SeisImager/DH™ Manual

Windows™ Software for Analysis of Downhole Seismic

Pickwin v. 7.2.1.0
PSLog v. 3.1.2.0

Manual v. 1.3

Jan 11, 2023

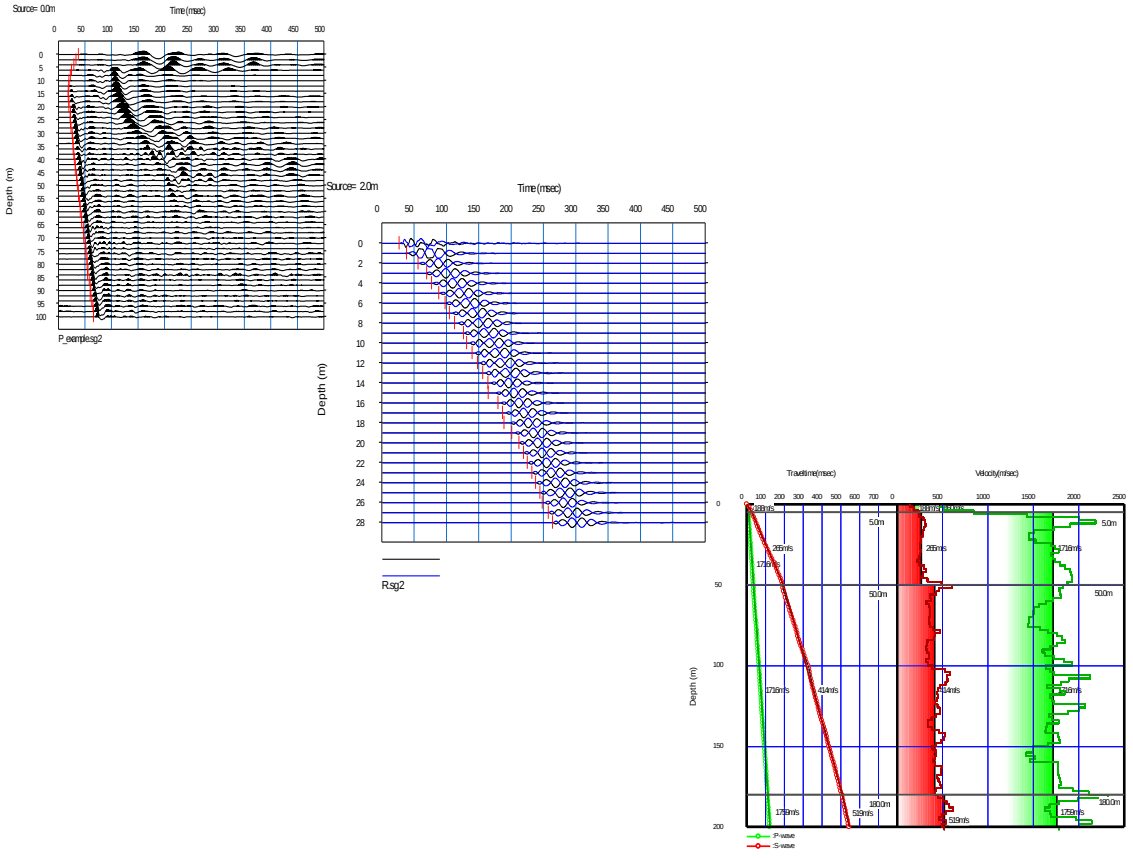


Table of Contents

1 – Introduction

Welcome to SeisImager/DH. SeisImager/DH is an easy to use, yet powerful program that allows you to analyze downhole seismic data obtained through various source-receiver configurations. SeisImager/DH includes functions to perform the following basic procedures, and more.

Input and display data.
Control how data is displayed.
Make changes/corrections to data files and save them.
Handle two horizontal components data together.
Show tow opposite direction sources together.
Pick first arrival for both P- and S- waves.
Calculate interval velocities from picked first arrival.
Calculate layer velocities from picked first arrival.
Display traveltime curves and velocity forms in graphical form.

SeisImager is the master program that consists of five modules for refraction, surface-wave method and downhole seismic data analysis. The individual modules are Pickwin, Plotrefa, WaveEq, GeoPlot and PSLog.

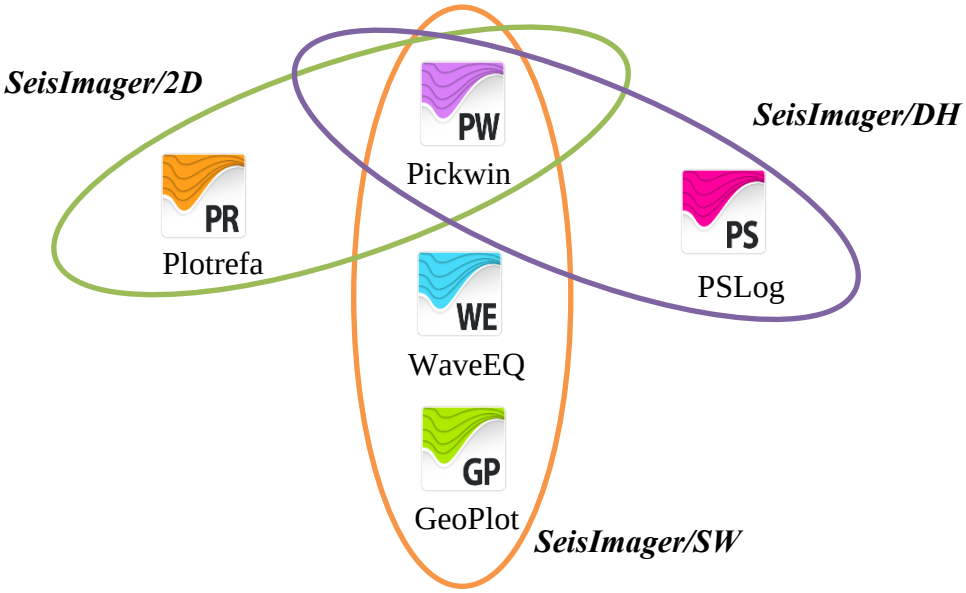


Figure 1. SeisImager packages

Pickwin and PSLog are the main modules used for downhole seismic data analysis, making up the program called SeisImager/DH™.
For refraction data analysis, Pickwin and Plotrefa make up the program called SeisImager/2D™. A separate manual exists for SeisImager/2D. For surface wave data analysis, Pickwin, WaveEq and GeoPlot make up the program called SeisImager/SW™. A separate manual exists for SeisImager/SD.
Due to the overlap of Pickwin with SeisImager/DH, reference is made to the SeisImager/2D and SeisImager/SW manuals for explanation of the common Pickwin menus.
SeisImager is also available for rent in run-time periods of 40, 75, and 250 hours. The rental package by default includes both SeisImager/2D and SeisImager/SW-2D.

1.1 Outline of processing

Pickwin and PSLog are the main modules used for downhole seismic data analysis, making up the program called SeisImager/DH. Figure 2 shows outline of downhole seismic processing using SeisImager/DH. At first, Pickwin edits waveform data and picks first arrivals. Next, PSLog calculates velocity models from first arrivals picked by Pickwin. Generally, downhole seismic method measures both P- and S-wave velocity. Sources and receivers used in downhole data acquisition are usually different and measurements of two waves are performed separately. Therefore, Pickwin and PSLog process P- and S-wave separately and PSLog displays both velocities together at last.

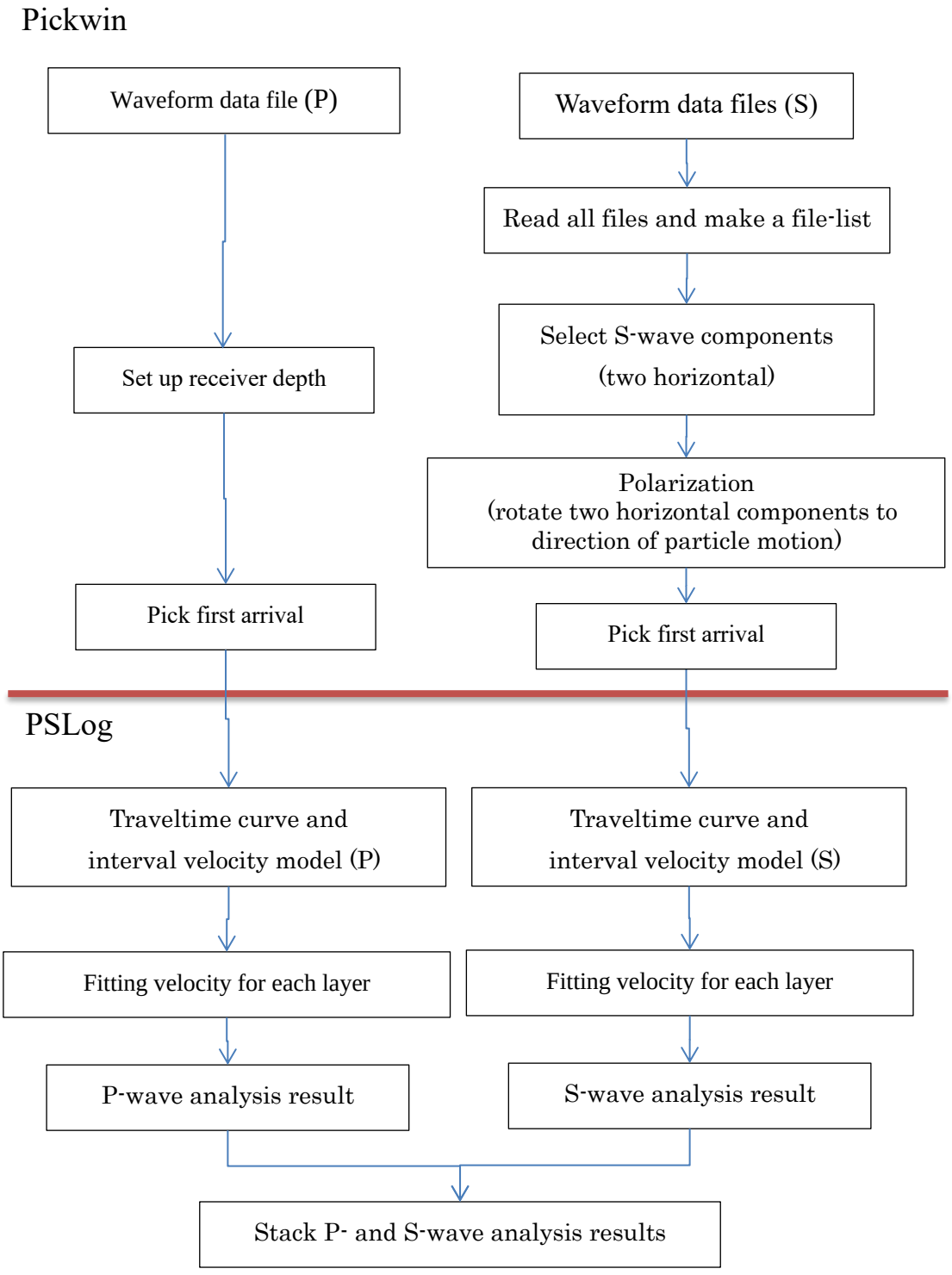


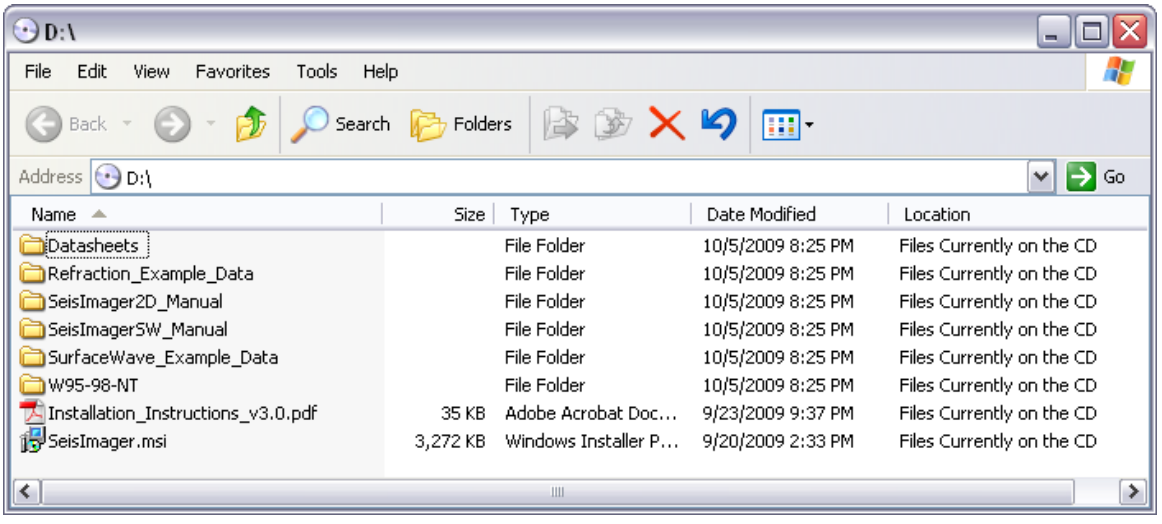
Figure 2. Outline of processing.

2 – Installing the Software

The SeisImager software CD is supplied (1) for trial evaluation of the programs, (2) for purchase, rental, or upgrade of one of the programs, or (3) with purchase of an ES-3000, SmartSeis ST, Geode, or StrataVisor NZ seismograph, which all include the Lite version of SeisImager/2D. The single CD contains all programs and all documentation. Occasionally, there will be a software release in between CD releases. In this situation, the CD will be labeled with a notice to refer to the SeisImager website to download the latest version.

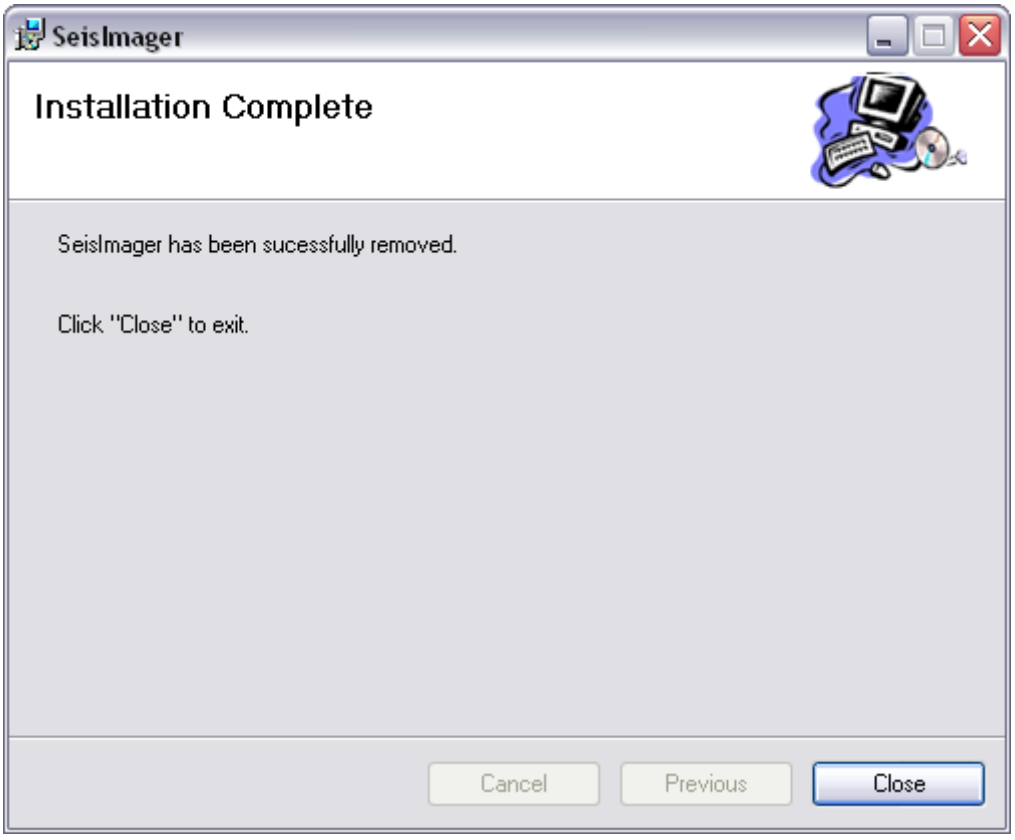
SeisImager is recommended for Windows XP Home or Professional but is compatible with all versions of Windows up to Windows-7. Note that you must have Administrator rights to install the software. After installation by an Administrator, users with lower level privileges can use the software.

1. To install the software, insert the SeisImager CD into the CD drive. The contents of the CD will be listed as shown below.

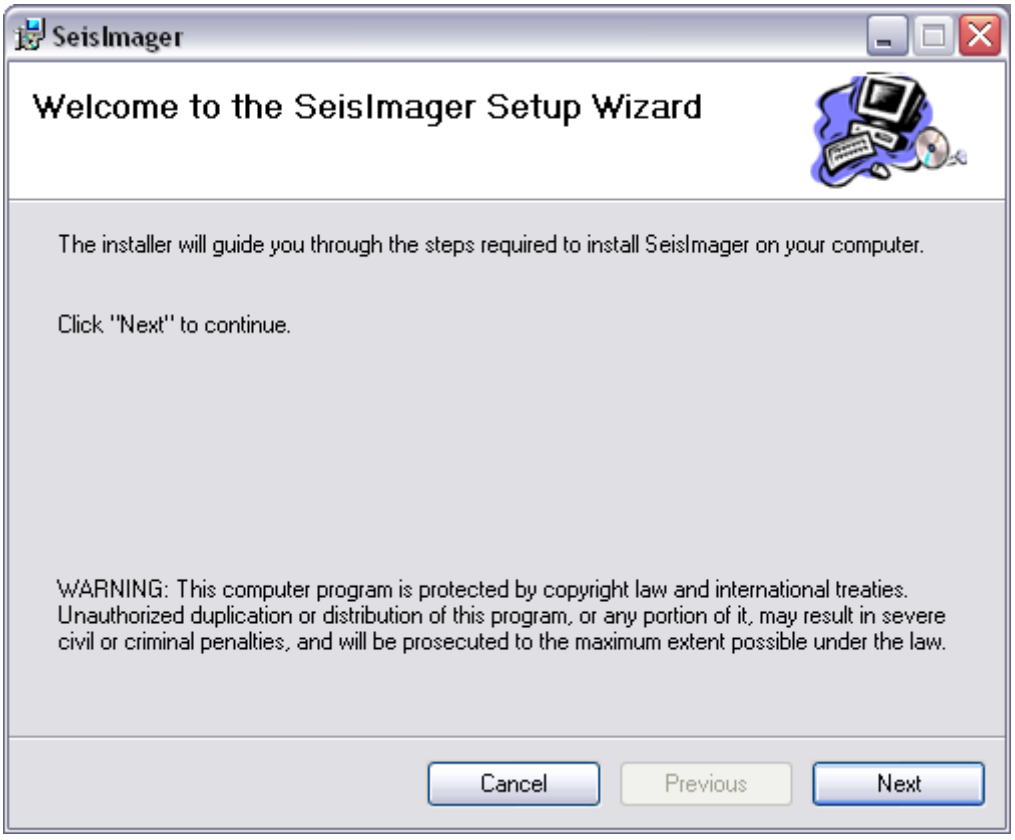


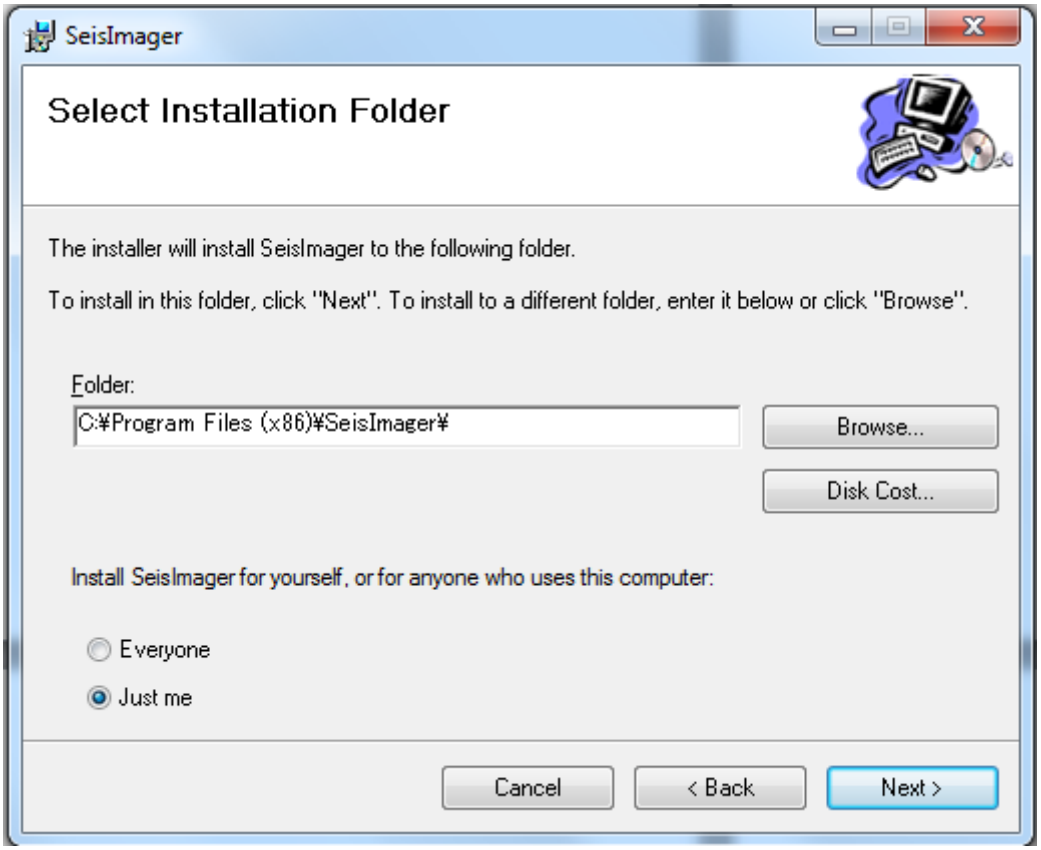
2. Double-click on the file named SeisImager.msi to install the software. The Welcome to the SeisImager Setup Wizard window will appear as follows.

a. **If you are presented with the option to *Repair SeisImager* or *Remove SeisImager* as shown below, the installer has detected an older version. Select *Remove SeisImager* and click on *Finish*, then *Close* after the uninstall process is complete.** Double-click again on the file SeisImager.msi to install the new version as described in Step 2b.

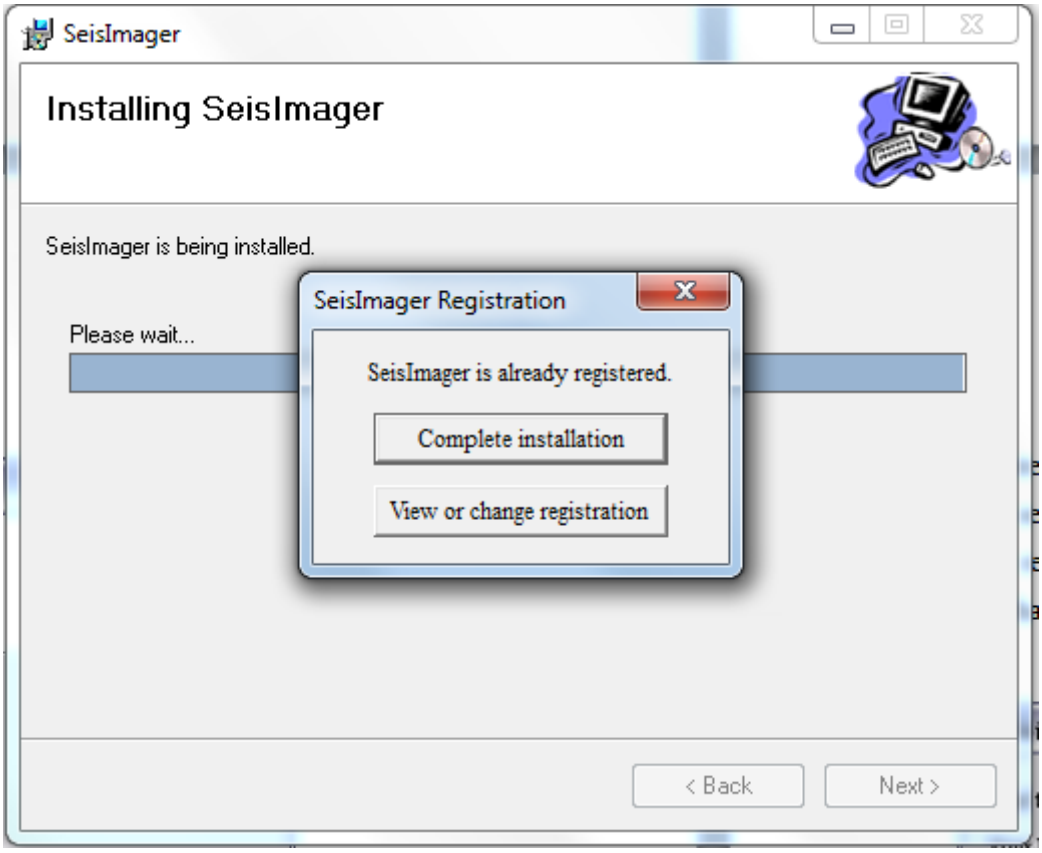


b. **If an older version is not detected**, you will be presented with the installer as shown below. Click on *Next*, indicate the directory for installation (the default directory is recommended), click on *Next*.


SeisImager
Welcome to the SeisImager Setup Wizard
The installer will guide you through the steps required to install SeisImager on your computer.
Click "Next" to continue.
WARNING: This computer program is protected by copyright law and international treaties. Unauthorized duplication or distribution of this program, or any portion of it, may result in severe civil or criminal penalties, and will be prosecuted to the maximum extent possible under the law.
Cancel
Previous
Next

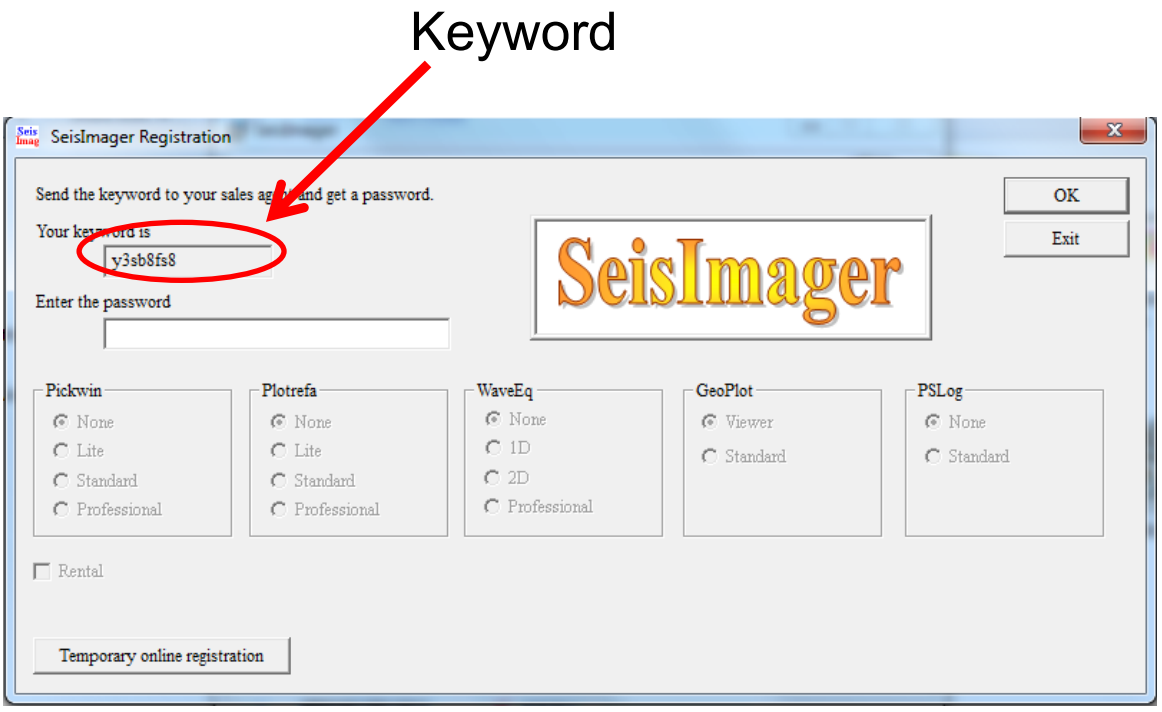

SeisImager
Select Installation Folder
The installer will install SeisImager to the following folder.
To install in this folder, click "Next". To install to a different folder, enter it below or click "Browse".
Folder:
C:¥Program Files (x86)¥SeisImager¥
Browse...
Disk Cost...
Install SeisImager for yourself, or for anyone who uses this computer:
Everyone
Just me
Cancel
< Back
Next >

If you have already registered any SeisImager (2D, SW, DH), you are presented with a dialog box shown below. If you purchase or upgrade SeisImager, click *View or change registration*. If you just install new version without purchase or upgrade, click *Complete installation*. Typically, installing an upgrade of the software does not require re-registration, but if you are upgrading from a version older than April 2007, you will need to re-register.

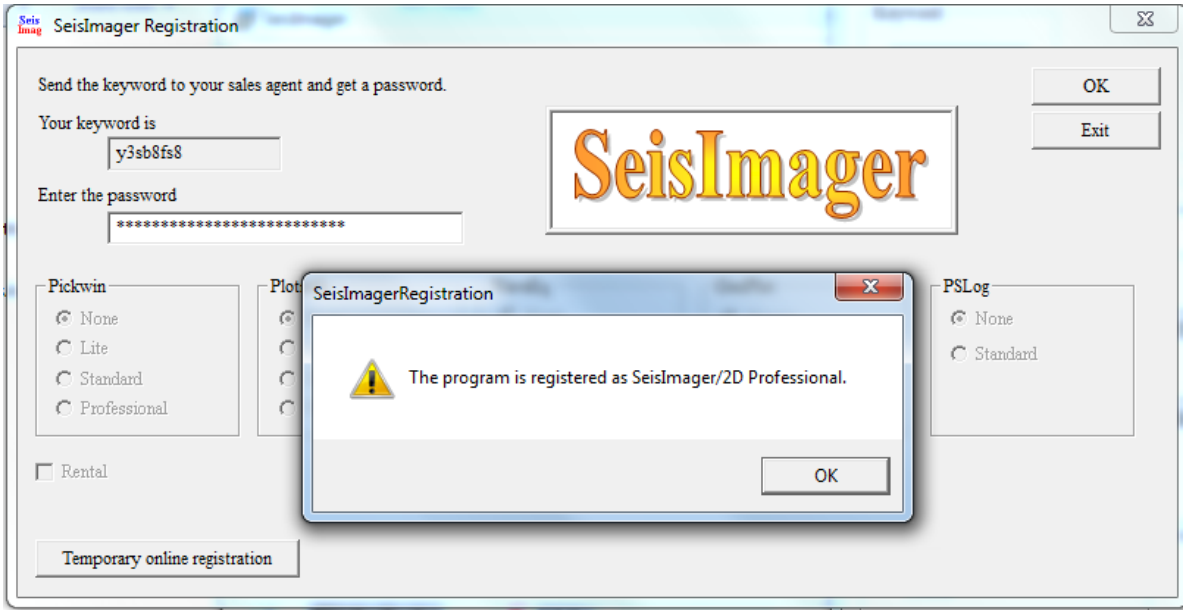


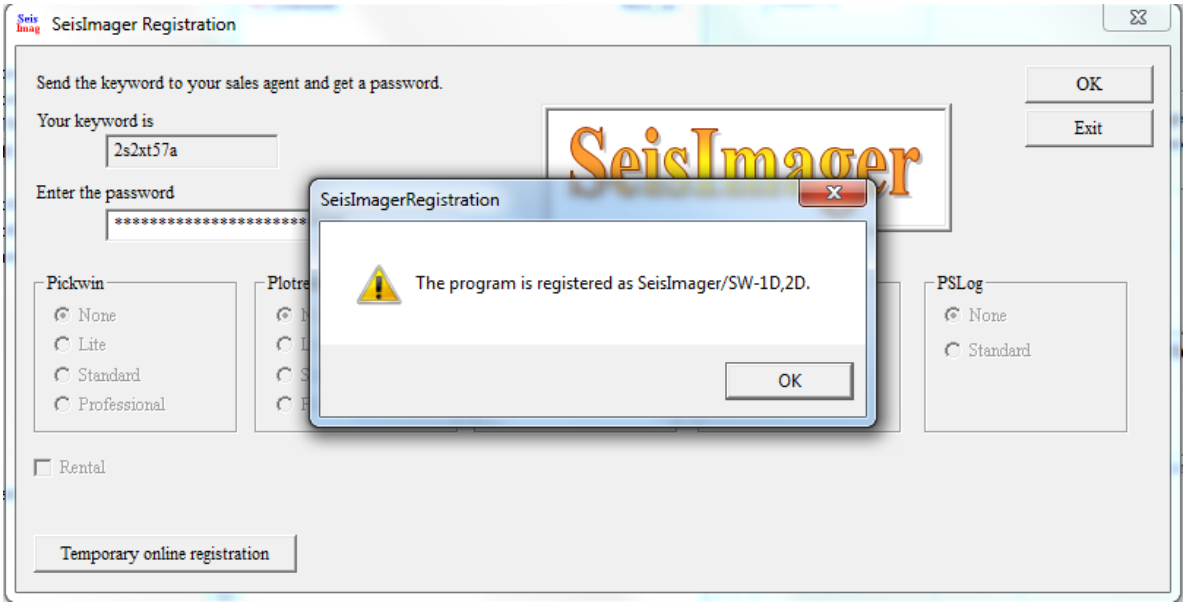
3. You are presented with a register as shown below. **If you are using the software on a trial basis in demonstration mode, skip to Step 6.** If you would like to register SeisImager later, you can also skip to step 6. Reinstallation after the installation is described in Step.5.

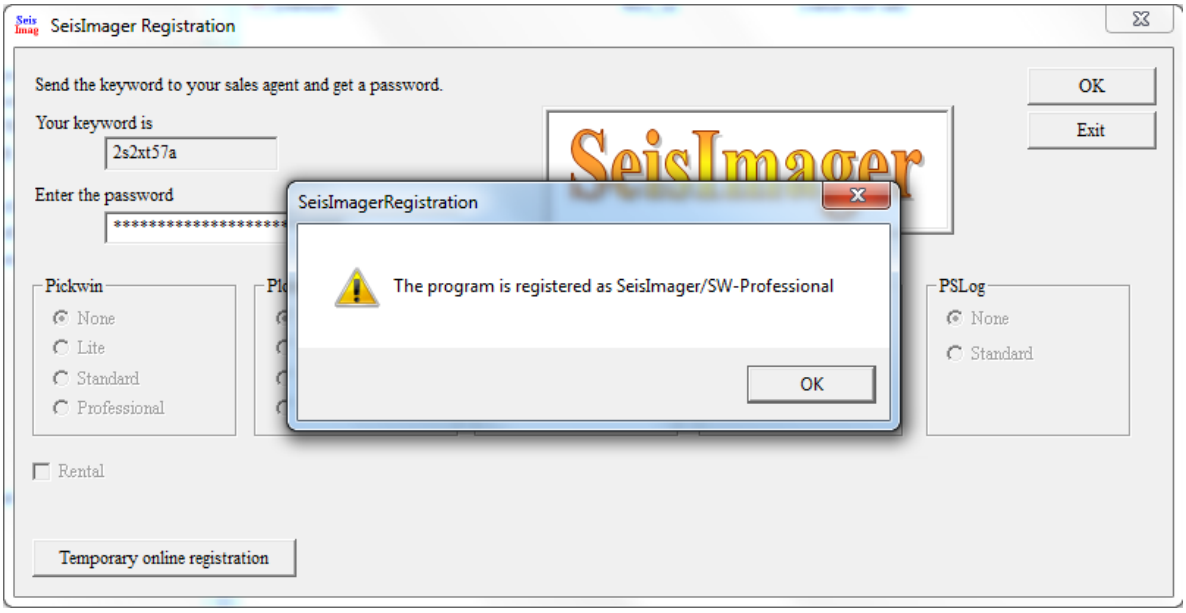
Email the keyword shown in the register to support@geometrics.com with your order number and seismograph serial number (if you purchased the software with a seismograph) and we will reply with a registration password to enable the version of the software you have purchased. Once received, enter the password into the password field and click *OK*.

