



TEREN: A RESPONSIVE DESKTOP APP AND DATABASE FOR FIELD SEISMIC SURVEY

User guide

Refraction module

Contents

- Introduction 3
 - Introduction..... 3
 - Main_features.htm..... 3
 - Software requirements 3
 - Installation..... 4
- Getting started 5
 - User interface 5
 - Database management 6
 - Creating new project 8
- Refraction and reflection survey 9
 - Create new seismic line 9
 - Geometry input 10
 - Data acquisition..... 11
 - Import SEG2 records 14
 - Monitoring the data folder..... 15
 - Monitoring Summit X One folder 15
 - Data processing mode 17
 - Output mode..... 18

Introduction

Teren is a Windows based application for field seismic survey. It had been primarily used for field notes but has later grown to a database software and basic seismic data manipulation. The name originates from the word *teren* (eng. terrain), which in general also means a field survey in slovenian language.

There is no need for field notes and complicated and confusing sheets and reports. Teren simplifies the field work and collects both metadata and the measured data into a single database. All the data are unified into projects, which are organised by the date created and data measured. The projects themselves or their individual components (seismic lines, measurements, records etc.) can be exported to another PC for further data manipulation very easily, thus migrating the data from the field to the office.

Main features

- responsive to almost any display resolution
- suitable for shallow refraction, MASW, downhole
- storing records, stacks and field notes into a single database
- data are collected in projects and surveys which can be imported or exported between computers
- records can be either imported or copied automatically by monitoring a folder (compatible with Summit X One System or any PC based data acquisition application)
- support for most SEG2 binary formats (SEG-Y not supported)
- SEG2 file traces manipulation (mute, reverse, delete)
- multiple SEG2 file display combination to clearly identify S-arrivals
- geometry input for consistent trace tracking
- on-site dispersion image creation (MASW) and first breaks picking (internal or external software)
- data preparation for export to some known formats for further processing (tomography, inversion etc.)
- basic processing and evaluation (plus-minus, delay time, 2-layer and 3-layer)
- static corrections calculation

The following shallow geophysical seismic methods are currently available in Teren application:

- Refraction/reflection module (REFRAK)
- Downhole survey module (DH)
- MASW survey module (MASW)
- Horizontal to vertical spectral ratio (HVSR, experimental)
- Walkaway module for noise-test survey (Walkaway)
- Literature module (experimental) to store additional documentation, literature etc. (separate database)

Hardware and software requirements

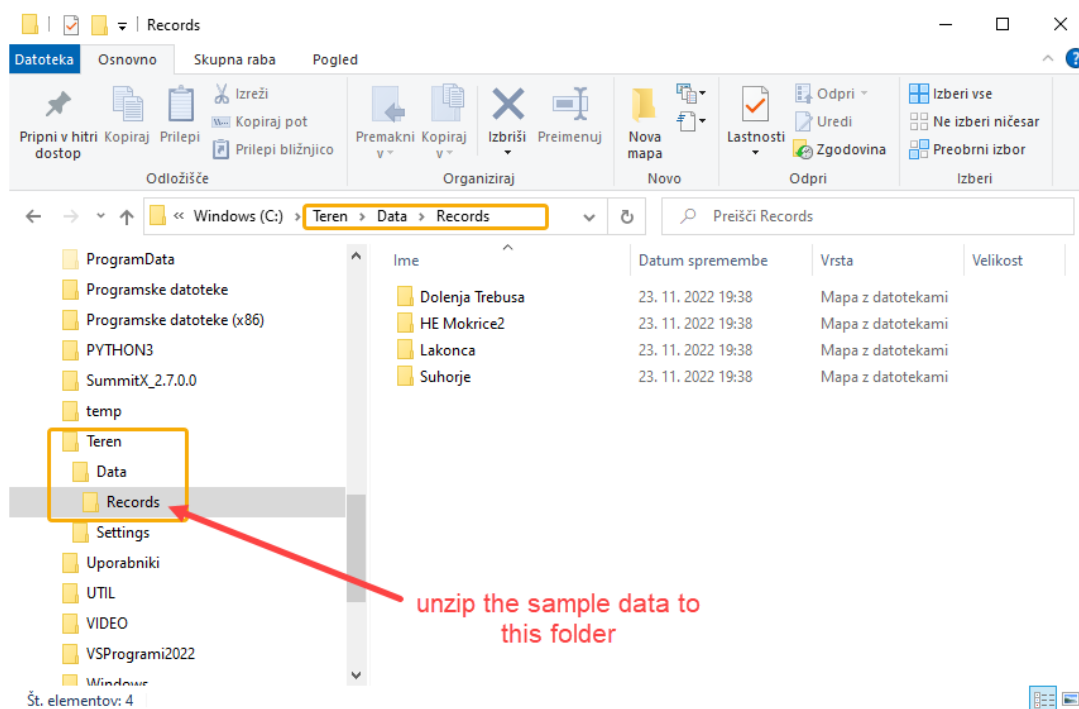
- Windows based laptop or desktop PC computer

- Operating system: Windows 7, Windows 10 and above
- min. 2 GB RAM
- min. 20 GB Hard disk space (for large and multiple SEG2 files)
- (optional) using Summit X One system: Summit X One Data Acquisition software
- (optional) external first break picking (Interpex Ixseg2segy recommended)

Installation

Before the installation unzip the file to a local directory. Run Setup.exe and follow the instructions. We recommend to install to a local folder and not inside the Windows 'Program Files' folder. The local folder will allow additional control to the database files and will possibly not be write protected.

