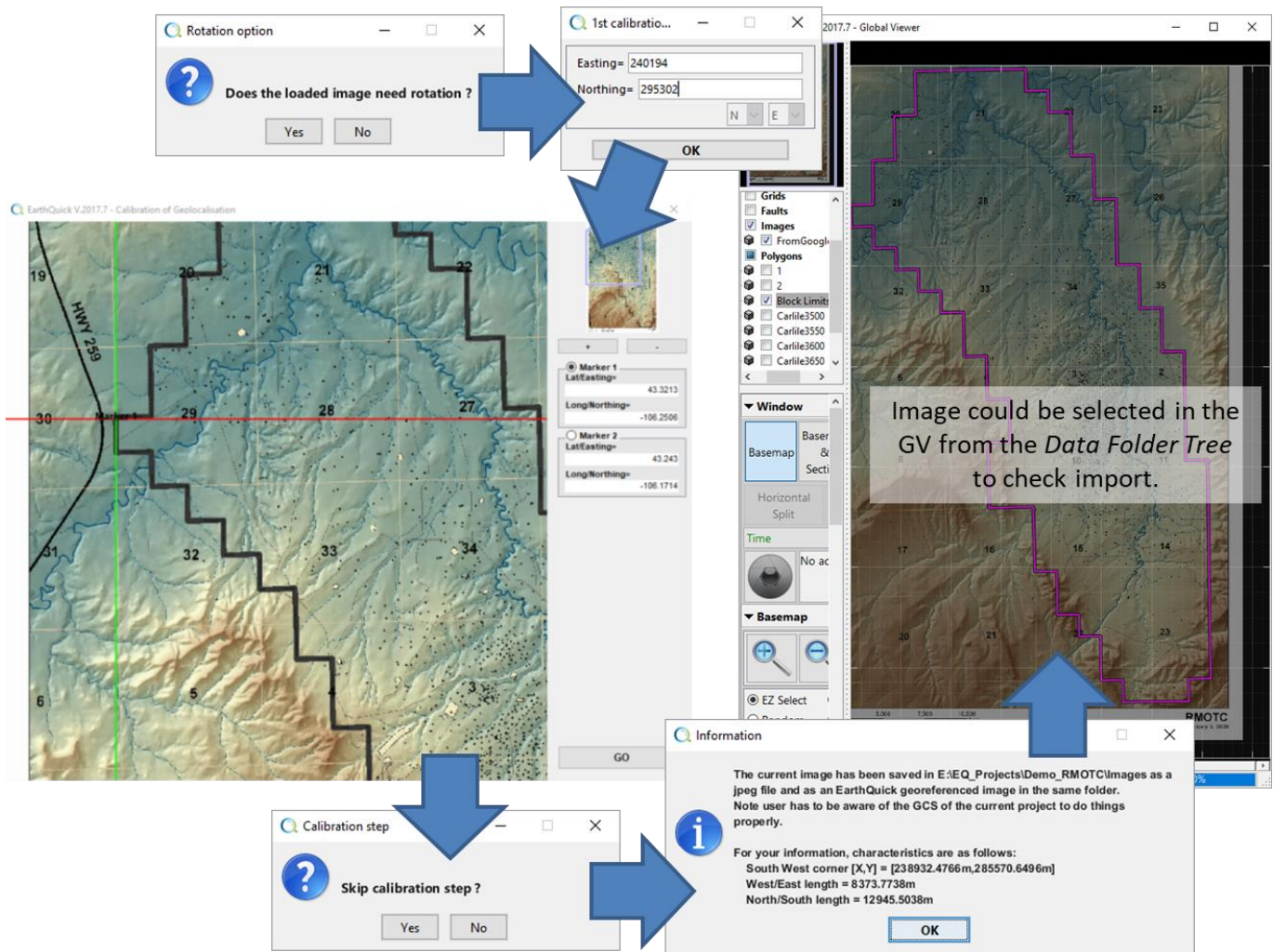


Figure 129: Image georeferencing workflow with an image file (skipping the calibration step).

Two import possibilities are shown in Figure 129 and Figure 130. The 1st uses an image file provided by users whereas the 2nd relies on Google facilities for image source. Here, the 1st skips the calibration step whereas the 2nd goes through that calibration step. That could be proceeded in any cases.

To go for Google images instead of user-defined input image, the toggle button *Google Apps* must be pushed in the GeoPosit frame. If internet connection is provided through a proxy, error messages could occur depending on its settings. At minimum, the requested image shall be displayed in the default web browser hosted by users' machine. Manual georeferencing must be proceeded afterwards.

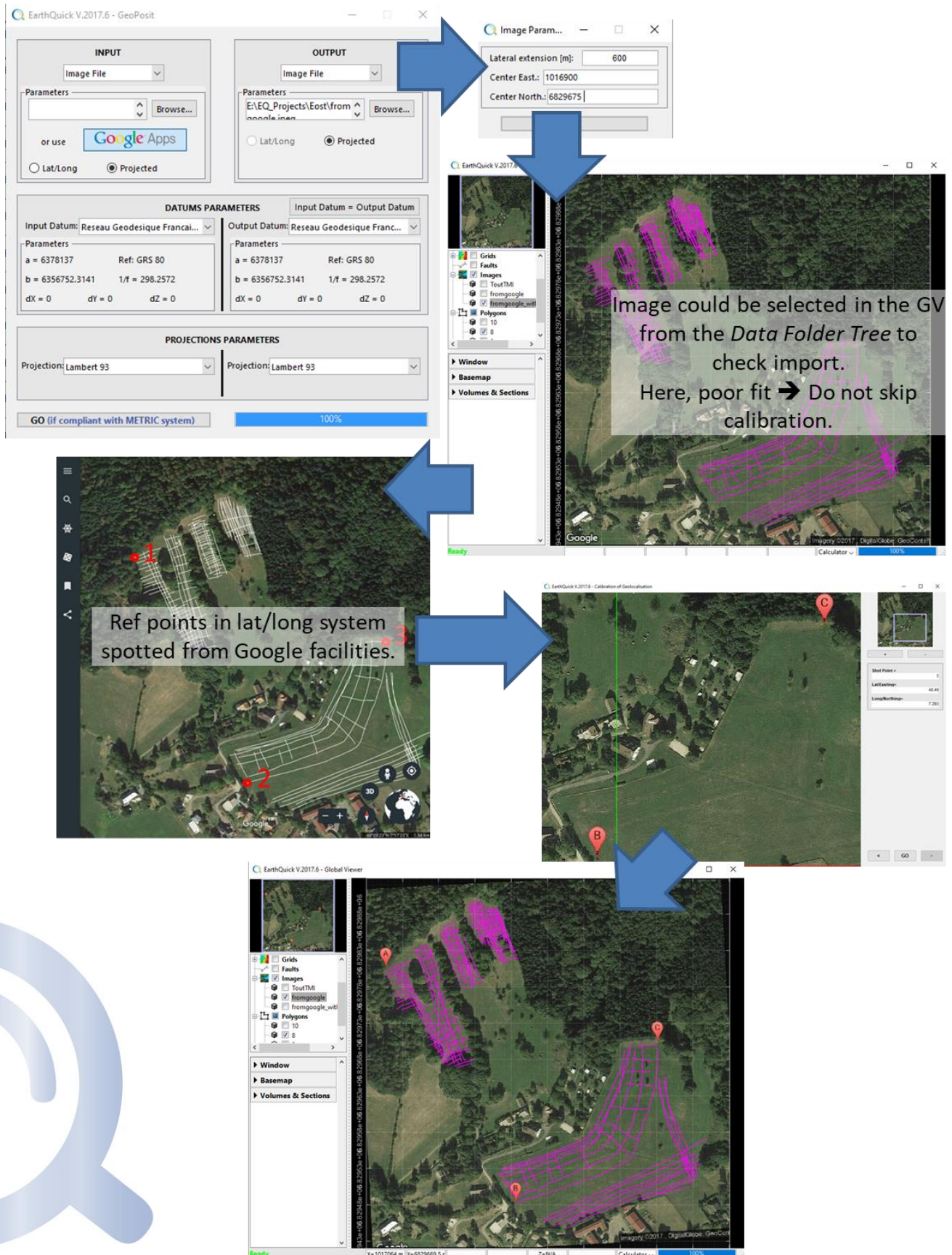


Figure 130: Image georeferencing workflow with a Google image (including the calibration step).

9.7 Polygons/lines import from shapefiles

To import polygons/lines enclosed in a shapefile directly in the Global Viewer and write simultaneously information in an ASCII file.

General information about the Coordinate Reference System (CRS) (contained in an eventual PRJ file (*.prj) aside) are provided after picking a shapefile (*.shp) with the file browser.

Pushing the *Preview* button gives access to fields and Polygons/lines indices investigation.

Either all Polygons could be imported at once choosing *ALL* for *Index*, or only one chosen index.

If *Alphanum. Field* is not blank, Polygons names take the field values.

In case *Alphanum. Field* is only made of numeric values, users could load the shapefile as a grid. That ability has been added for shapefiles hosting contour lines. Note a grid layout must be first already defined in the Global Viewer to enable the option.

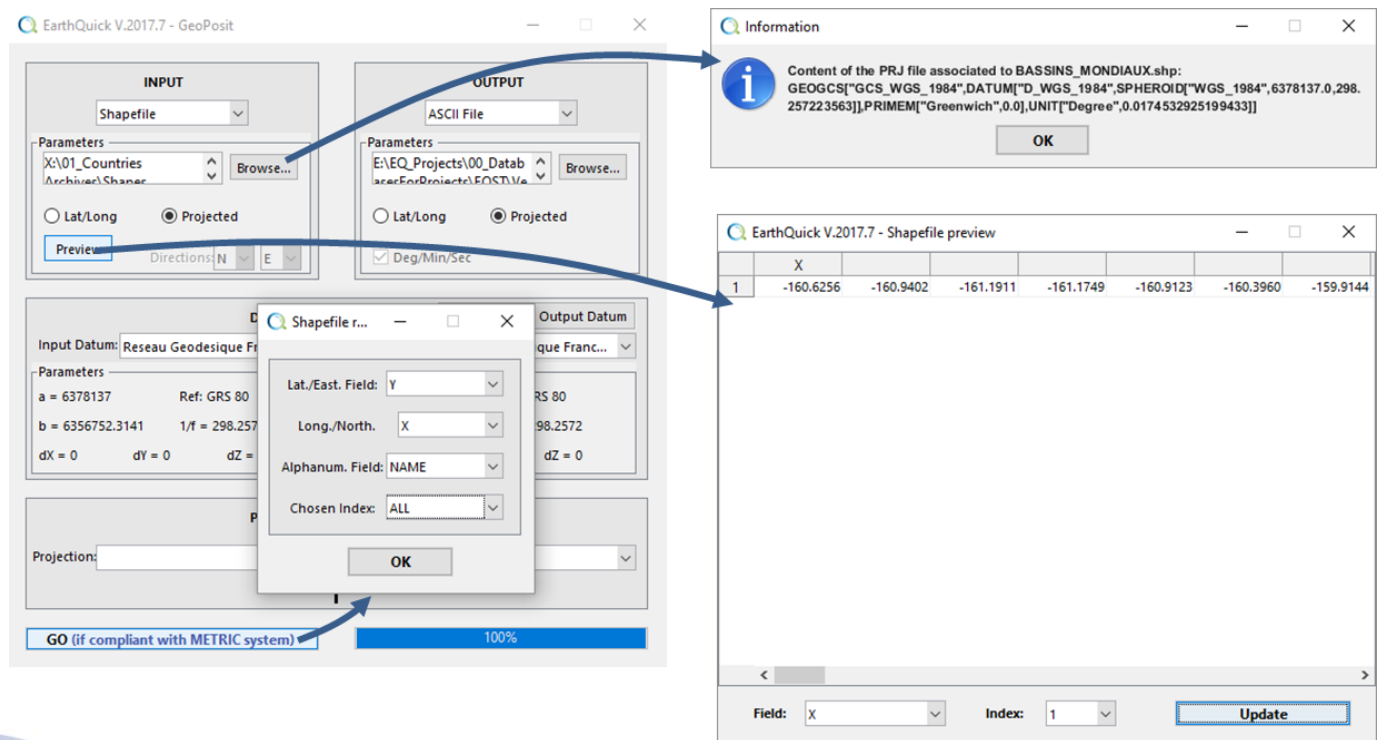


Figure 131: Shapefiles import.