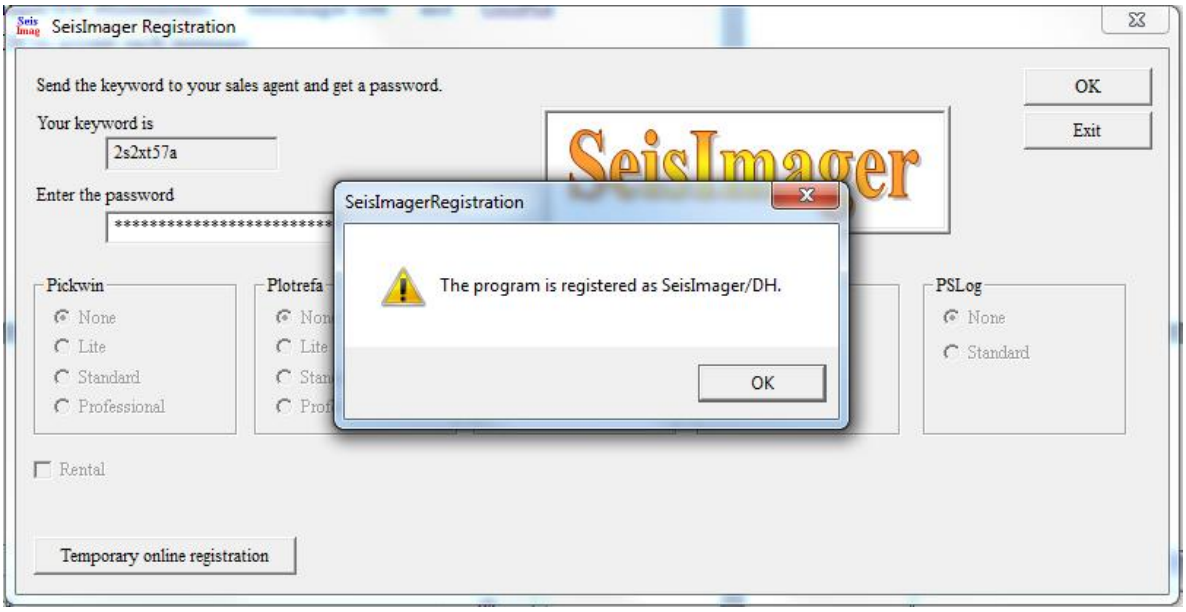


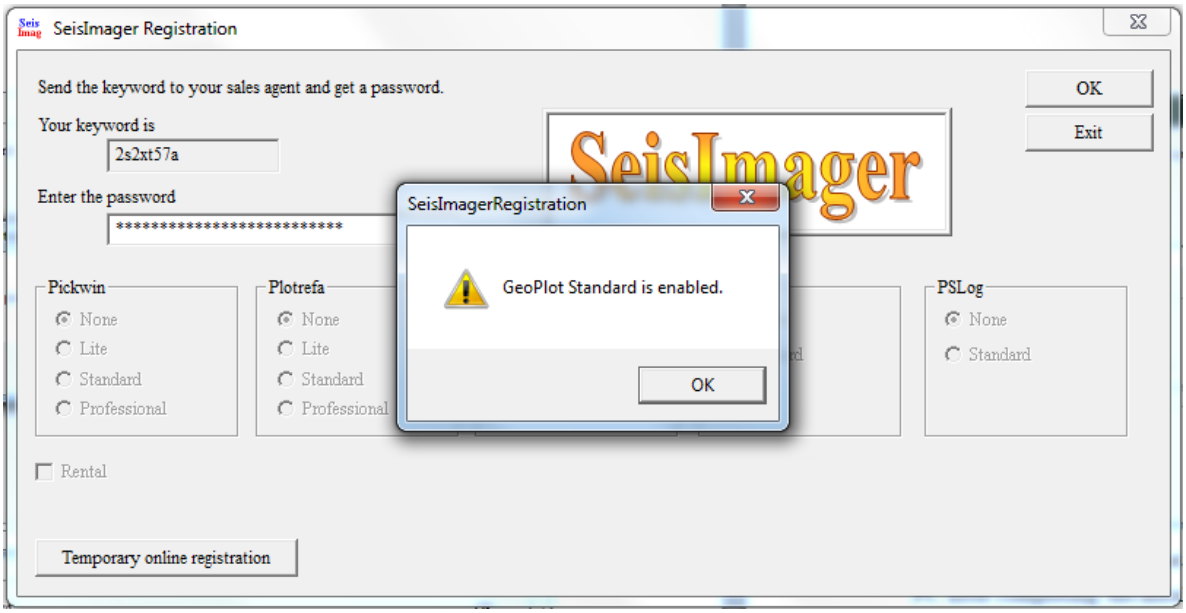
The programs enabled by the password will be reported in a series of messages. For example, as shown below, for purchase of SeisImager/2D Professional, SeisImager/SW Professional and SeisImager/DH, the register reports that SeisImager/2D Professional, SeisImager/SW-1D,2D, SeisImager/SW-Professional, SeisImager/DH and GeoPlot Standard are registered. Click *OK* to accept each message.


SeisImager Registration
Send the keyword to your sales agent and get a password.
Your keyword is
y3sb8fs8
Enter the password
OK
Exit
SeisImager
Pickwin
None
Lite
Standard
Professional
PSLog
None
Standard
Rental
Temporary online registration
SeisImagerRegistration
The program is registered as SeisImager/2D Professional.
OK

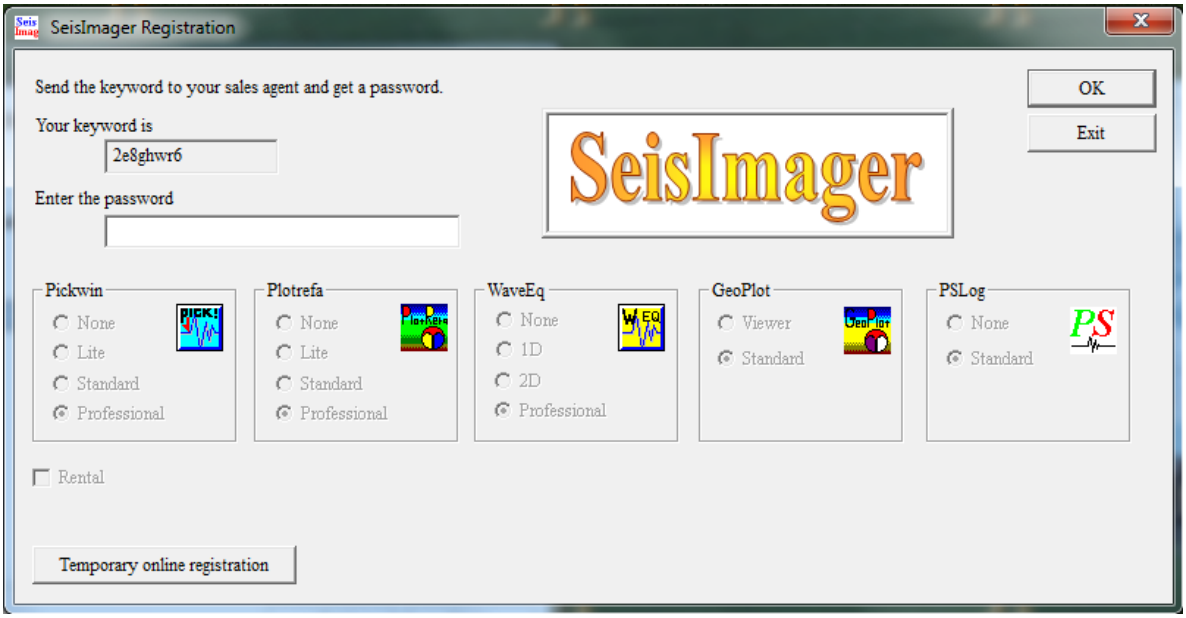

SeisImager Registration
Send the keyword to your sales agent and get a password.
Your keyword is
2s2xt57a
Enter the password
OK
Exit
SeisImager
Pickwin
None
Lite
Standard
Professional
PSLog
None
Standard
Rental
Temporary online registration
SeisImagerRegistration
The program is registered as SeisImager/SW-1D,2D.
OK


SeisImager Registration
Send the keyword to your sales agent and get a password.
OK
Exit
Your keyword is
2s2xt57a
Enter the password
SeisImager
SeisImagerRegistration
The program is registered as SeisImager/SW-Professional
OK
Pickwin
None
Lite
Standard
Professional
PSLog
None
Standard
Rental
Temporary online registration

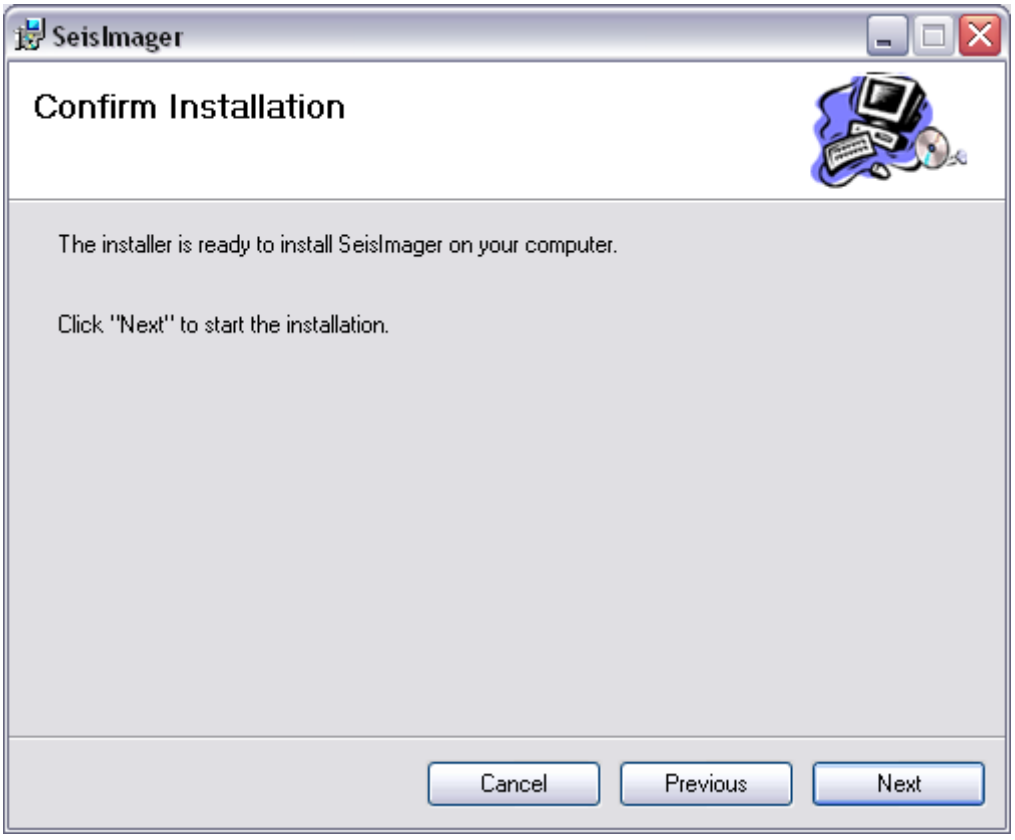

SeisImager Registration
Send the keyword to your sales agent and get a password.
OK
Exit
Your keyword is
2s2xt57a
Enter the password
SeisImager
SeisImagerRegistration
The program is registered as SeisImager/DH.
OK
Pickwin
Plotrefa
None
Lite
Standard
Professional
PSLog
None
Standard
Rental
Temporary online registration

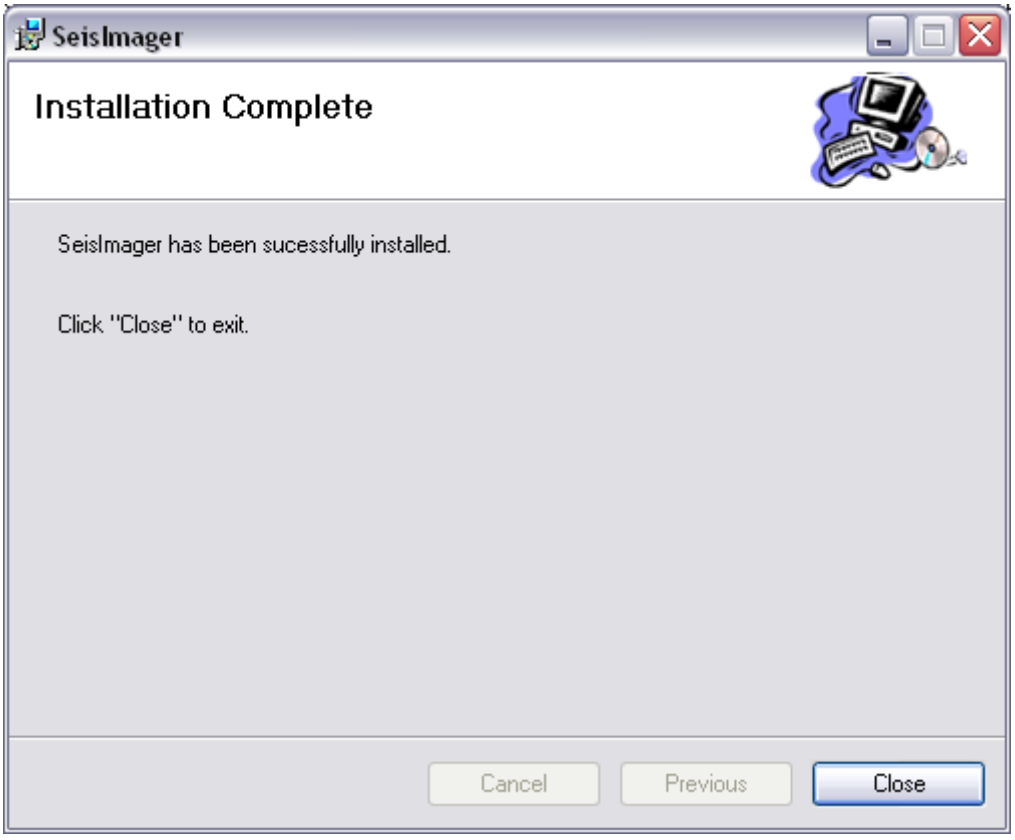


After these messages have appeared, the register will also reflect the programs that have been registered, as shown below.



After completion of registration, Click on *Next*, and *Close*. It is not necessary to reboot the PC after completing the installation.

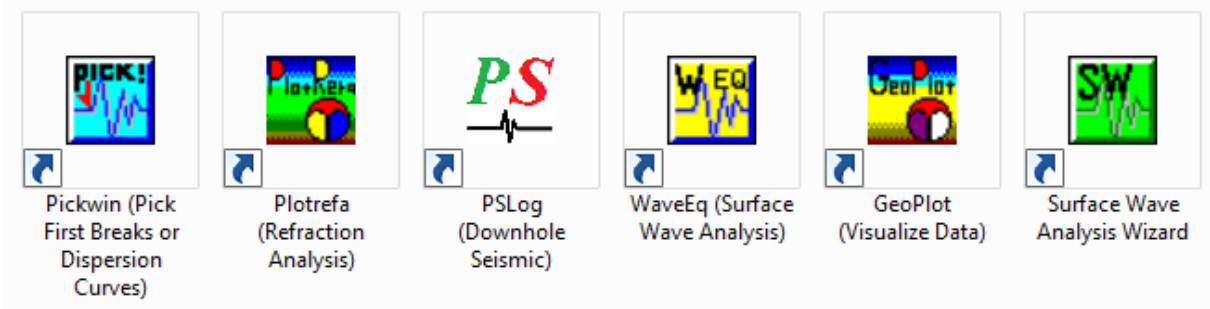

SeisImager
Confirm Installation
The installer is ready to install SeisImager on your computer.
Click "Next" to start the installation.
Cancel
Previous
Next



4. To copy the SeisImager manuals to your hard drive (~125 MB), select the folders SeisImager2D_Manual and SeisImagerSW_Manual on the CD and copy them to your hard drive in the desired location. Note that the SeisImager2D_Manual folder contains .avi video clips that must reside in the same location as the files SeisImager2D_Manual_vX.X.pdf and SeisImager2D_Examples_vX.X.pdf (where X.X is the current version).

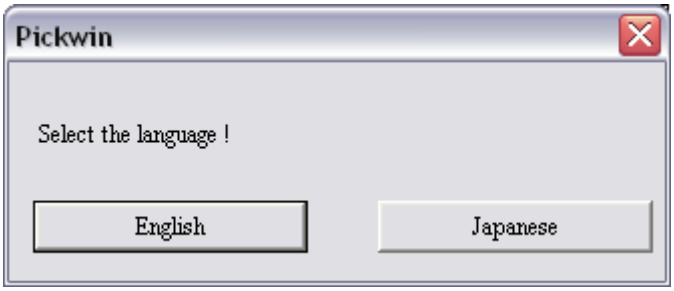
You will need Adobe's freeware program Acrobat Reader to view the manual files. If you need this program, go to the Adobe website to download the latest version compatible with your operating system.

5. To register the software after the installation, go to the *Start* menu, under *All Programs*, *SeisImager* to find the SeisImager Registration SeisImager Registration and open the register.
6. Once installed, the program modules can be opened directly through the desktop icons shown below or through the links in the *SeisImager Start* menu folder.

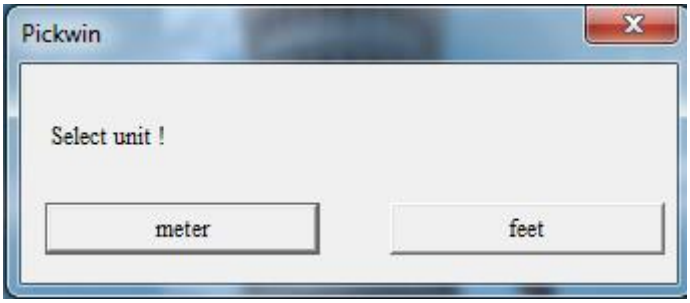


SeisImager/2D consists of the Pickwin and Plotrefa modules. SeisImager/SW-1D consists of the Pickwin and WaveEq modules. SeisImager/SW-2D and SW-Professional consists of the Pickwin, WaveEq, and GeoPlot modules. SeisImager/DH consists of the Pickwin and PSLog modules. The Surface Wave Analysis Wizard is not a separate module but automatically calls on specific functions from Pickwin, WaveEq, and GeoPlot to walk you through the surface wave analysis process. All of the icons will be shown regardless of which program(s) have been purchased or will be used.

To begin using the software, double-click the Pickwin module icon. If you have installed for the first time or upgraded from a version older than April 2007, a prompt will ask you to set the language as shown below. Choose *English*.

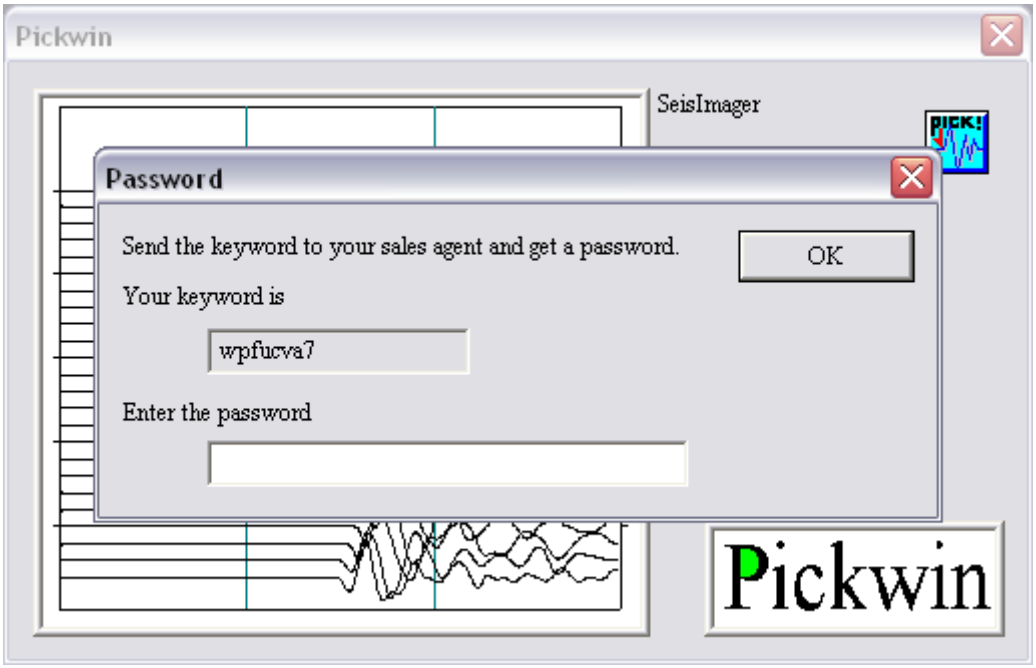


A prompt will ask you to select desired unit labels. Choose preferred one.

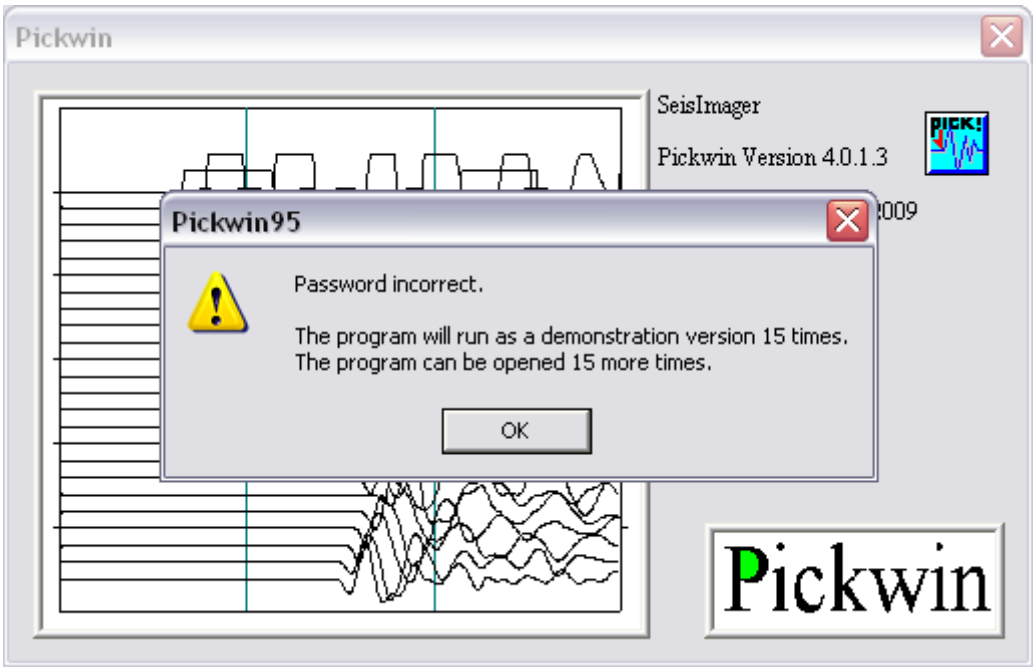


For registered installations, upon selection of the language, the module opens and is ready for use. As well, the other registered modules are ready for use. For unregistered installations running in demonstration mode, proceed to Step 7.

7. If you are using the software in demonstration mode, after opening any SeisImager modules, you will be presented with the registration dialog box as shown below. Leave the password field empty and click *OK*.



Detection of no password and the number of available run-times will be reported as shown below. Click *OK*.



After running the software in demonstration mode, if you later purchase the software, refer to Step 8 on how to enter your registration password.

8. To enter your password after running the software in demonstration mode, go to the *Start* menu, under *All Programs*, *SeisImager* to find the SeisImager Registration SeisImager Registration program as shown below. Open the register and email the keyword shown to support@geometrics.com with your order number and seismograph serial number (if you purchased the software with a seismograph) and we will reply with a registration password to enable the version of the software you have purchased. Once received, enter the password into the password field and click *OK*.

Once the software is registered (refer to Step 3 for a full description of the process), the data input dimensions of the demonstration version will be updated to reflect the limits of the program purchased. Click *OK*.

3 - Data acquisition and first break picking

3.1 Source-receiver configurations can be processed by SeisImager/DH

Several source-receiver configurations are used for downhole seismic data acquisition. SeisImager/DH can process following configurations.

A) P-wave data using a multi-channel receiver (Figure 3).

If a borehole is filled with water, using multi-channel receivers, e.g. hydrophone cable, is easiest way to obtain P-wave data. This data acquisition results in one waveform data file for one borehole (Figure 4). In the analysis, Pickwin opens the file and pick first arrival.

B) P-wave data using a single channel receiver (Figure 6).

If a borehole is not filled with water, receiver(s) must be fixed on borehole wall by clamp. Geophone with clamp has generally one or two set of receivers (usually three components) and all depths cannot be measured at once. Data acquisition must be done by each depth. Precise shot time is a key in this configuration. It is recommended that one receiver is fixed on ground surface and used for monitoring shot time. Data acquisition results in many waveform files as shown in Figure 7. Each waveform file contains one trace for one depth. In the analysis, Pickwin opens all files at once, extracts intended traces, displays as a common shot gather and picks first arrivals.

C) S-wave data using a single channel receiver (Figure 9).

S-wave cannot propagate in water and receivers must be fixed on borehole wall by clamp for data acquisition. Geophone with clamp has generally one or two set of receivers (usually three components) and all depths cannot be measured at once. Data acquisition must be done by each depth. Precise shot time is a key in this configuration. It is recommended that one receiver is fixed on ground surface and used for monitoring shot time. Shear beam is a common form of an S-wave energy source. It is strongly recommended that striking both end of shear beam so that waveform traces with opposite polarity can be observed. Data acquisition results in many waveform files as shown in Figure 10. At each depth, two waveform files in which two horizontal components (X and Y) are obtained. In the analysis,

Pickwin opens all files at once, extracts intended traces at first. Polarization is applied to two horizontal components and two traces are rotated to the direction of particle motion.

This configuration can be divided to two procedures.

C1) Left and right shots are individually recorded to different file (Figure 10 and 11).

C2) Left and right shots are recorded to same file (Figure 12 and 13).

The second method can be achieved using "Hold" function in seismographs so that the reverse of polarity can be confirmed in field easily. Left and right shot records can be analyzed separately using Pickwin basic functions. The procedure is noted as:

C3) Analyze left and right hitting data separately (optional).

D) S-wave data using a multi-channel (double) receiver (Figure 15).

Downhole seismic test can be performed without a borehole using a cone penetrating probe. One or two sets of receivers are installed in the probe. Downhole seismic test using the cone penetrating probe is called a seismic cone test. Analysis using the cone probe with one set of receiver is same as procedure B) or C). It is recommended that one receiver is fixed on ground surface and used for monitoring shot time. If the cone probe has two sets of receivers (Figure 15), traveltime can be obtained as the difference of first arrivals. Traveltimes can be precisely determined and accurate shot time is not needed so that the receiver for shot time monitoring is not necessary.

E) OYO Suspension (P)

P-waveform data obtained by OYO suspension can be processed. Source receiver geometry is similar to the double receivers (D) except source is placed beneath receivers. Processing can be performed similar to double receiver processing. You do not need to care about the difference of receiver position.

F) OYO Suspension (S)

S-waveform data obtained by OYO suspension can be processed. Source receiver geometry is similar to the double receivers (D) except source is placed beneath receivers. Processing

can be performed similar to double receiver processing. You do not need to care about the difference of receiver position.

A) P-wave data using a multi-channel receiver.

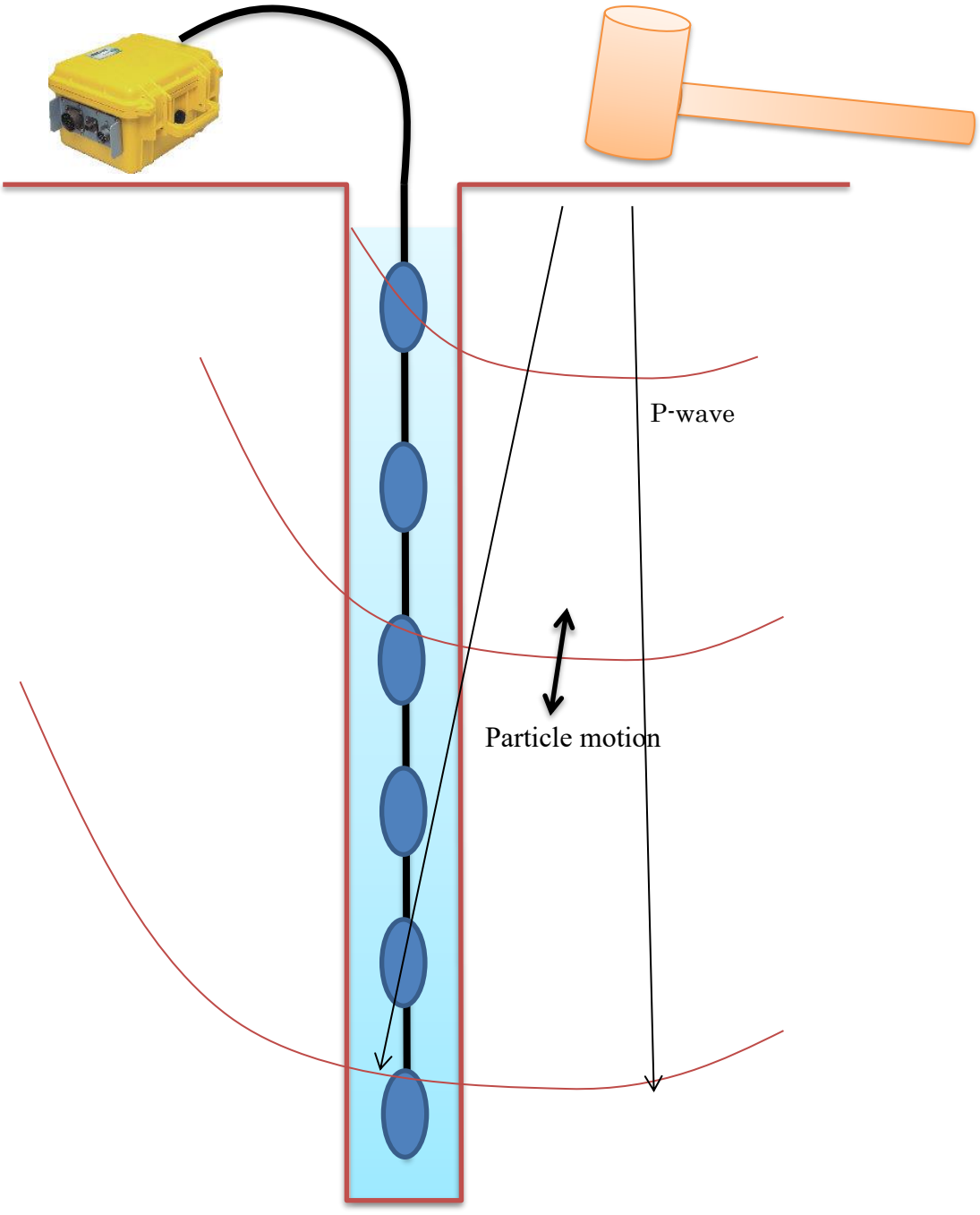


Figure 3. P-wave data acquisition using multi-channel receiver cable.

Analysis uses single waveform data file for one shot.

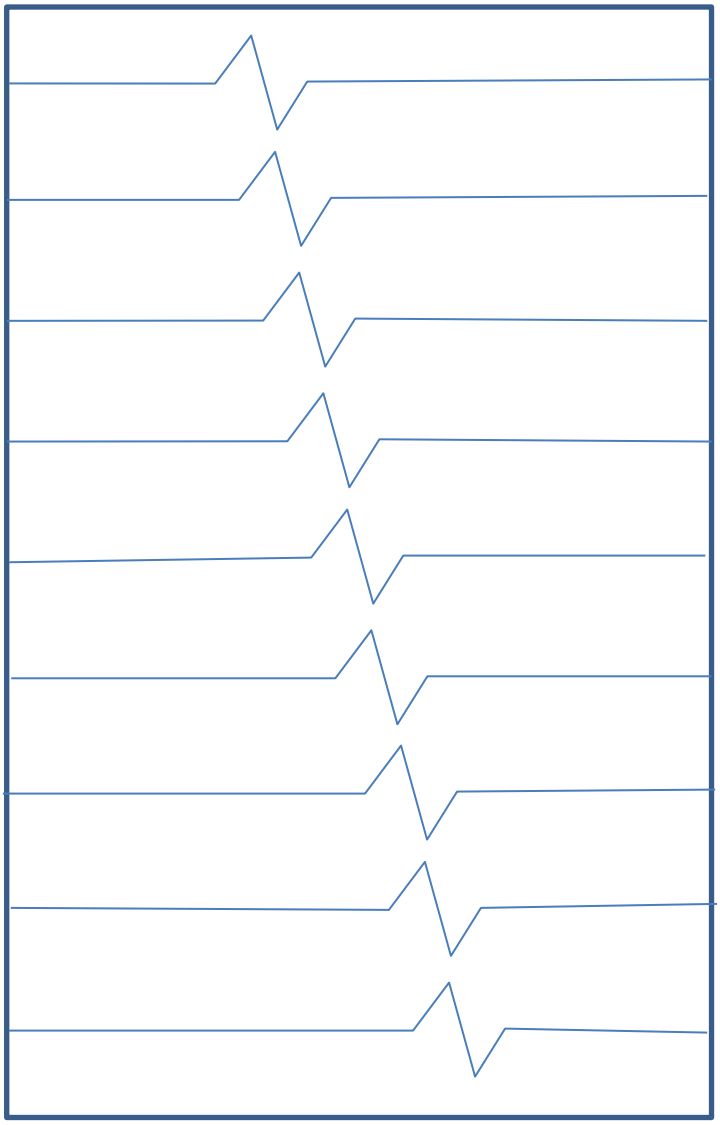


Figure 4. P-wave data obtained by multi-channel receiver cable.

Pickwin

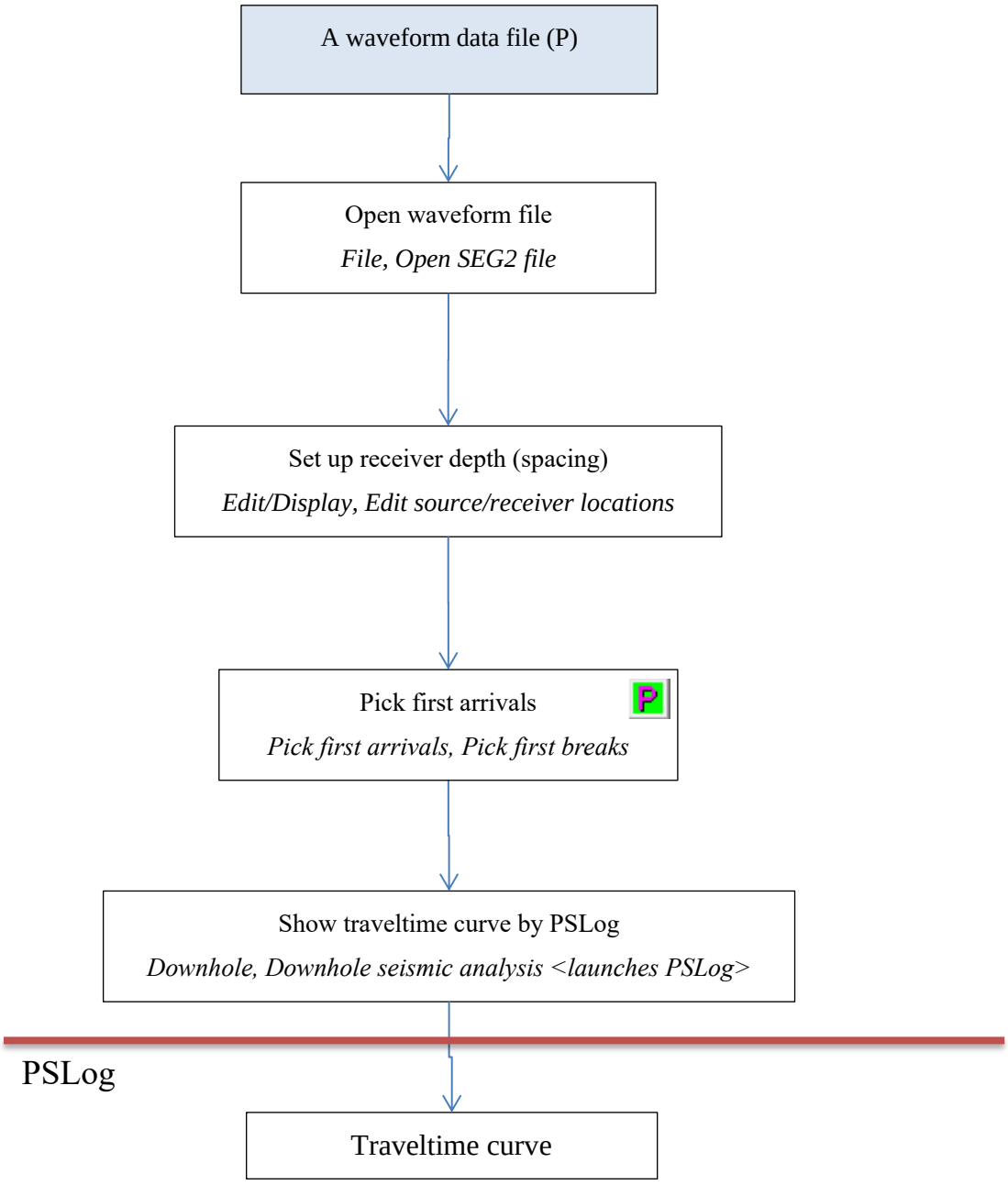


Figure 5. Processing flow of P-wave data obtained by multi-channel receiver

B) P-wave data using a single channel receiver.