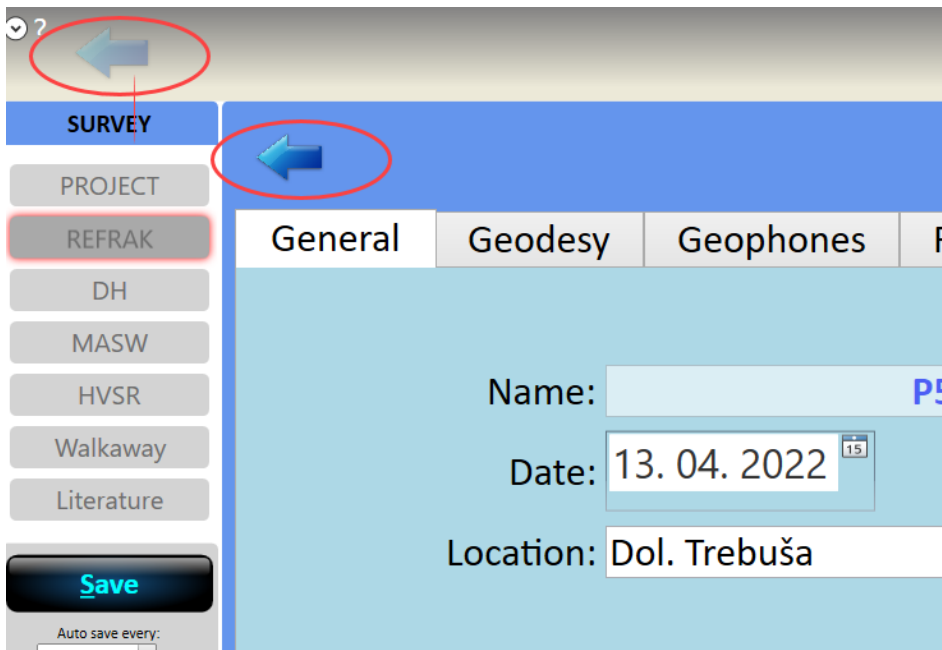
If sample files are distributed along with the Setup files, unzip the sample file and move the contents to the folder <Install folder>\Data\Records. The structure of the folder should be like this (otherwise the record samples will not be accessible):



User interface

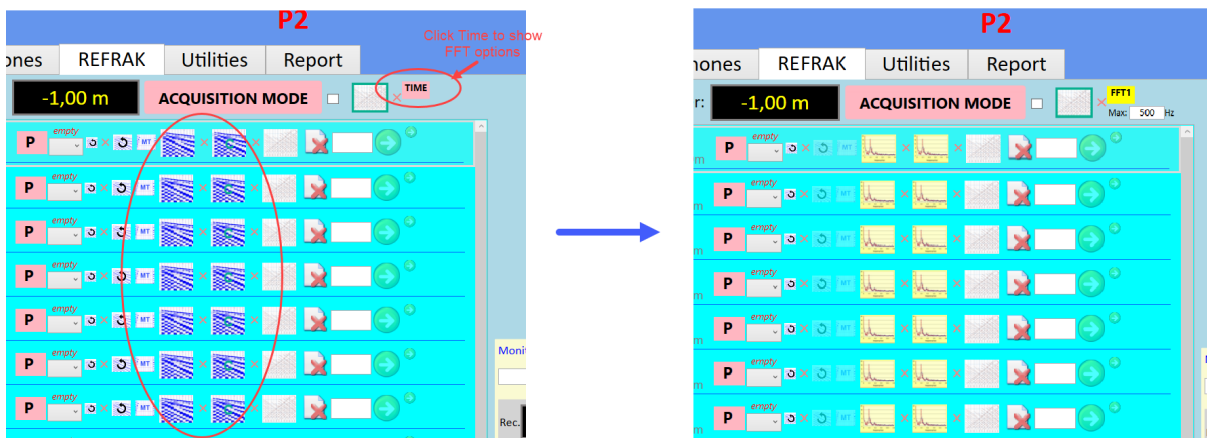
The program Teren is a responsive desktop application which means it responds to different display resolution. In other words, the controls and fonts re-size automatically according to screen resolution thus beeing almost the same size on various LCD screens, laptops and PC's.

The main program site is a single page with subpages, which can be navigated through arrows and buttons (picture 1).

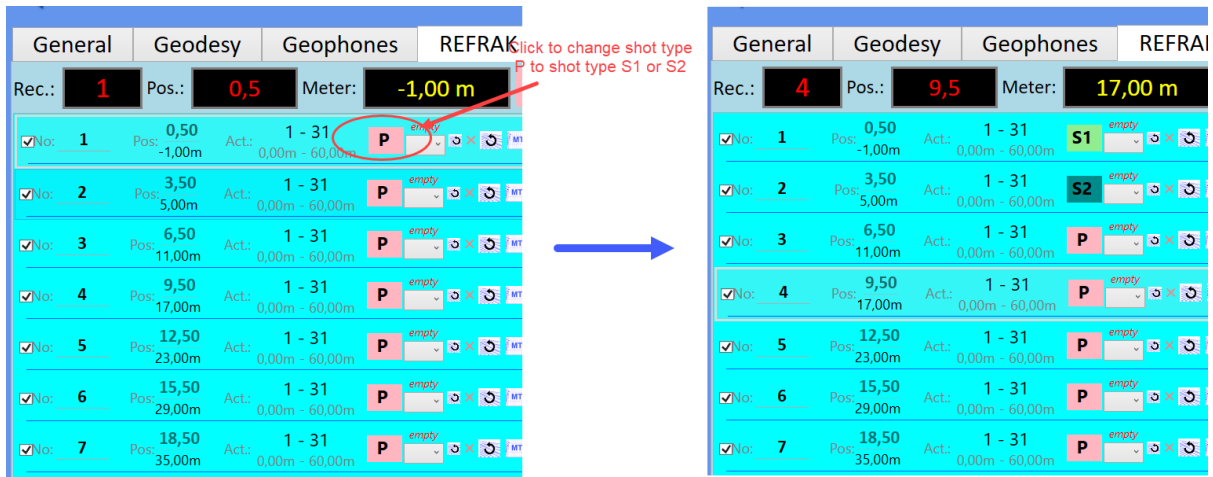


Picture 1. Navigation arrows

Individual components of the program (modes, graphic display, survey options etc.) can be reached by windows buttons or text buttons (clickable text) which are indicated with specific background color. Exanples are illustrated in the following pictures.