9.8 Polygons/lines import from KML files

To import polygons/lines enclosed in a KML file directly in the Global Viewer and write simultaneously information in an ASCII file.

Different elements are split with "NaN NaN" rows in the output ASCII file.

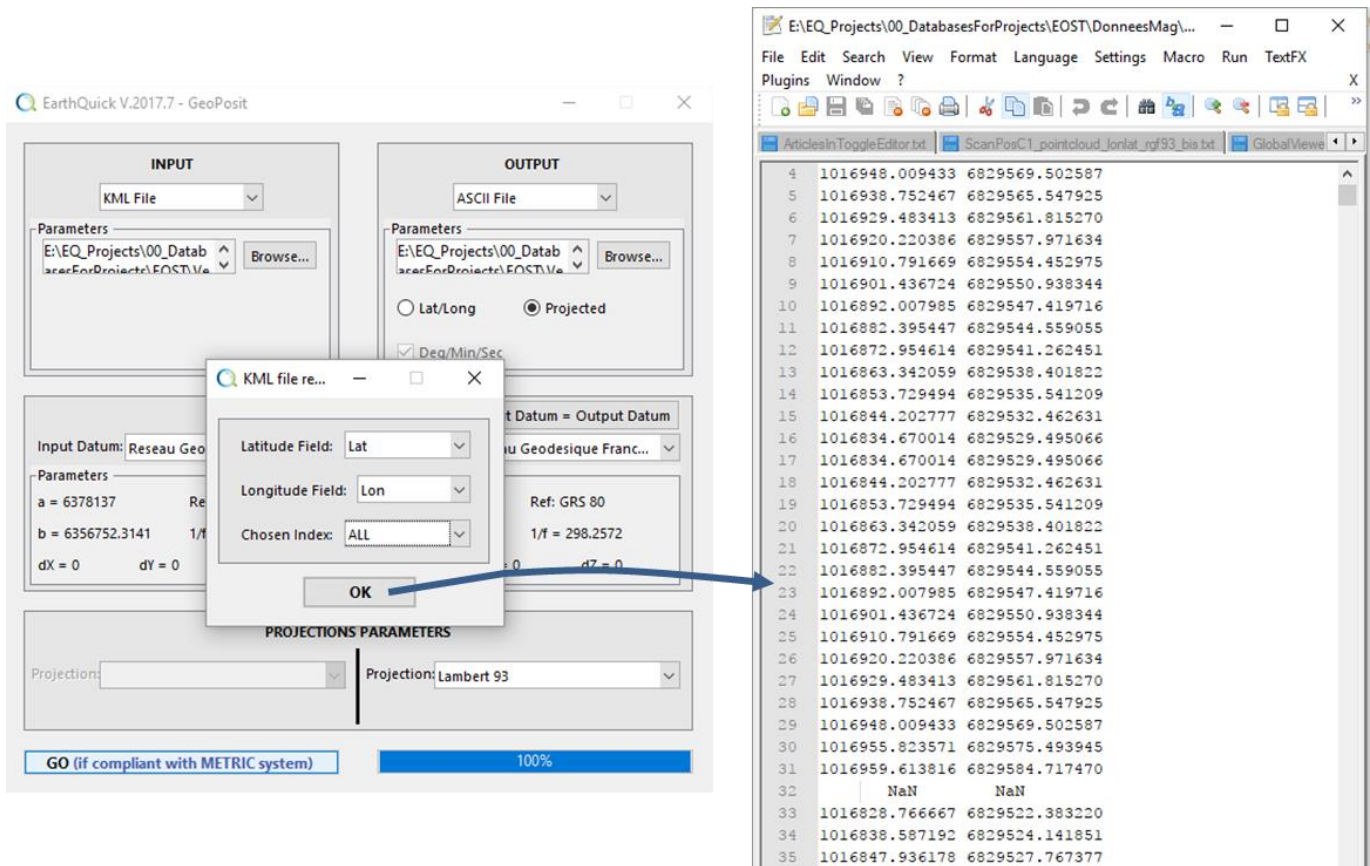


Figure 132: KML files import and output visualization in a third-party text editor.

9.9 Web Map Services

A Web Map Service is a standard protocol developed by the Open Geospatial Consortium in 1999 for serving georeferenced map images over the Internet. These images are typically produced by a map server from data provided by a GIS database.

The service endpoint URL's are to be provided as only input to deliver spatial information as map images (e.g., JPEG, PNG), by clicking the *Paste* pushbutton after copying a proper URL in the clipboard.

Outputs are:

- A JPEG image named in the Output panel by the users.
- A georeferenced image saved in the project and displayable in the Global Viewer (see Chapter 3.2).

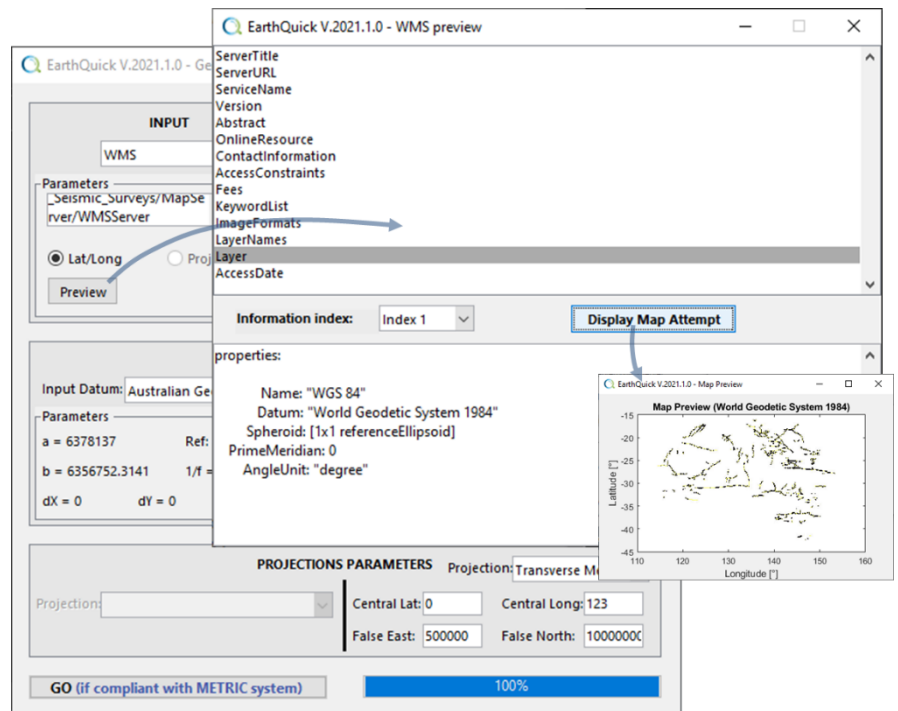


Figure 133: Exploring and displaying URL data content (Data courtesy of the Australian Geoscience Information Network).

Before going for loading, users could investigate the data content/fields, pushing the *Preview* pushbutton with possibilities to display maps. The *WMS Preview* window (see Figure 133) contains an upper panel made of a list box, which updates the entire frame on users' selection.

When pushing *GO*, users simply have to select *Layer Map Field* and *Chosen Index* to launch data import/loading.



- 32) Get 48-X-28 well geographic coordinates in WGS 1984. What if original projected coordinates were not in NA 1927 but in WGS 1984 instead?
- 33) Import NPR3-FieldBoundary.txt located in the *Original Data Folder*.
- 34) Georeference image NPR3_BASEMAP.jpg located in the *Original Data Folder*.
- 35) Import satellite image which fits the area of interest.



10 ScanPaperLine

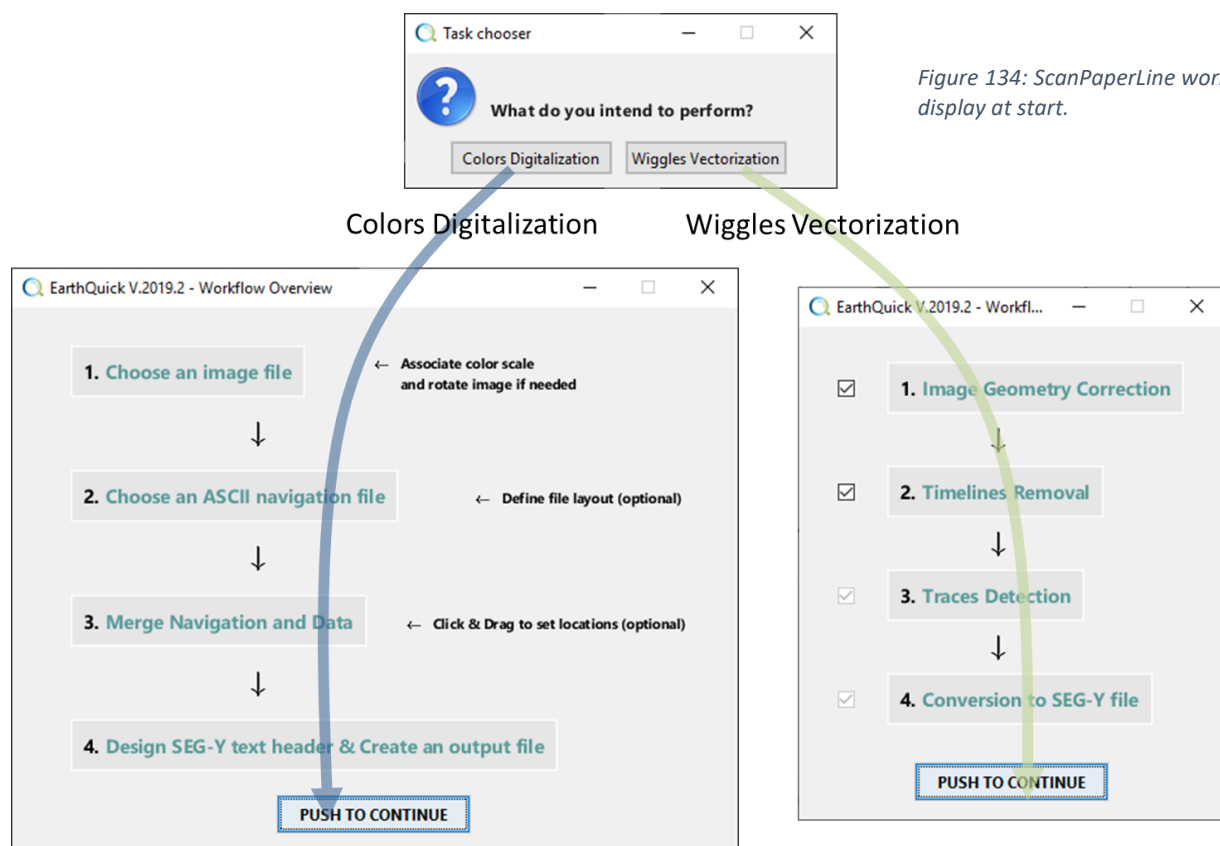


Figure 134: ScanPaperLine workflows display at start.