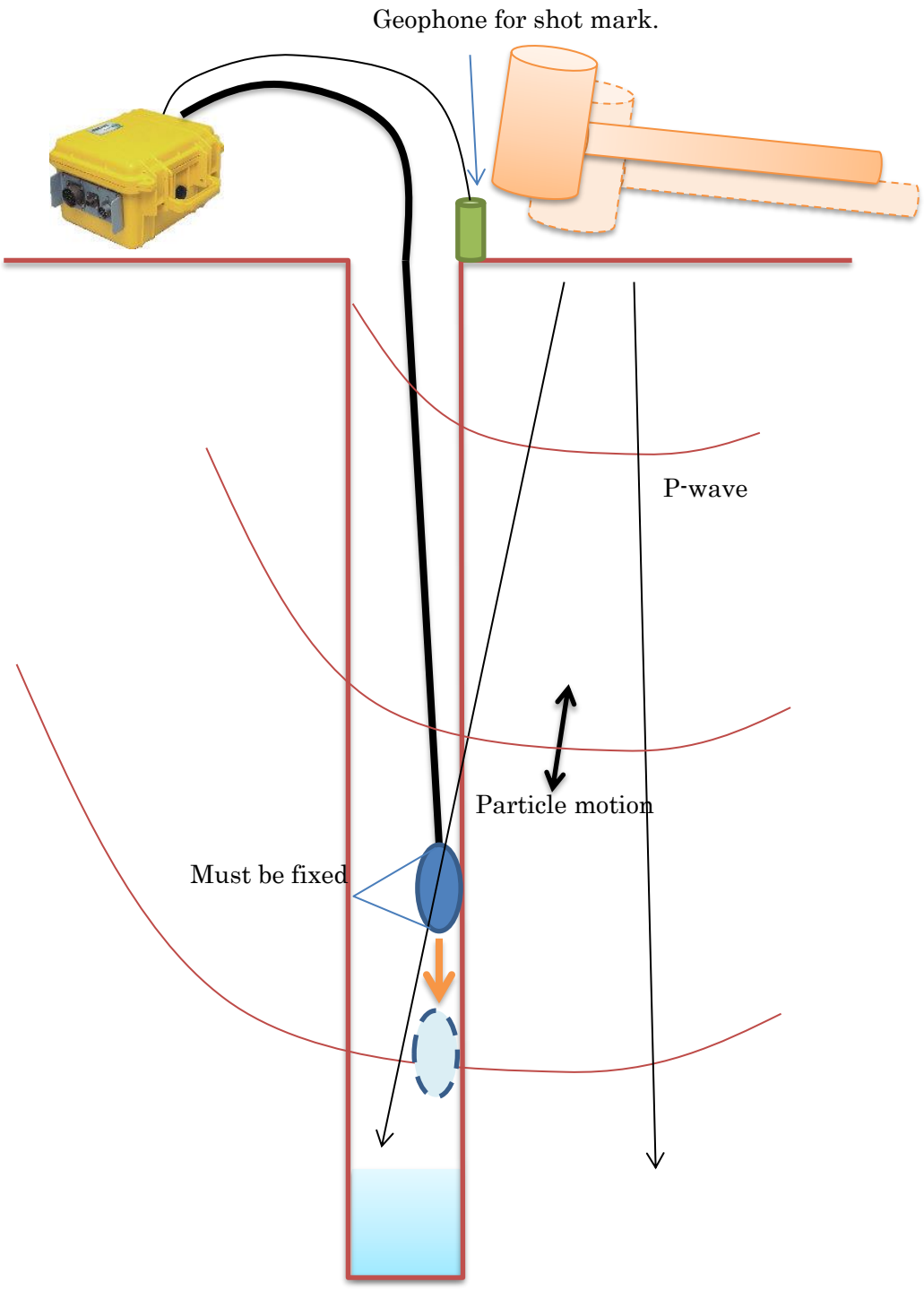


Figure 6. P-wave data acquisition using single channel receiver.

Analysis uses many waveform data files for many shots.

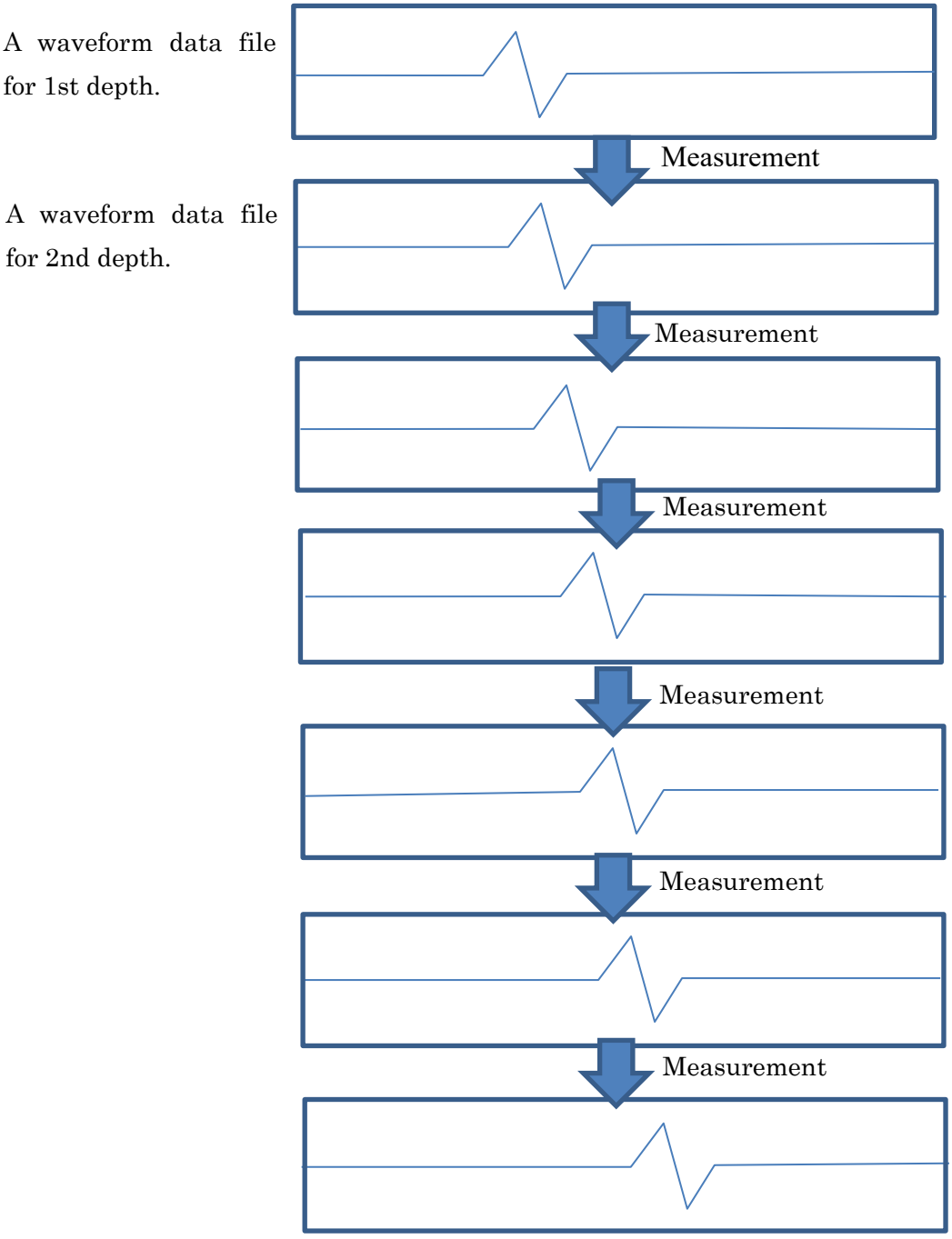


Figure 7. P-wave data obtained by single channel receiver.

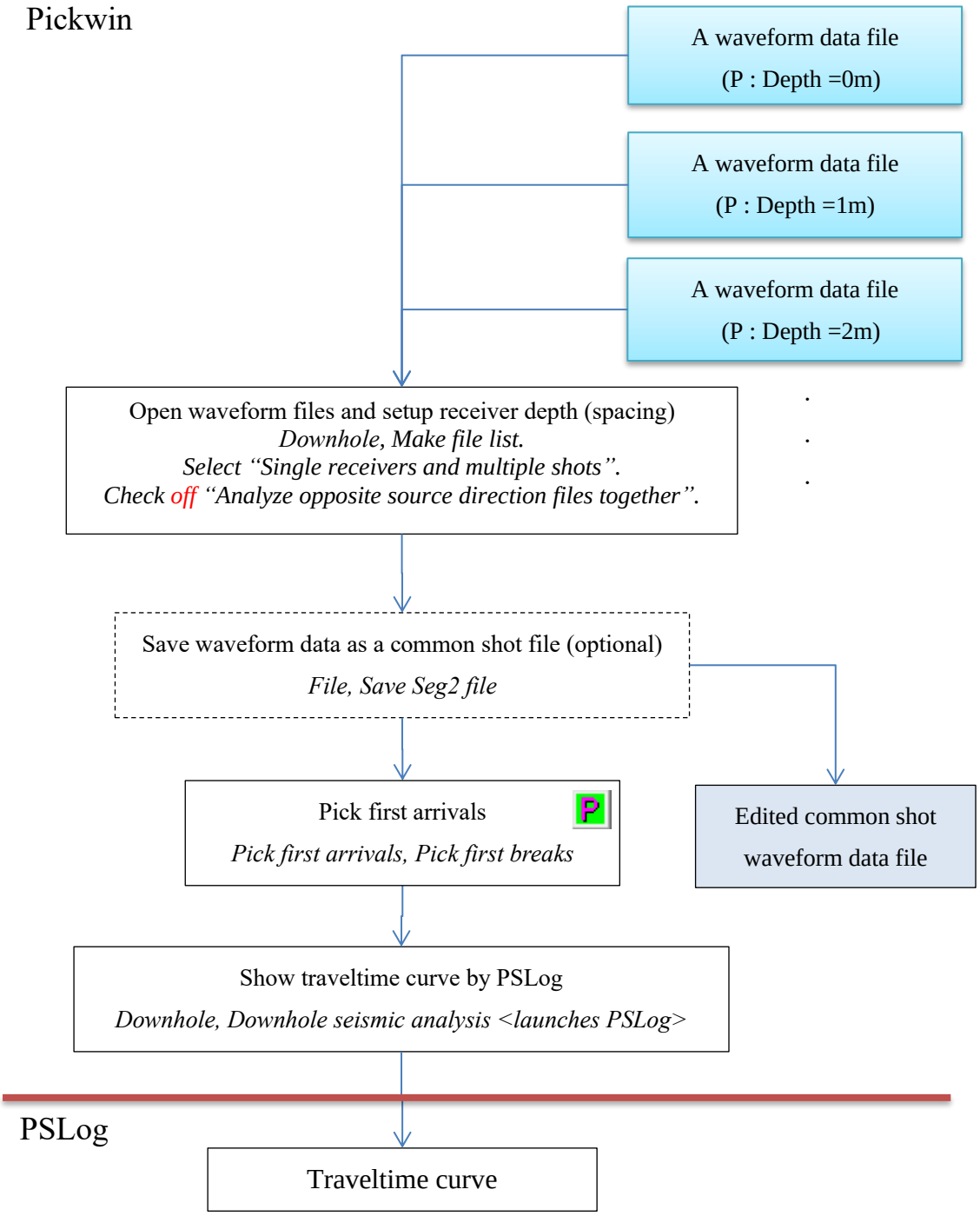


Figure 8. Processing flow of P-wave data obtained by single channel receiver.

C) S-wave data using a multi-channel receiver (strike opposite directions).

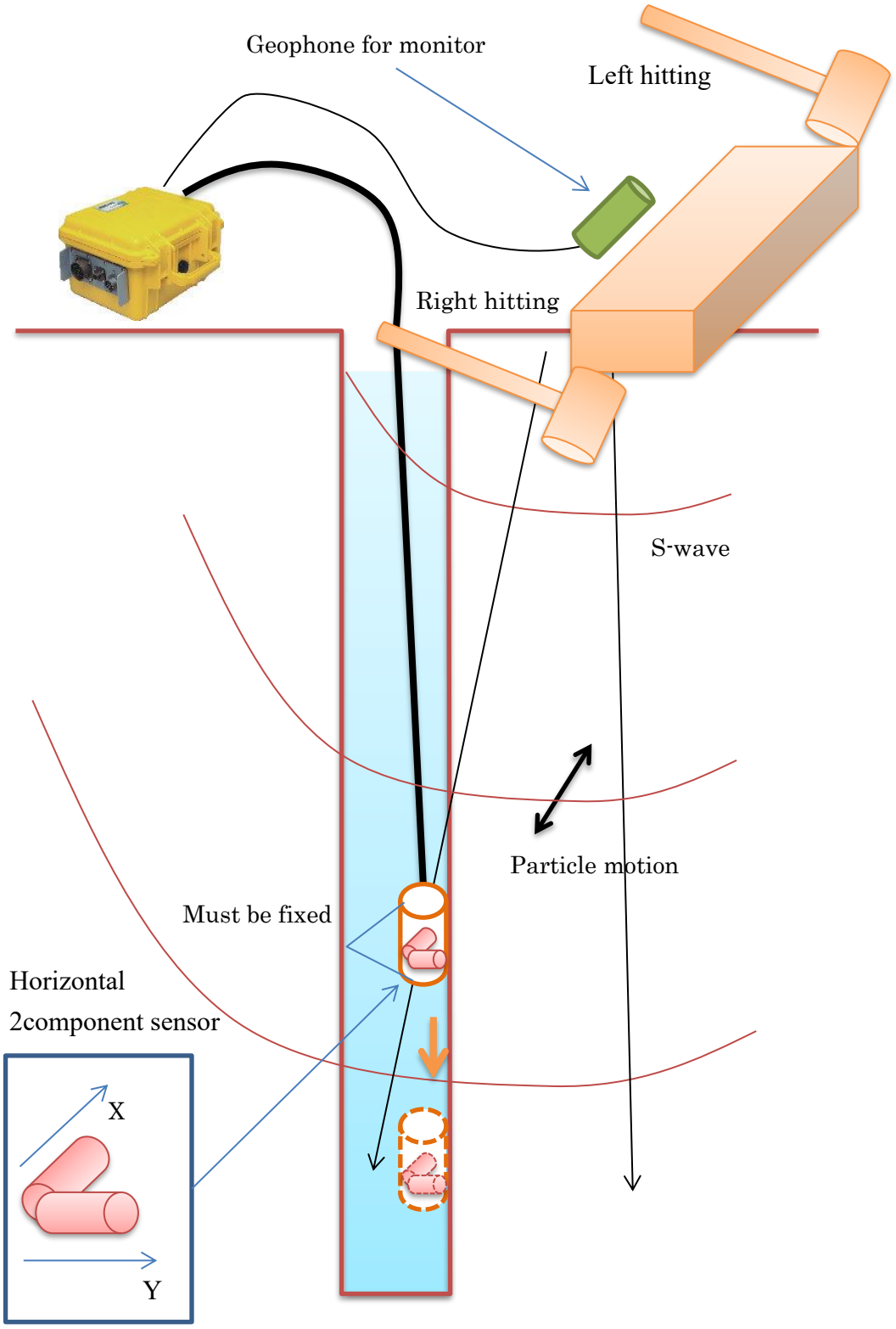


Figure 9. Data acquisition of S-wave using a single channel receiver.

C1) Analysis using many waveform data files for many shots.

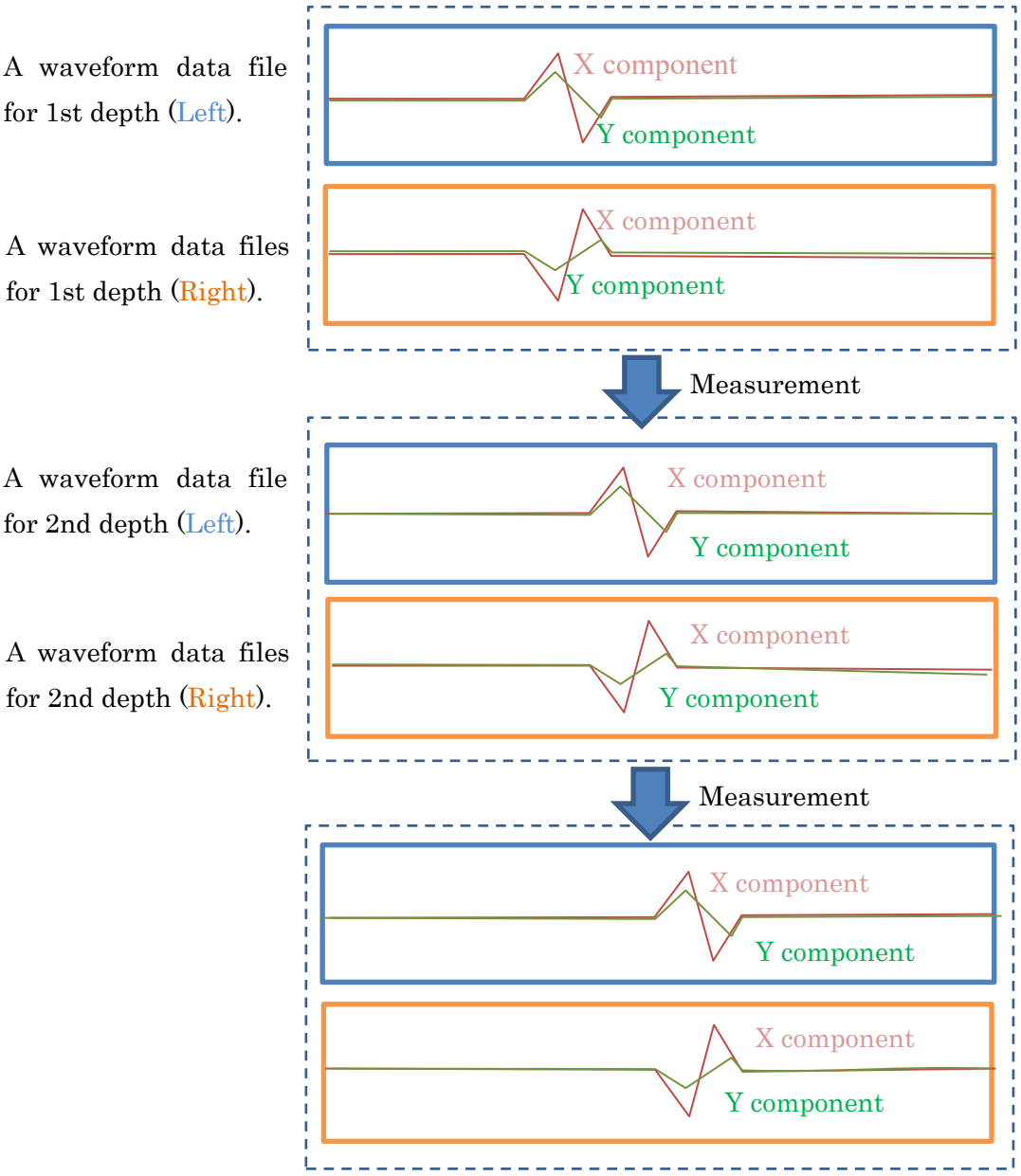


Figure 10. S-wave data obtained by a single channel receiver.

C1) Analyze left and right hitting data together.

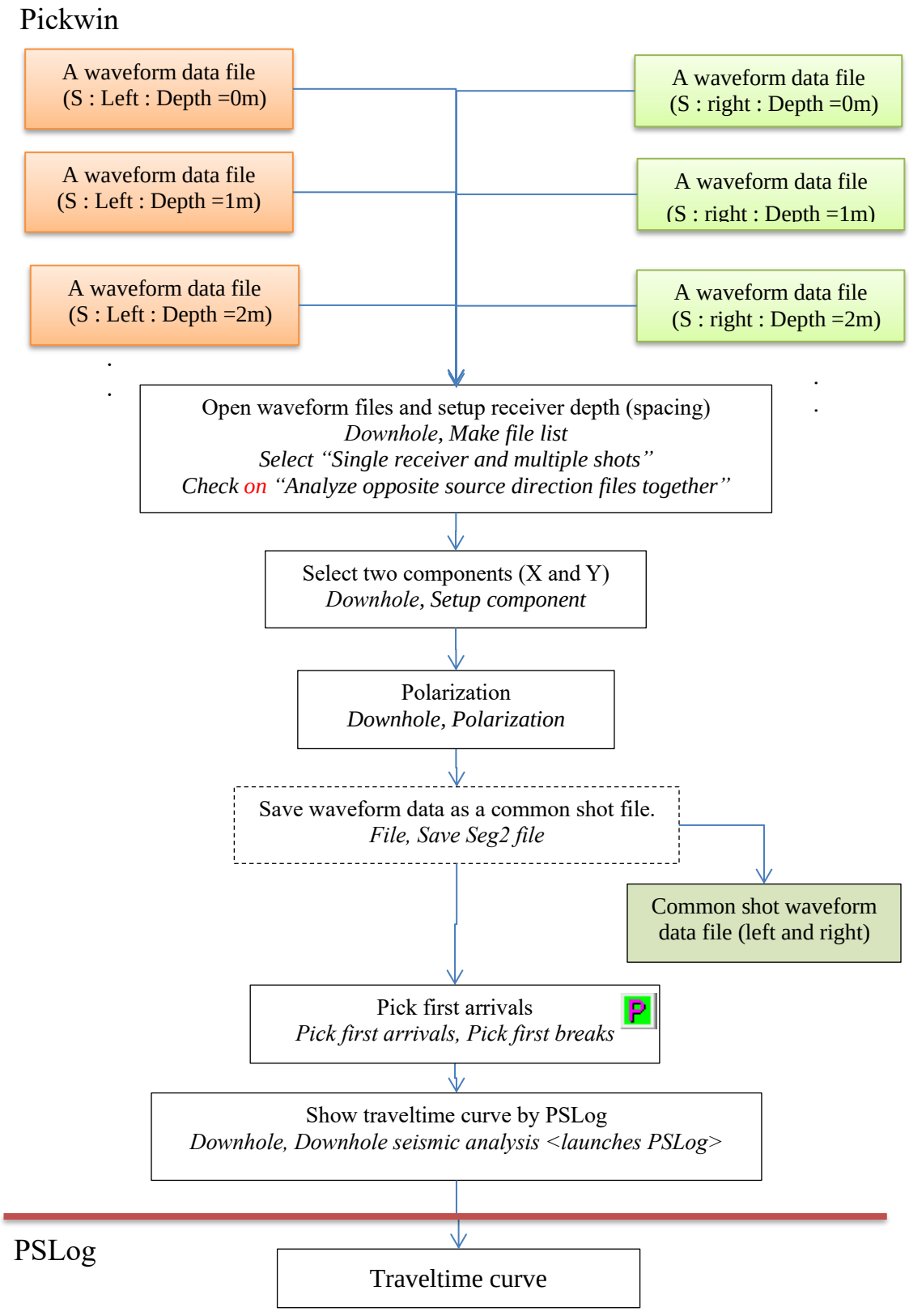


Figure 11. Processing flow S-wave data obtained by a single channel receiver (Analyzing left and right hitting data together).

C2) Analysis using many waveform data files for many shots.

A waveform data file for 1st depth. The file contains both left and right shots.

A waveform data file for 2nd depth. The file contains both left and right shots.

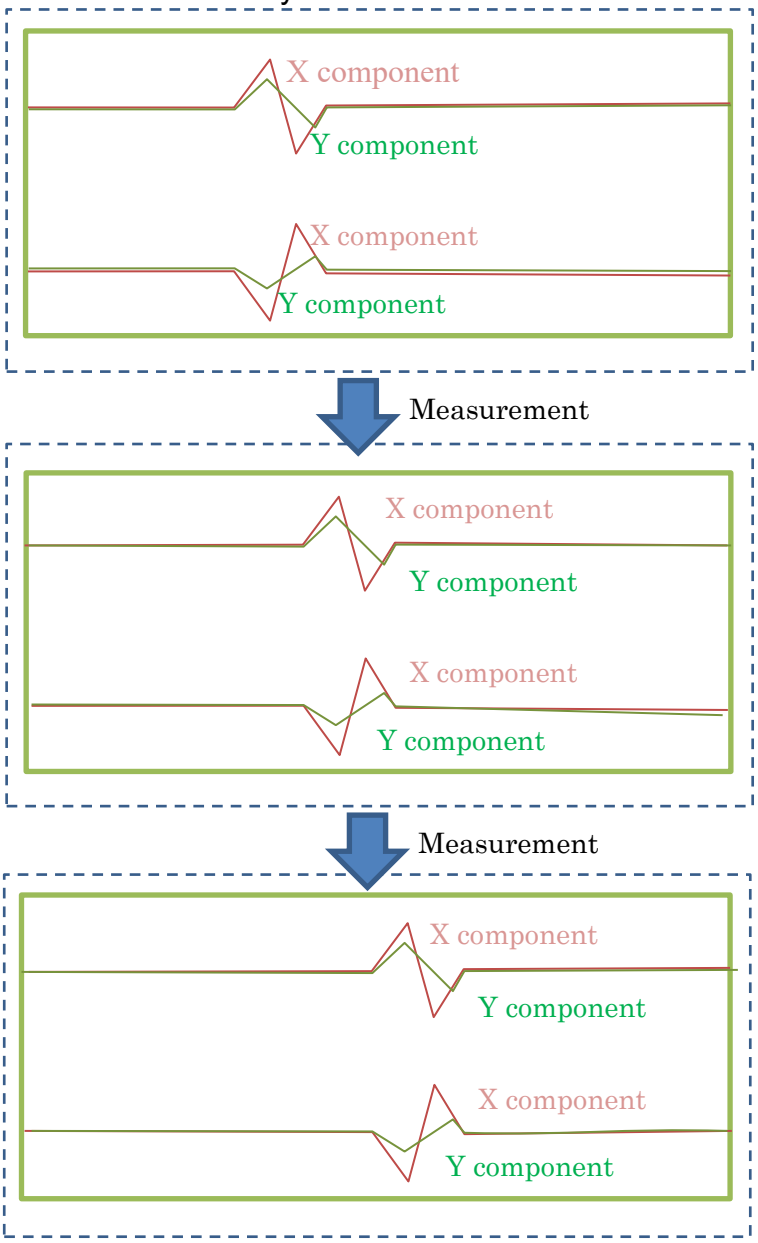


Figure 12. S-wave data obtained by a single channel receiver. Wave form data files contain both left and right shots

C2) Analyze left and right hitting data together. Waveform data files contains both left and right shots.

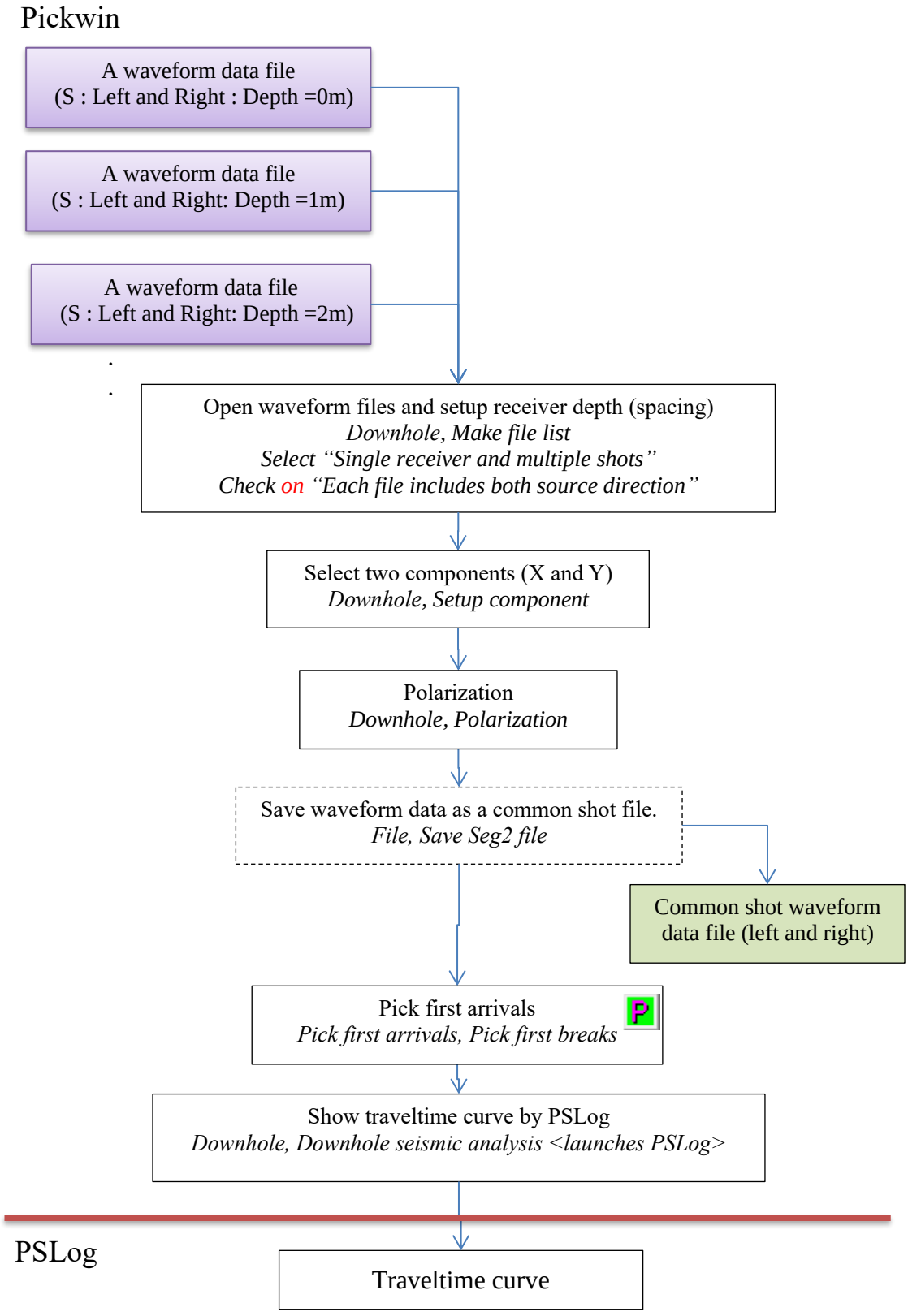


Figure 13. Processing flow S-wave data obtained by a single channel receiver (Analyzing left and right hitting data together).

C3) Analyze left and right hitting data separately (optional).

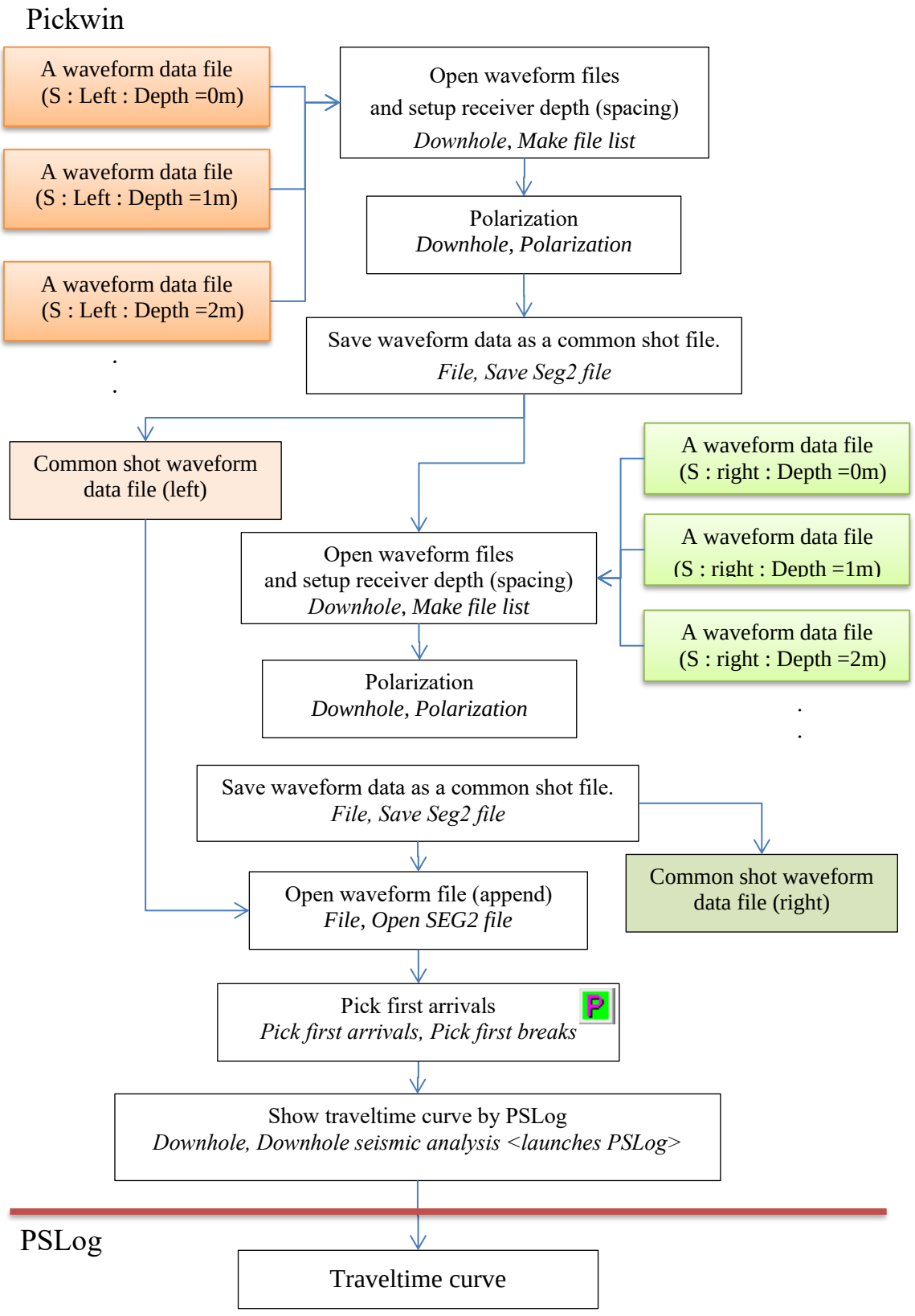


Figure 14. Processing flow S-wave data obtained by a single channel receiver (Analyzing left and right hitting data separately).

D) S-wave data using a multi-channel (double) receiver (strike opposite directions).

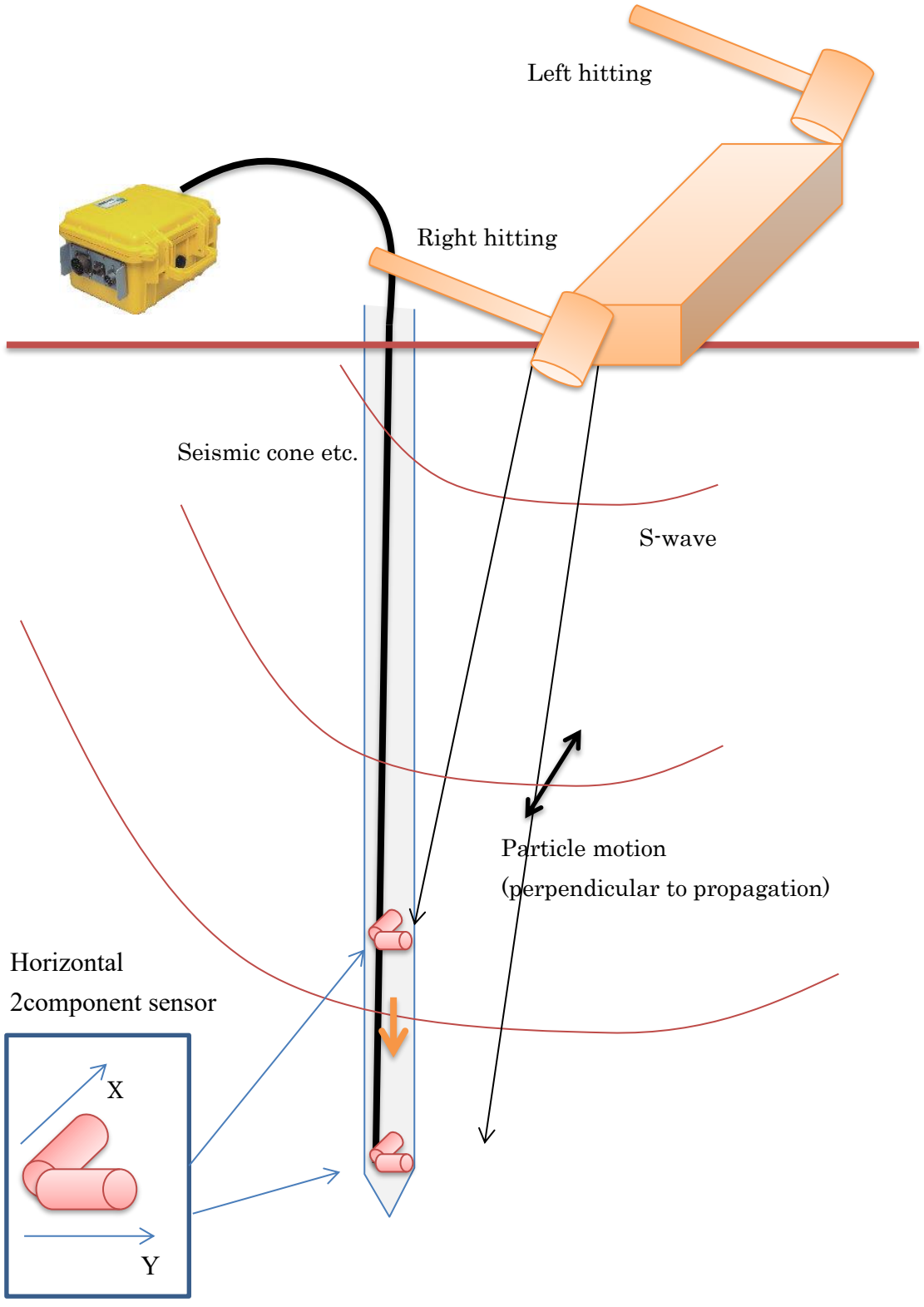


Figure 15. Data acquisition of S-wave using a multi-channel (double) receiver (strike opposite directions).