Picture 2. Clickable text Time (red background) to show Fast Fourier Transform option for recorded records



Picture 3. Clickable text P (red background) to change shot type to S1 or S2

The buttons and text buttons and many other features are briefly explained in ToolTips (picture 4).

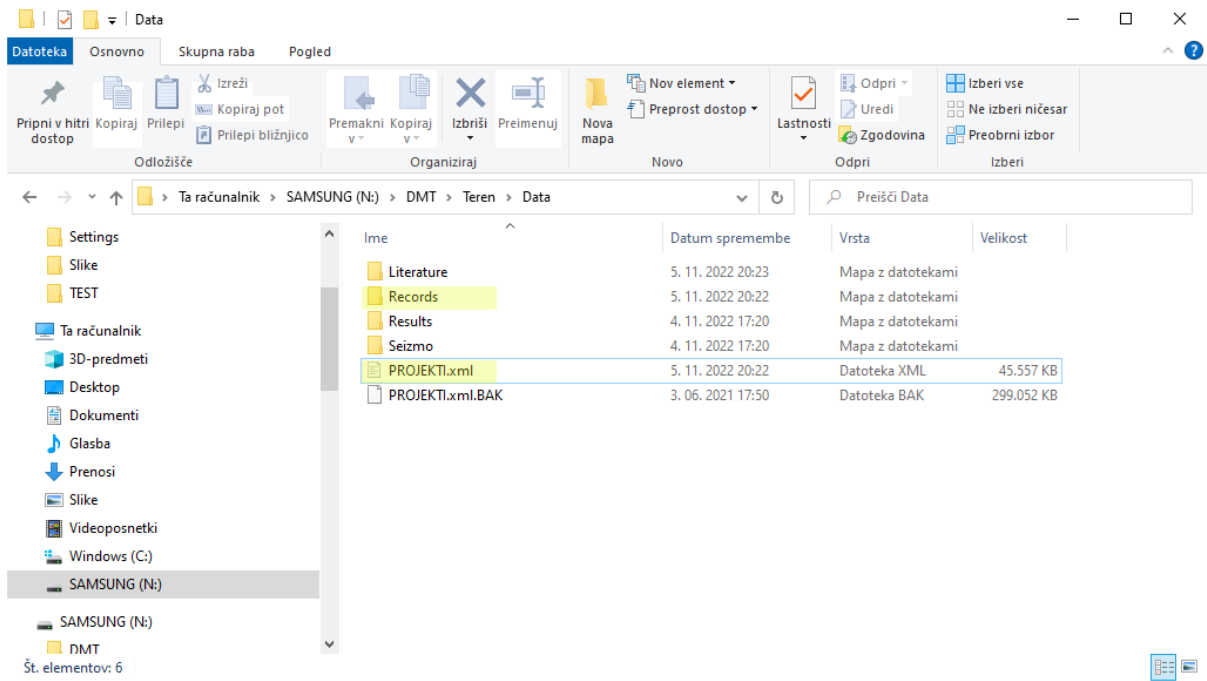


Picture 4. Tooltip to show the explanation of the DMT button in the stack area and tooltip to explain 'Open depth model' button

Database management

The structure of the database is: YEAR (Project list) -----> SURVEY (Methods list) (surveys) --> Individual survey (General, Geodesy, Geometry, Geophones, Acquisitions REFRAC/MASW/DH/HVSR/WALKAWAY, Utilities, Report)

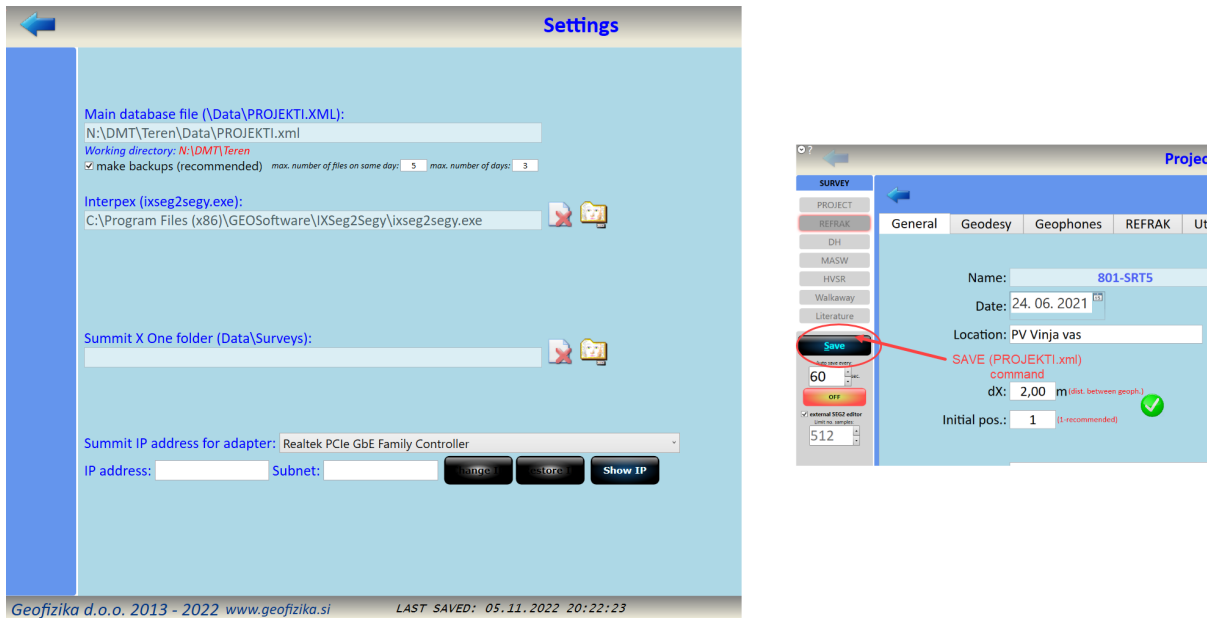
The main database file PROJEKTI.xml is located in \Data subfolder of the program. It contains all metadata information about the projects, survey and records. The corresponding SEG2 records are separately stored in a subfolder \Records, which contains additional subfolders with individual Project name (see Picture 5).