ScanPaperLine is a step-by-step process to convert any kinds of scanned images (e.g. seismic reflection or GPR data) into SEG-Y format.

As shown in Figure 134, the workflows proposed by the module allow both digitalization and vectorization of data.

With the **Colors Digitalization** process, signal amplitudes are color-coded (see Figure 135) so that a color could be directly linked to one single scalar value. Hence Digitalization could be assimilated to a color scale recognition.

When a section of data shows signal amplitudes as wiggles (see Figure 137), which looks like multiple side-by-side seismograph curves, with the **Wiggles Vectorization** process instead, the curves could be retraced with pattern/curve recognition algorithms.

10.1 Colors Digitalization

First option, namely Colors Digitalization, combine a scan of 2D sections and its related navigation to generate a SEG-Y file and ultimately being able to review the latter with the Global Viewer.

Steps quoted by the workflow reminder on Figure 134 are such as:

- An image representing a vertical section of the subsurface must be chosen (with rotation possibilities) and its color scale must be carefully handled,
- Navigation, if any, is loaded with a flexible ASCII loader,
- Links between image and navigation, if any, are set through a friendly user interface,
- SEG-Y export ends the workflow.

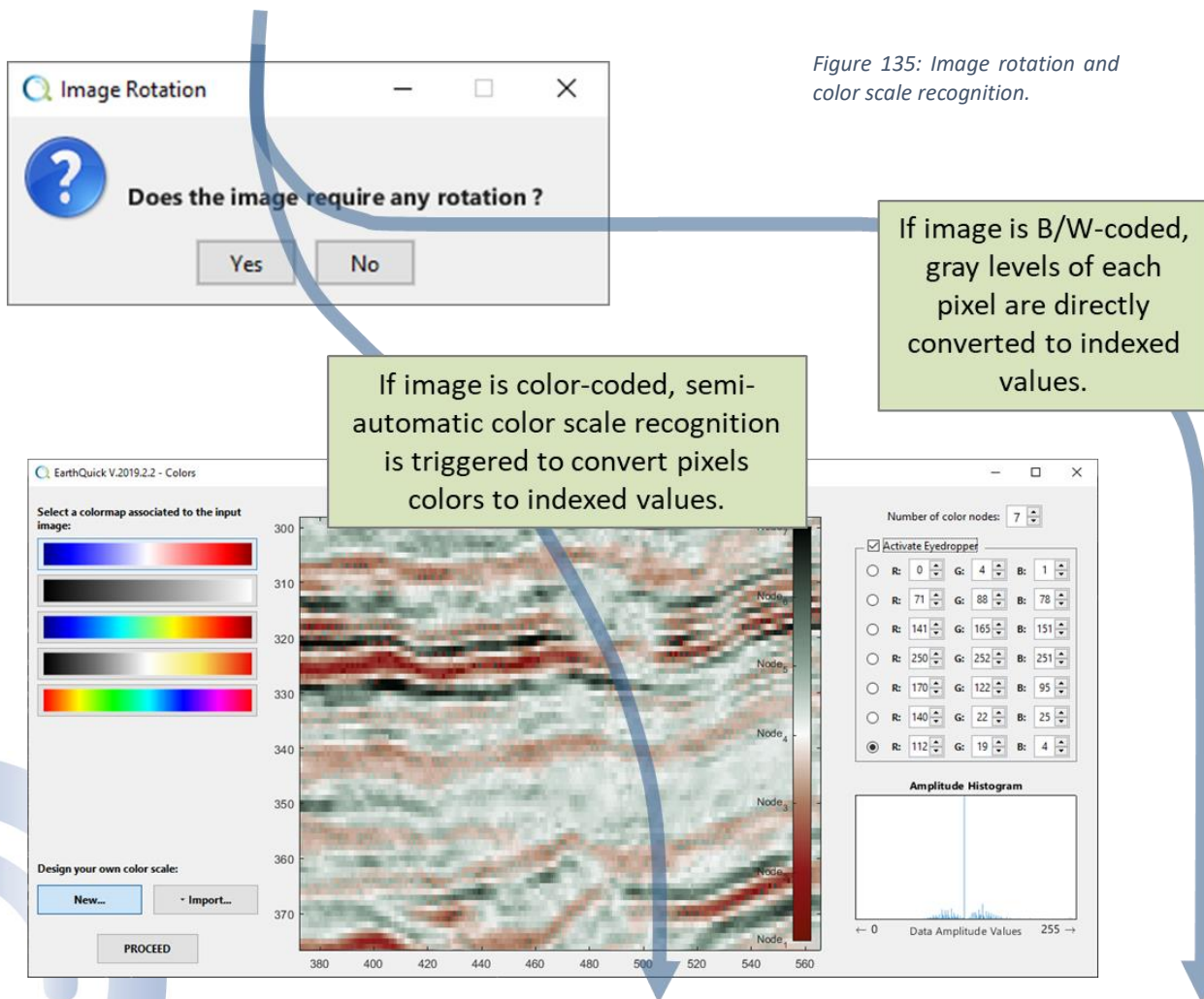
10.1.1 Image file import

A vertical section of the subsurface has not to be only B/W but must be compliant with a color scale chosen by user. 5 pre-defined could be used and custom color scales could be designed with to 7 color nodes and reused for further digitalization works (see Figure 135). Supported image formats of graphics files are bmp, cur, gif, hdf, ico, jpg/jpeg, pbm, pcx, pgm, png, pnm, ppm, ras, tif/tiff.

If the image is not an RGB image (i.e. a 3-layered image) but an indexed image (i.e. 1-layered image also called image with a gray color scale) instead, the color scale recognition is irrelevant and automatically skipped (see Figure 135).



Choosing automatically the B/W color scale when it is improper could result in a confusion between peaks and troughs in the signal.



If while reviewing the accuracy of the color scale recognition users identify some speckle effect on the section, *Power Spectra* facilities could be used to remove the effect. Then, pushing the *Save as Filtered Section* button in the *Power Spectra* window (see Figure 71 and Figure 72) enables to export the filtered section as a new SEG-Y file.

10.1.2 ASCII navigation file import

With the typical ASCII file loader in EarthQuick, users could select columns corresponding to Reference navigation points, X (Easting) and Y (Northing).

No specific format but ASCII with typical delimiters between columns is required. That step is optional. If no navigation is available, user could give CDP range for further navigation implementation through the GeoPosit module (see Figure 136 – Route B).

10.1.3 Merge of navigation and image

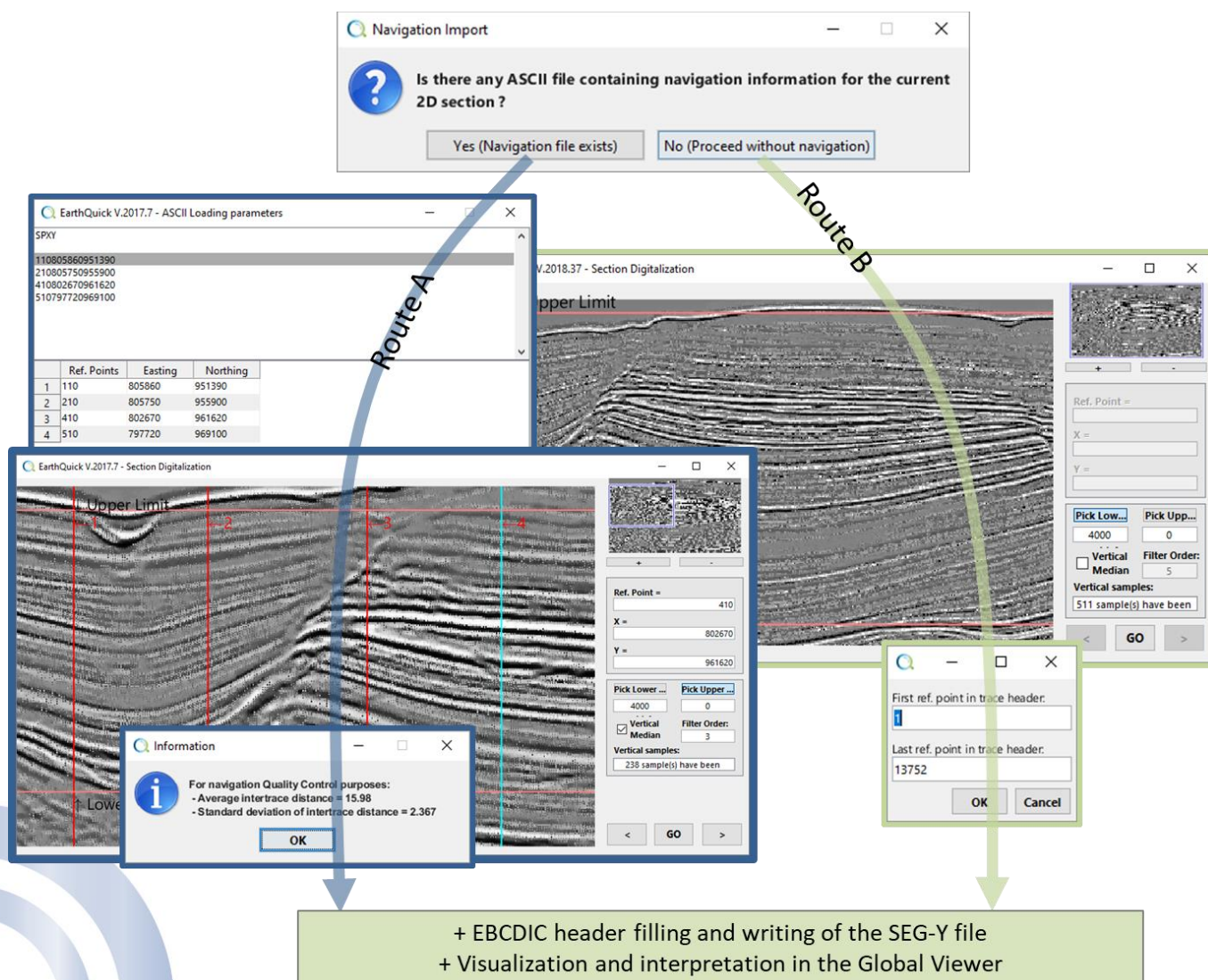


Figure 136: ScanPaperLine workflow: from loaded image to SEG-Y file.