D) Analysis uses many waveform data files for many shots.

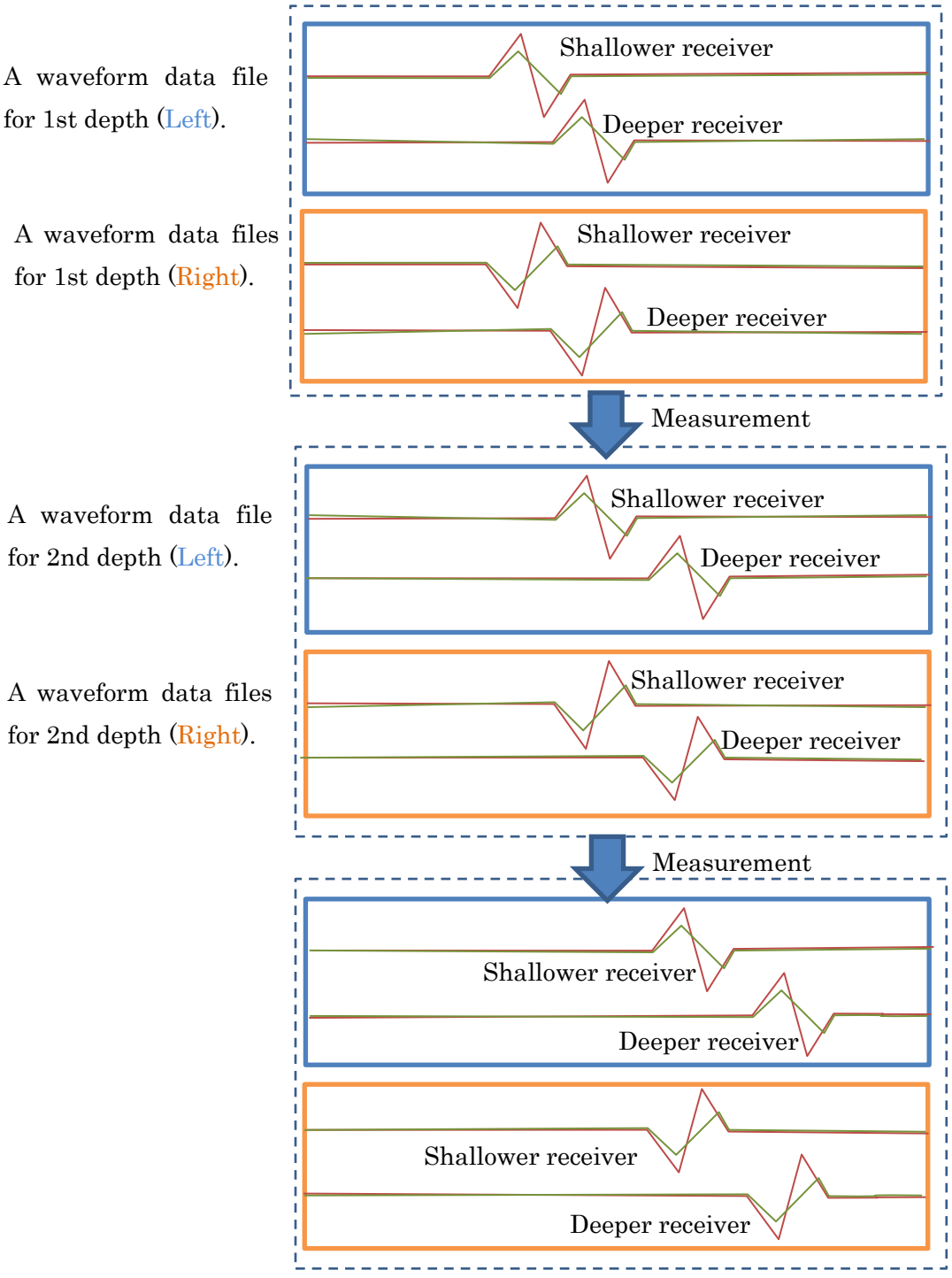


Figure 16. Data acquisition of S-wave using a multi-channel (double) receiver (strike opposite directions).

D) S-wave data using a multi-channel (double) receiver (strike opposite directions).

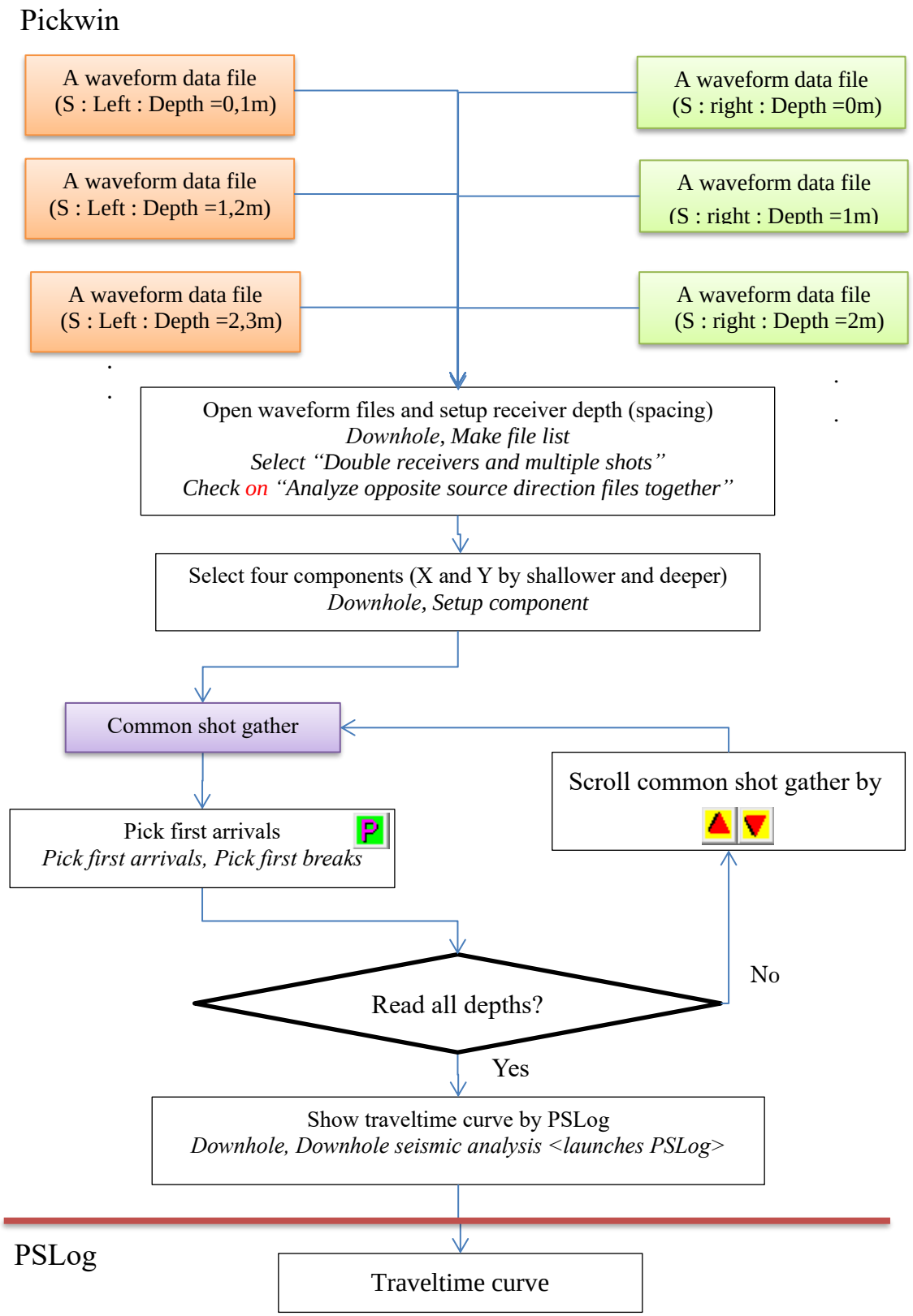


Figure 17. Data acquisition of S-wave using a multi-channel (double) receiver (strike opposite directions).

3.2 Optional acquisition and analysis method

3.2.1 Using monitor for trigger in data acquisition

In the methods B**)** and C), waveforms in each depth must be acquired separately and shot time must be very accurate. Accuracy of trigger depends on seismography. Shot time of trigger may not be enough accurate in some seismographs. In order to confirm accurate shot time, using a monitor geophone is effective. The monitor geophone is connected to ordinal channel of a seismograph and pre-trigger must be used in data recording. The configuration of monitor geophone and example of short record are shown in Figure 18. Analysis using the monitor geophone is described in later.

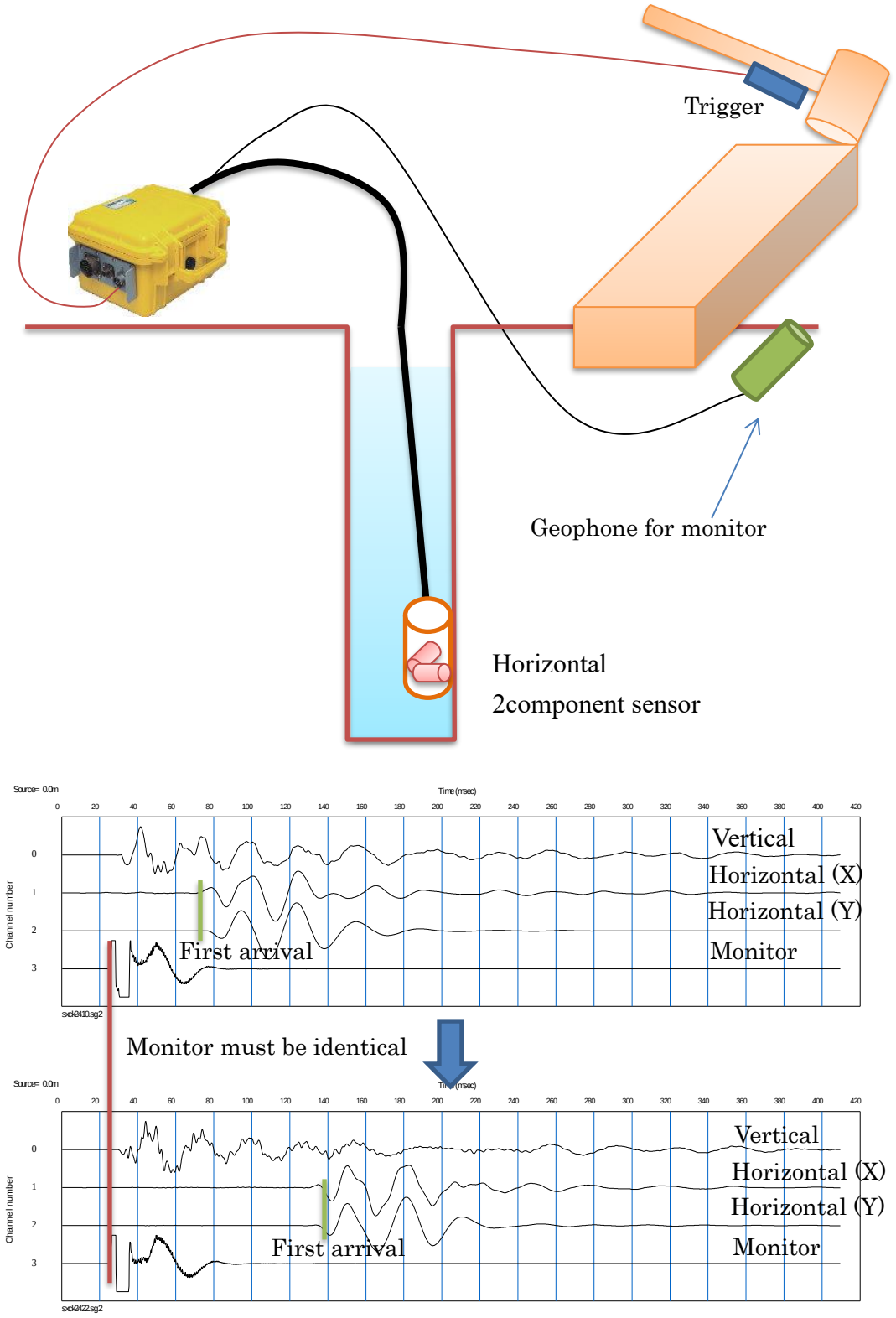


Figure 18. Configuration of monitor geophone and example of short record.

3.2.2 Polarization by manually

It is generally difficult to set the direction of receiver in borehole during the data acquisition of S-waves except a seismic cone penetrometer. Therefore, orthogonal two horizontal receivers are used for data acquisition and two traces are rotated in processing so that the direction parallel to the shot is obtained. This processing is called “Polarization”. It is difficult to know the direction of receiver in borehole, SeisImager/DH guess the angle of direction as following procedure:

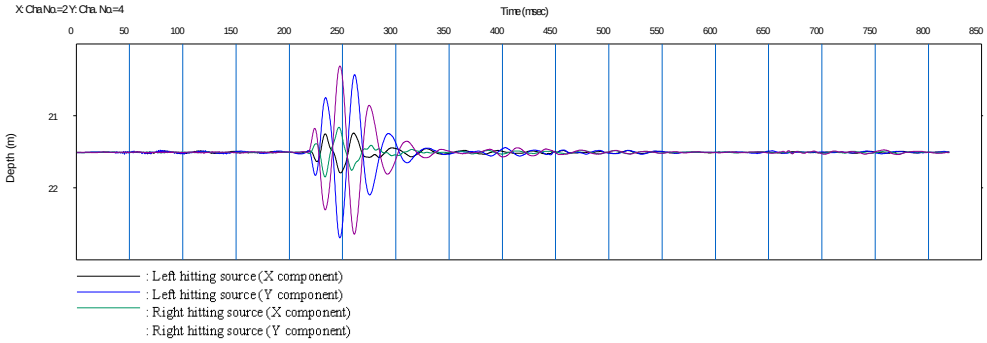
1) Plot the motion of particle from two orthogonal waveform traces.

2) Calculate a straight line passing through the origin using a least squares method.

3) If there are waveforms for two opposite direction sources (left and right hitting), both directions waveforms can be handled together.

Figure 19 shows the example of the particle motion. With the default setting, SeisImager/DH obtains rotation angle automatically by the least squares method. Sometimes, appropriate rotation angle cannot be automatically obtained. SeisImager/DH can also setup rotation angle manually for such situation.

Waveform traces



Particle motion

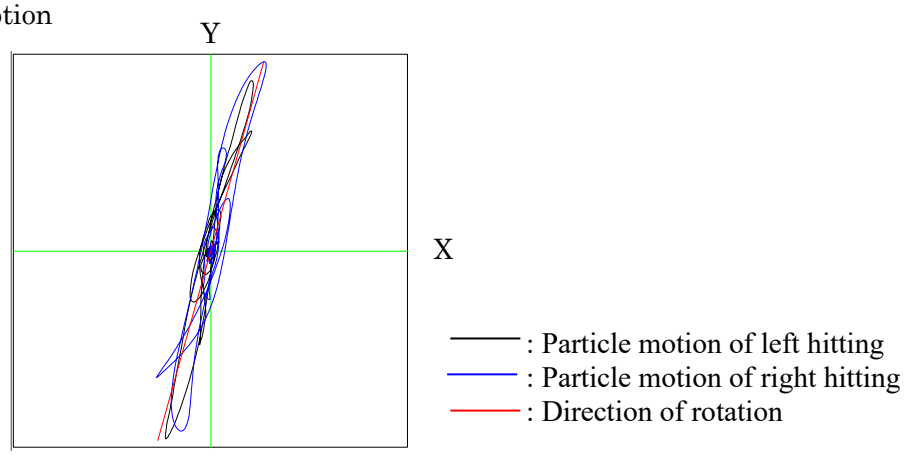


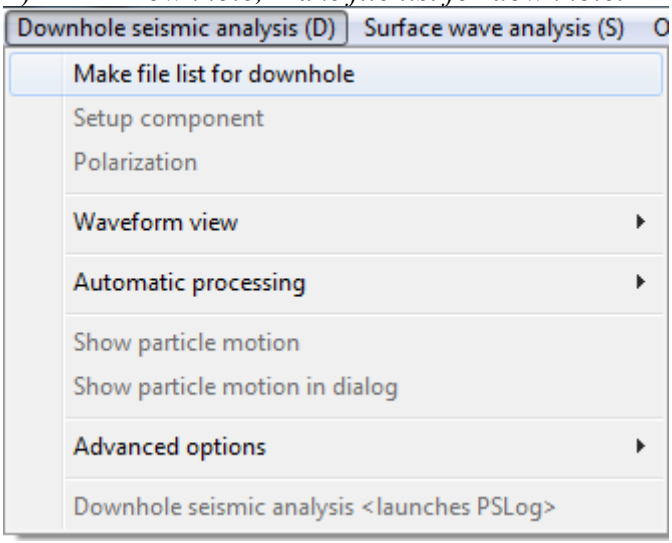
Figure 19. Example of particle motion.

4- Basic processing flow

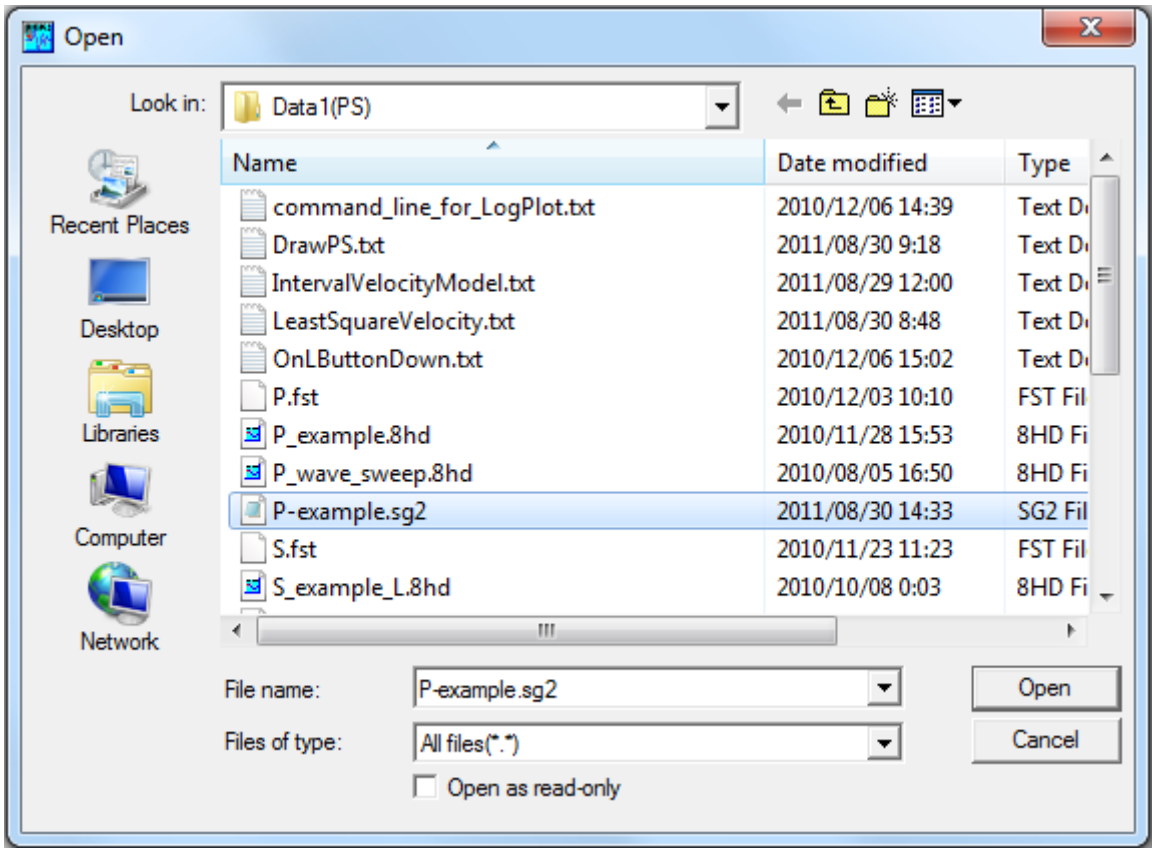
4.1 Processing for P- and S-wave data with typical source-receiver configuration.

A) P-wave data using a multi-channel receiver

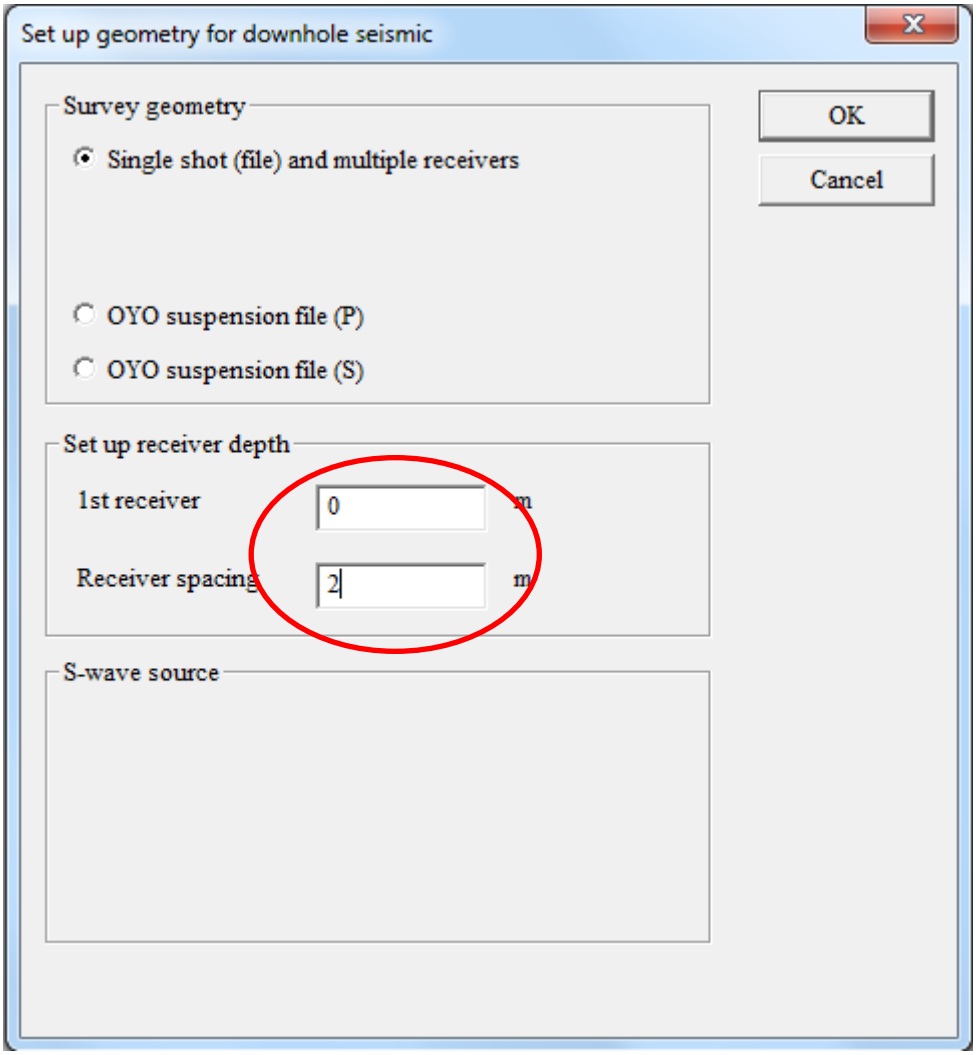
1) Select *Downhole, Make file list for downhole.*



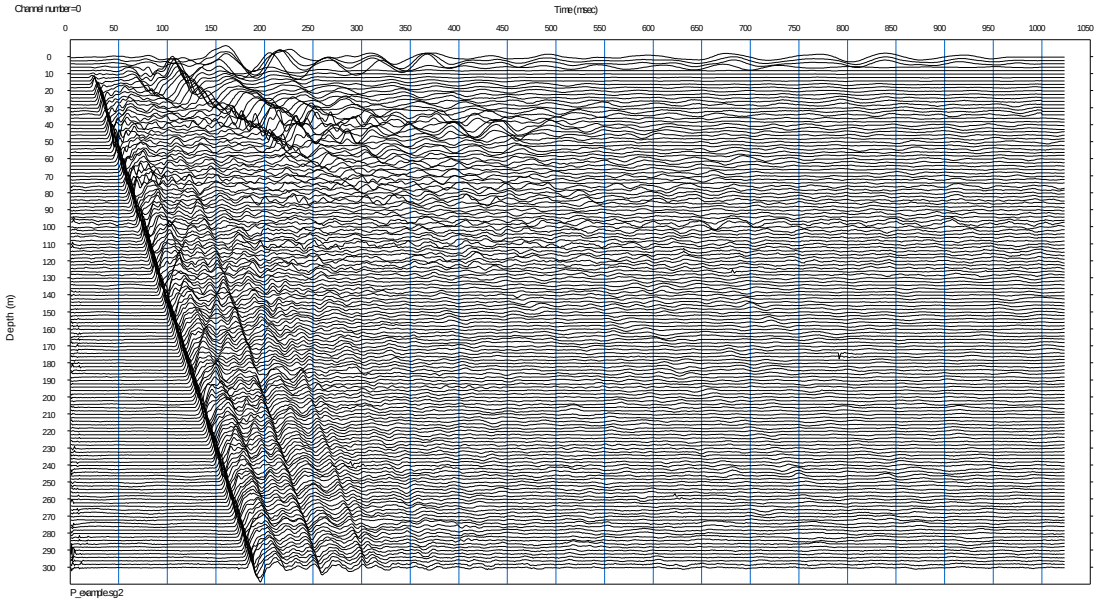
2) Select a single file.



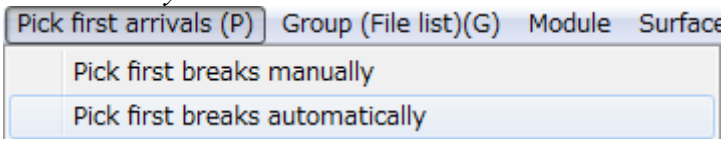
3) Select *Single shot (file) and multiple receivers* and set up *1st receiver depth* and *Receiver spacing*.

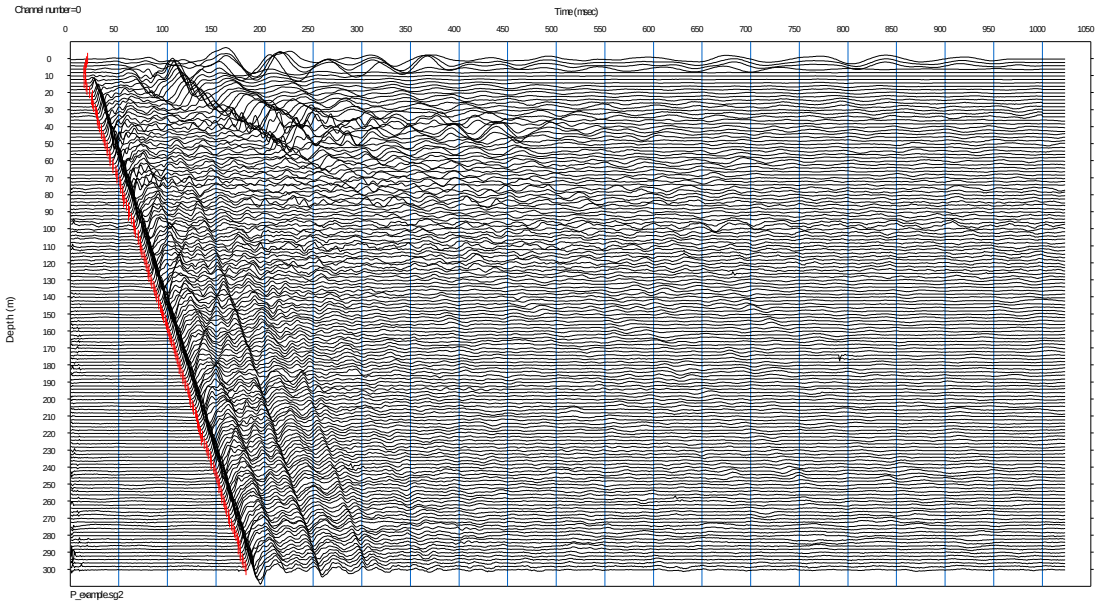


4) Waveform data is shown.

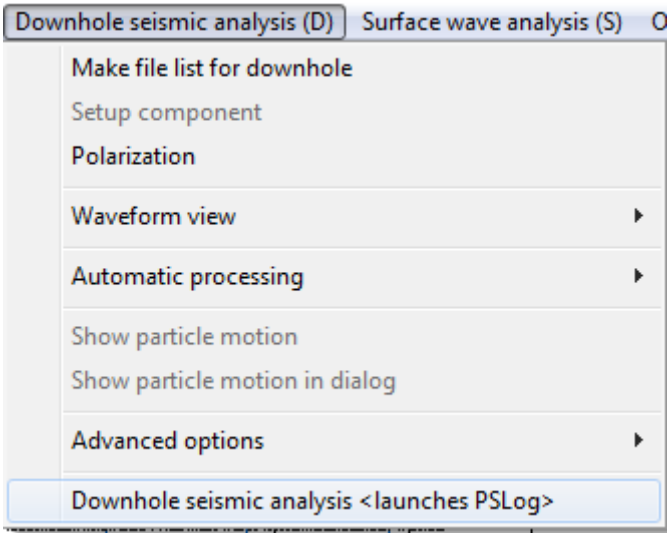


5) Pick first arrivals by *Pick first arrivals, Pick first arrivals manually* or *Pick first arrivals automatically.*

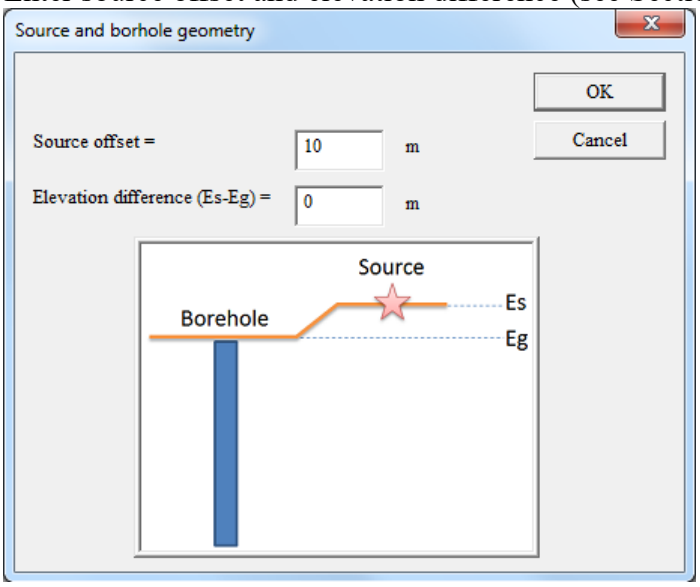




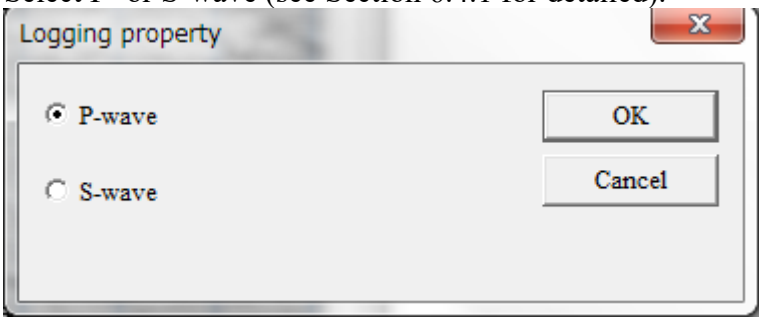
6) Select *Downhole, Downhole seismic analysis <launches PSLog>* for showing a traveltime curve.



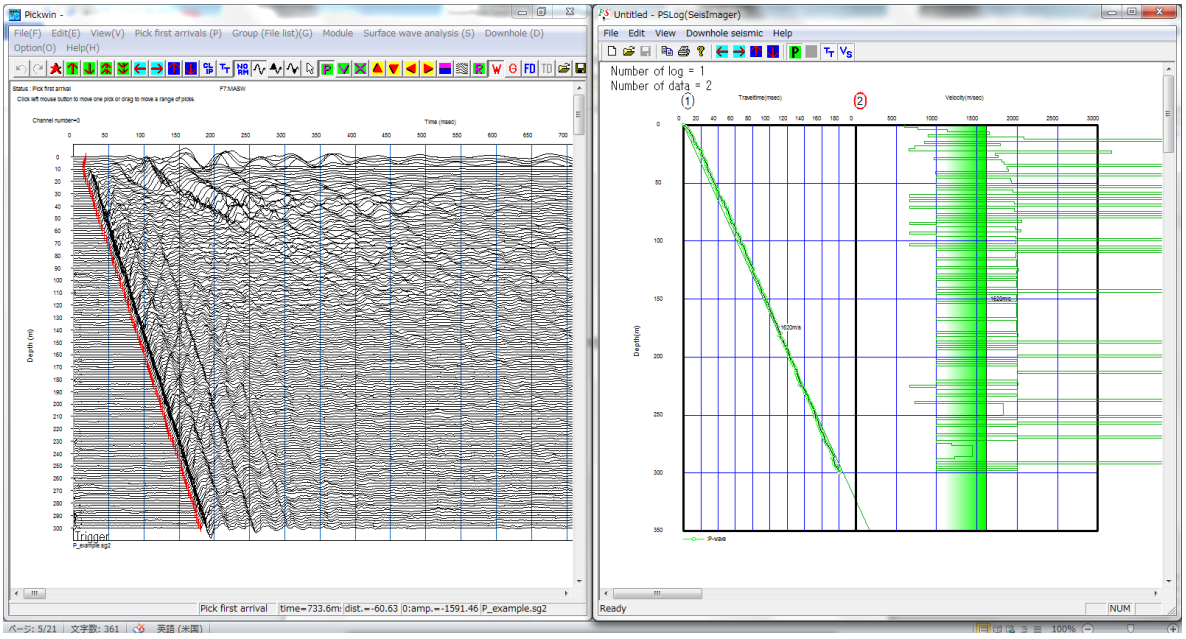
Enter source offset and elevation difference (see Section 6.4.2 for details).



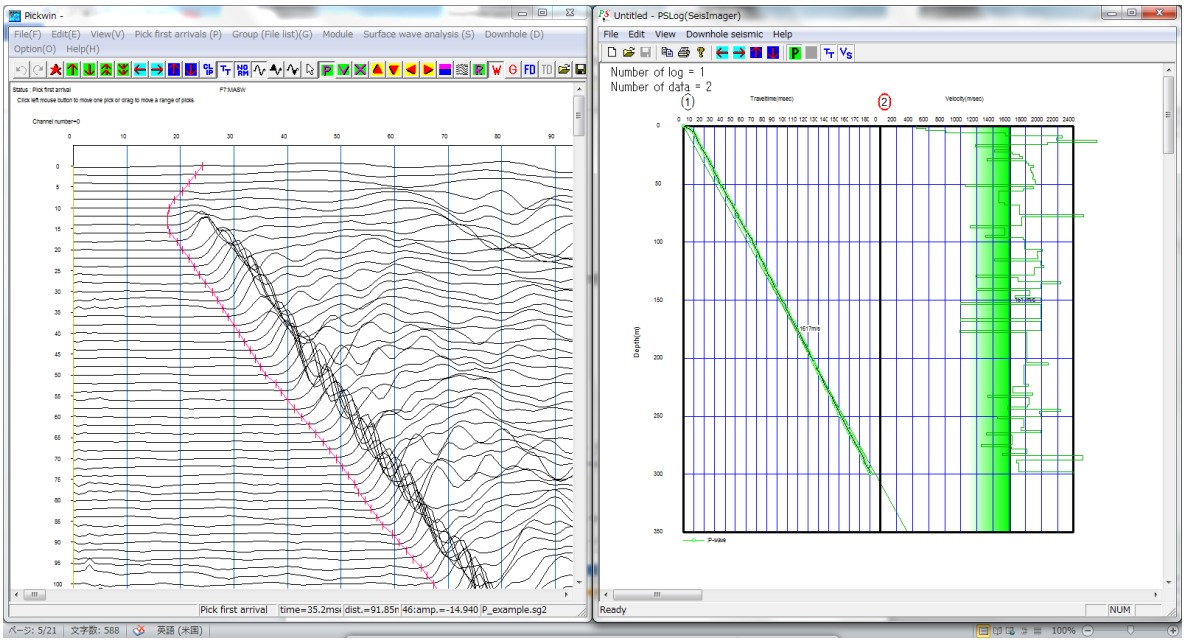
Select P- or S-wave (see Section 6.4.1 for detailed).