Picture 5. Folder structure of Teren app and data files

The \Data folder should not be changed.

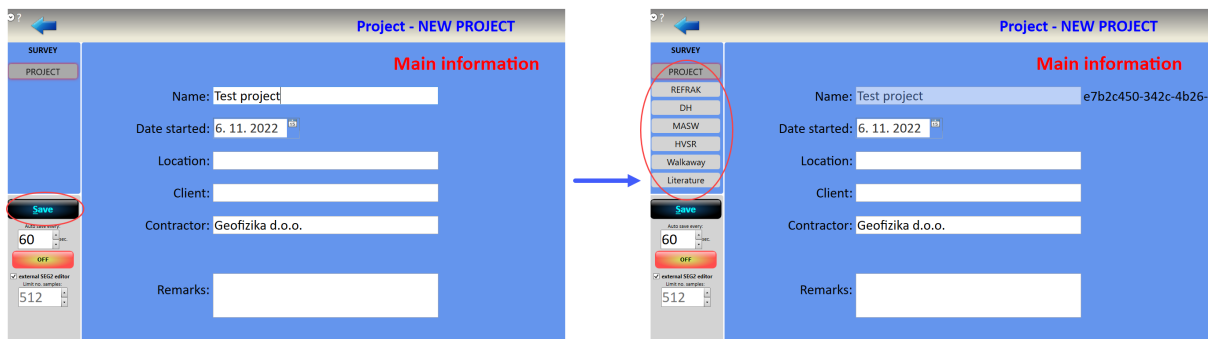
The user can choose the (recommended) option to automatically make backups on each SAVE command (see Settings, picture 6). The backup files (of PROJEKTI.xml) are stored in \BACKUP folder. The backups can be used in case of main file PROJEKTI.xml loss or beeing corrupted.



Picture 6. Settings with the option of Backups on the left and SAVE command on the right

Creating new project

A new project is created by the button 'New Project' on the main page. After project name and additional information is assigned and saved, new options are available (picture 7).



Picture 7. New project with the name 'Test project' is created

The project and all possible surveys will be stored according to the year of creation.

Refraction and reflection survey

Creating new seismic line

Choose option REFRAK on the left side of the Project window. Then choose 'New' on the right side. A General tab is shown where user can define the seismic line name and necessary parameters of the survey. The illegal characters are not allowed for the name (due to Windows folder names limitations).

After changing the name of the line (picture 8) the additional tabs are shown such as Geodesy, Geophones, REFRAK, Utilities and Report. The meaning of particular tab is as follows:

- General - main data parameters of the survey (date, location, geophone distance, number of geophones etc.)
- Geodesy - this option only works for old teodholite measurements and Stonex R15
- Geophones - geometry input and calculation
- REFRAK - this is the main data acquisition tab where the records are collected. It also includes data processing and output
- Utilities - different utilities for manipulating graphic outputs from external software (Surfer, Seisimager, Rayfract etc.)
- Report - optional report and final graphic outputs storage

Important: when the number of geophones or geophone spacing are changed please be sure to confirm with the 'Confirm' green button located right next to the parameter. The geometry of seismic line is changed due to new parameters.

The screenshot shows the 'Test profile' window with the following details:

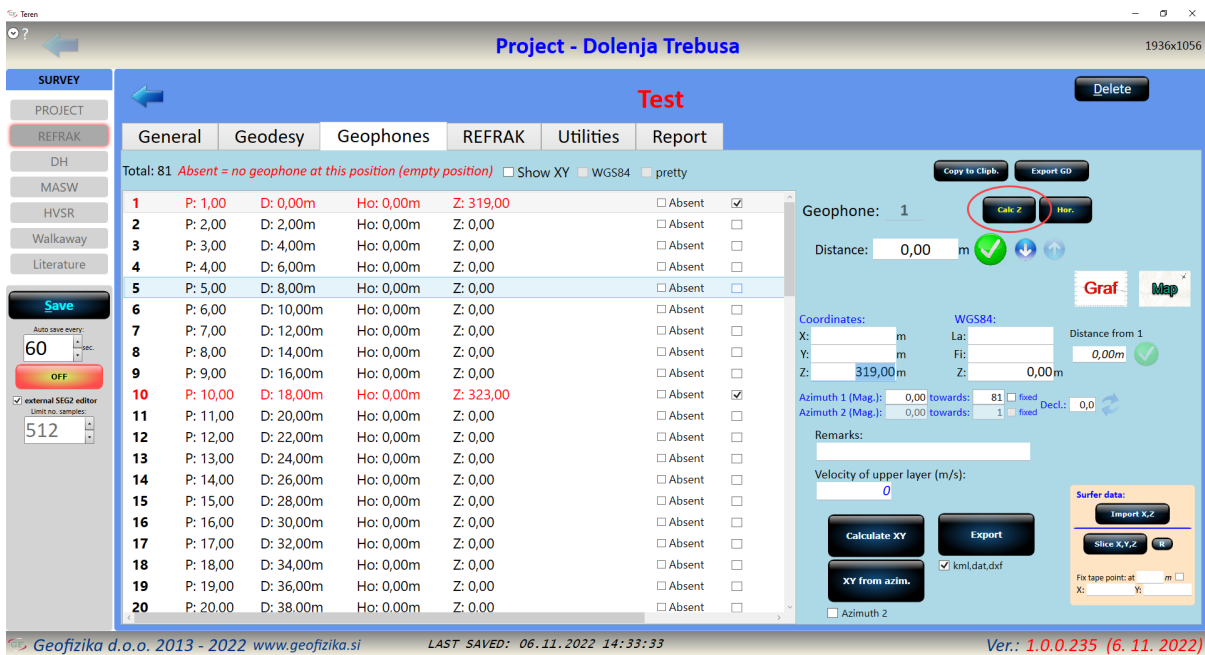
- Project:** Dolenja Trebusa
- Survey:** REFRAK (selected)
- General Tab:**
 - Name: Test profile
 - Date: 6. 11. 2022
 - Location: Kranj
 - dX: 2,00 m (dist. between geoph.)
 - Initial pos.: 1 (1-recommended)
 - Remarks:
 - No. of geophones: 24
 - Active: 36
 - length: 160 m
 - Instrument: Summit X One
 - Operator: R. Stopar
- Dialog Box:** NO. GEOPHONES. No. geophones needed: 81 (2 x 36) + (1 x 9) = 160,00m. Accept Number of Geophones? Buttons: V redu, Prestiži.

Picture 8. New seismic line and changing the parameters

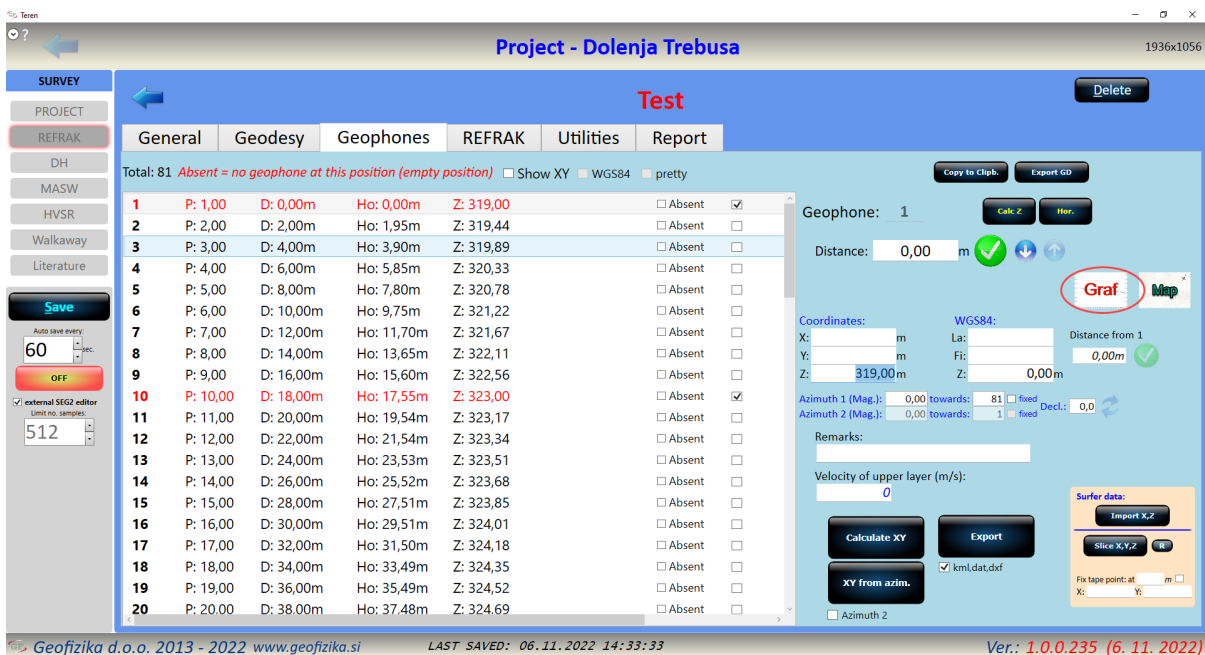
User has the option to calculate the total number of stations (geophones) according to a desired length of the line. Example: the line should be 160 m long and the active number of geophones is 36. By clicking the calculator on the right side of No. of geophones the result will show 81 geophones are needed to reach the length.

Geometry input

By confirming the total geophone number and geophone distance the new geometry is constructed. In 'Geophones' tab the user can assign fixed geophone positions (picture 9) with known elevation (Z) and optionally known coordinates X, Y. By pressing 'Calc Z' button, the elevation of all un-fixed geophones is interpolated. Also, the horizontal distances are calculated in respect to terrain distances and elevation Z (picture 10).



Picture 9. Assigning fixed geophones with known elevation Z



Picture 10. Elevation Z and horizontal distances calculated and Graf button

By choosing the Graf button the topography of the line is shown. When the records are recorded during data acquisition the shot positions will be shown as well (picture 11).

Picture 11. Topography of the seismic line

Data acquisition

The REFRAK tab is explained on picture 12.