Workflow to implement, handling frame on Figure 136 - Route A:

- Start with navigation points picking with MB1 on the main graphics in the left-hand side.
 - Click **>** to move to next point. Key Shortcut is "N".
 - Click **<** to move to previous point. Key Shortcut is "P".
 - When flying over the main graphics, a green vertical line follows mouse motions.
 - When the current navigation point has been picked on the image, its marker is a vertical static blue line.

- When a navigation point has been picked on the image and is not the current navigation point selected for picking, its marker is a vertical static **red** line.
- Push the toggle button *Pick Lower Limit* and *Pick Upper Limit* to respectively pick the lowest and shallowest known Z values on graphics and assign proper values in the editable text control underneath.
 - When toggled in, these buttons stop picking of navigation points.
 - If vertical axis corresponds to time domain, value must be considered as in milliseconds.
 - If vertical axis corresponds to depth domain, value must be considered as in meters.
 - These units are a direct legacy of the SEG-Y format with sampling rates expressed in microseconds and millimeters.
- When ticked on, *Apply Vertical Median Filter* enables to remove spiky events along the Z axis. The *Filter Order* correspond to the length of the filtering window in samples.
- Push GO when points allocations, vertical limits and filtering are set.

10.2 Wiggles Vectorization

Second option in the ScanPaperLine module, namely Wiggles Vectorization, enables pattern recognition of seismograph-like curves and translate them to signal amplitudes.

That functionality relies on algorithms deeply inspired from a publication by Daniel Sopher from the Geological Survey of Sweden: Sopher, D. (2018) Converting scanned images of seismic reflection data into SEG-Y format. Earth Science Informatics, 11, 241. Available at: <https://doi.org/10.1007/s12145-017-0329-z>.

Steps quoted by the workflow reminder on Figure 134 are such as:

- After loading the input image (including rotation possibilities), warping, adapted to the current data kind, is proposed. That step remains optional and skipped if not ticked on in the workflow reminder (see Figure 134),
- Removal of timelines is the following optional steps if images are marred by timelines, often occurring every 100ms on seismic sections. That is also skipped if not ticked on in the workflow reminder (see Figure 134),
- Detection of trace baselines is a mandatory step. That corresponds to central value of oscillating signal of each signal trace,
- Trace amplitude recognition follows with frequency filtering possibilities.
- SEG-Y export ends the workflow.

Note if users intend to implement navigation in the vectorized product, that step could be fulfilled in GeoPosit since SEG-Y export includes trace number filling in the trace headers, both in ascending and descending orders.

10.2.1 Image warping

Image warping (see Figure 137) is done in two directions:

- 1- Horizontal correction using *Baselines Picking*. Up to 4 different baselines could be picked in case of deformation variations all along the profile.
- 2- Vertical correction with the *Timeline Picking*.

Note if users are only interested by one of both corrections, picking of the unwanted correction must remain empty/blank.

To enable a more convenient displacement within the image when zoom level is very deep, users could rely on the keyboard arrows. Note the warped image could be saved by ticking on the *Save Output* checkbox.

After being satisfied with picking, users must push *PROCEED* to validate settings and go to next step.

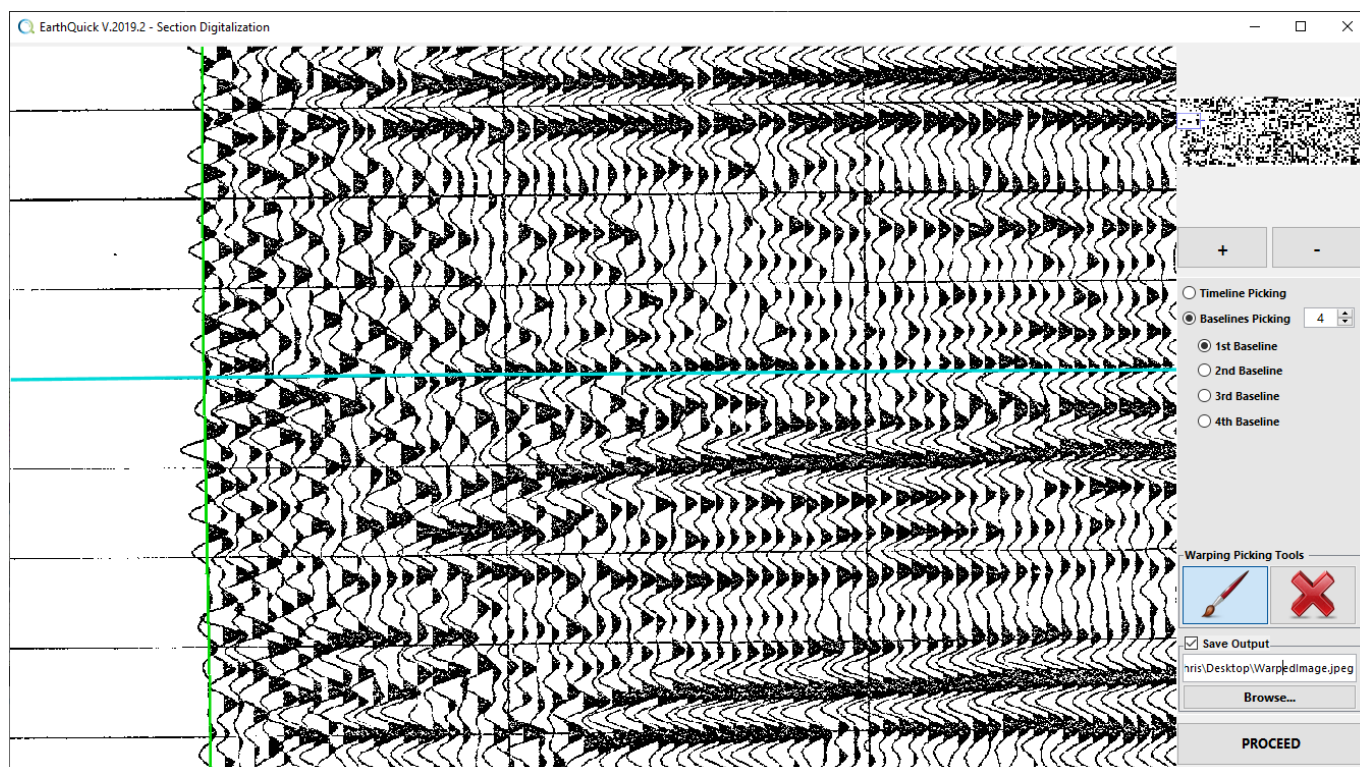


Figure 137: Image warping.

10.2.2 Removal of timelines

Removal of timelines is a process which could be adapted to images with different resolutions, different intertrace distances in pixels and different thicknesses of timelines in pixels.

Only 2 parameters have to be fixed here:

- The *Lateral operating distance in pixels*, directly linked to the intertrace distance but depending on the noise level too,
- The *Expected horizontal line thickness in pixels*.

In the bottom right corner, users could design a rectangle to limit the zone when testing the parameters. To do so, after adjusting a rectangle, *Capture Selection* must be pushed, followed by another push on *PREVIEW WITH SELECTION*.

After being satisfied with chosen parameters, users must push *PROCEED* to validate settings and go to next step.

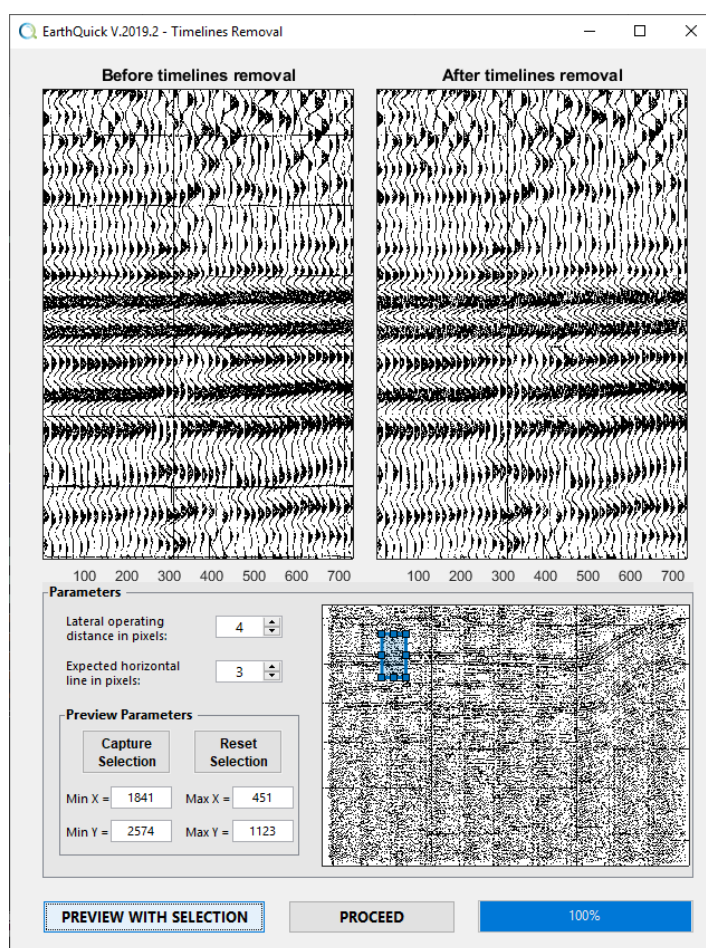


Figure 138: Removal of timelines.