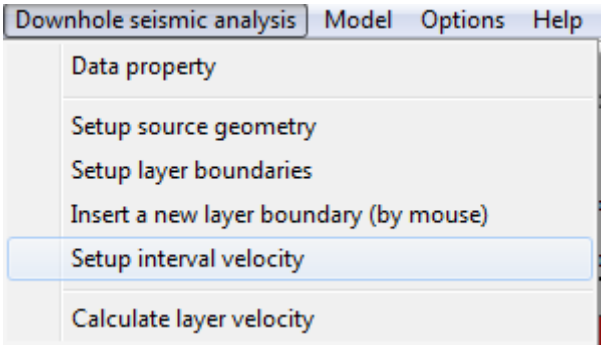
A traveltime curve and a velocity model are shown by PSLog.



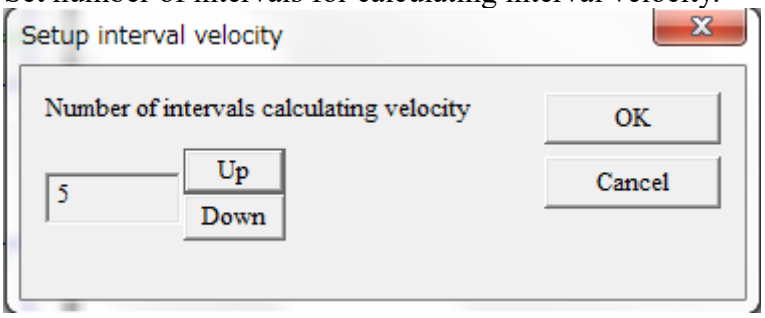
7) Change first arrival picking and click a red star  in Pickwin, the traveltime curve and the velocity model is automatically updated.



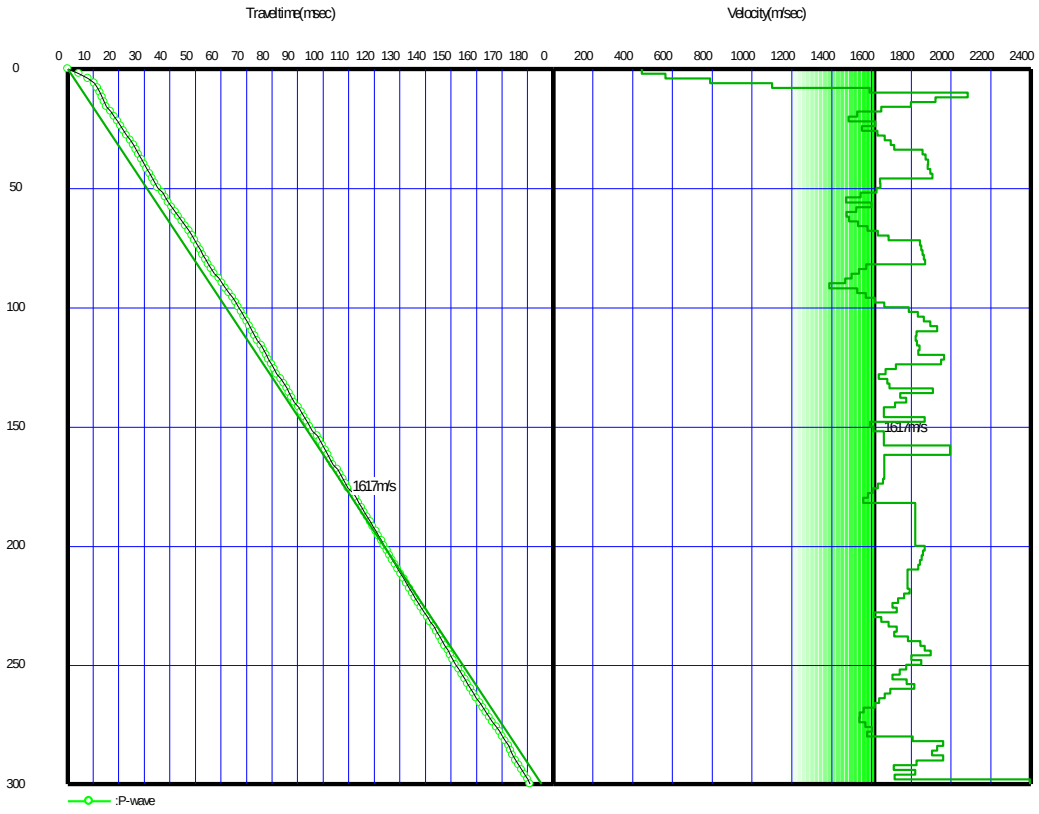
8) Calculation of interval velocity can be changed by *Downhole seismic, Setup interval velocity.*



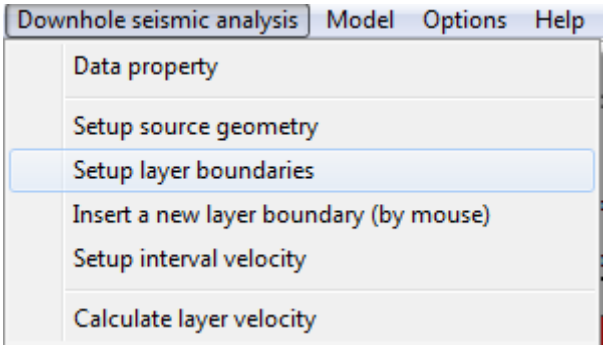
Set number of intervals for calculating interval velocity.



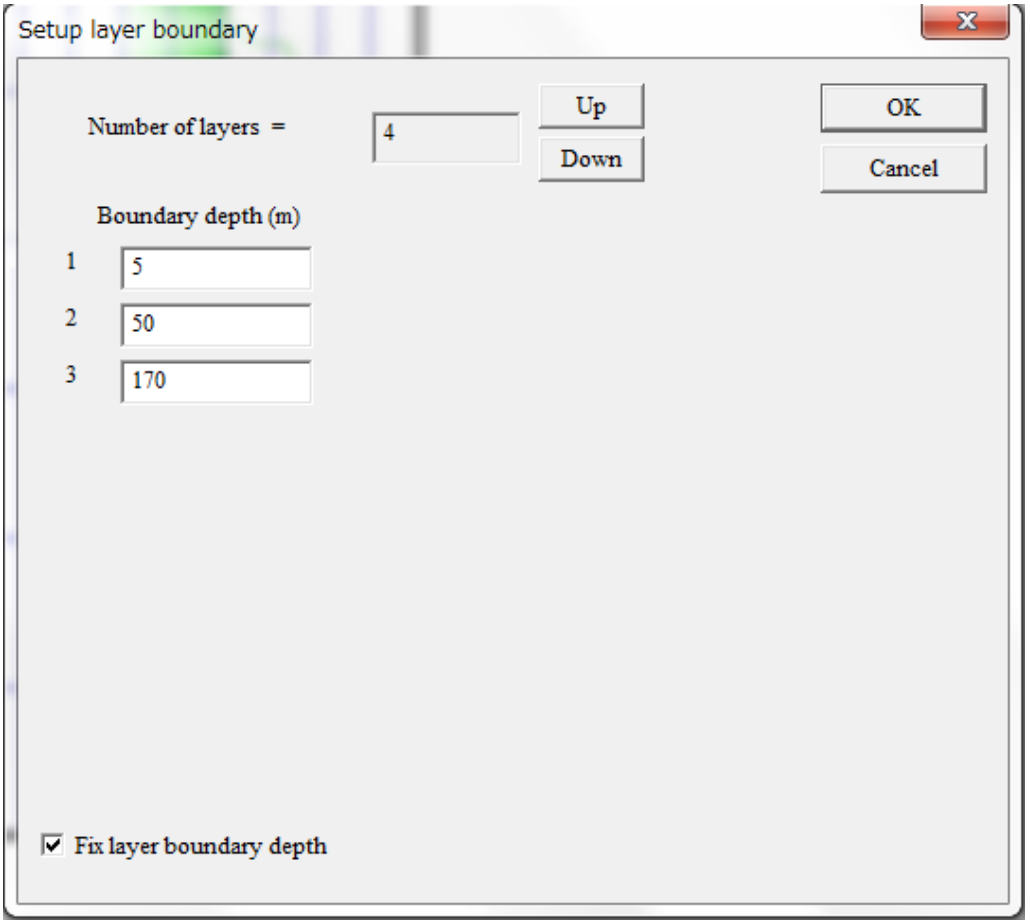
Increasing the number makes the interval velocity smoother (see Section 6.4.5 for details).



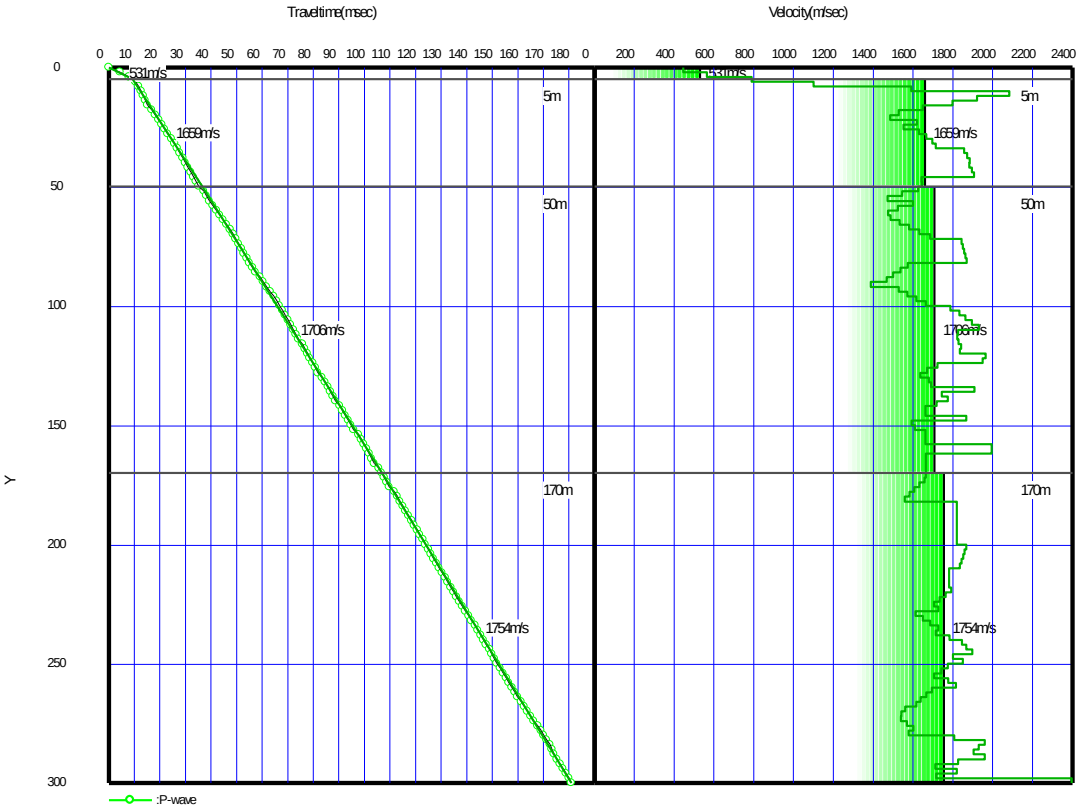
8) At first, one layer model is assumed and least squares velocity is shown. For increasing number of layer, select *Setup layer boundary.*



Change *Number of layers* and setup *Boundary depth* (see Section 6.4.3 for details).

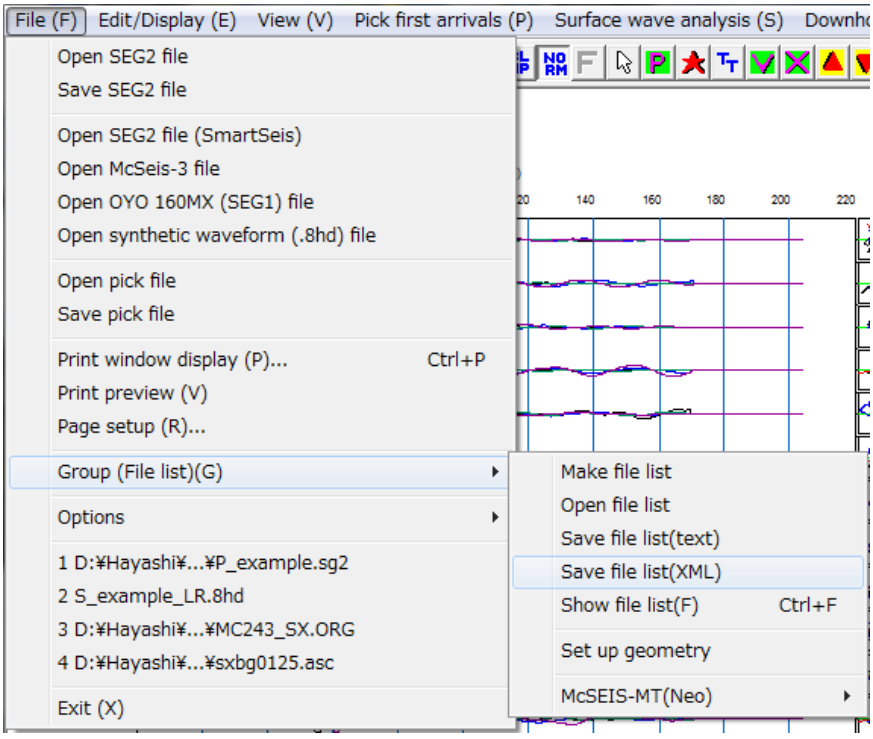


Updated traveltime curve and velocity model is shown.

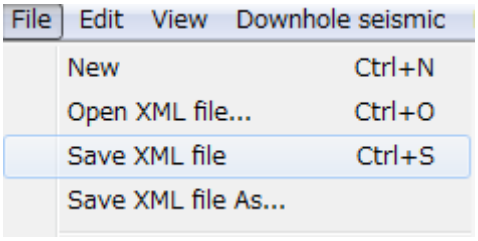


9) At the end of analysis, save the list of waveform files, source-receiver configuration and first arrival into a XML file by Pickwin, and save traveltime curves and layer velocities into another XML file by PSLog.

In the Pickwin, use *File, Group (File list), Save file list (XML)* to save XML file. Extension must be *.xml*.

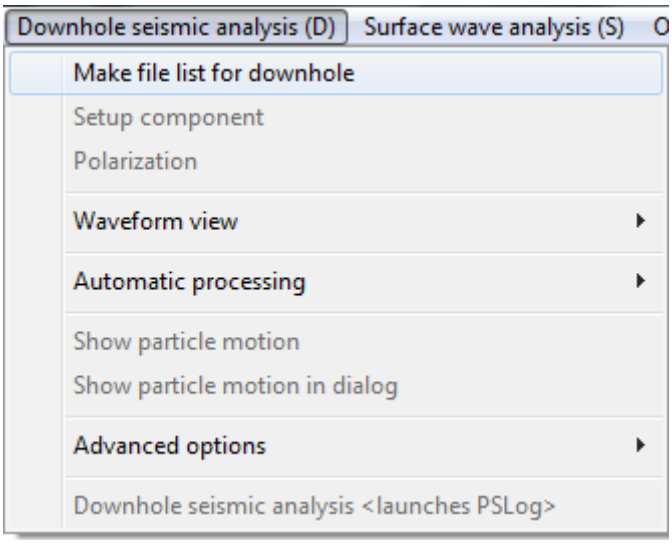


In the PSLog, use *File*, *Save XML file* or *Save XML file as* to save XML file. Extension must be *.xml*.

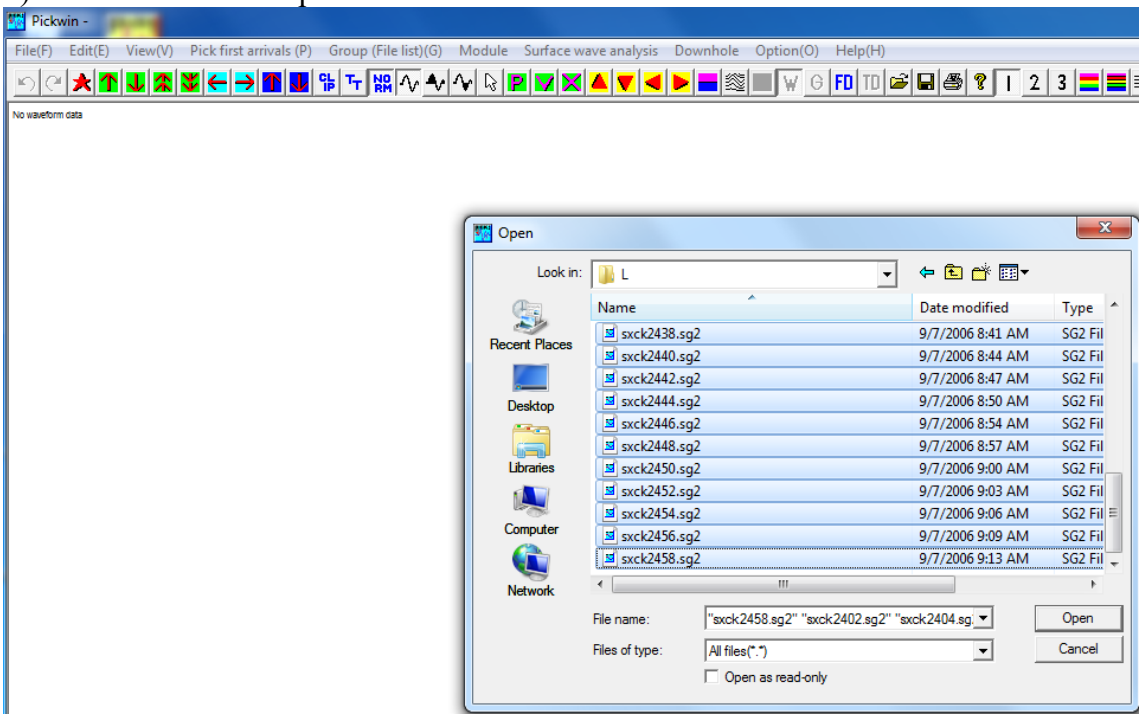


B) P-wave data using a single channel receiver

1) Select *Downhole, Make file list for downhole.*

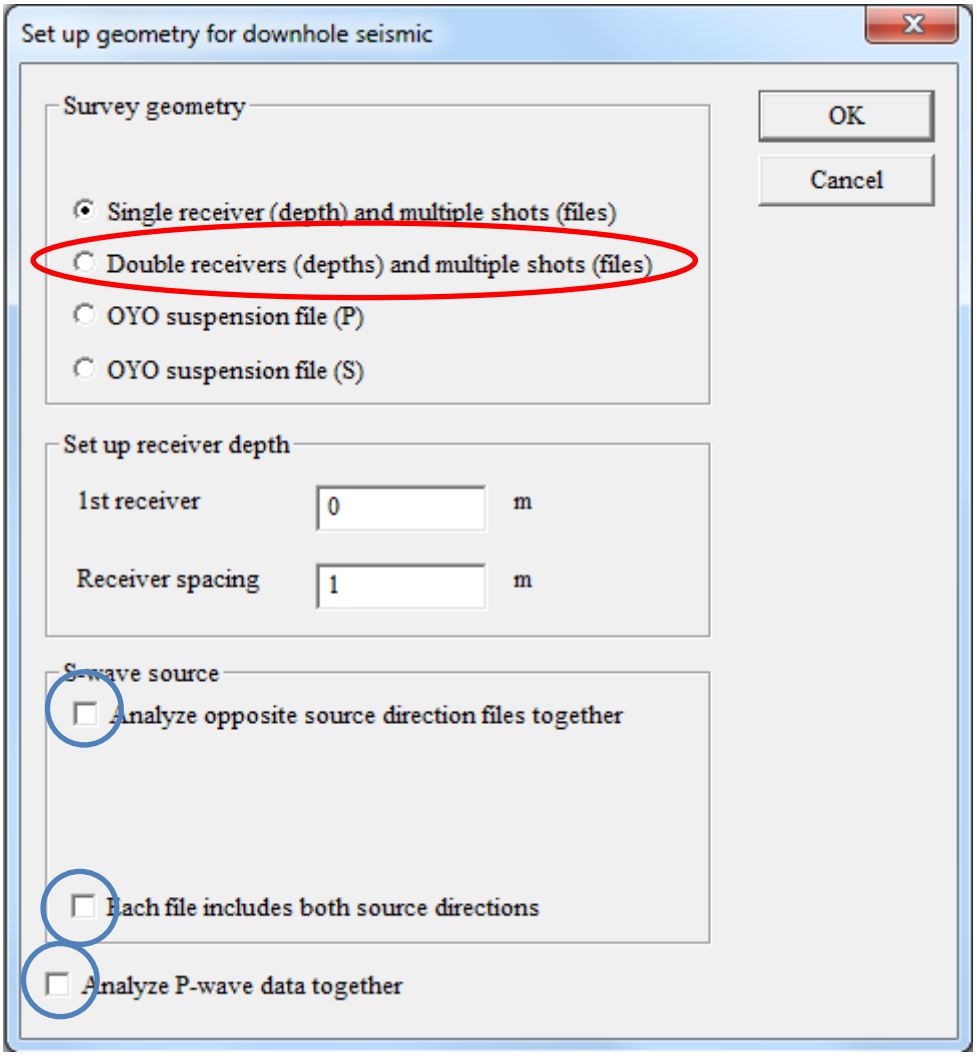


2) Select all files to be processed.

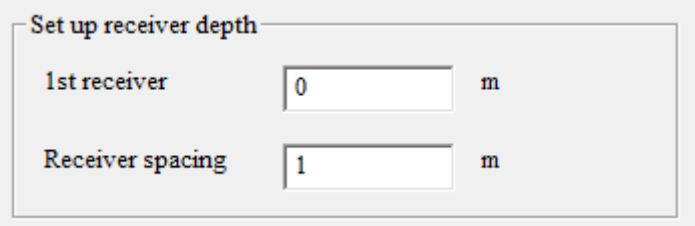


3) Setup 1st receiver depth and receiver spacing.

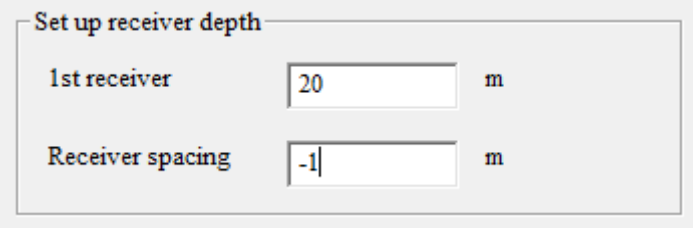
Select *single receiver (depth) and multiple shots (files).* Check off other check boxes.



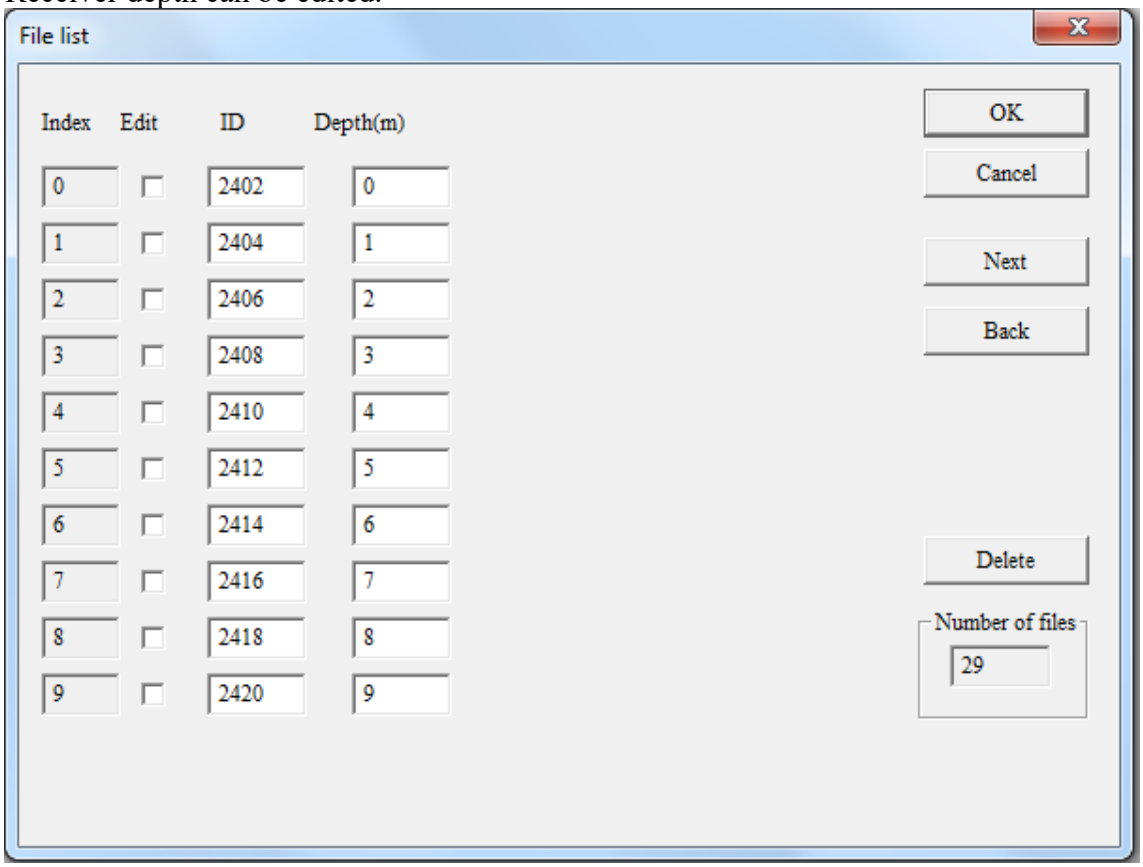
If data acquisition proceeds from a top of borehole to deep, put the shallowest receiver depth to *1st receiver* and positive value to *Receiver spacing*.



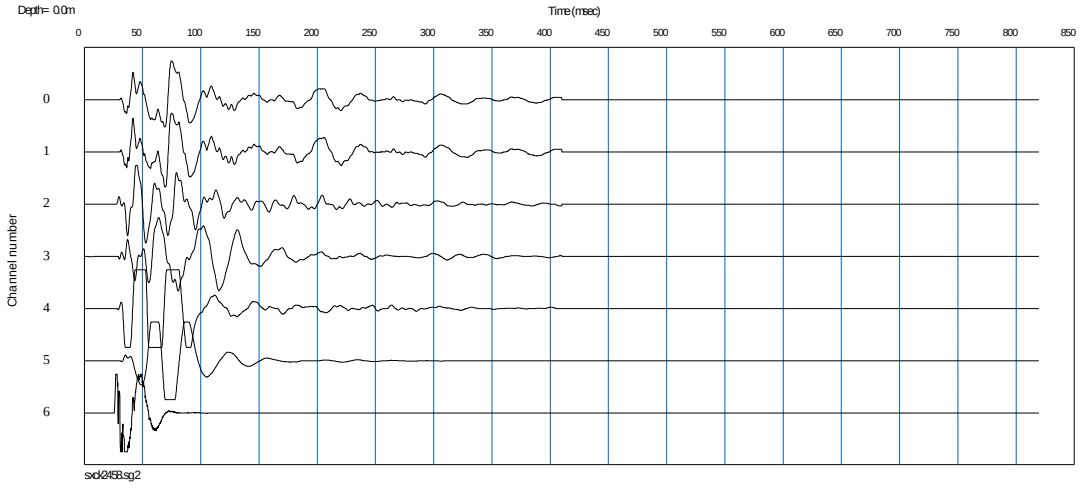
If data acquisition proceeds from a bottom of borehole to shallow, put the deepest receiver depth to *1st receiver* and negative value to *Receiver spacing*.



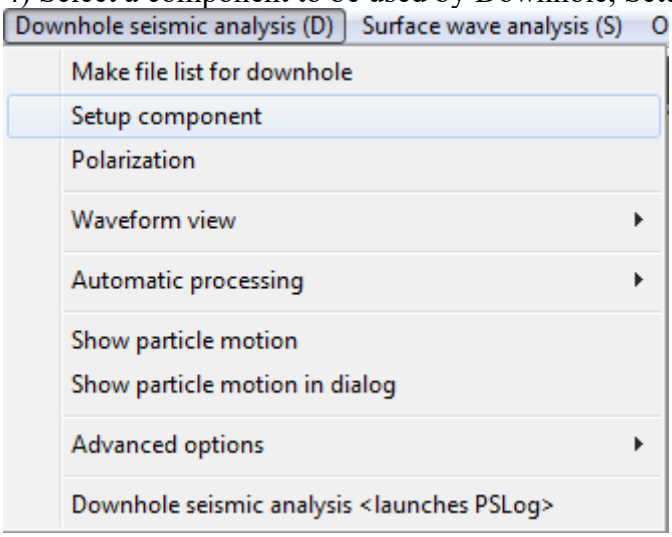
Receiver depth can be edited.



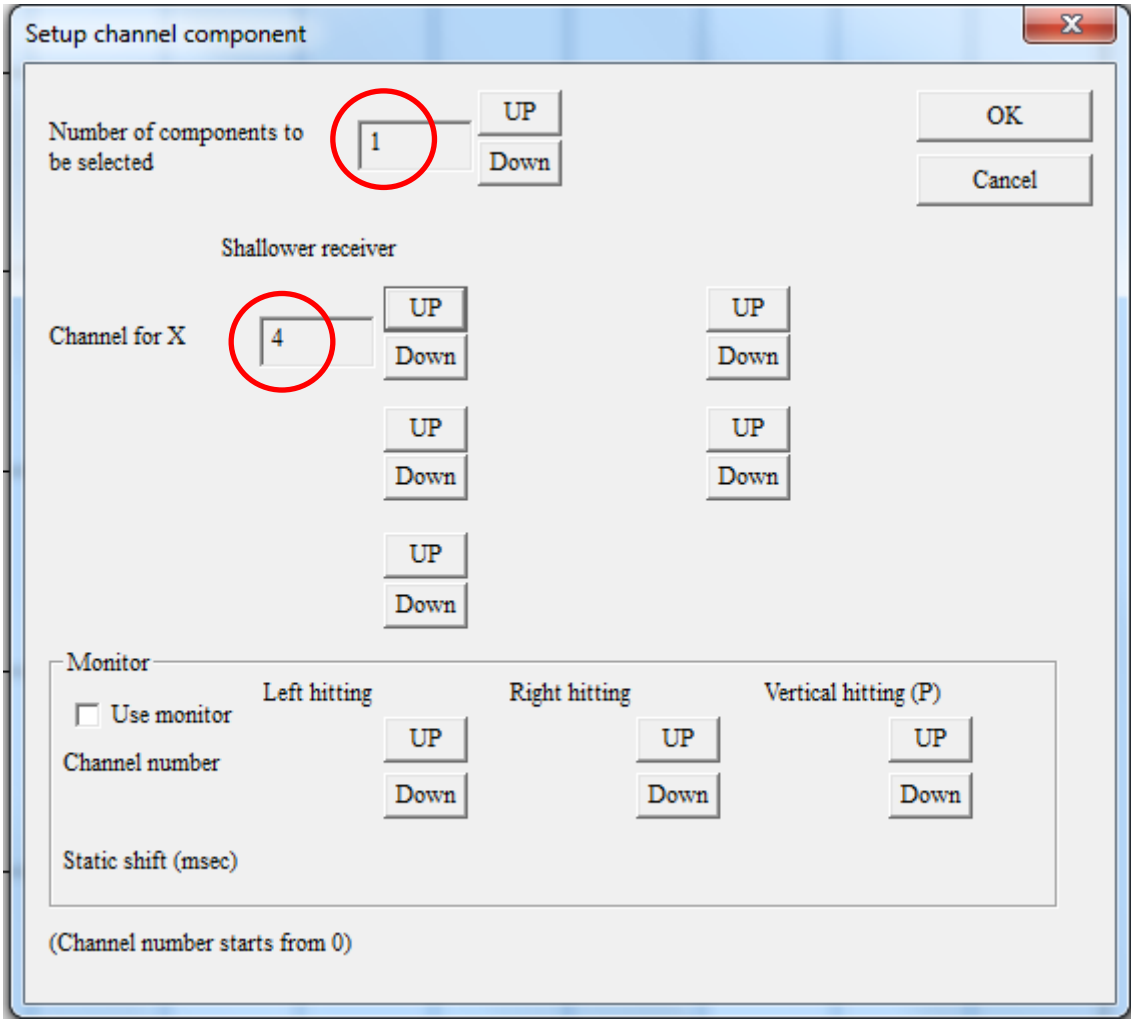
Waveform data for a file is shown.



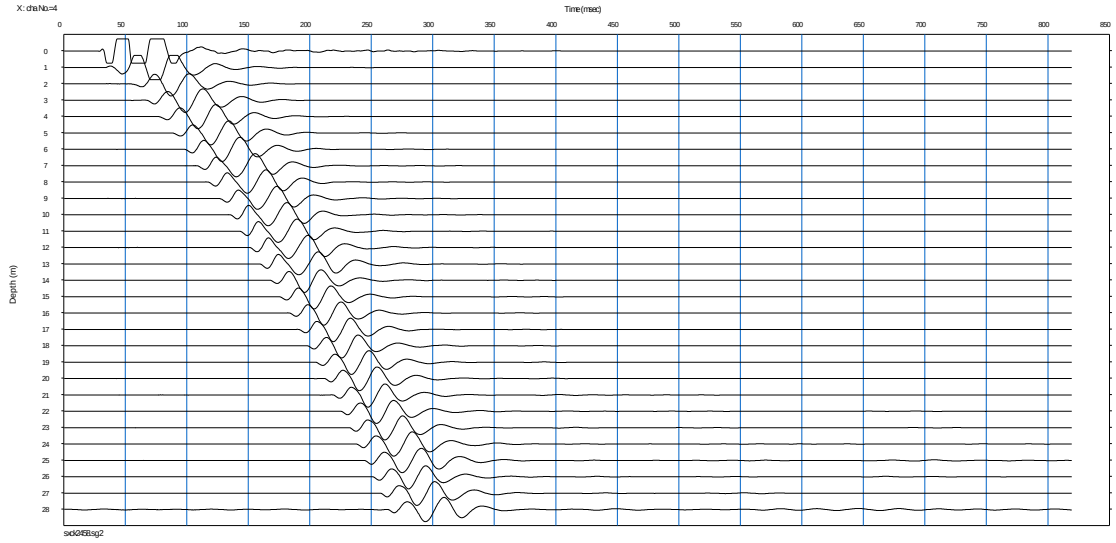
4) Select a component to be used by Downhole, Setup component.



Select component to be used in a dialog box. Set *Number of components to be selected* to 1 and set channel number to be processed (channel number index starts from 0).



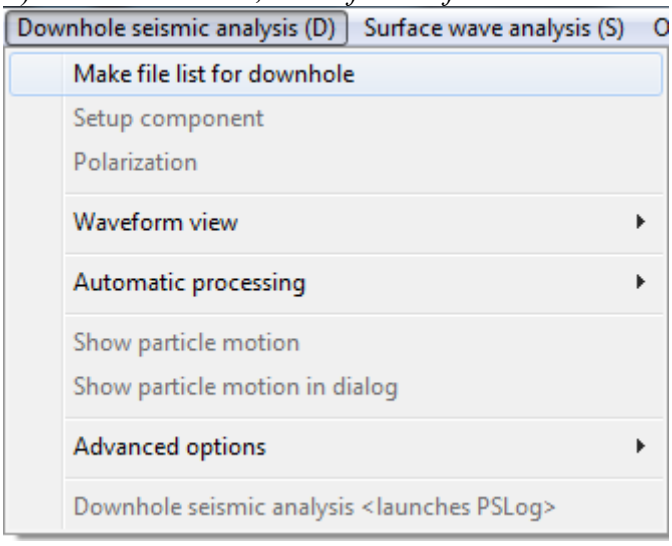
Waveform data is shown as common shot gather.



5) See other previous for picking first arrivals, editing and assigning layers.