Picture 12. Basic elements of acquisition and records tab for refraction/reflection survey

Teren

Page 11 of 18

The basic parameters of the seismic line and record acquisition are Position and Distance. The position is of equal unit of 1. It usually corresponds to geophone number, while distance is the actual distance in meters from the first position (geophone). For example, the position of third geophone is 3 and the distance is 4 m in case of 2 m geophone spacing. The program allows to calculate automatically the position and vice versa the distance of a geophone. By using a tape on the field user can assign initial position and distance (picture 13, top right side of the tab) and the actual distances will be automatically calculated. The tape can be moved along the line.

The REFRAK tab has 3 modes, which can be achieved by pressing 'Mode' button on top of the tab (picture 13):

- Acquisition mode - stacks and records collection
- Data mode - basic processing and data preparation
- Output mode - export and output data for external processing



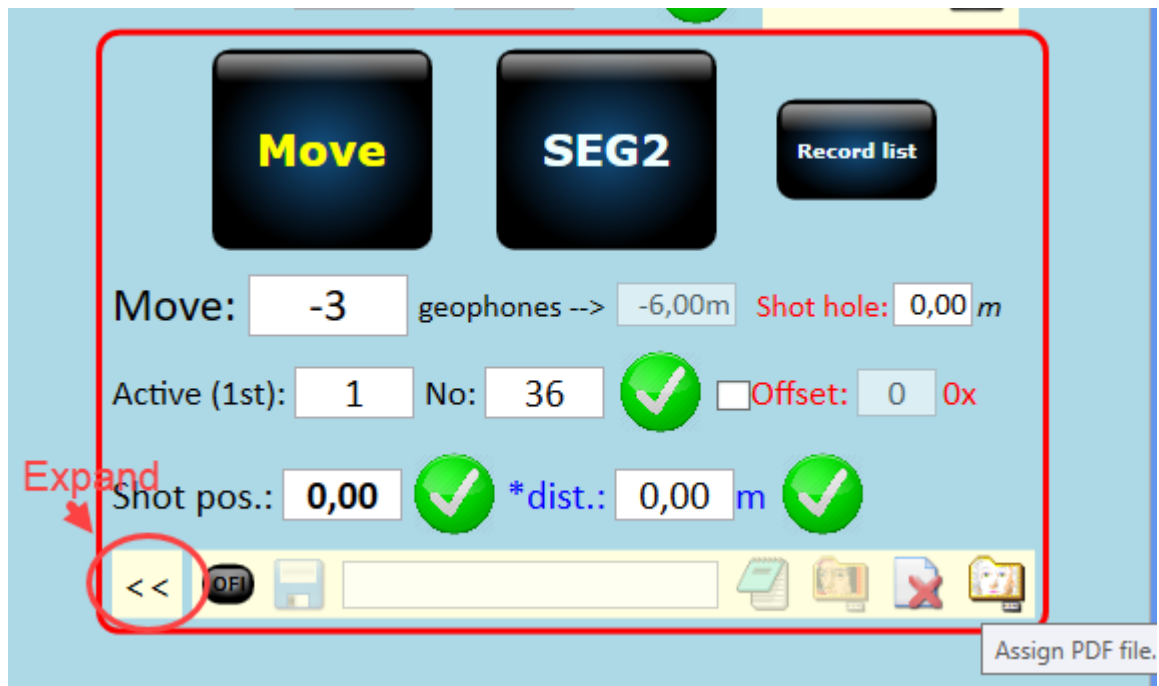
Picture 13. Different mode selection

When a new seismic line is generated and saved the record collection can be initiated by pressing Move button. The first record is shown. It's position and active geophones can be changed. The Auto save button is also triggered thus enable user to spontaneously save and backup the measurements. We highly recommend that Auto save button is ON during acquisition.

The acquisition can be done in three ways:

- acquisition by importing records after the measurements (Button SEG2)
- monitor the folder with SEG2 files which are generated by external data acquisition software (Windows PC based)
- using the Summit X One system (similar to monitor the folder)

Additional backup is possible by using PDF file generator while records are collected on the field. These data are stored in a user defined folder. The benefit of this option is that the user can obtain data (by using Record list button, picture 13) in case of program breakage or data loss in the field. The option is shown on picture 14.



Picture 14. Additional backup option

The measurements and records collecting are performed in the following steps (picture 15 and picture 16):

- Move the shot position (picture 15) - the shot position is automatically changed due to Move parameter (example -3, picture 14), the active spread is unchanged
- Move the active spread (picture 16) - the active spread is changed in regard to total number of geophones, the shot position is unchanged
- Repeat the shot, if needed (picture 16) - both shot position and active spread are unchanged