10.2.3 Detection of baselines and trace amplitude recognition

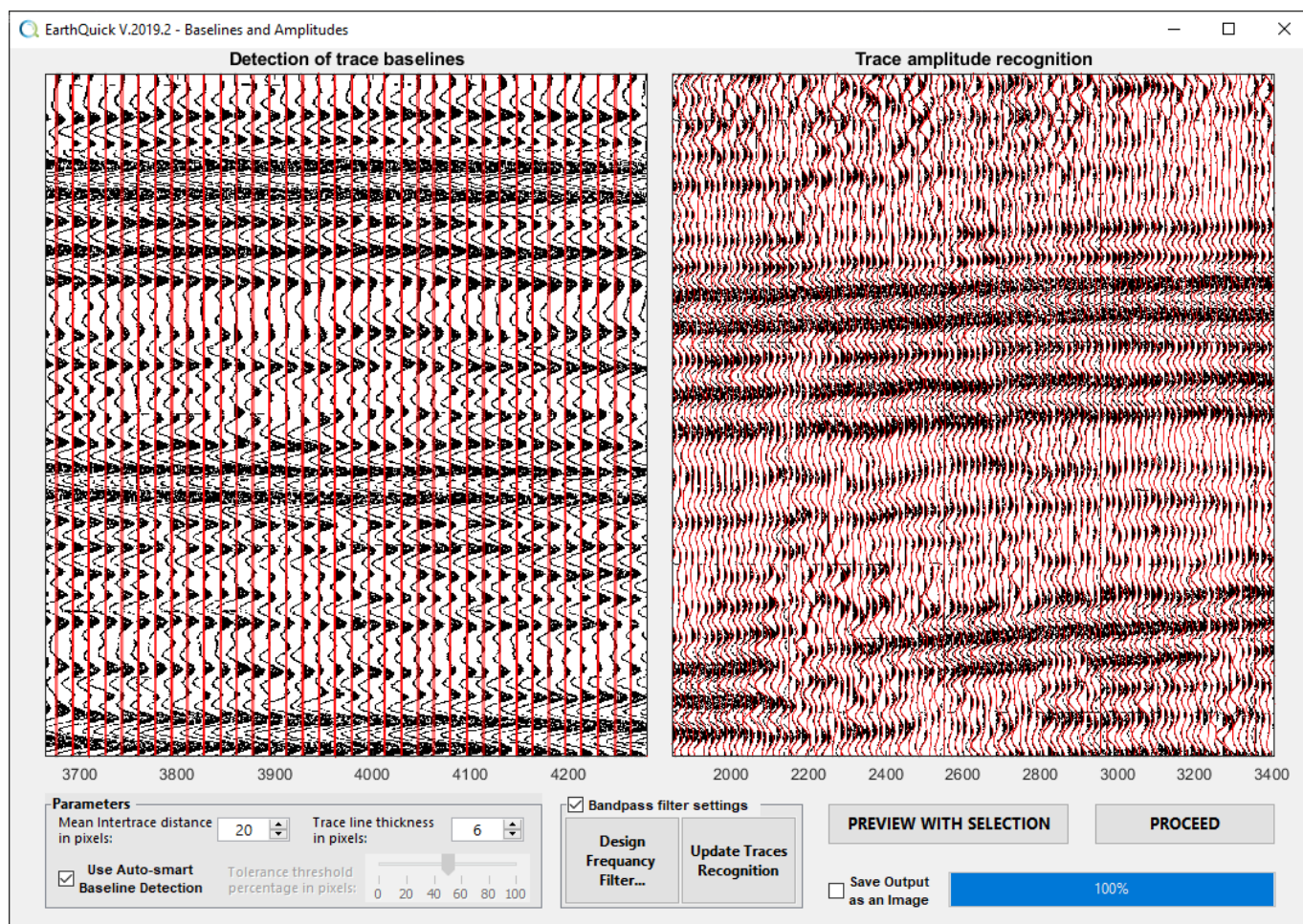


Figure 139: Detection of baselines and trace amplitude recognition.

Figure 139 displays both the baseline detection on the left-handed panel and the trace amplitude recognition on the right-handed panel.

- The baseline detection panel is made of the horizontal image overlapped by plotted baselines occurrence (red lines). The more confidence is high, the more the baseline plot goes down on the image.
- The trace amplitude recognition panel is made of the horizontal image overlapped by plotted traces (red curves) after recognition.

On Figure 139, different levels of zoom have been arbitrarily chosen by the user. Zooming facilities are active to let users scroll dynamically through the entire section on both panels.

Only 3 parameters have to be fixed here:

- The *Mean intertrace distance in pixels*. Assessment is straightforward relying on zooming facilities.
- The *Trace line thickness in pixels*. That corresponds to the curve thickness on the left-handed side of the baseline.
- The *Tolerance threshold percentage in pixels*. As an example, when set at 40%, only baselines with confidence above 40% are kept for further trace amplitude recognition.

An *Auto-smart Baseline Detection* is also suggested. If selected, *Tolerance threshold percentage* is not anymore required from the users.

Users has the possibility to add a frequency bandpass filter when ticking the *Bandpass filter settings* checkbox. Frequency is obviously not in Hz here but homogeneous to *1/pixel* instead. Vectorization product could also be saved as an image file by ticking on *Save Output as an Image* option.

After being satisfied with chosen parameters, users must push *PROCEED* to validate settings and go to export in SEG-Y format.



Additionally, that is reminded navigation could be implemented in the SEG-Y product through GeoPosit subsequently to vectorization.

Usual checks are also recommended, such as:

- In the Global Viewer, amplitude histograms could track amplitude cropping (see Figure 59) and F-k filtering (see Figure 72) could help with vectorization artefacts clean-up.
- In the SEGManager, decimation of traces and amplitude scaling/cropping could be handled. Decimation is recommended with too heavy SEG-Y product.

10.3 Outputs

Users have then the ability to fill the EBCDIC header on their own as shown on Figure 140 both with Digitalization and Vectorization processes:

- When a row is selected in the list, it becomes editable in the text edit control beneath. Then pressing the “return” key or the *Print In* button confirm modifications.
- Pressing the *Get File Header from a SEG-Y*, the EBCDIC header from another SEG-Y could be imported, and subsequently manually modified to be adapted to the current file.

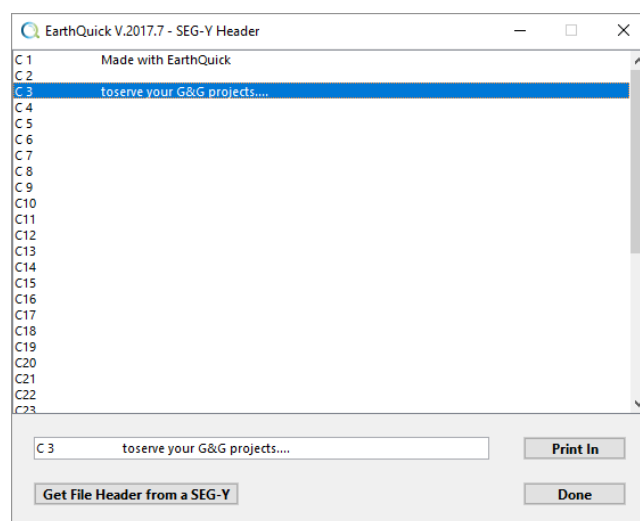


Figure 140: Output EBCDIC header filling.



Sampling interval of the output section, written in the SEG-Y format, is suggested with some rules quoted below:

- If $(\text{Lower Z value} - \text{Upper Z Value}) / \text{Height of image in pixels} < 0.1$, then Sampling interval = 25 in microseconds or millimeters.
- If $(\text{Lower Z value} - \text{Upper Z Value}) / \text{Height of image in pixels} < 0.5$, then Sampling interval = 125 in microseconds or millimeters.
- If $(\text{Lower Z value} - \text{Upper Z Value}) / \text{Height of image in pixels} < 1$, then Sampling interval = 250 in microseconds or millimeters.
- If $(\text{Lower Z value} - \text{Upper Z Value}) / \text{Height of image in pixels} < 2$, then Sampling interval = 1000 in microseconds or millimeters.
- If $(\text{Lower Z value} - \text{Upper Z Value}) / \text{Height of image in pixels} < 4$, then Sampling interval = 2000 in microseconds or millimeters.

- Sampling interval = 4000, otherwise.

Users have still the ability to force sampling interval to an arbitrary value from 25 μ s or mm to 4000 μ s or mm.

Image is then vertically resampled to fit the selected sampling interval.

In case of GPR data loading, users are advised to directly load sections in the depth domain. With average velocities of EM wave about 0.1m/ns in sediments and sampling rate of recording down to 0.2ns, depth sampling rate is as small as 2cm. In such conditions, loading in the time domain instead would result in a harsh image downsampling.

Quality control of the obtained section could then be done interactively by going straight to the Global Viewer after getting the success message. Note that generated section in SEG-Y format is automatically loaded in the current project.

If users are either eager to crop the side or decimate the trace sampling of the digitized section, the SegManager is the ideal tool to fulfil these tasks.



In case no navigation is directly available within a proper ASCII file, but as a drawing on a map, note that georeferencing of that map in GeoPosit followed by use of the polygon/polyline tool to pick the section path in the Global Viewer could simply cope with that issue. In case of crooked line, remarkable points only should be picked to enable subsequent implementation of navigation in the SEG-Y file. As a reminder, polylines/polygons are directly saved as ASCII file in the EarthQuick DB to make it easy to use afterwards.



36) From the publication in *chiaramonte2007.pdf*, located in *the Original Data Folder*, turn 2nd Figure to a SEG-Y file. Check navigation and distributions of geological formations.



11 EM1D

Giving multiplicity of phenomena at stake during a marine Controlled-Source Electromagnetic acquisition (mCSEM) between geometric, galvanic and inductive effects, every mCSEM project requires a feasibility study to evaluate the electromagnetic response of the most-likely subsurface resistivity layering, giving an indication of whether or not the target HC reservoir could be detected.

A tabular medium (1D) modeling algorithm is normally always used since it is fast and provides sensitivity analysis of the hypothetical HC reservoir response. EM1D intends to fulfill that basic need.

Key abilities are quoted below:

- Interface to design subsurface models,
- Frequencies, offsets and target resistivities screening,
- Responses Normalization,
- Ambient noise modeling,
- Pulse shape design,
- Well logs visualization,
- Save/open models.

11.1 1D Model and physical parameters to be tested

Thickness and resistivity (or conductivity) of the modeled layers are first defined based on geological knowledge. A set of parameters (source frequencies, source-receivers offset, noise level) are then tested to understand how a HC bearing layer could lead to an electromagnetic anomaly, seen on different components of the electric and magnetic fields.

Figure 141 is the main frame of the module and is composed of:

- In the top, a menu bar with commands detailed in next subchapter.
- On the left-hand side, a graphical representation of the model. Note every layer interface could be dragged to change its thicknesses by hand. Model is tuned to fit geology and fluid content layer. Here, orange layer corresponds to the hydrocarbon bearing reservoir layer under scrutiny.
- On the right-hand side, top panel, the *Model Settings* panel (see Chapter 11.1.1).
- On the right-hand side, middle panel, the *Transmitter-Receiver Elevations* panel (see Chapter 11.1.2).
- On the right-hand side, bottom panel, the *Computation Parameters* panel (see Chapter 11.1.3).