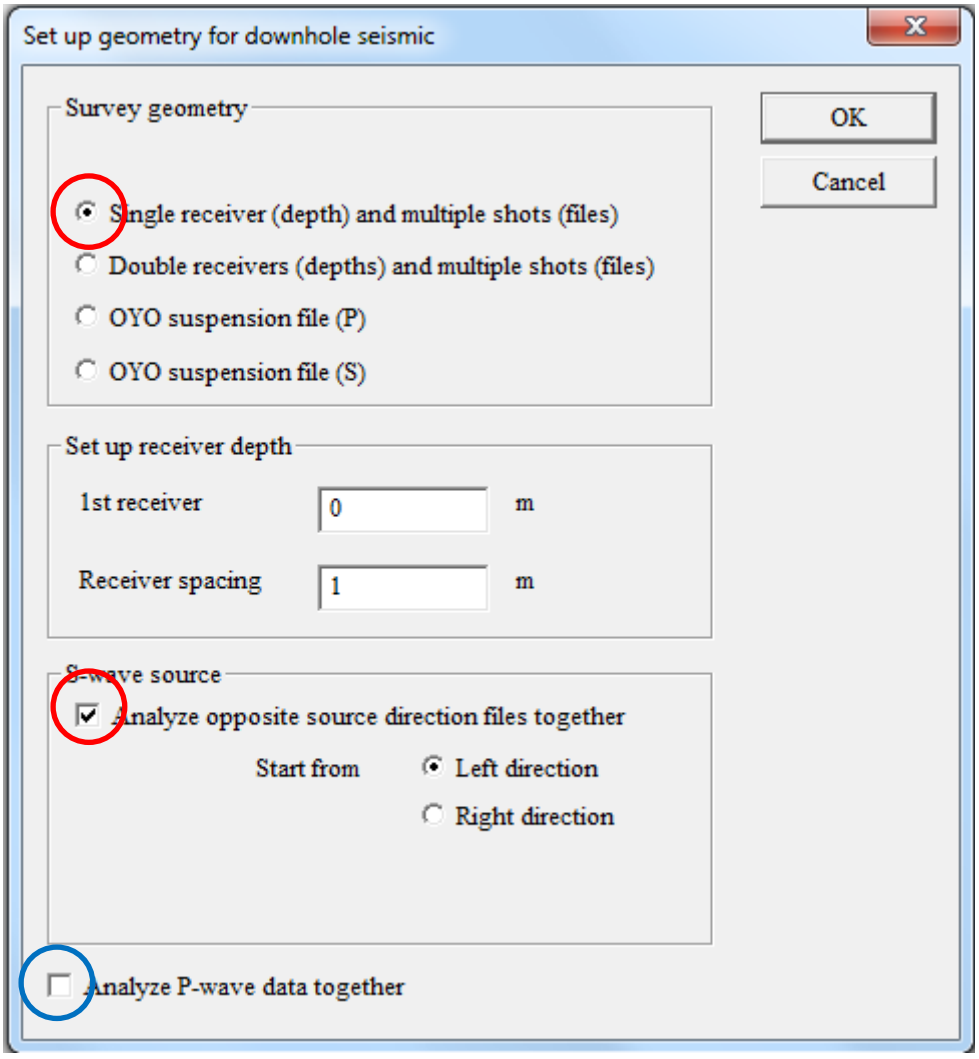
C1) S-wave data using a single receiver

1) Select *Downhole, Make file list for downhole.*

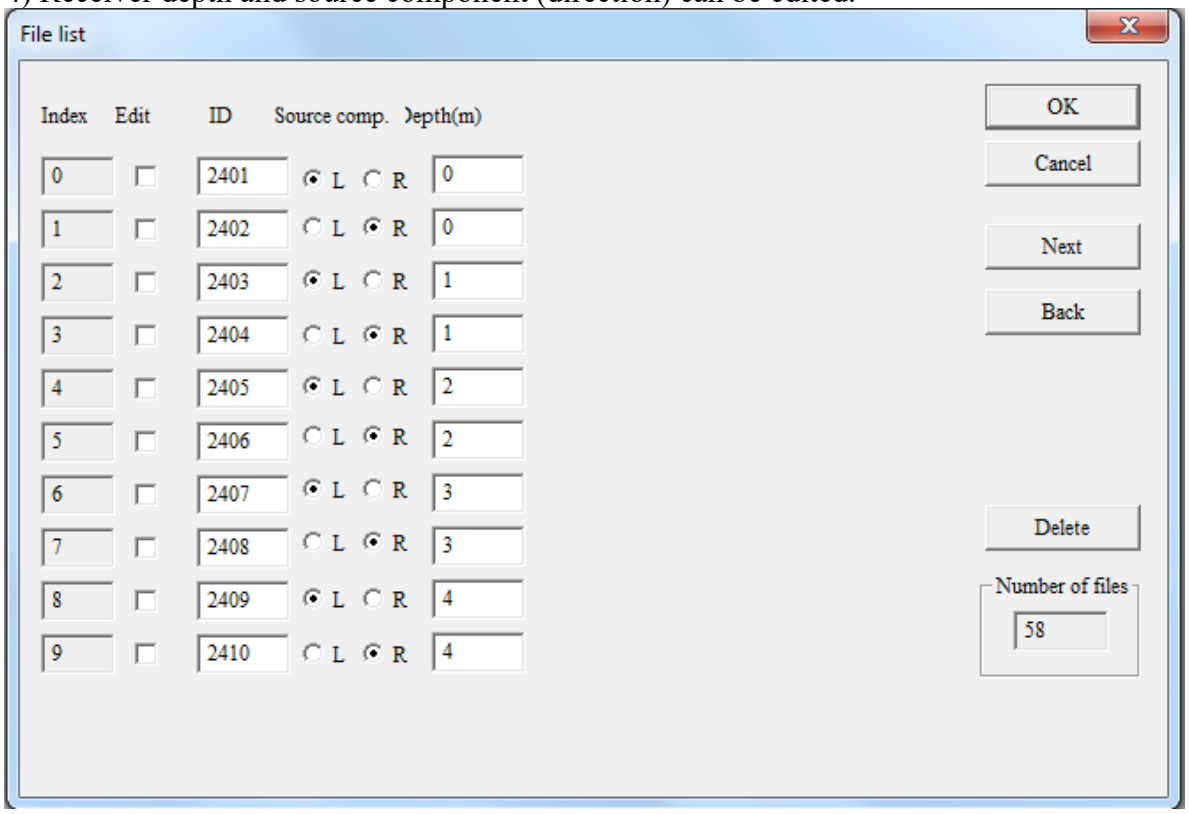


2) Select all files to be processed.

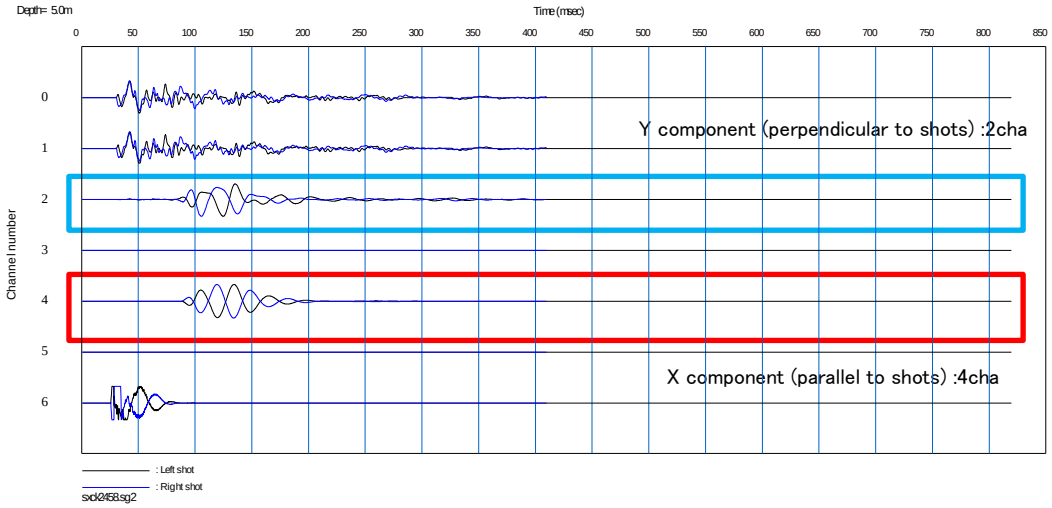
3) Setup geometry.
Select *Single receiver (depth) and multiple shots (files)*.
Check on *Analyze opposite source direction files together*.
Check off *Analyze P-wave data together*.
Select *Left direction* or *Right direction* for the order of source direction. Source direction (left or right) has no important meaning and you can just put it as *Left direction*.



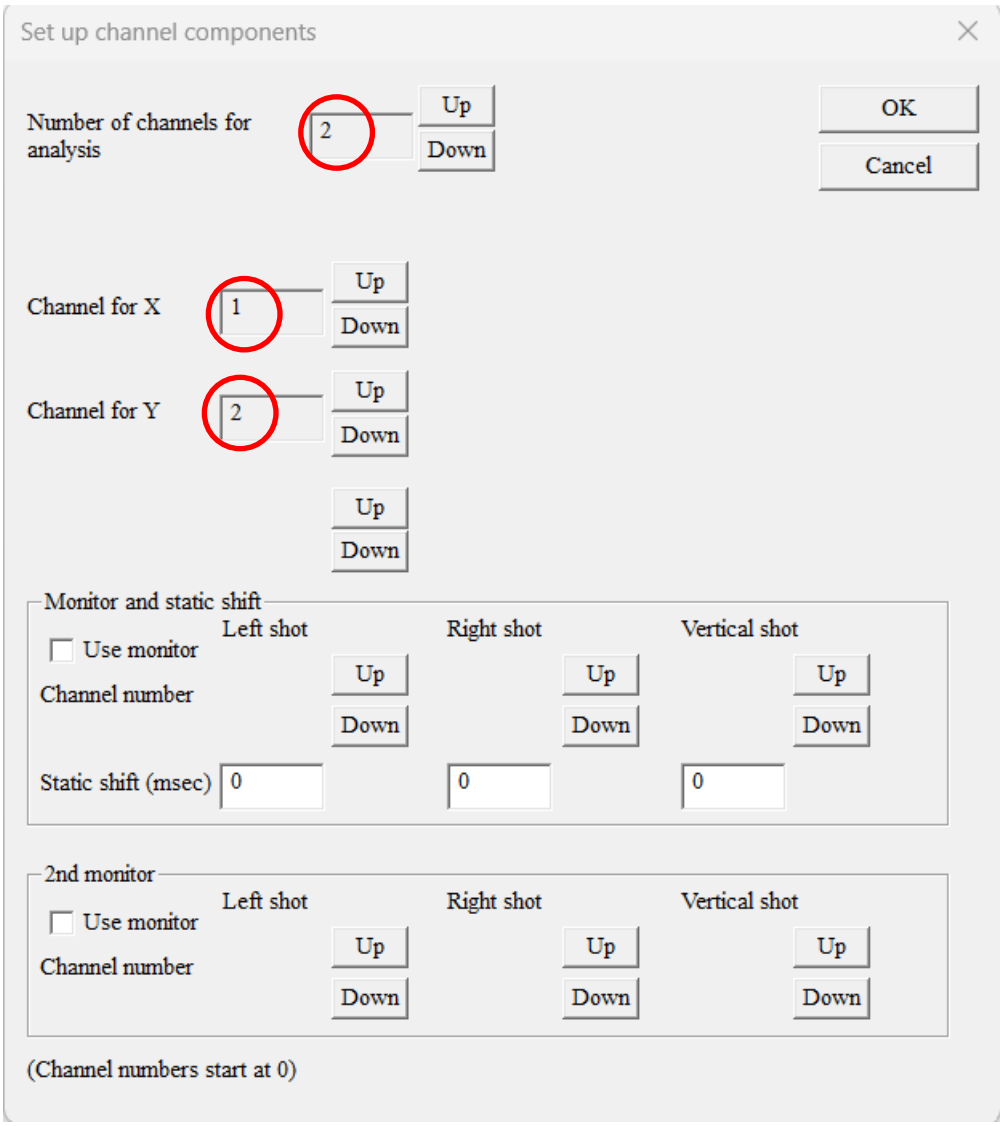
4) Receiver depth and source component (direction) can be edited.



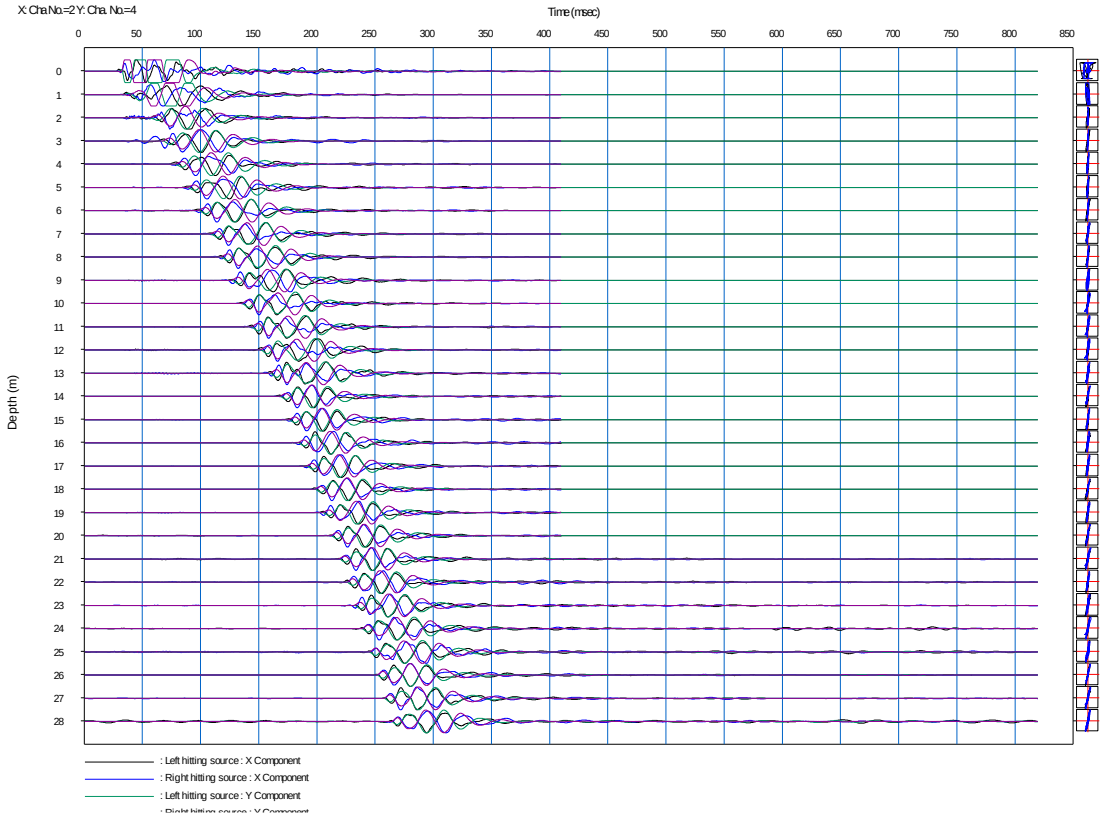
4) Waveform data for one depth (left and right shots) is shown.
You can scroll receiver depth by  and  .



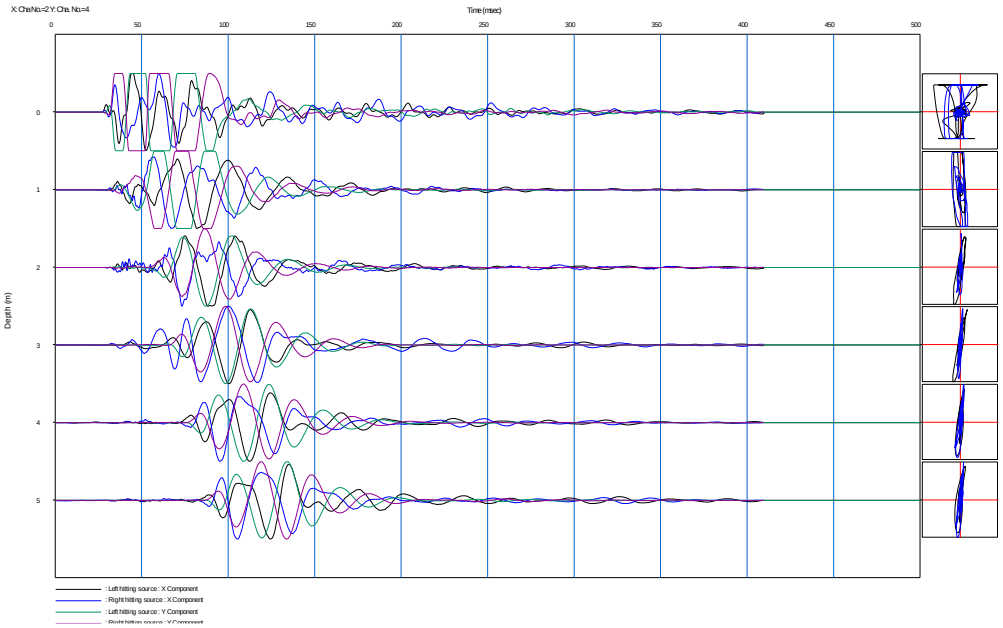
5) Select *Downhole, Setup component* and select components to be processed.
Set *Number of components to be selected* to two and set channel numbers to two horizontal components.



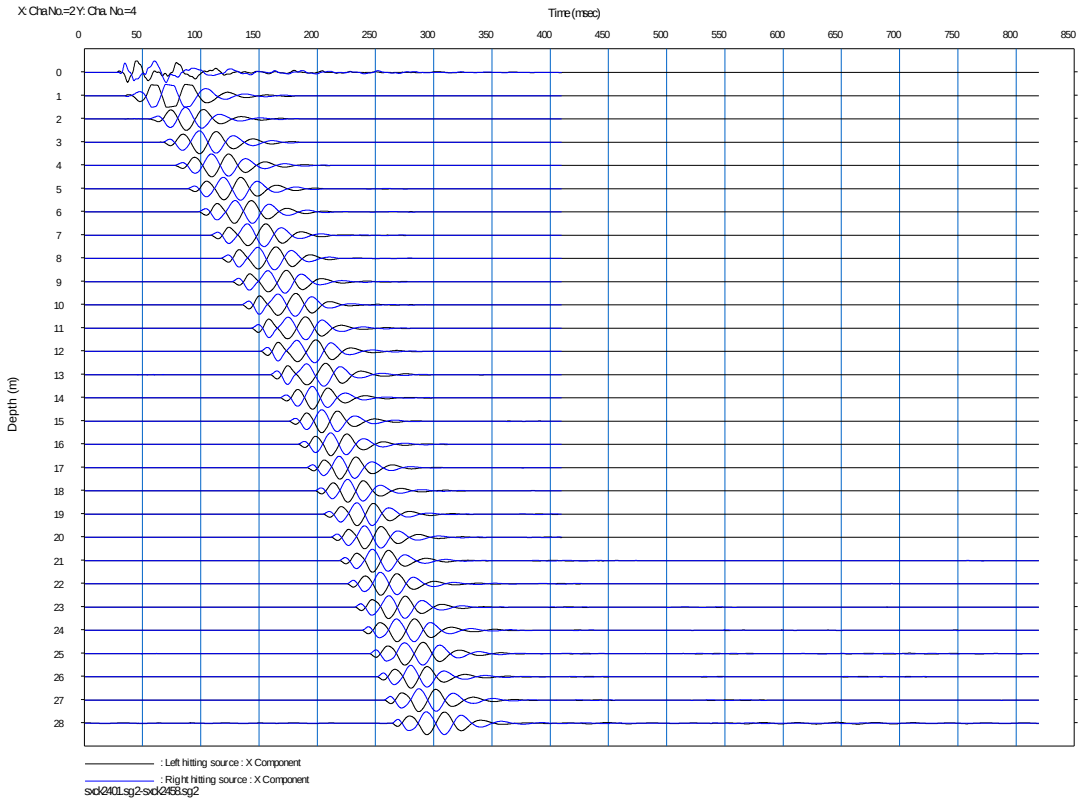
6) Selected components to be processed are shown. X components are shown as black (left) and blue (right) and Y components are shown as green (left) and purple (right).



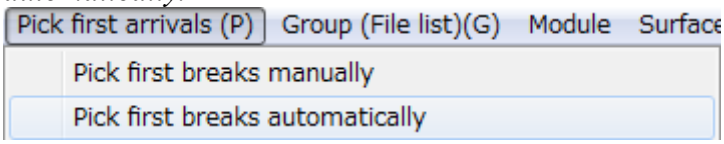
Particle motion of each depth is shown at the right of traces.

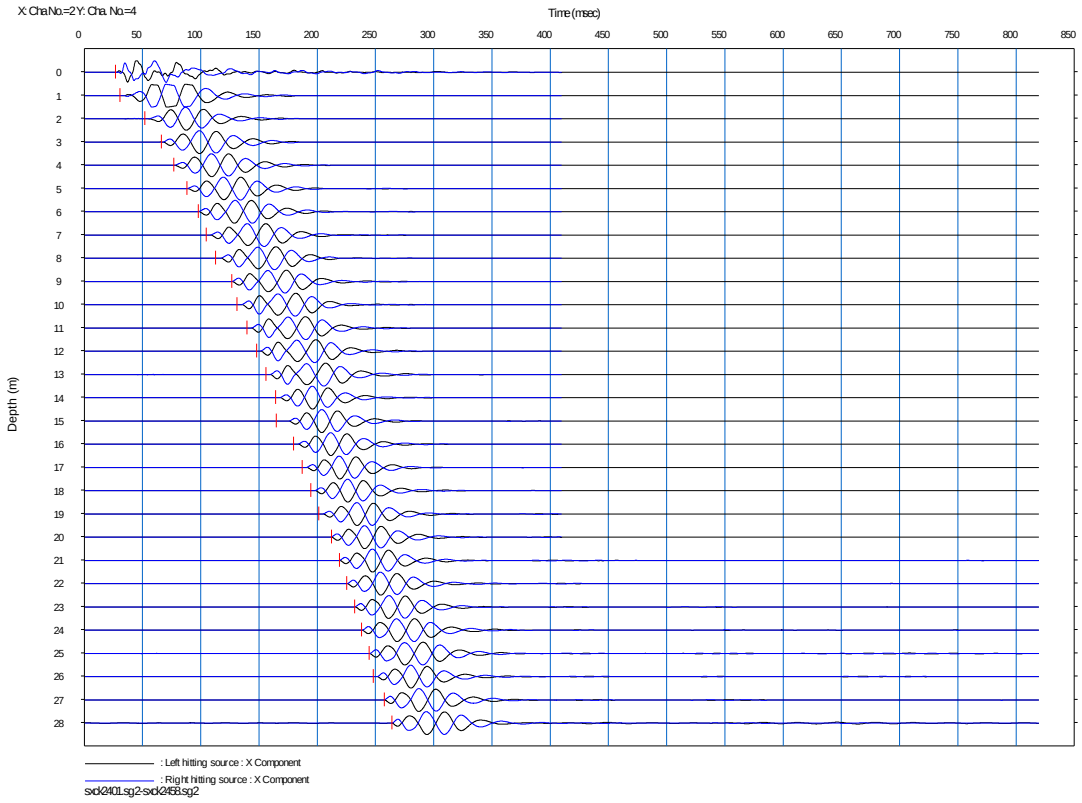


7) Select *Downhole, Polarization* for rotating two components. Rotated waveform data (left and right shots) is shown.

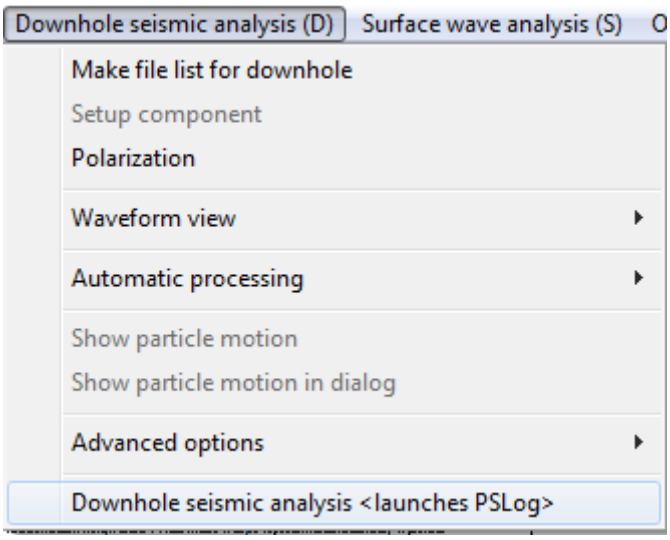


8) Pick first arrivals by *Pick first arrivals, Pick first arrivals manually* or *Pick first arrivals automatically.*

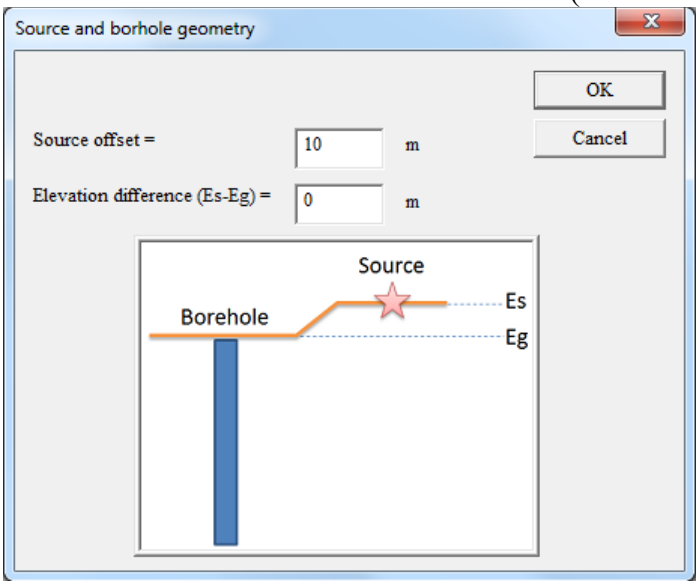




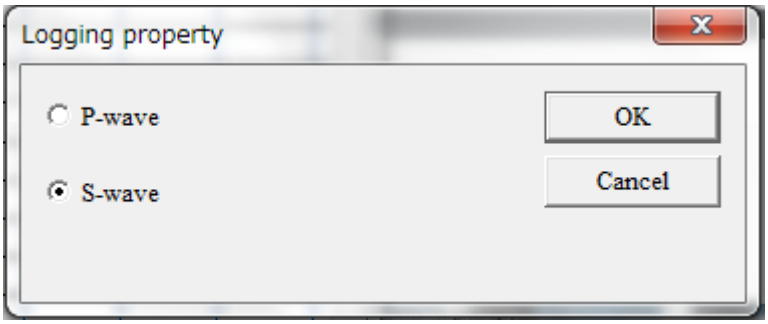
9) Select *Downhole, Downhole seismic analysis <launches PSLog>* for showing a traveltime curve.



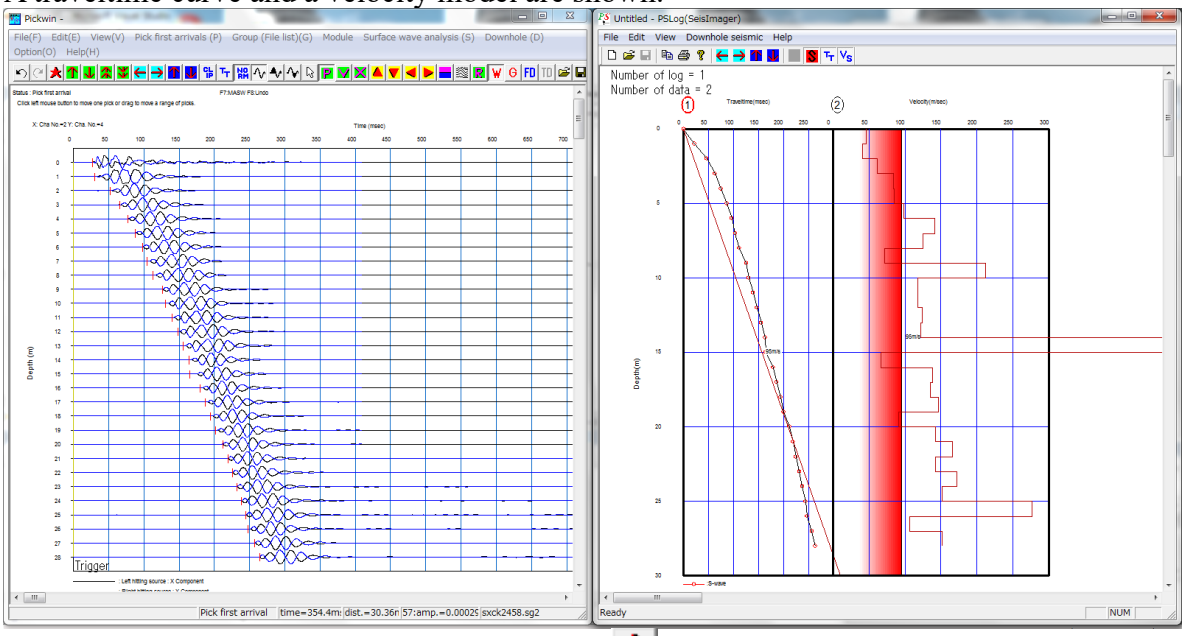
Enter source offset and elevation difference (see Section 6.4.2 for details).



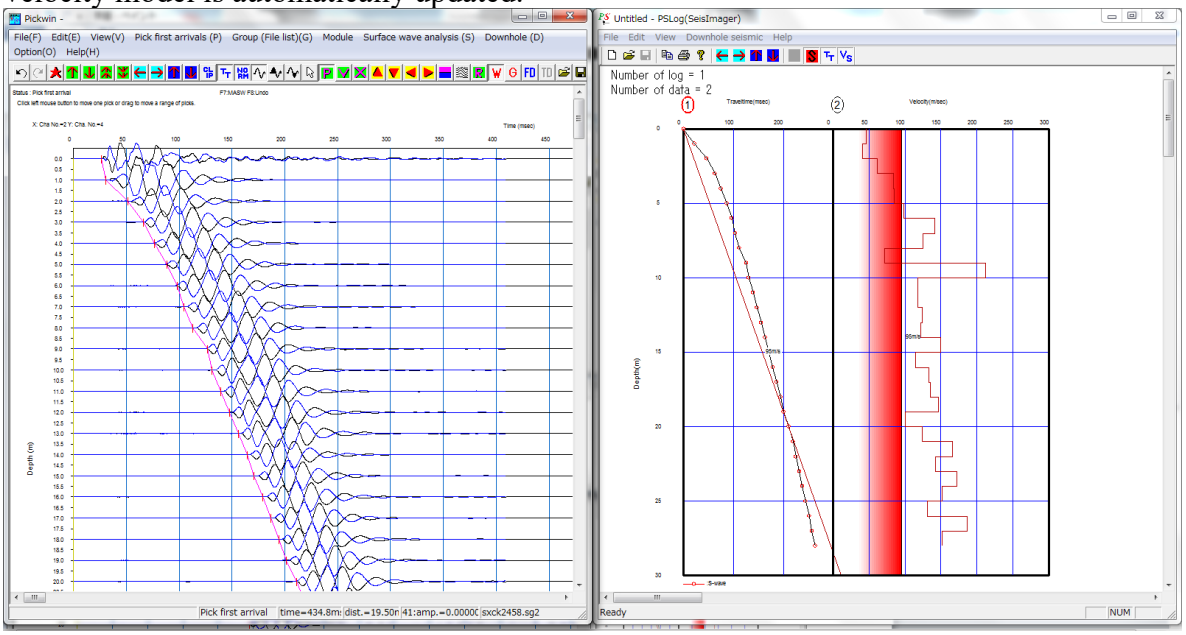
Select P- or S-wave (see Section 6.4.1 for details).


Logging property
P-wave
S-wave
OK
Cancel

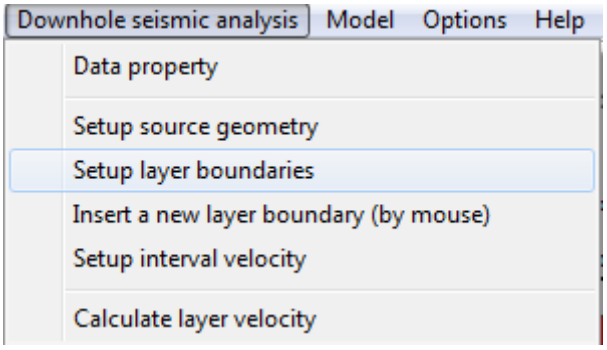
A traveltime curve and a velocity model are shown.



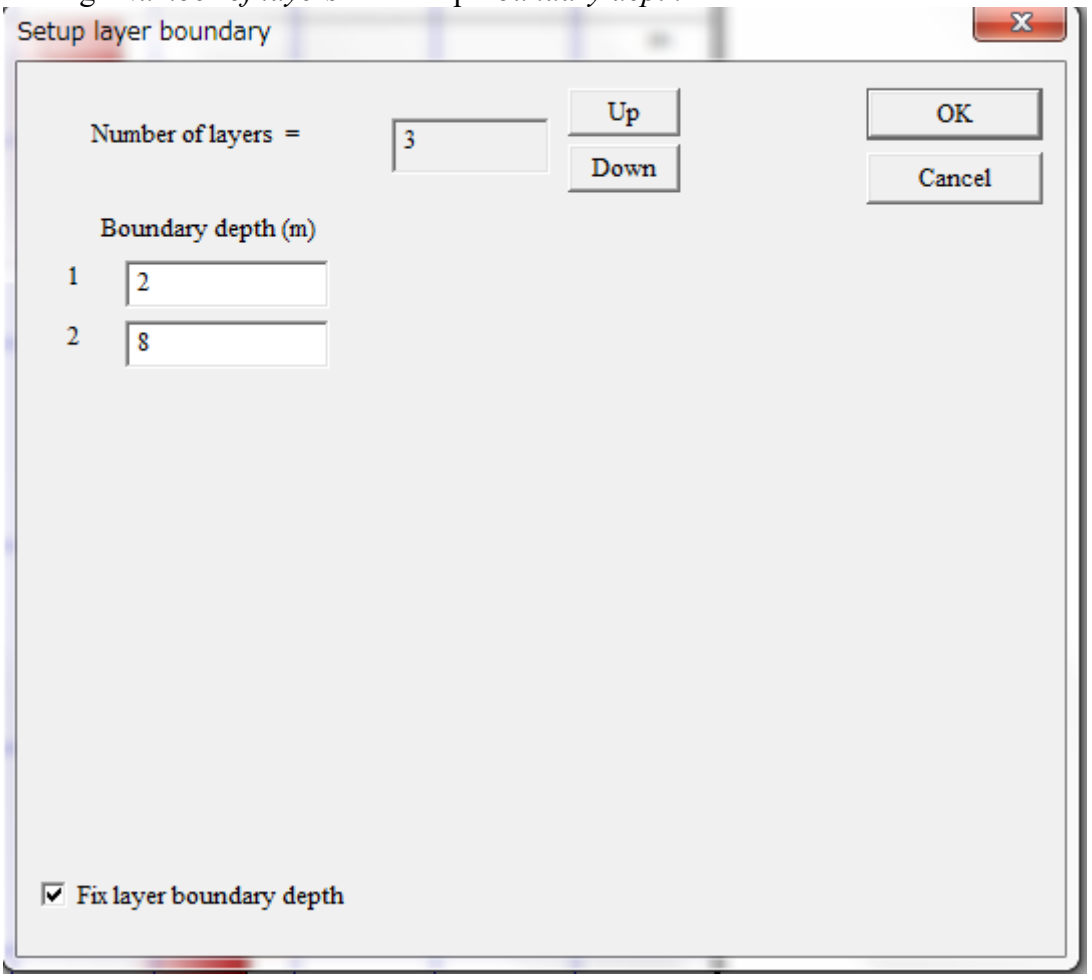
Change first arrival picking and click a red star  in Pickwin, the traveltime curve and the velocity model is automatically updated.



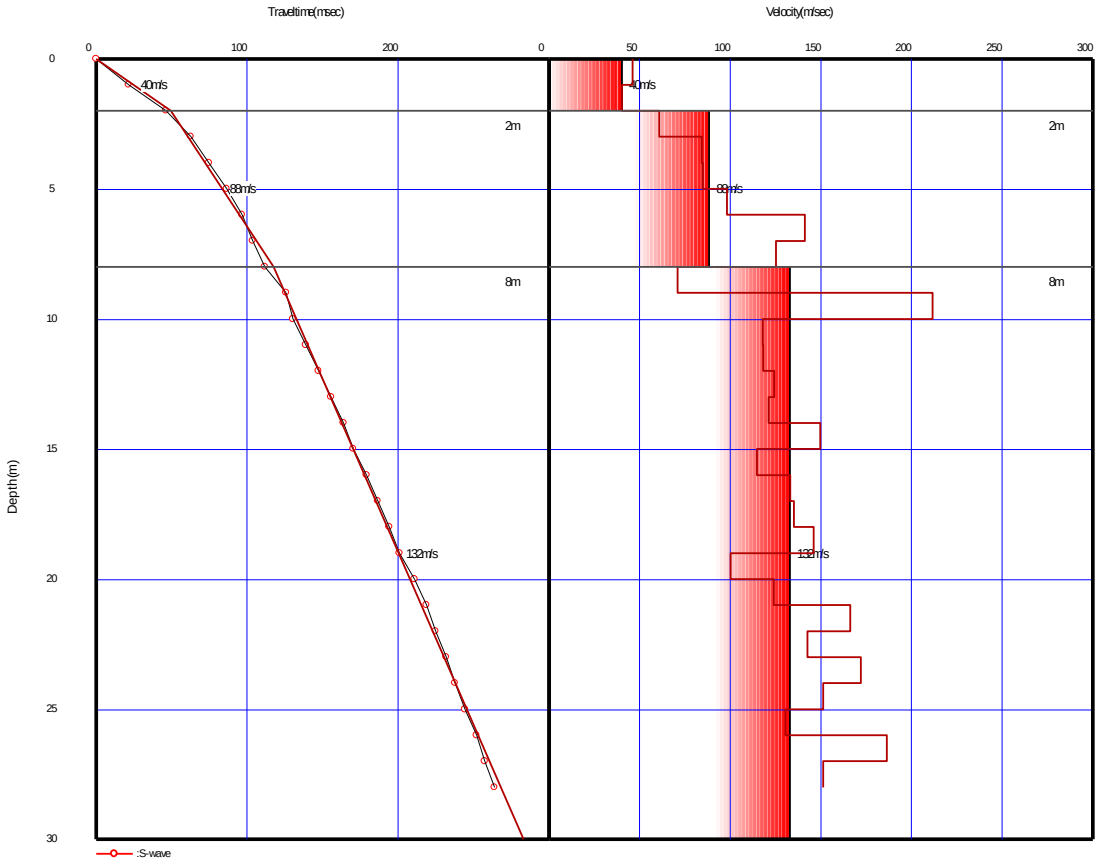
10) At first, one layer model is assumed and least squares velocity is shown. For increasing number of layer, select *Setup layer boundary.*



Change *Number of layers* and setup *Boundary depth*.