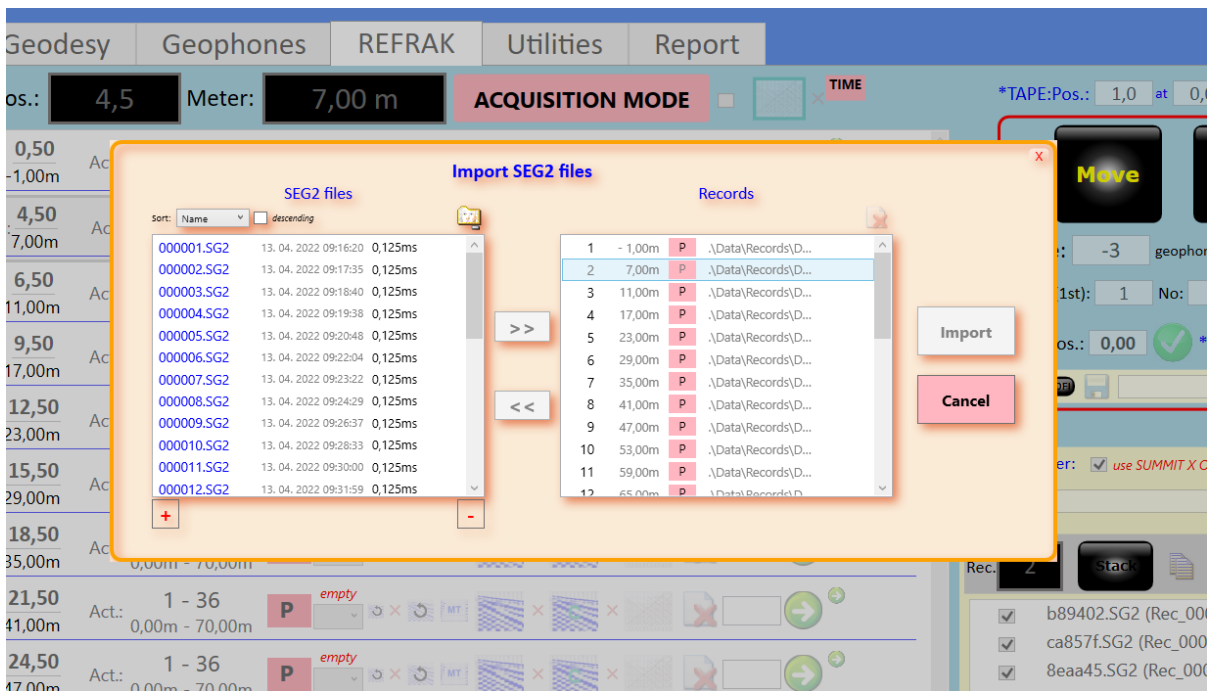
Picture 15. Moving the shot position



Picture 16. Moving the spread or repeat the shot, if needed

Import SEG2 records

When all the records metadata are collected on the field, the actual SEG2 files can be imported by using the button SEG2 in acquisition mode. After the folder with SEG2 files is selected a dialog for import is shown (only the first SEG2 file can be selected, the others are shown automatically). The records can be assigned to different SEG2 files (picture 17).



Picture 17. Dialog for importing SEG2 files

The records are then copied to the database folder and renamed.

Monitoring the data folder

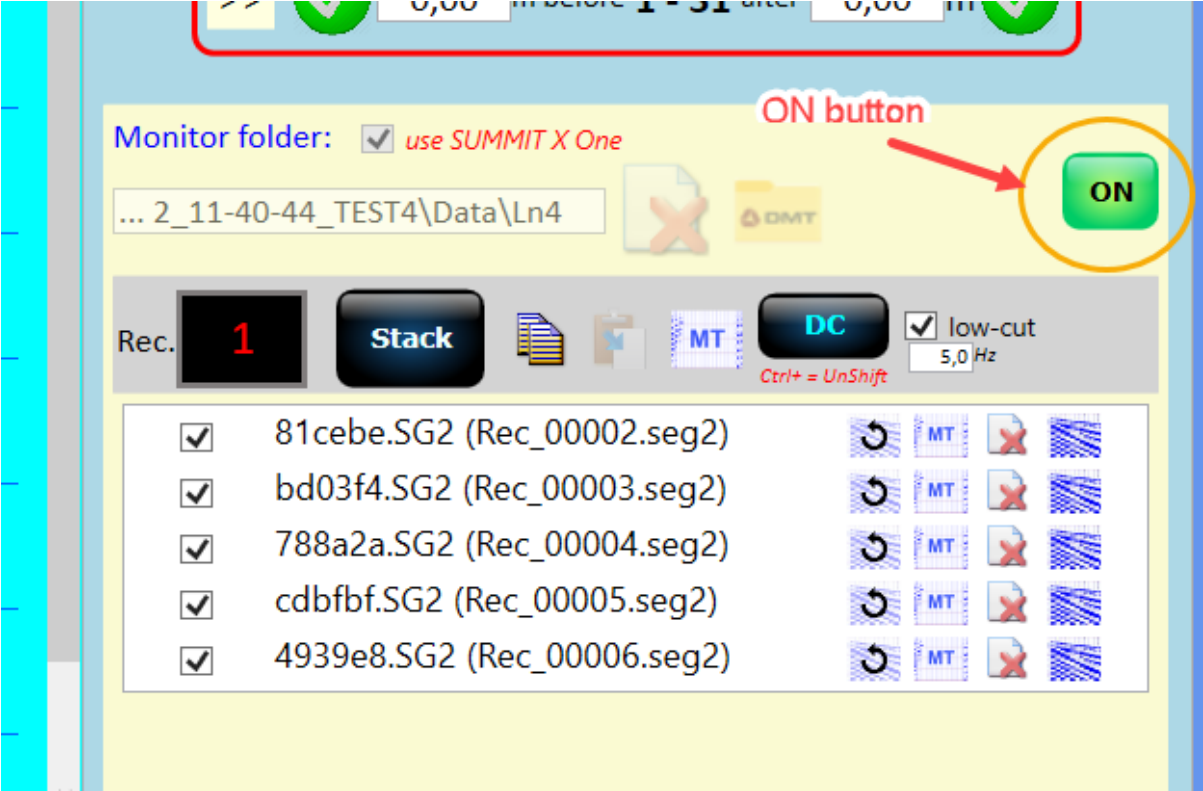
This data acquisition option is only suitable if the actual acquisition is done by an external Windows PC based software. What the program does is it monitors the folder where SEG2 records are recorded. When SEG2 file is recorded it is shown in a dialog and can be accepted or rejected by the user. The file is then copied and renamed to the stack area and can be additionally checked (picture 18). Be sure to switch monitoring ON while recording.