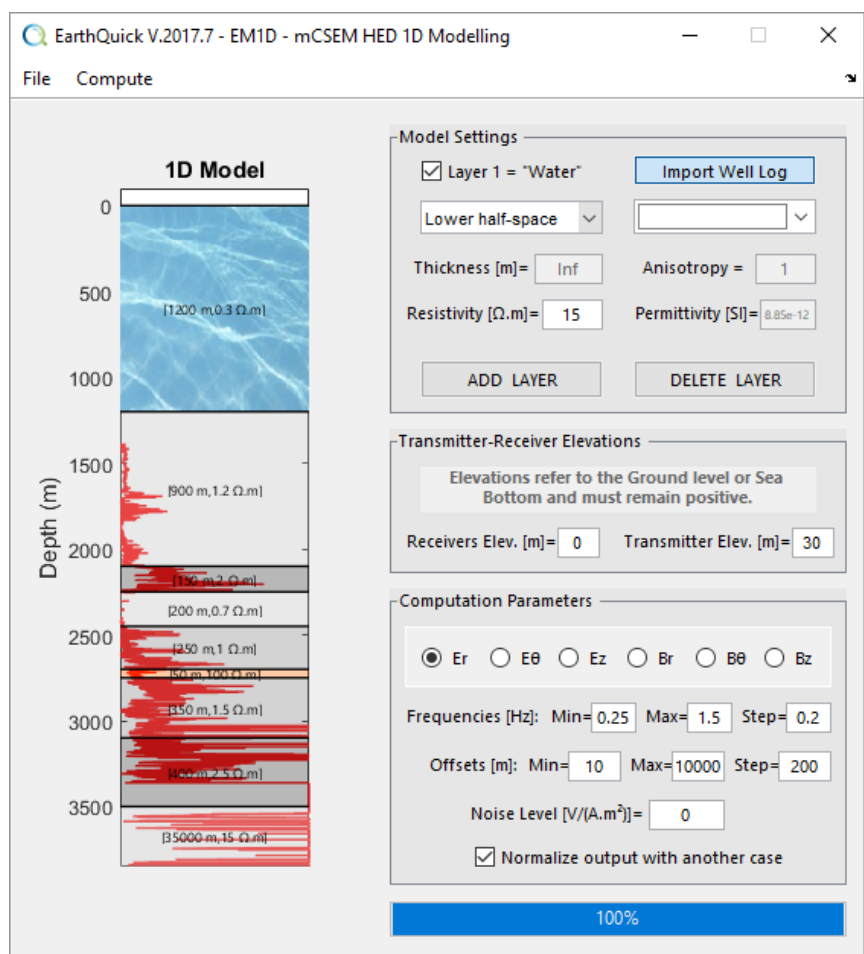


Figure 141: EM1D main frame.

11.1.1 The Model Settings panel

When clicking on a layer with the mouse on the 1D model graphics, that is then selected, and displayed *Thickness* and *Resistivity* are relative to the latter. The left dropdown menu shows the reference of the clicked layer in the same time. The right dropdown menu enables to choose the color of the selected layer.

The selection of the layer could be made with the left dropdown menu too.

1st layer of the model could be turned to water layer by ticking on the checkbox named *Layer 1 = "Water"*.

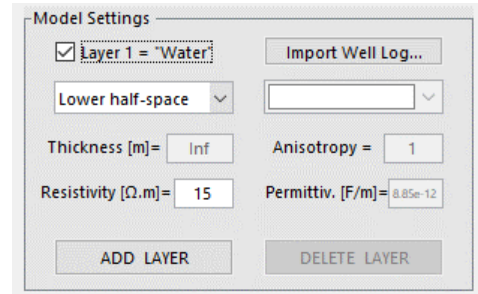


Figure 142: EM1D - Model Settings panel.

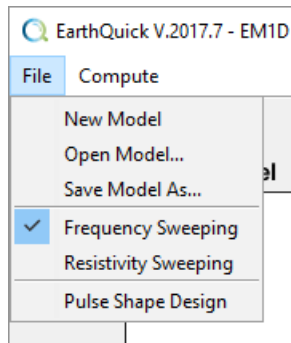


Figure 143: EM1D menu bar.

If users are eager to display a well log (already loaded in the project) on top of the 1D model; that requires to push *Import Well Log...*

Anisotropy and Permittivity are not modifiable yet but are still displayed for information.

When pushing the *ADD LAYER* button, a layer is added below the actual lower half-space to become the new lower half-space.

To delete a layer, that must be selected first, followed by a push on the *DELETE LAYER* button.

From the menu bar (see Figure 143), the model could be flushed or saved in an EarthQuik proprietary format. Saved project could then be opened a posteriori.

11.1.2 The Transmitter-Receiver Elevations panel

Elevations are given above the ground level or Sea Bottom and must remain positive.

Figure 144 shows an example when receivers are laid on the sea bottom and the Horizontal Electric Dipole is towed 30 meters above the sea bottom.

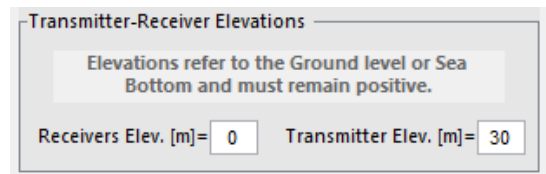


Figure 144: EM1D - Transmitter Receivers panel.

11.1.3 The Computation Parameters panel

Figure 143 shows two modes could be chosen: either Frequency or Resistivity sweeps. A change of mode has an impact on the panel components. While Figure 146 correspond to the panel for Frequency sweeps, Figure 145 correspond to the panel for Resistivity sweeps.

Figure 145: The Computation Parameters panel with Resistivity sweep.

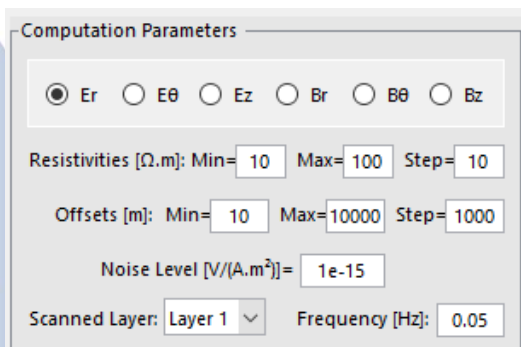
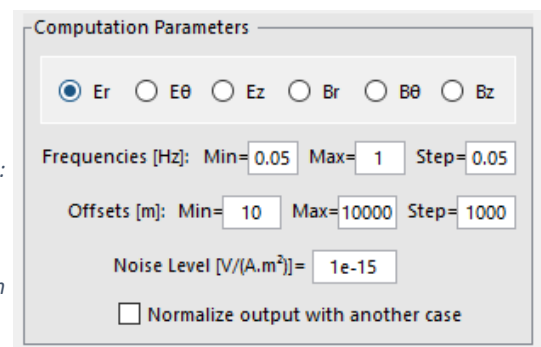


Figure 146: The Computation Parameters panel with Frequency sweep.



The term “sweep” refers to the possibility to test a range of different values for some parameters. Note for both quoted modes, a sweep of offsets (i.e. the transmitter-to-receiver distance) is always possible.

To avoid multiplicity of graphical results, users must choose one single component of one single electromagnetic field. E is the electric field and B the magnetic flux density.

Indices determine components. Index r, stands for “Inline”. Index θ , stands for “Broadside”. Index z, stands for “Vertical”.

Noise could be added to mimic reality (noises of natural and electronic origins).

In the frequency sweep mode, when normalization checkbox is ticked in, users could “divide” a case with a HC bearing reservoir by a case with a water bearing reservoir. Doing so, anomaly of amplitude due to HC bearing is highlighted.

11.1.4 Typical workflow

Natural way to proceed is first to test a wide set of values for some key parameters (i.e. offset, frequency, resistivity of the reservoir layer). Figure 147 illustrates the response of a model on the inline component of the Electric field, tested by screening parameters such as frequency, transmitter- receivers offset or noise level. Normalizing of the HC bearing case with a water case has been made to highlight signal content induced by the HC bearing layer only. Resistivity of the layer of interest could be screened the same way. Slider in the bottom part, enable to add contour levels.

For a closer look to anomalies, including responses in phase, users could then restrain frequency or resistivity sweeps to single values (i.e. minimum = maximum) to observe graphics such as Figure 148. Here, users fixed frequency to 0.5 (Min = 0.5 and Max = 0.5), leaving results shown as color-coded maps to curves.

Modeling computation is launch by clicking *Compute* → *Run Modeling* in the menu bar.

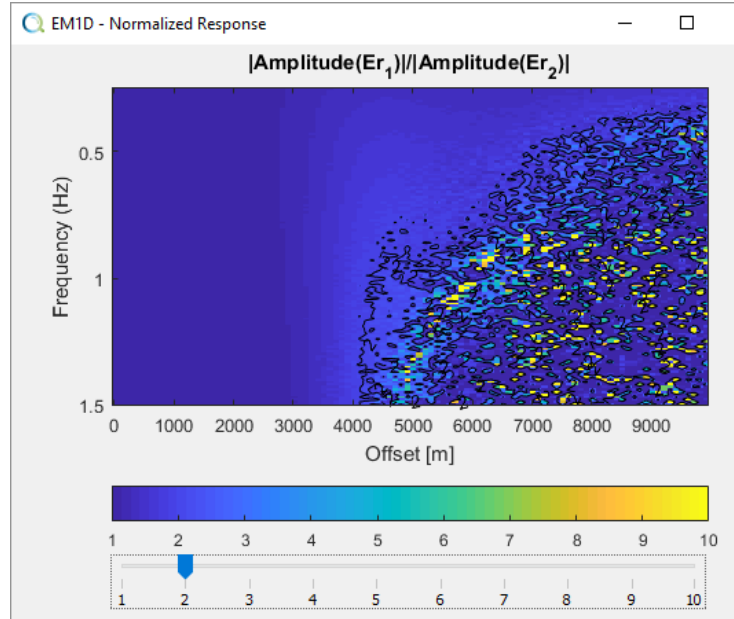


Figure 147: Normalized inline electric response of a model in frequencies vs. offsets.