The updated traveltime curve and the velocity model are shown.



11) Selecting *File, Save XML file* or *Save XML file as* saves the traveltime curve and the velocity model into XML file.

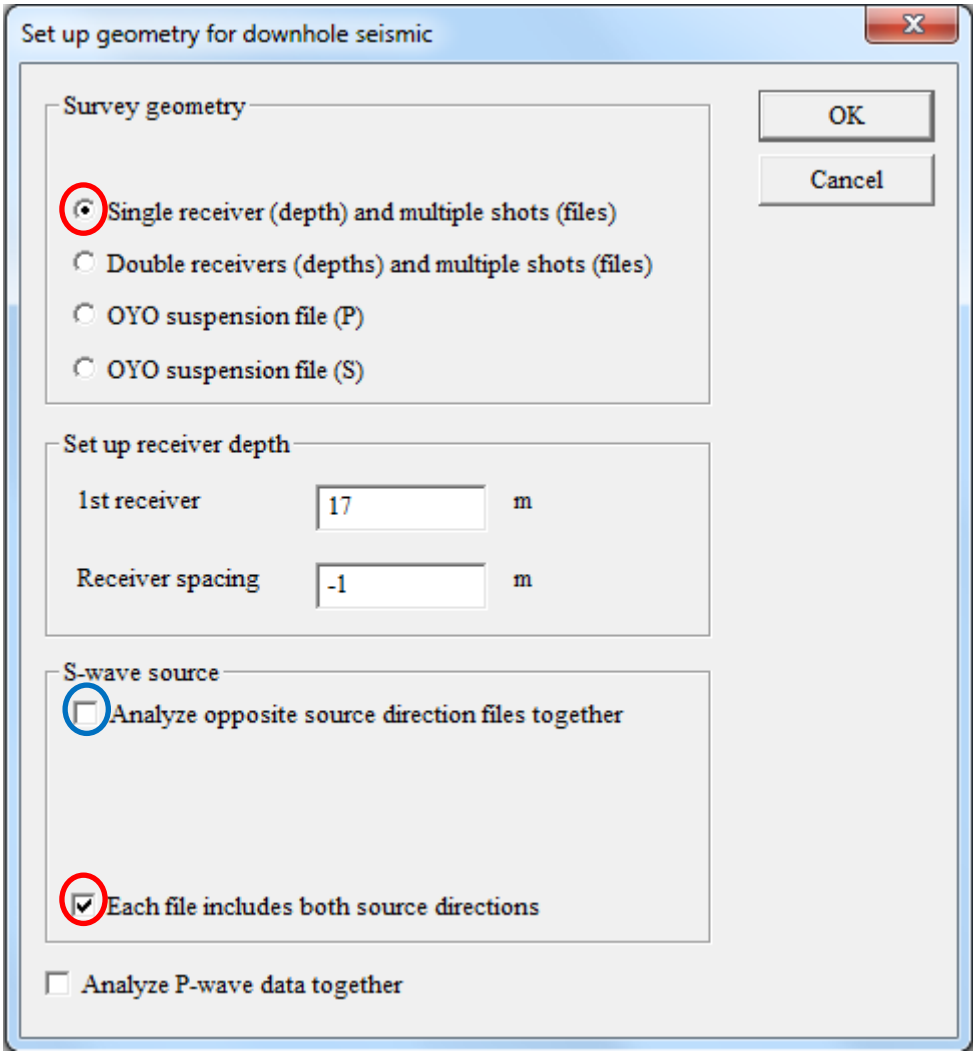
C2) S-wave data using a single channel receiver (Left and right shots are recorded to same file)

1) In the geometry setup:

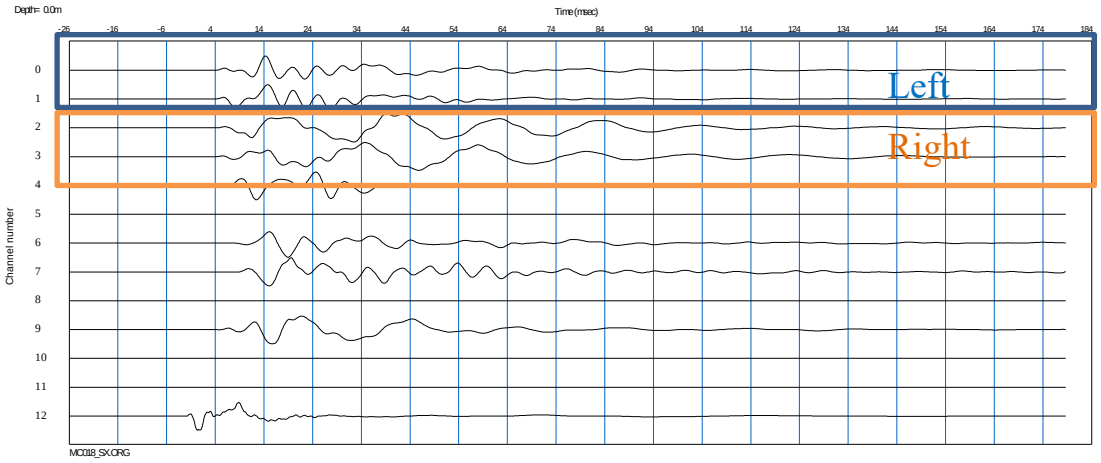
Choose *Single receiver (depth) and multiple shots (files)*.

Check off *Analyze opposite source direction files together.*

Check on *Each file includes both source directions*.



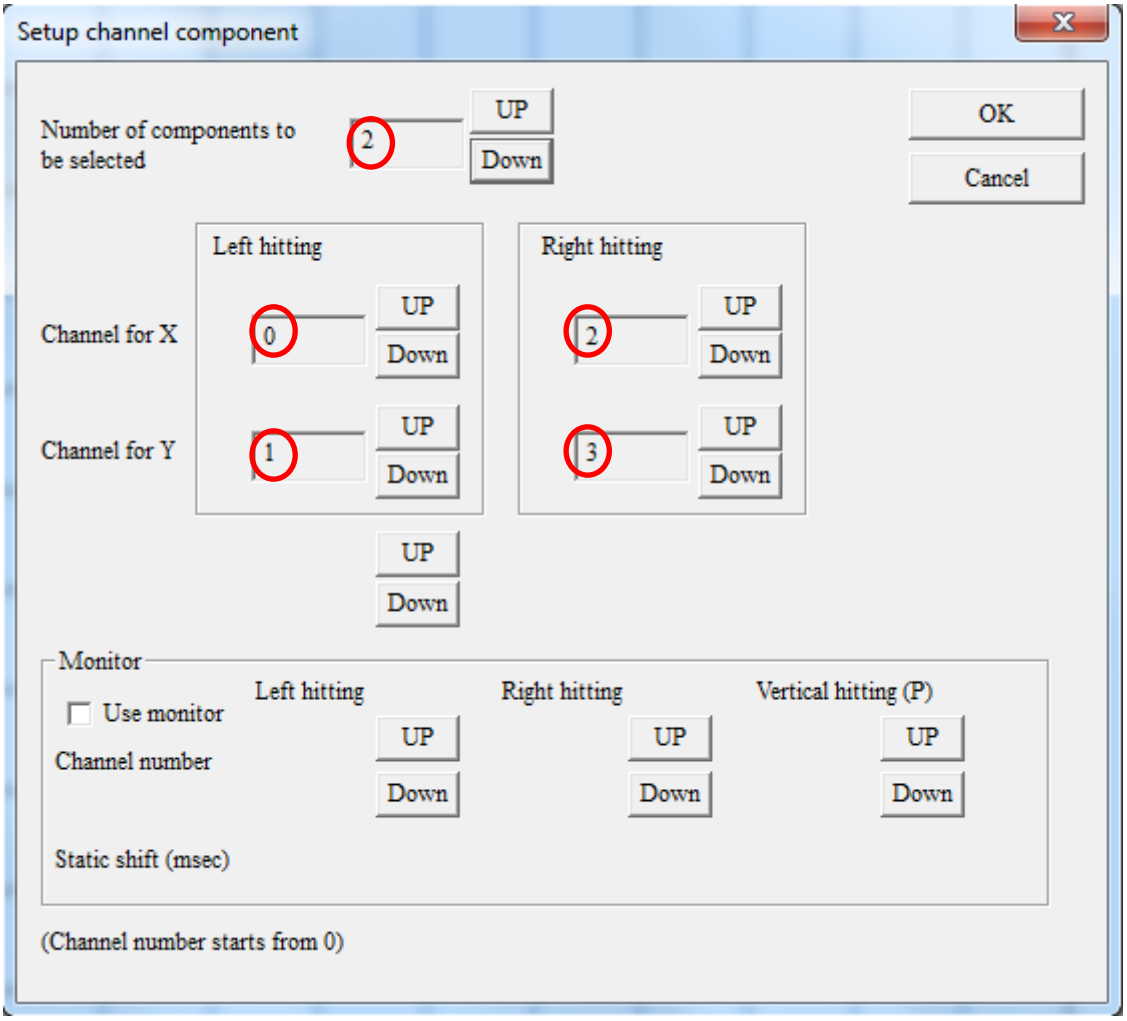
Waveform for 1st depth is shown. Both left and right shots are included.



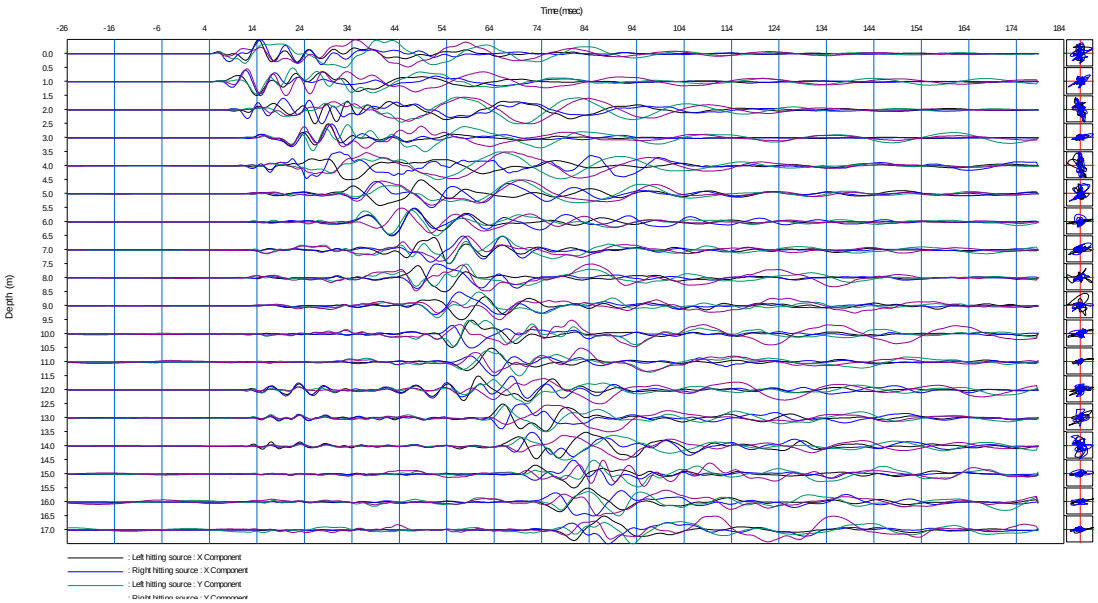
2) In the setup of components,

Set *Number of components to be selected* to two.

Set channel number for two components and two shot directions.



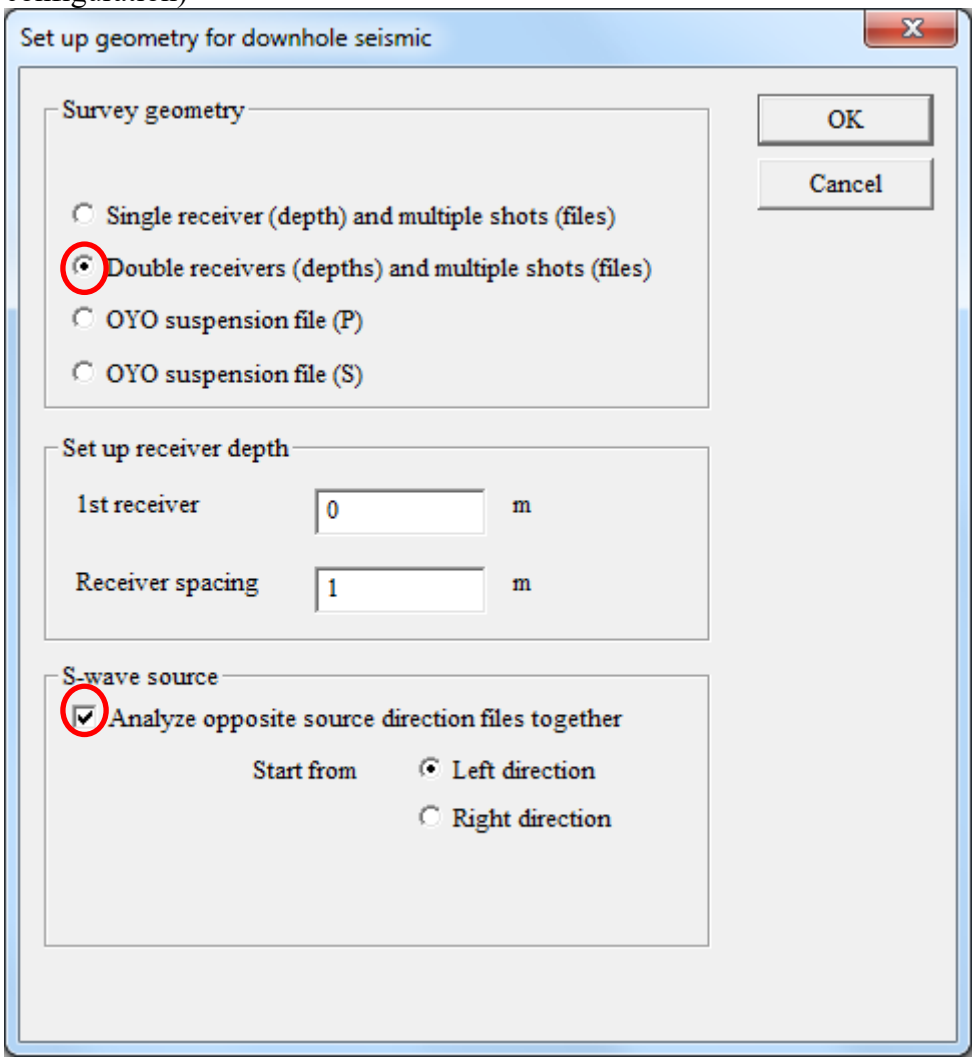
3) Selected components to be processed are shown. X components are shown as black (left) and blue (right) and Y components are shown as green (left) and purple.



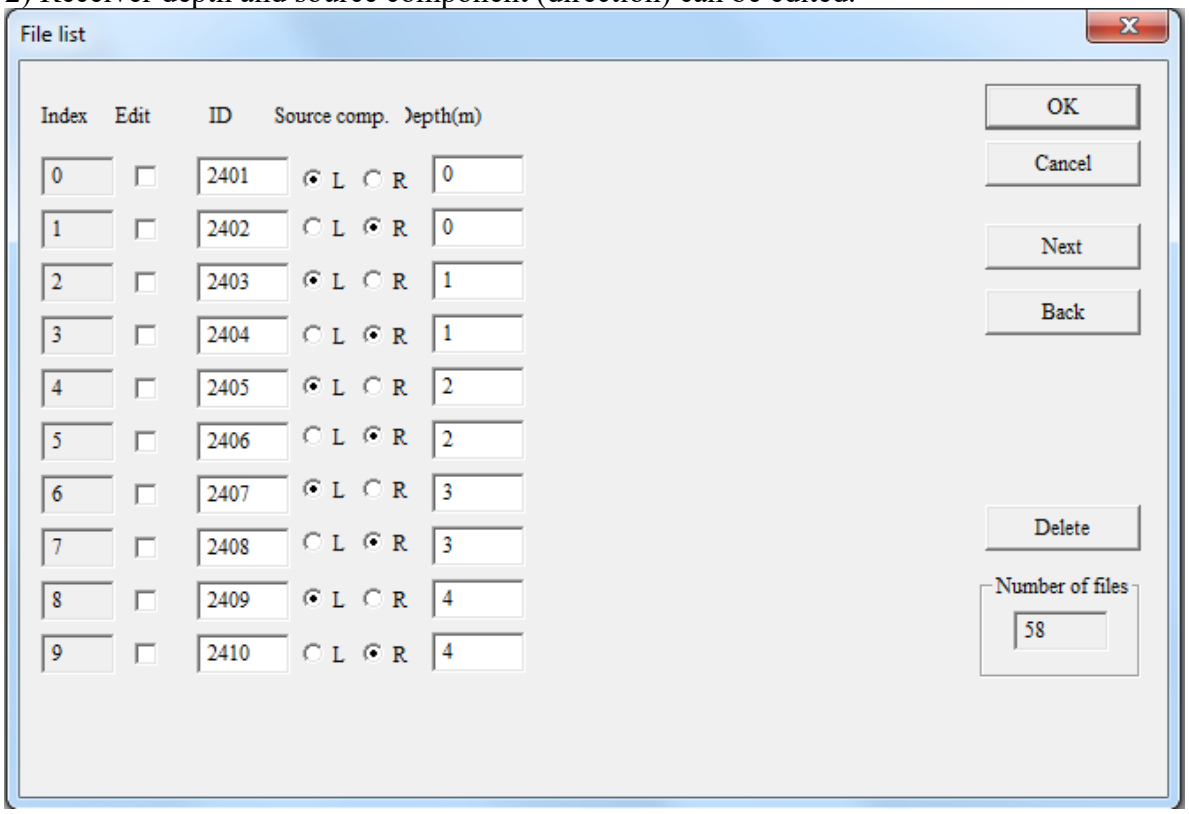
4) See other sections for processing beyond this step.

D) S-wave data using a multi-channel (double) receiver

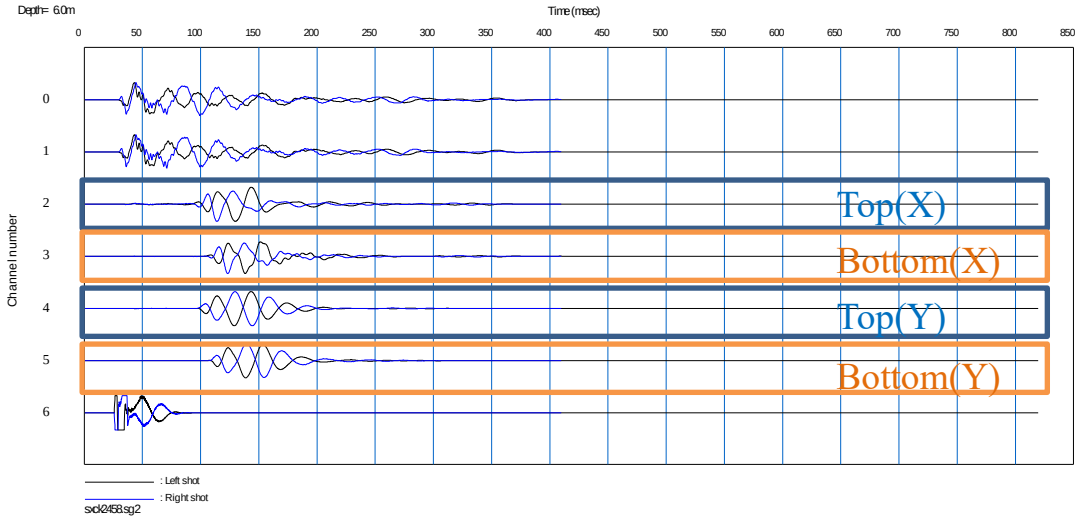
1) In the geometry setup,
choose *Double receiver (depth) and multiple shots (files)*,
check on *Analyze opposite source direction files together*,
Set 1st receiver depth (top receiver) and receiver spacing. (Generally, receiver spacing and spacing of data acquisition assumed to be same in this configuration)



2) Receiver depth and source component (direction) can be edited.



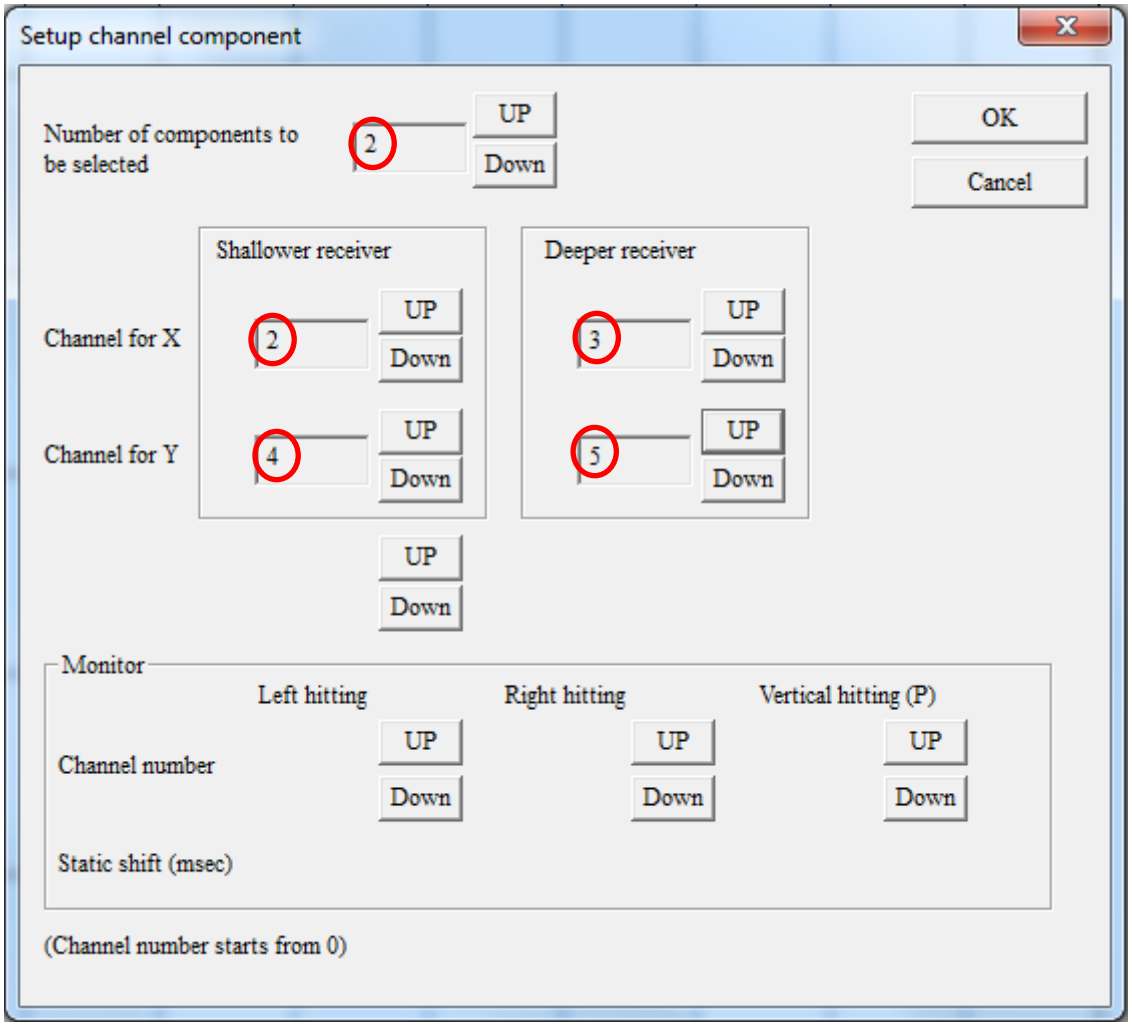
Waveform for two depths is shown. Both left and right shots and X and Y components are included.



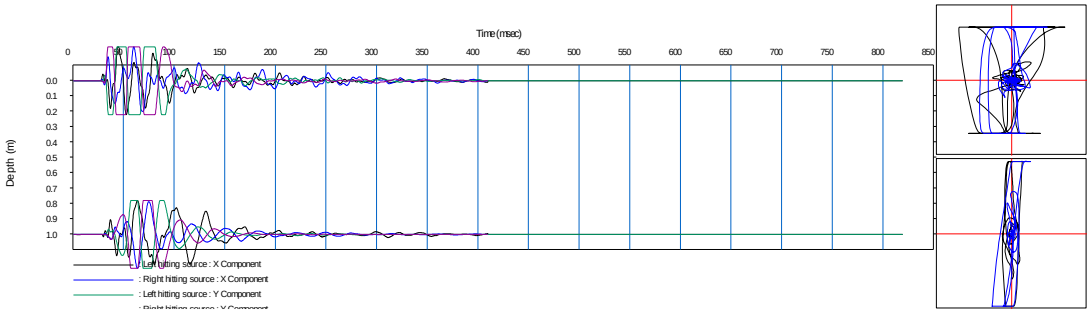
3) In the setup of components,

Set *Number of components to be selected* to two.

Set channel number for two components and two depths.

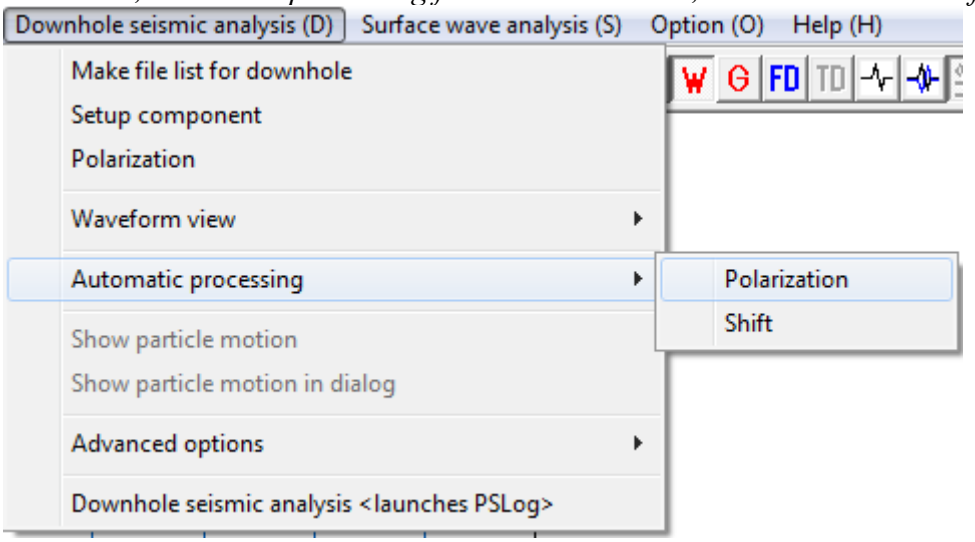


4) Waveform data for 1st shot is shown.

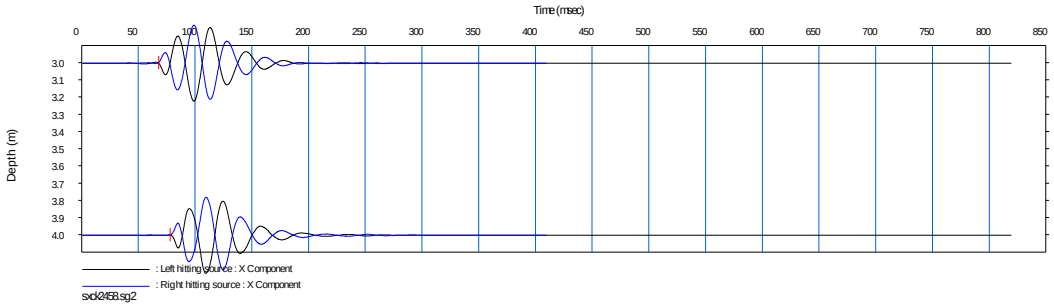


5) Shot (depth) can be scrolled by  and  . Pick first arrivals for two depths and scroll depth. Repeat these procedures till end.

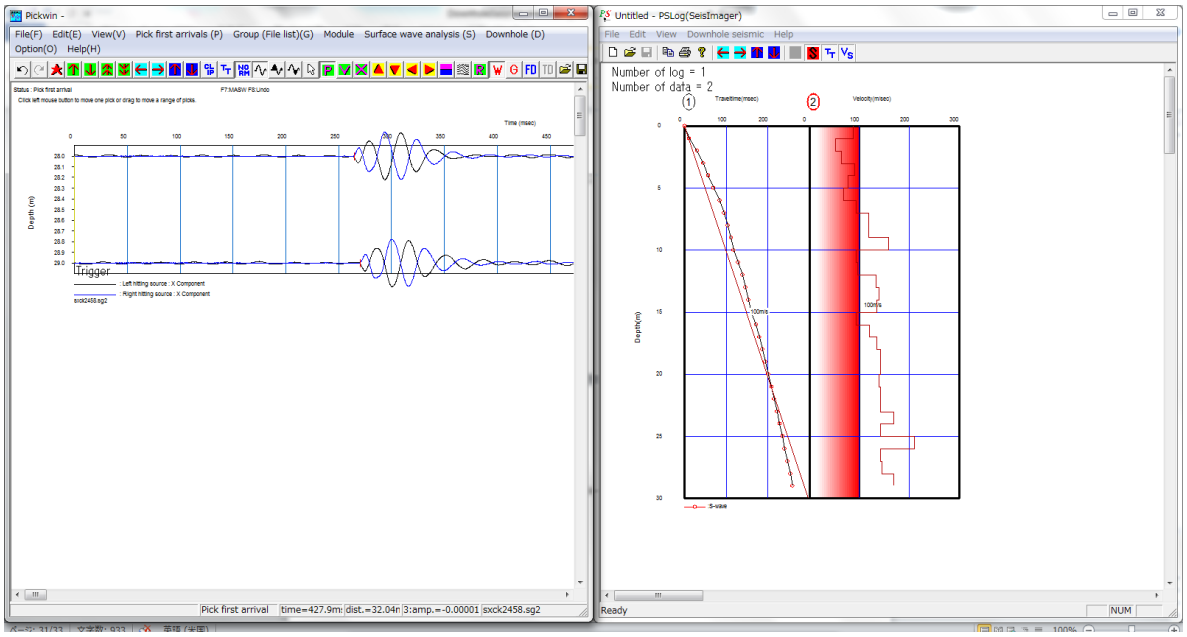
6) Polarization and shift of left and right shots can be automatically done with scrolling. Set *Downhole, Automatic processing for double receivers, Polarization* and *Shift* to on.



Polarized and shifted waveform data.

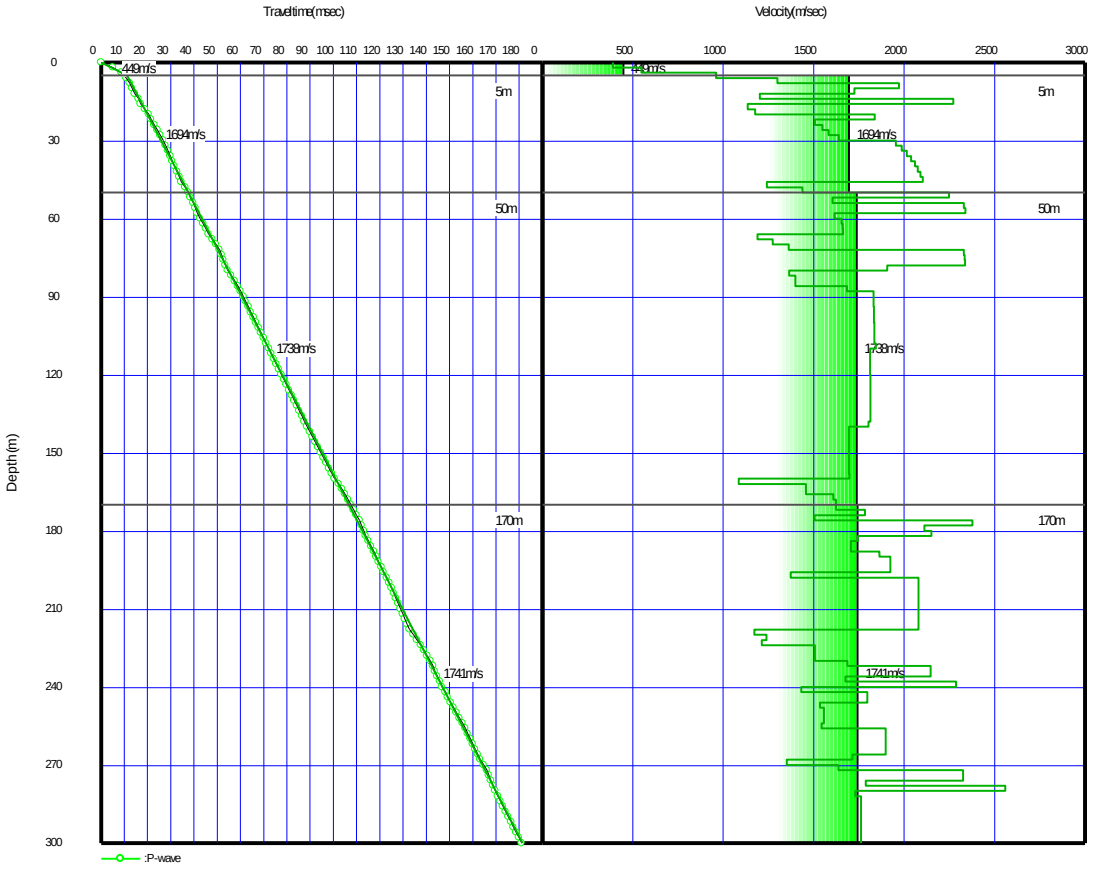


7) Select *Downhole, Downhole seismic analysis <launches PSLog>* for showing a traveltime curve.

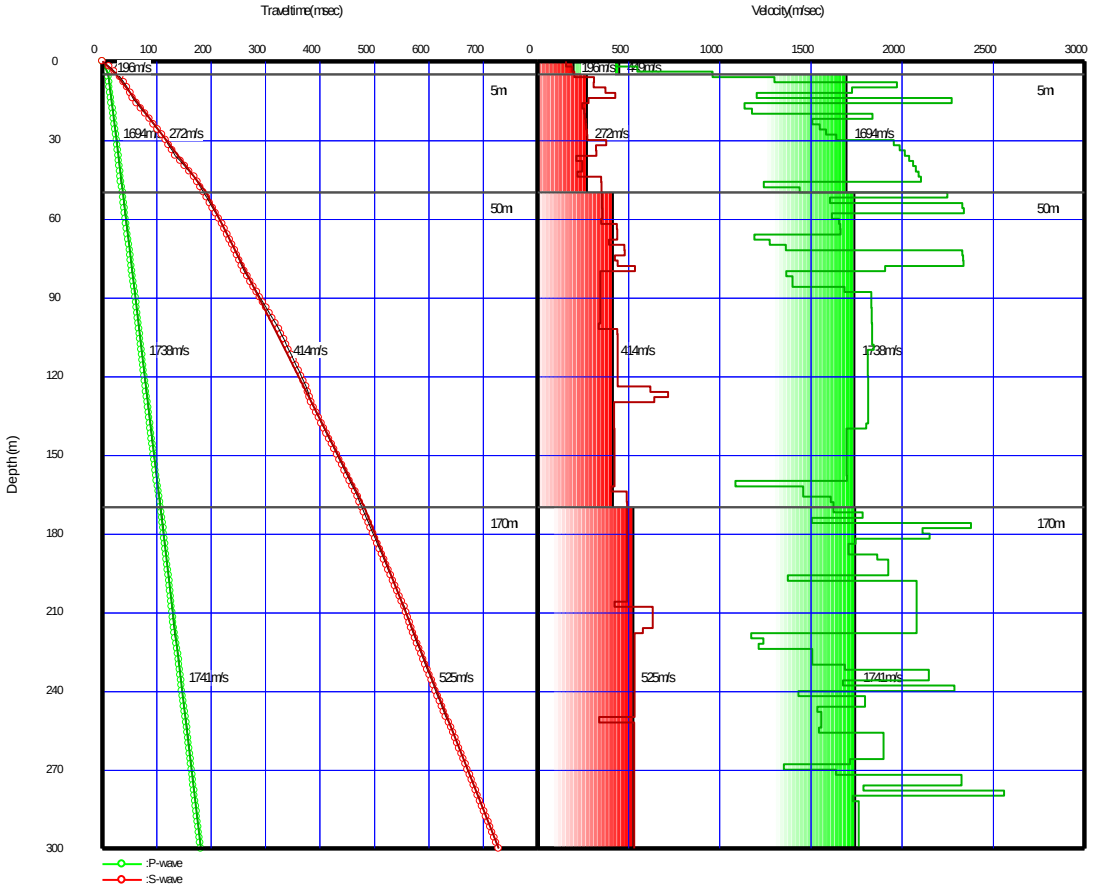


4.2 Combining P- and S-wave traveltime curves and velocity models using PSLog.

1) Open P- or S-wave traveltime curves and velocity models by Select *Open XML file*.