Picture 18. Stacks with renamed SEG2 files

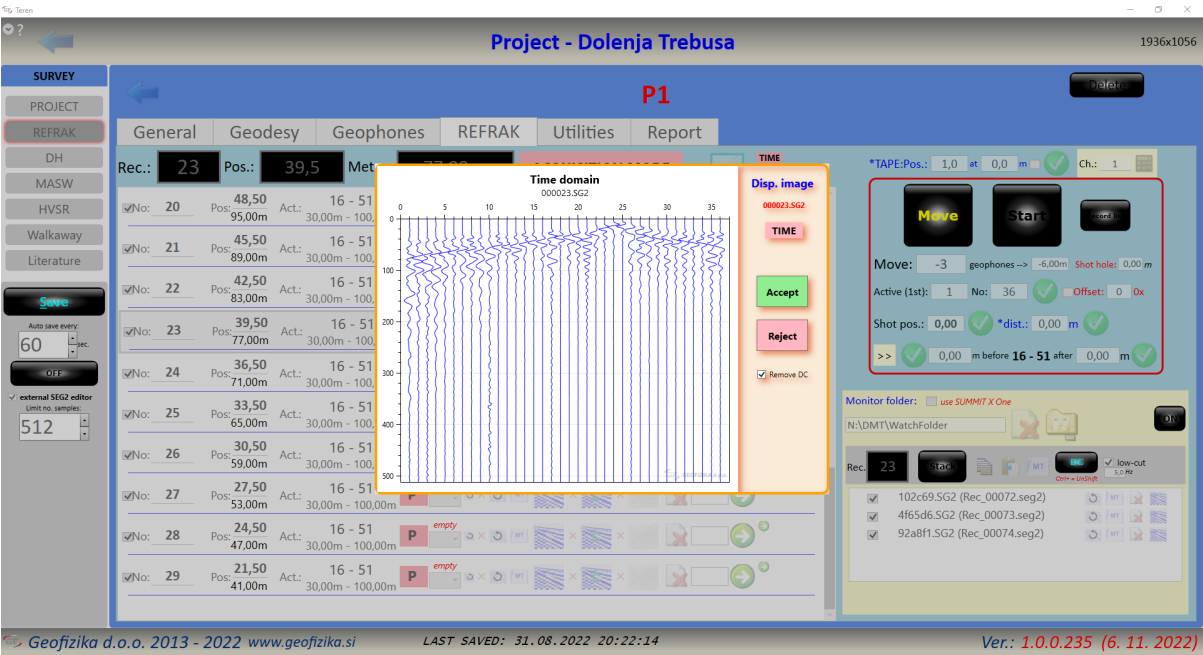
Monitoring Summit X One folder

This method is similar to previous, except it uses the Summit X One acquisition system. Use Settings to assign the main Summit Data acquisition software location. Select the correspondent survey line (not the folder itself) from Summit Data folder and switch the monitoring button from OFF to ON (picture 19).



Picture 19. Selecting Summit survey (DMT button) and turning the monitoring switch to ON

The program is checking the SUMMIT Data folder whenever a new SEG2 files is created. Currently, only SEG2 files are allowed in Teren app, so make sure you select SG2 or SEG2 file output option in Summit X One acquisition program. Also, please note, that only final records from Summit X One Acquisition software are taken, the Summit stack files are ignored. For example, when a shot number 2 is triggered, the stack file Shot_2_Stack_3.seg2 is ignored. When the final record Shot_1.seg2 is created in Summit Data folder, the file is recognized by Teren and shown in the program to either Accept or Ignore (picture 20). If accepted, the record is copied into the stack area and renamed.



Picture 20. Shot is triggered and the record is displayed to accept or ignore it

Important: The Summit X One acquisition software creates a special folder inside Data folder specific to the name of the line (example Ln4) only when the first shot is triggered. Therefore, the OFF/ON button is disabled until the first shot creation. We recommend to trigger a test shot inside the Summit X One acquisition first before the actual measurements to enable the monitoring button OFF/ON (picture 19).

Data processing mode

When the records are collected the basic data processing can be done by using the option DATA MODE in REFRAX tab (picture 21). After checking the stacks for individual records the basic processing can be done in the following steps:

- 1. Stack all - stack files are summed for all records
- 2. Geom + up - assign geometry and eventual uphole times to the stacked records (optional)
- 3. Combine - combine records from the same source position to obtain more channel seismogram (overlapped traces will be summed)



Picture 21. Data mode

After above steps are done the first break picking can be done. Select the combined record icons for individual records and open SEG2 file. If external SEG2 editor is assigned (see Settings) the external software will open the file. This option can be ignored by using internal editor (check button on the left side).

Important: **DO NOT USE STACKED RECORDS FOR FIRST BREAK PICKING, USE ONLY COMBINED RECORDS** (picture 21).

After first breaks are assigned to the combined records, the travel times can be analysed by pressing the travel times button (green border box on top or in the Data processing box on the right). The reciprocal times can be checked and analysed, the layers assigned (2 or 3 layer case) and velocity model calculated. Automatic layer assignment works only on a 2 layer case. Third layer should be assigned manually.

The velocity model can be calculated by two methods: plus-minus in case of reciprocal shots (Hagedoorn, 1959) or delay time method using half-intercept times for multifold case without reciprocal shots (Palmer, 1980).

Output mode

Click 'DATA MODE' on top to access the 'OUTPUT MODE' (picture 22). The user can export the travel times to different formats for further processing by using some of the well known refraction processing programs, such as Seisimager, Rayfract and IxRefrax.



Picture 22. Output mode

Some other options are also available. If depth model is calculated in Travel time analysis window and stored, it can be accessed from here.

The static corrections can also be calculated in Travel times window. If stored (saved) they can be accessed here. By pressing the 'Correct' button the corrections can be applied. The combined records will be used, but corrected records will be exported to a user defined folder.