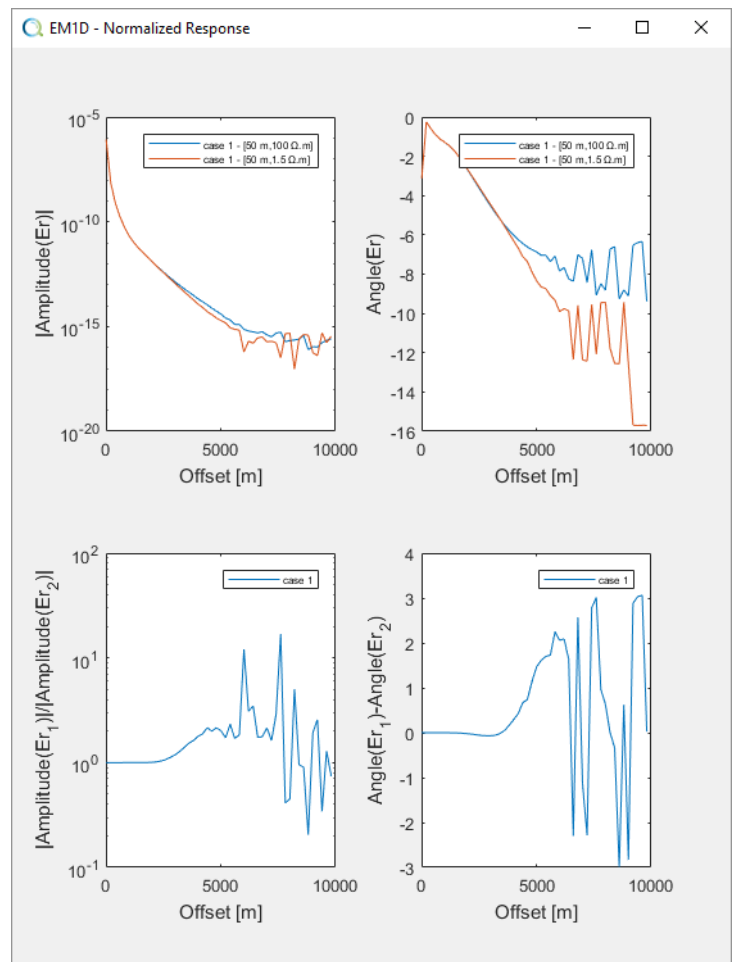


Figure 148: Normalized inline electric response of a model in amplitude vs. offsets with fixed frequency.

11.2 Transmitter pulse shape design

Pulse shape design is a product of the feasibility survey. After identification of source responsive frequencies, the signal – or pulse – must be tuned to contain the latter frequencies. Square waves are used to enable the maximum of energy to be transmitted.

To launch *Transmitter Pulse Shape* facilities and get same frame as shown on Figure 149, *File* → *Pulse Shape Design* must be clicked (see Figure 143).

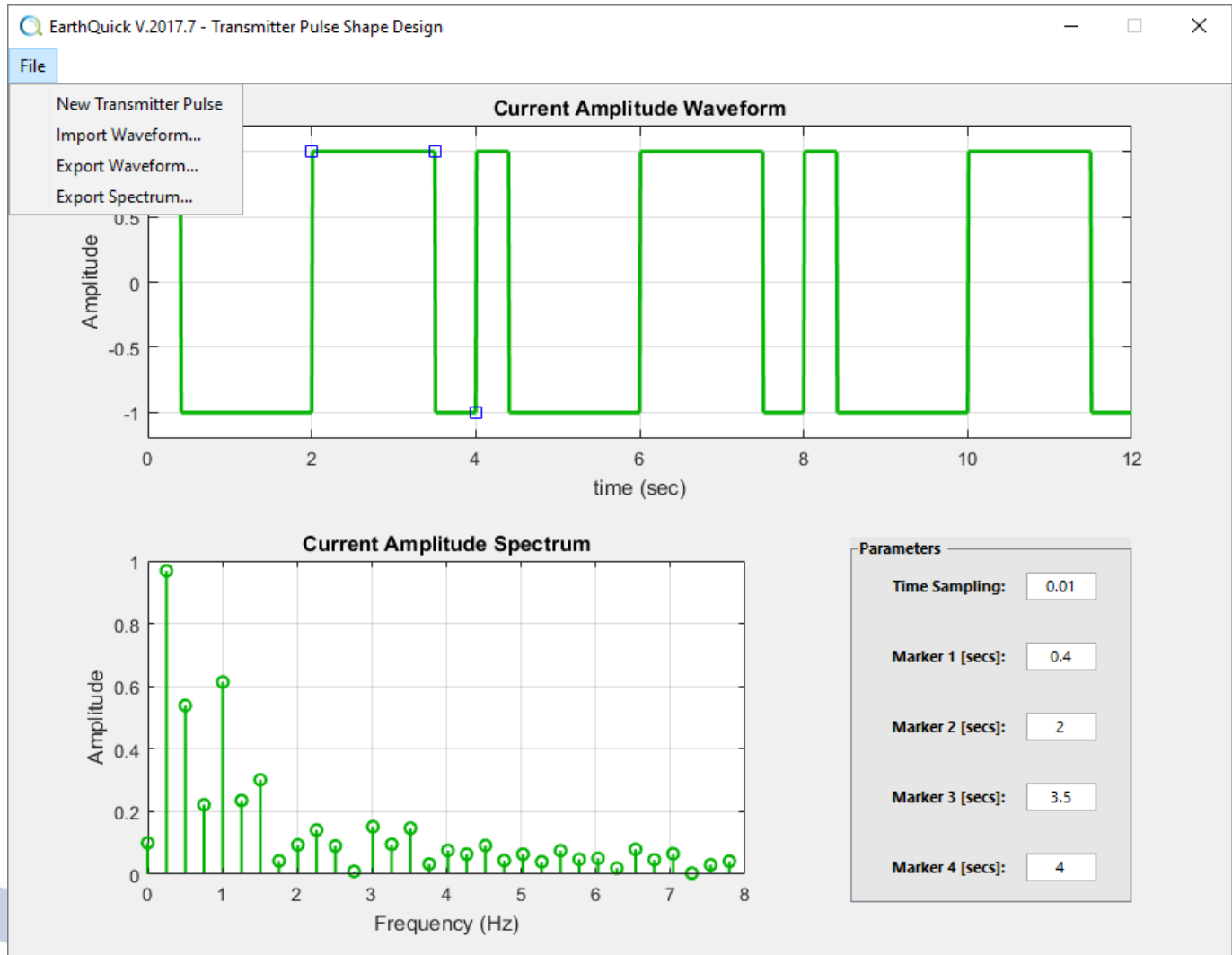


Figure 149: Transmitter pulse shape design in time and frequency series.

The Transmitter Pulse Shape Design frame is made of 3 panels:

- In the top part, the time series. Blue squared markers let users to change manually the pulse shape (green curve) by dragging them laterally.
- In the bottom part, on the right-hand side, same markers could be moved by giving their exact locations in seconds in the time series. Time sampling is also modifiable there.
- In the bottom part, on the left-hand side, the amplitude spectrum, automatically reset when time series are modified. Mouse wheel enables dynamic zoom along the frequency axis.

Regarding the menu bar options:

- Outputs of modeling could be exported by clicking *File* → *Export Waveform...* (i.e. time series), or *File* → *Export Spectrum...*
- ASCII import of time series could be triggered by clicking on *File* → *Import Waveform...*, achievable through the typical ASCII file loader in EarthQuick.
- Frame could be reinitiated by clicking on *File* → *New Transmitter Pulse*.



12 Risked Eyesight

Through Monte Carlo simulations, triggered on multiple distributed parameters, users could handle risks managements at a glance. Deterministically, the result, meaning the risked quantity, corresponds to the multiplication of all added and selected parameters.

Main characteristics of the Risked Eyesight module are detailed below:

- Number of parameters is not limited,
- Possible distribution kinds are Uniform, Normal (i.e. Gaussian) and Log-normal.
- Minimum number of simulations is 5,000. Maximum is 1,000,000.
- Parameters could be temporally excluded from computation by unticking related checkbox in the Selection column.
- Decision tree analysis is not part of the module.

Settings (see Figure 150) could be handled such as:

- All cells of the table of parameters are editable, and correspond to:
 - Column 1: Parameter name.
 - Column 2: Selection, parameter only considered if ticked on.
 - Column 3: Minimum value (also mentioned as P99) of the distributed parameter, always mandatory.
 - Column 4: P50 value of the distributed parameter. That could be irrelevant depending on distribution kind.
 - Column 5: Maximum value (also mentioned as P01) of the distributed parameter, always mandatory.
 - Column 6: Distribution kinds. 3 possibilities, namely Uniform, Normal or Log-normal.
- Monte-Carlo Simulations spinner enables users to change number of draws from 5,000 to 1,000,000.
- Add row and Delete row enable respectively to add and delete parameters.

For each parameter, required inputs are such as:

- P99 and P01 values are considered to be respectively Min and Max.
- P99 and P01 are required for all distribution kinds.

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Parameters	Selection	P99	P50	P01	Distributions
Area	<input checked="" type="checkbox"/>	300000.000	1190000.0...	2080000.0...	Gaussian
Thickness	<input checked="" type="checkbox"/>	3.000	6.000	9.000	Gaussian
Porosity	<input checked="" type="checkbox"/>	0.200	0.250	0.300	Gaussian
Oil Saturation	<input checked="" type="checkbox"/>	0.100	0.500	0.900	Gaussian
RF	<input checked="" type="checkbox"/>	0.400	0.550	0.700	Gaussian
MMstdcm--> bbl	<input checked="" type="checkbox"/>	6.290	NaN	6.290	Uniform

Monte-Carlo Simulations = 100000

Riskd Quantity = Area . Thickness . Porosity . Oil Saturation . RF . MMstdcm--> bbl

Add row Delete Row Cancel Launch

Figure 150: Settings of parameters of which the product corresponds to the risked quantity.

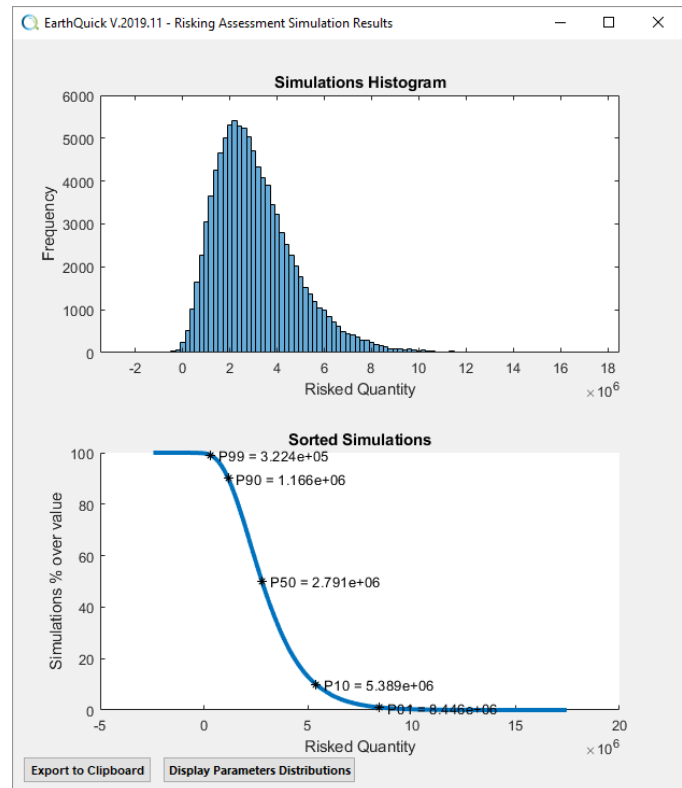


Figure 151: Risked Quantity from Monte-Carlo simulations.

- If users want to multiply results by a constant factor a constant factor, that is achievable by the use of Uniform distribution with Min value equals max value.
- A *NaN* string could be added in the table of parameters when value is not applicable. For example, for Uniform and Log-normal distributions, there is no point to define a P50 value.

To trigger simulation, after complying with parameters definition and selection, and fixing a number of simulations, users could push the *Launch* button. After running required simulation, EarthQuick displays the Risked Quantity distribution, highlighting P01, P10, P50, P90, P99 on the Sorted Simulations graph. Sorted simulations could also be exported to the computer clipboard by clicking *Export to Clipboard* for further use of results outside EarthQuick. Figure 151 illustrates these possibilities. Every distributed parameter could then be individually observed by clicking the *Display Parameters Distributions* button (see Figure 152).

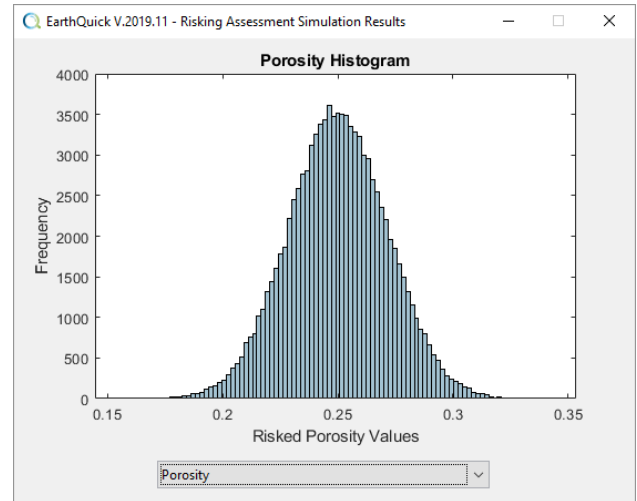


Figure 152: Focus on an individual parameter distribution.

VolumetricsParam.csv file created when launching a Monte-Carlo simulation in the Risked Eyesight module. The latter contains parameters distributions.



37) From parameters definition in Figure 150, get to result in Figure 151. Obverse effects of a drop to 5,000 draws on results.



13 Projects transfer and content filtering

For some reasons, an EarthQuick project transfer from a location to another, including some project, may be required.

Transfer and content filtering remain easy tasks with EarthQuick since:

- Project DB is restricted to simple folders and files with explicit names, accessible through the Windows File Explorer.
- Only 2 files to handle data paths per project (EQProjects.csv and DataPaths.txt).
- Project sizes are fairly reduced by the absence of heavy files (mostly SEG-Y's) rewriting using an internal proprietary format.

13.1 Project transfer

Before transferring, the project location must be found in the users' storage. Two simple ways to access project paths:

- Directly from the EarthQuick Launcher after selecting a project (see Figure 17 – tab (2)).
- From the root item of the *Data Folder Tree* in the GV and the WB.

Then, after copying/pasting the project folder to the location of interest with the Windows™ File Explorer, users must get to your folder *My Documents* or *Documents* and get in the folder *EarthQuick*. In there, *EQProjects.csv* is used by the Launcher and gathers projects attributes (Root folder, Name, Date of Creation). Attributes are separated to each other by a comma.

When projects are created or deleted with the Launcher, *EQProjects.csv* is automatically updated.

In case a project is moved manually, *EQProjects.csv* must be modified manually. For instance, to import a project and make it visible in the Launcher, a row must be added to *EQProjects.csv*.



EQProjects.csv must be edited only when EarthQuick is NOT running. It is also strongly recommended to use the text file editor and freeware Notepad++™ (<https://notepad-plus-plus.org>) to modify or at least check all modifications made on all CSV files generated by EQ.

13.2 Project content filtering

13.2.1 Volumes and Sections content filtering

Files with prefixes "SubXEastNorth" in the root directory of a project link SEG-Y files to that project and make them visible to EQ. One for each loaded/created SEG-Y file.

If these files are manually deleted, the link is simply removed. To recover the latter, making volumes or sections data visible again to EQ, the loading steps must be fulfilled again within the SegManager.

If you copy/paste one of these files, you shall retrieve visibility of related data.



Handling manually SubXEastNorth-prefixed files could require manual update of the DataPaths.txt file if SEG-Y sources are located in an "unexplored" folder for the current project. See Chapter 3.3 for more explanations.

13.2.2 Wells data filtering

Wells data could be handled directly within EQ. However, in case of massive intervention on a DB, another approach is suggested.

For more information about well data organization, Chapter 3 about Data Base must be read. However, it is reminded that all files mentioned in the current subchapter are part of the *Wells* folder of a project.

13.2.2.1 To remove/add a well outside EQ

A row must be removed/added in *ProjectWells.csv*.

In case of a well removal, all logs, deviation and T/D's associated to the concerned well should be manually deleted. However, each time the GV or WB is launched, EarthQuick looks for "orphan" logs, deviations and T/D's and delete them all.

13.2.2.2 To remove/add a well log outside EQ

Manual copy/paste through the Windows™ File Explorer could be done with care. Indeed, files names (including explicit wells names) must obviously remain consistent with *ProjectWells.csv*.

13.2.2.3 To remove/add markers outside EQ

WellsMarkers.csv must be updated. Third-party tables editors, such as Excel™, embed filtering functionalities on columns, which could ease handling of *WellsMarkers.csv*.

13.2.3 Other kinds of data

Other data could be simply remove or copied/pasted through the Windows File Explorer for filtering and transfer.

13.3 Miscellaneous information

In a project folder, if one of the subfolders \Events, \Polygons, \Images, \MetaData or \Wells is manually deleted, the project shall be seen as corrupted by EQ.

A file named *GCSandUnits.xml* could occur in the root folder of your project and contain information about geopositioning and system units (imperial or metric). It is strongly recommended to always keep it when transferring or filtering projects.



14 Mouse and Keyboard Shortcuts

	Shortcuts	Modules	Actions
LAYOUT	Ctrl-p	Global Viewer (GV)	For hard copy purposes, when using the screenshot facilities. Switches basemap and overview panels backgrounds color in the main window in sync with 3D viewer if activated (2 modes: Dark and Light).
		Wells Board (WB)	For hard copy purposes, when using the screenshot facilities. Switches wells headers and logs backgrounds color (2 modes: Dark and Light).
	Page up or Page Down	GV	Switches between <i>Basemap</i> , <i>Basemap & Seismic</i> and <i>Seismic</i> panels view modes. Same result as with eponymous toggle buttons.
DATA DISPLAY	a or q	GV – Basemap Panel	Zoom in and Zoom out on the basemap. Same result as with pushbuttons with magnifying glass icons.
	z	GV – Sections Panel	Activates possibility to define zooming level on displayed seismic sections by drawing a rectangle with the mouse.
	Double-click MB1 (mouse left click)	GV, SyntheticsGen	On sections panel, resets zoom to 1:1 aspect ratio.
	MB2 (mouse right click)	GV, SyntheticsGen	See comments below the table.
	Escape	GV	When drawing a polygon, enables to stop drawing without adding a last dot using MB2 click.
	+ or -	GV – 3D Viewer	Scrolls through seismic volumes along Inlines, Xlines and Time slices.
	Delete or Space Bar (after any lasso selection)	GV– Sections Panel	Deletes highlighted Grids or Faults picking points.
		WB (X-Plotter)	Removes selection on X-plot and related highlighters on wells logs in the main frame.
	Mouse wheel	GV – Basemap Panel	If no Images are displayed: Zoom in or Zoom out. If an Image is displayed: Changes Image transparency.
		GV – Sections Panel	Zoom in or Zoom out. If pushing <i>Ctrl+Scrolling mouse wheel</i> : Horizontal Zoom only. If pushing <i>Shift+Scrolling mouse wheel</i> : Vertical Zoom only.
		GV – 3D Viewer	Zoom in or Zoom out.

		WB – Headers Panel	Horizontal Zoom in or Zoom out on the wells headers. Modifications affect log widths too.
		WB – Logs Panel	Vertical Zoom in or Zoom out on well logs. Modifications have no effect on well headers.
	Arrows (←, ↑, → and ↓)	ScanPaperLine (Vectorization)	Enables to scroll through image when picking baselines and timeline.
SEISMIC INTERPRETATION	p	GV	Activates picking/interpretation facilities.
	Ctrl - z or Ctrl - y	GV	<i>The Undo</i> and its counterpart <i>Redo</i> functionalities for Grids interpretation. Up to 20 steps of interpretation could be backed up.
	m	GV	Activates possibility to draw a rectangle in the Sections panel and drag the latter to assess vertical shifts (displayed in the status bar).
	Mouse wheel scrolling	GV – Mean Power Spectrum Window	Squeezes/Extends view along frequencies (abscissa). Filters simultaneously the frequency bandwidth of the selection in the Sections panel.
		GV – F-k Amplitude Spectrum Window	Folds/Unfolds a fan centered at the origin in the graph showing amplitude spectrum as a function of frequency and wave number. Filters simultaneously selection in terms of events dips.
	Ctrl-j	GV – 3D Viewer	Exports as a Polygon (within the folder tree of the main frame in the GV) the intersection between the active fault and the active grid. Active grid must be plotted as a surface to do so.
MISCELLANEOUS	F1	GV and WB	Triggers screenshot to PPTX facility.
	F4	GV and WB	Refresh the folder trees in case of freeze or display concerns.
	p or n	Geoposit	When interactively picking calibrating points for image georeferencing, <i>p</i> enables to select <i>previous</i> point picking while <i>n</i> stands for <i>next</i> .
		ScanPaperLine	When interactively picking shot points on the section, <i>p</i> enables to select <i>previous</i> point picking while <i>n</i> stands for <i>next</i> .

**Mouse Button 2 [MB2] or Right-button Action**

The use of MB2 is globally coherent in EarthQuick. User may consider its action is linked to a process of *removal* or *termination*.

For instance:

- In the GV, MB2:
 - Erases a shifted ZOI.
 - Cancels a merge of different seismic.
 - Terminates ongoing grid picking.
 - Terminates ongoing handsfree drawing.
 - Terminates a random line plot.
 - ...
- In the WB, MB2:
 - With the “Resizable Logs Screenshots” facility, erases the transparent overlapping log curve.
 - ...



15 Acronym and specific terms glossary

- CRS: Coordinate Reference System.
- DB: Data Base.
- EQ: EarthQuick.
- G&G: Geology and Geophysics.
- GB: Giga Byte(s).
- GCS: Geodetic Coordinate System.
- GPR: Ground Penetrating Radar.
- GV: Global Viewer.
- HC: Hydrocarbon.
- KB: Kelly Bushing. Sign of KB is positive if above the SRD, negative if below the SRD.
- MB1 – MB2: Click made with Mouse Button 1 - Mouse Button 2.
- Original Data Folder: Folder containing data made for training purposes.
- RAM: Random Access Memory.
- TD: Terminal Depth. Sign of TD is negative if above the SRD, positive if below the SRD.
- WB: Wells Board.