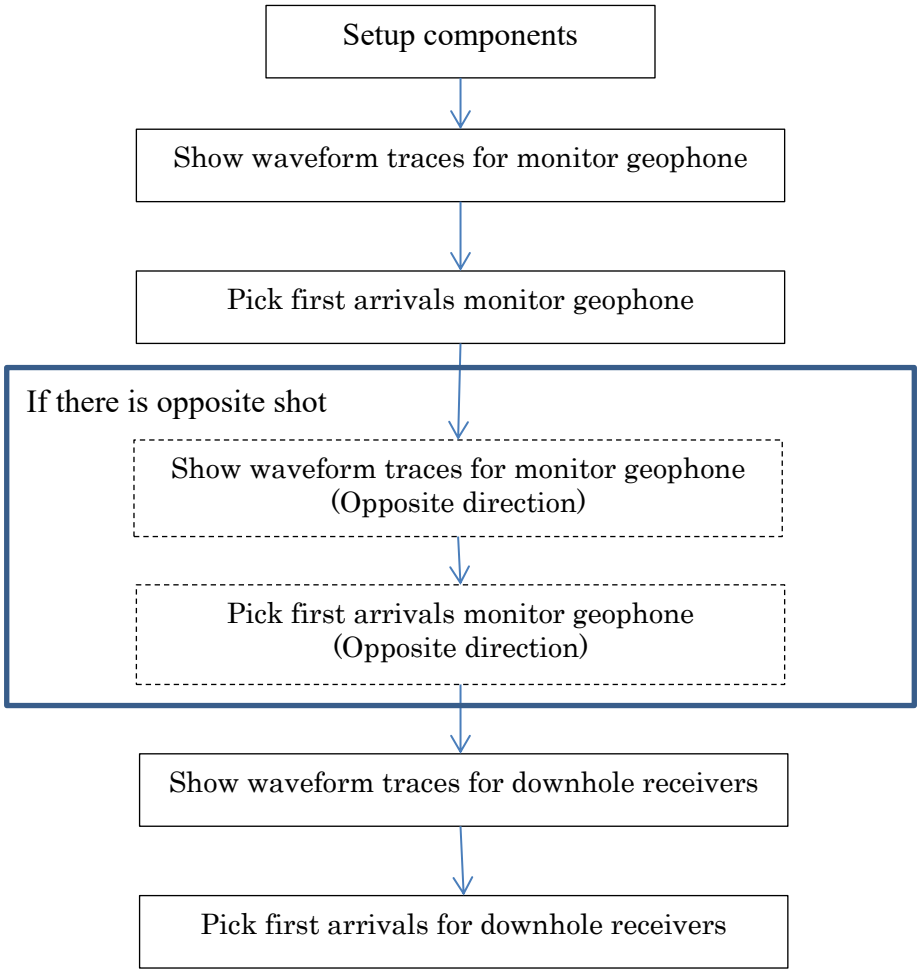
2) Open another XML file and choose *Append to present data*. Both P- and S-wave traveltime curves and velocity models are shown.



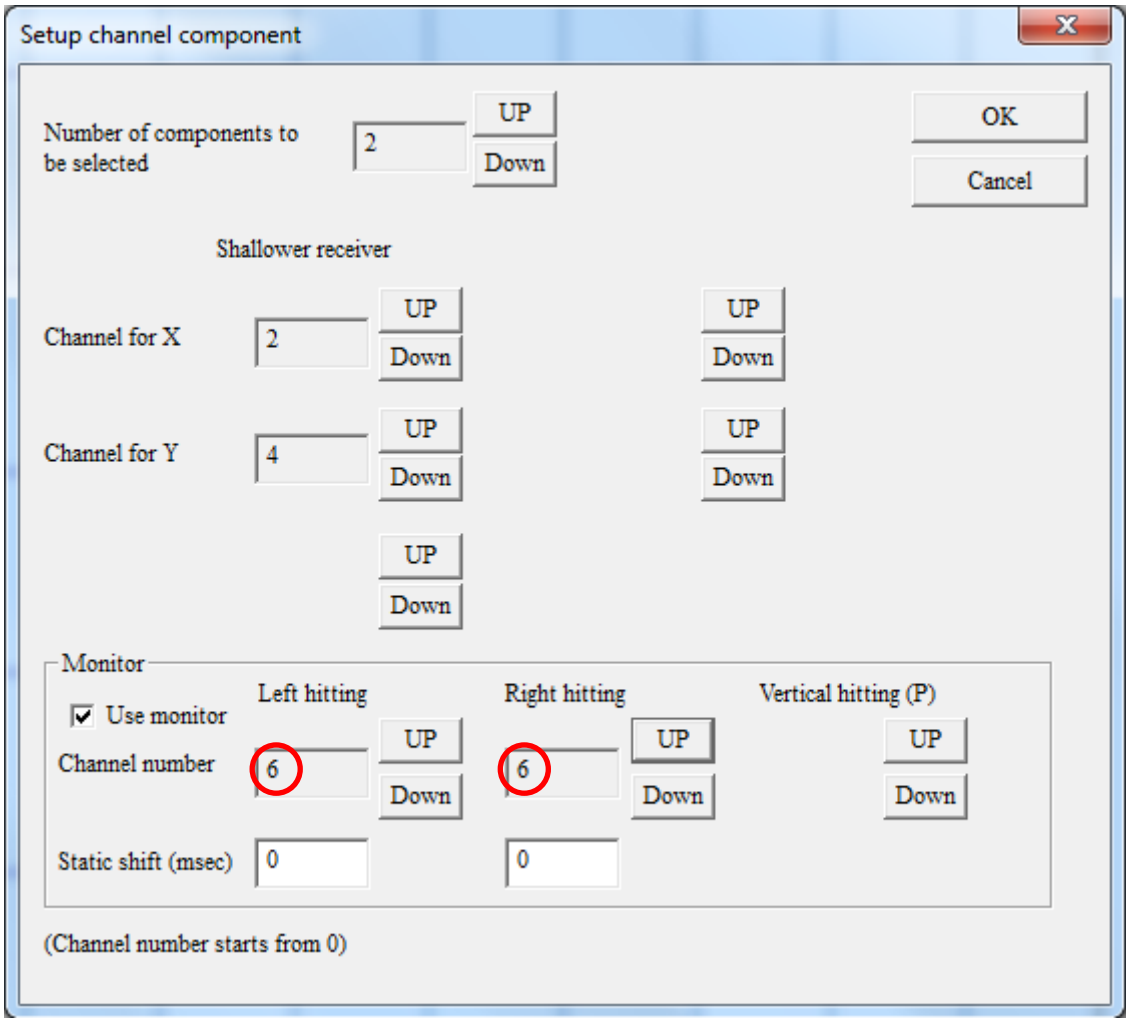
4.3 Optional analysis for detailed processing

4.3.1 Processing with monitor geophone

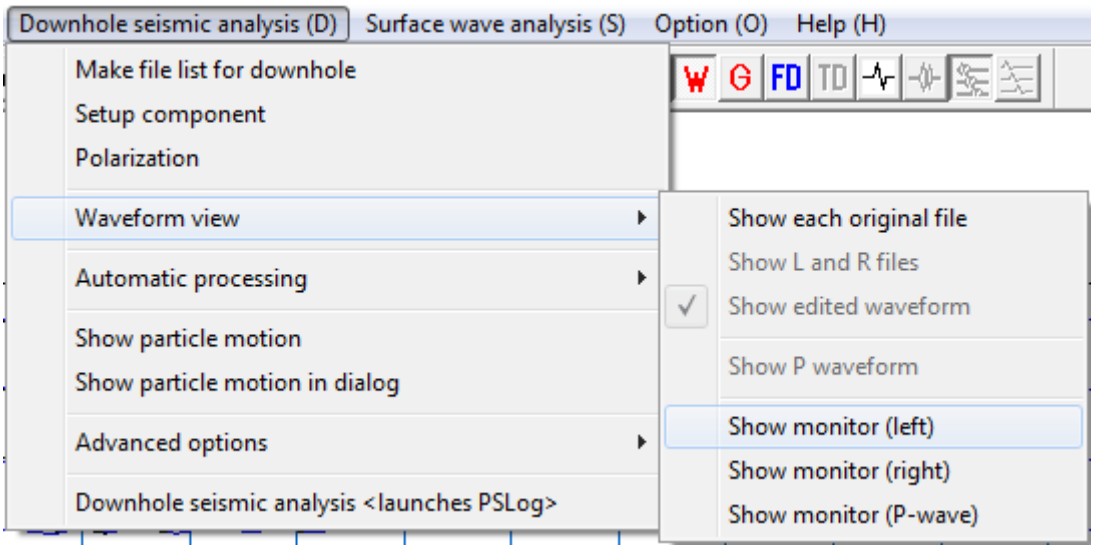
Processing flow using monitor geophone can be summarized as follows.



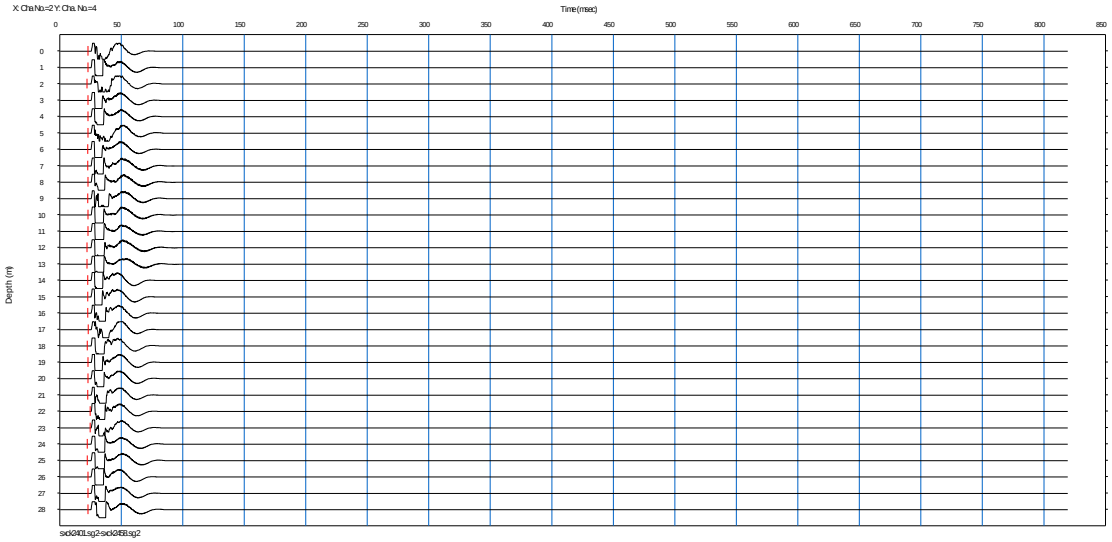
1) Set up number of monitor channel in the dialog shown by *Downhole, Setup component.*



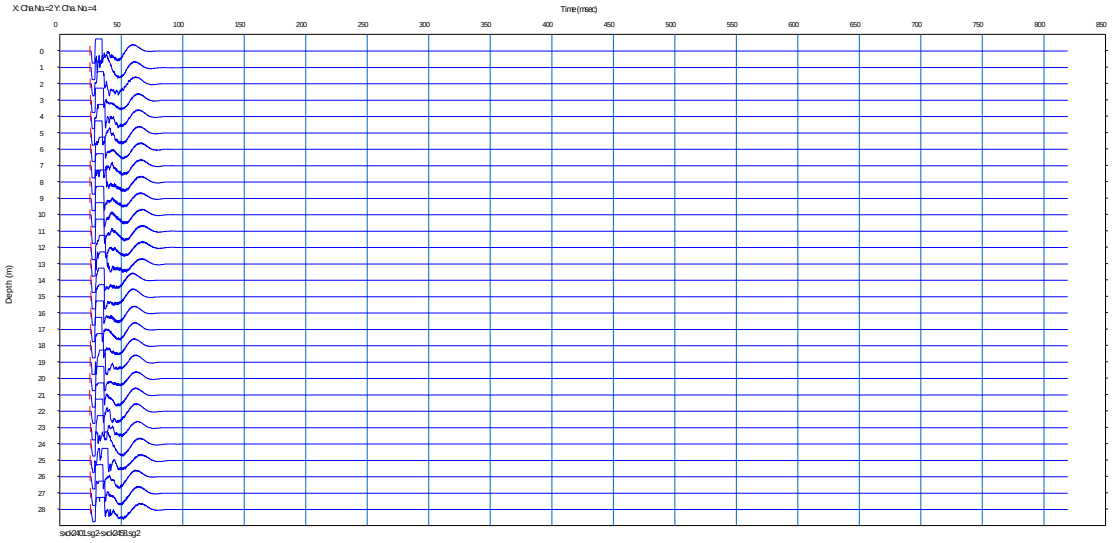
2) To display waveform traces for monitor geophoe, select *Downhole, Waveform view, Show monitor (left)* or *Show monitor (right)*.



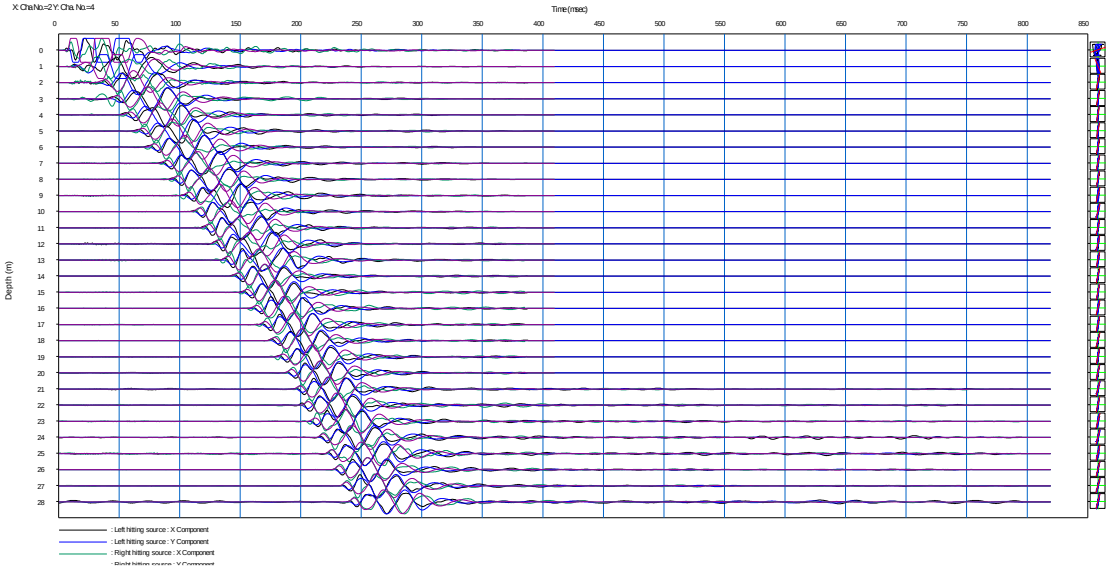
3) Waveform traces for a monitor geophone are displayed. Pick first arrival of monitor geophone.



4) Show and pick first arrival for opposite direction.

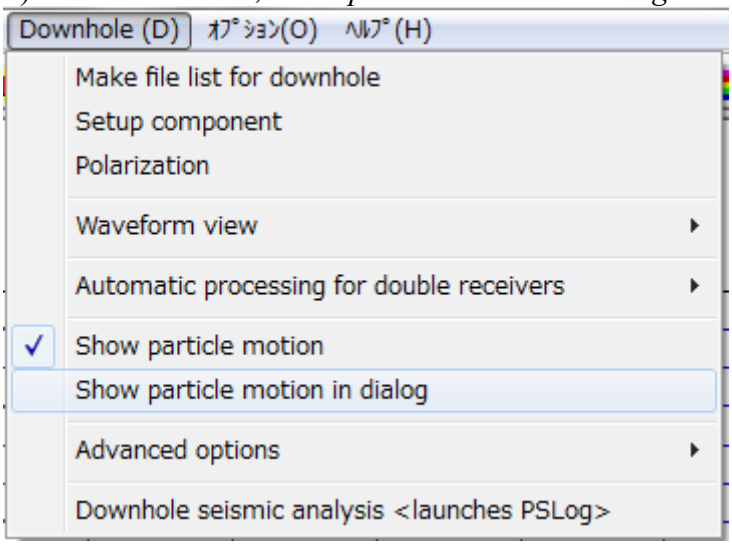


5) Select *Downhole, Waveform view, Show waveform* to show waveform traces recorded in a borehole. Displayed waveform traces are automatically shifted by picked first arrival time for monitor traces.

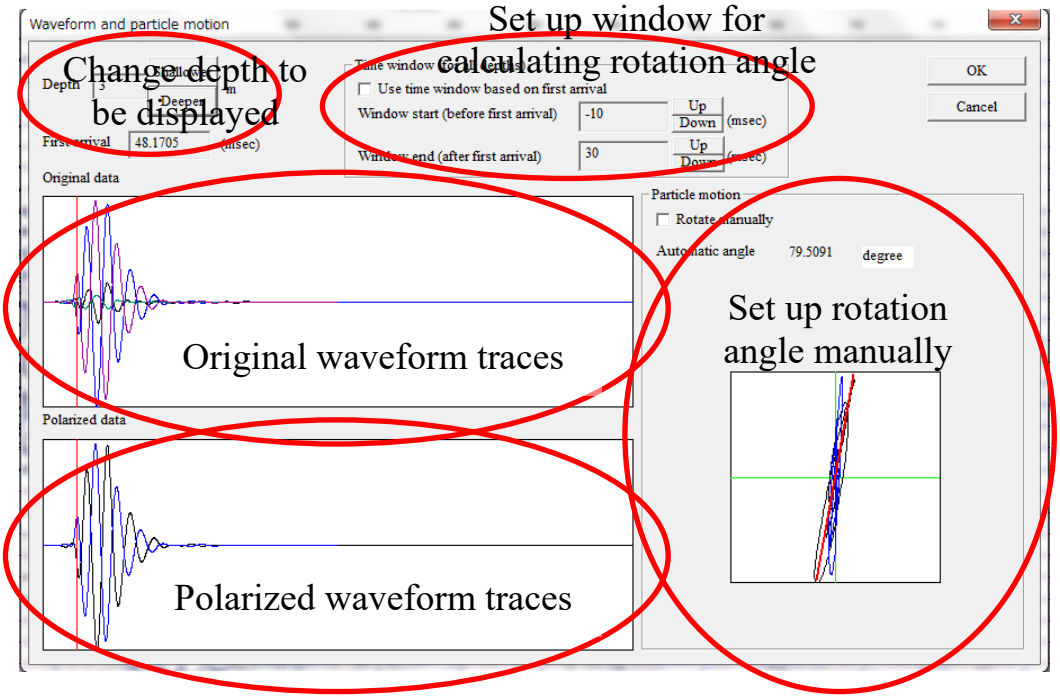


4.3.2 Set up rotation angle for polarization manually

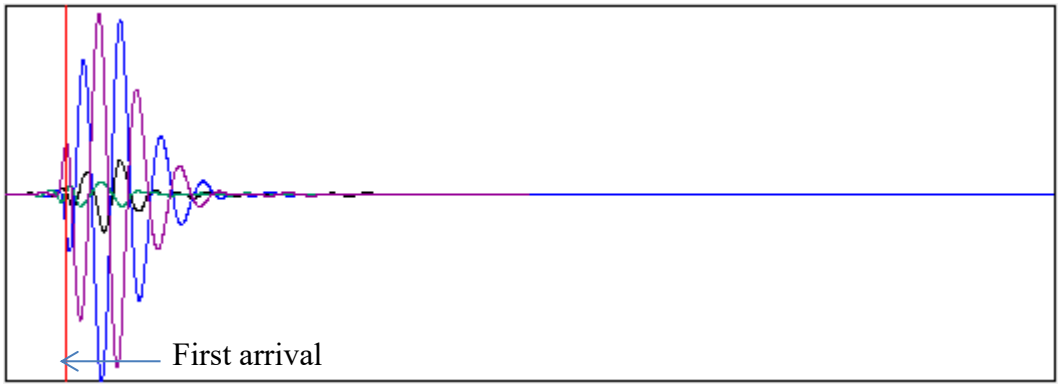
1) Select *Downhole, Show particle motion in dialog*.



2) Waveform traces for each depth are shown in a dialog box.

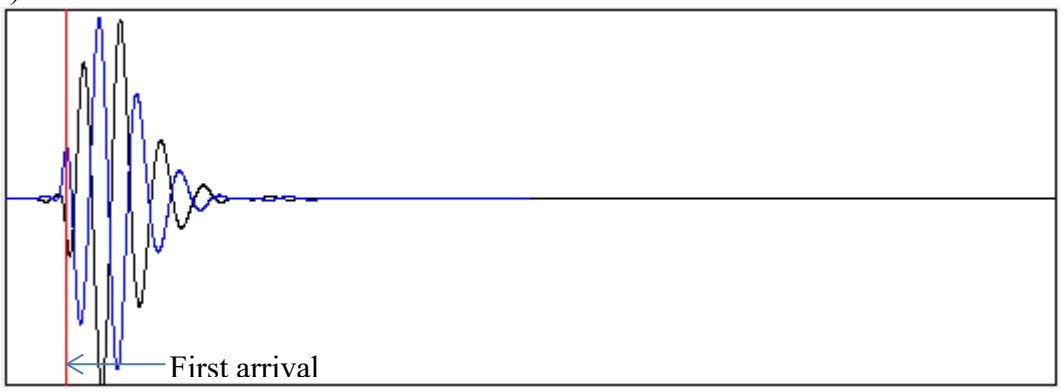


3) Original (before polarized) waveform traces are shown at the middle left. Picked first arrival is shown as a red vertical line.



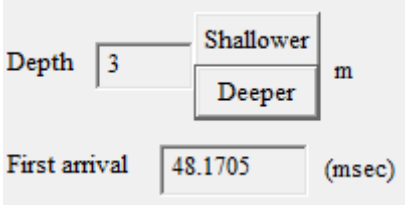
: Left hitting source (X component)
: Left hitting source (Y component)
: Right hitting source (X component)
: Right hitting source (Y component)

4) Polarized waveform traces are shown at the lower left.

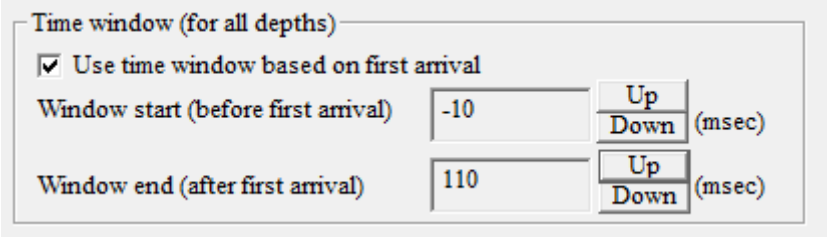


: Left hitting source
: Right hitting source

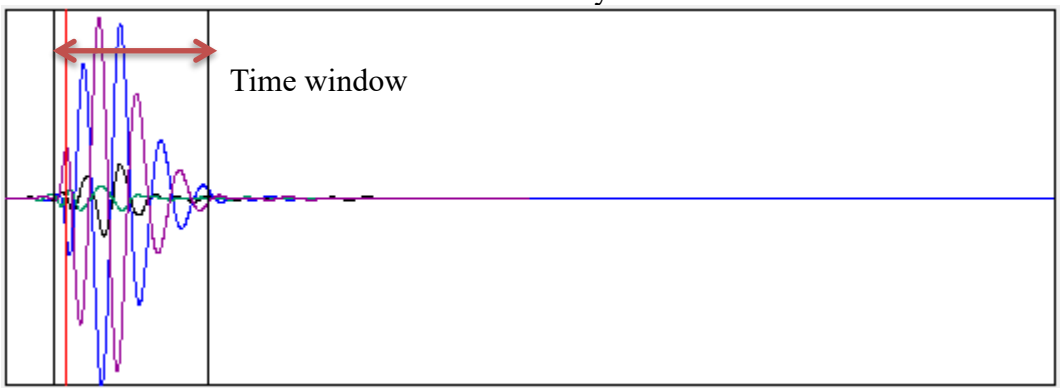
5) Scroll depth to be shown by *Shallower* and *Deeper* buttons.



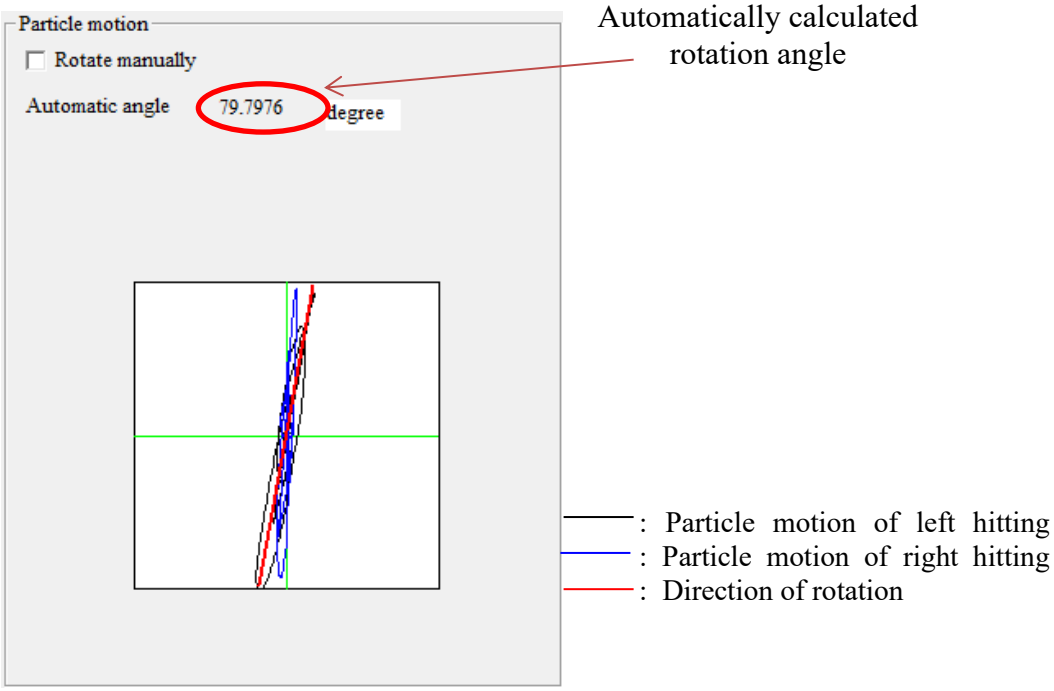
6) Set up time window for calculating rotation angle automatically by particle motion. The time window can be defined based on the first arrival. The time window is applied to all depths.



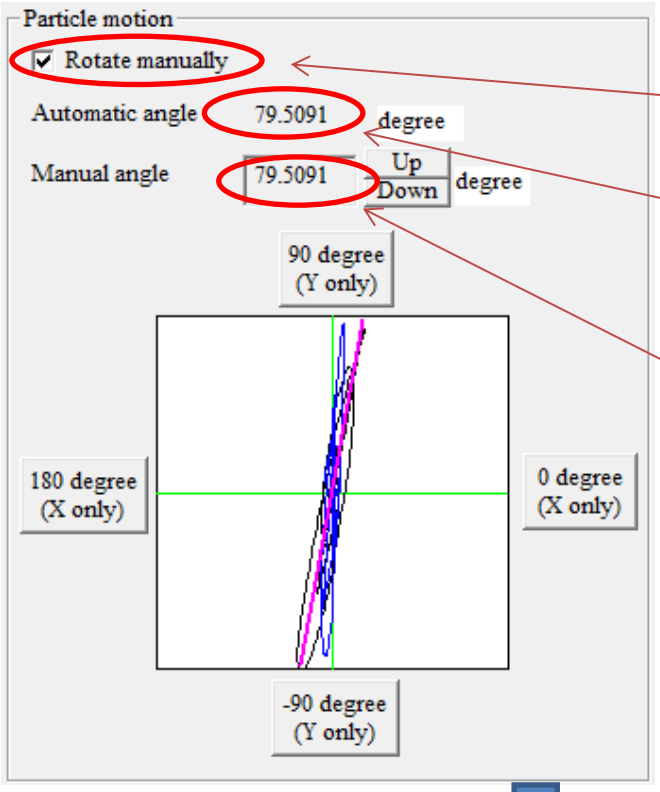
Check Use time window based on first arrival for applying the time window. If the time window is active, start and end of window are shown as black lines in waveform views at the left. Particle motion view shows the motion only in the window.



7) Particle motion and automatically calculated rotation angle is shown at the lower right.



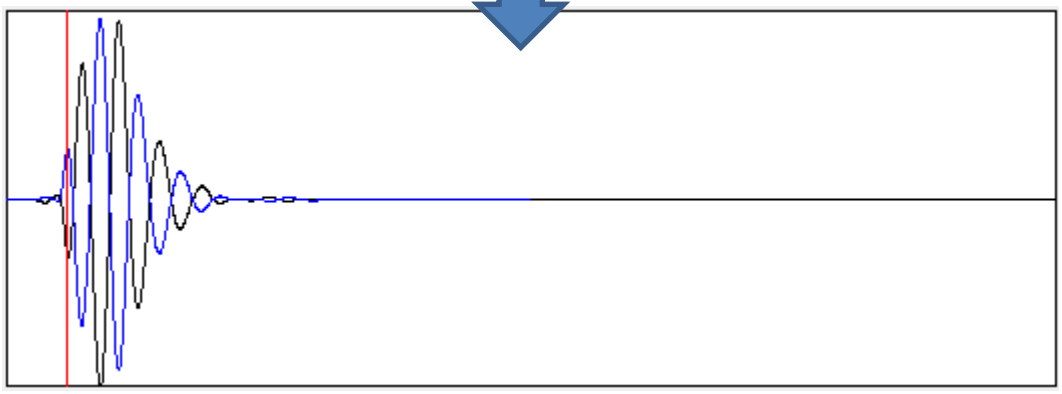
8) Rotation angle can be set by checking *Rotate manually* in particle motion setup at the lower right.



Check *Rotate manually* so that rotation angle can be set manually.

Rotation angle automatically calculated by least squares method.

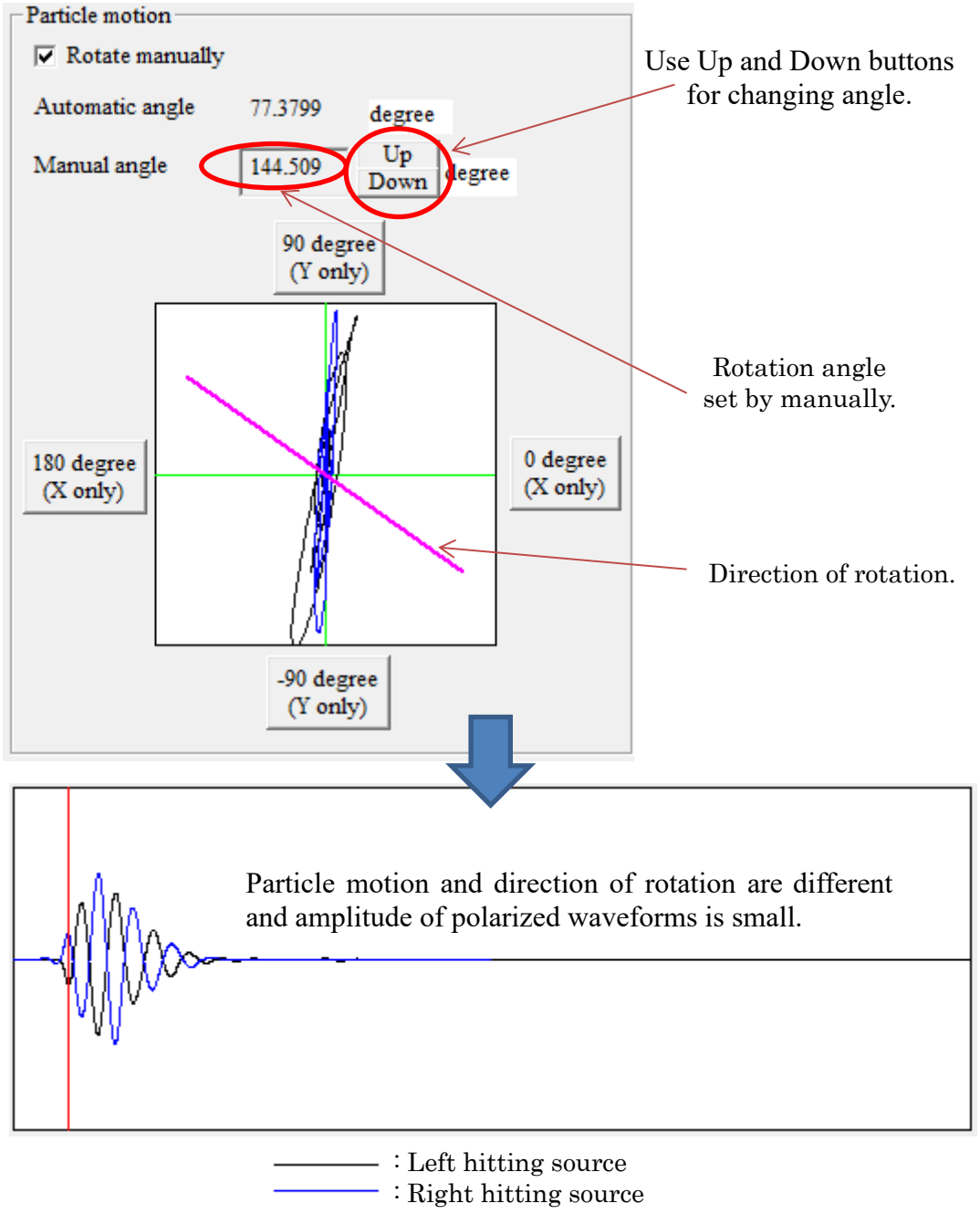
Rotation angle set manually.



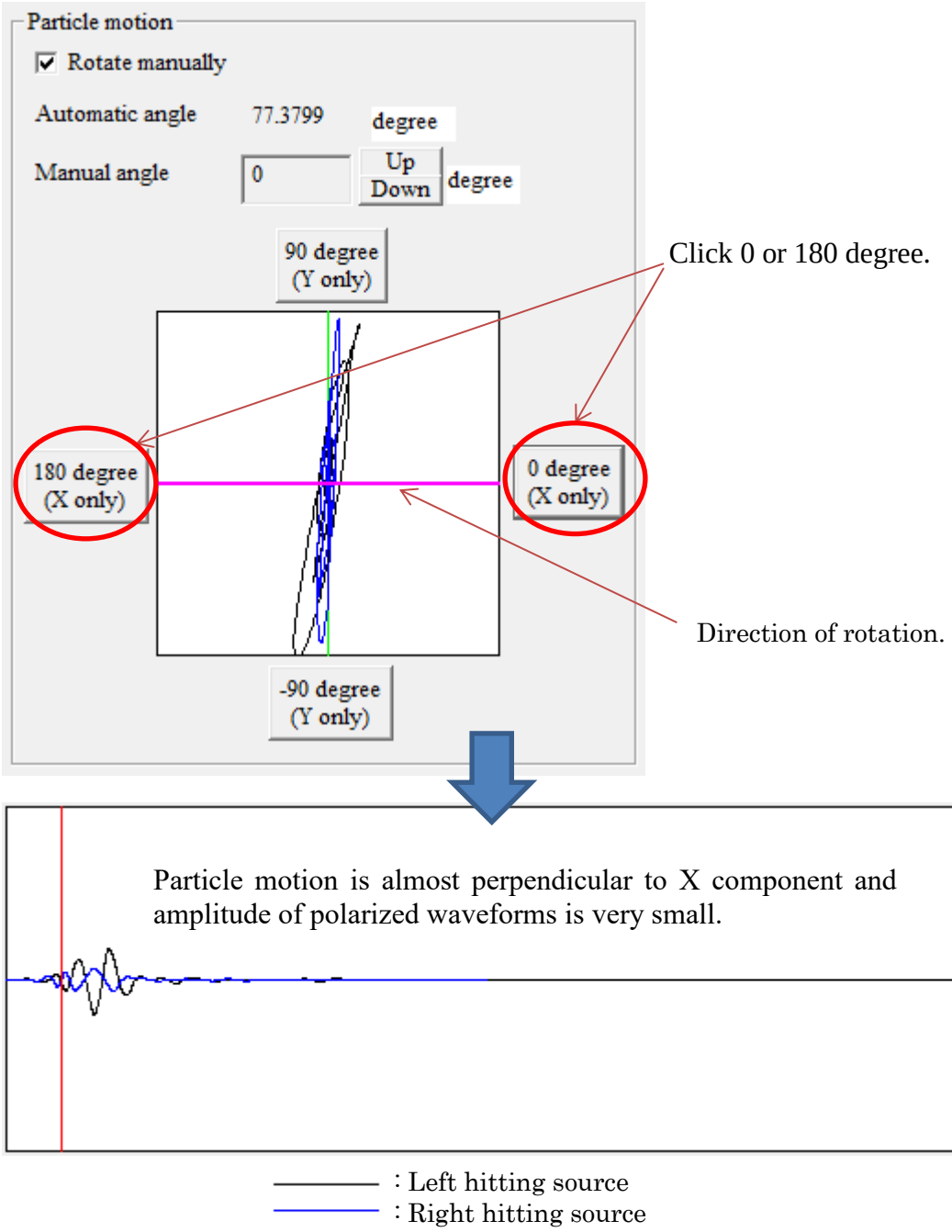
: Left hitting source

: Right hitting source

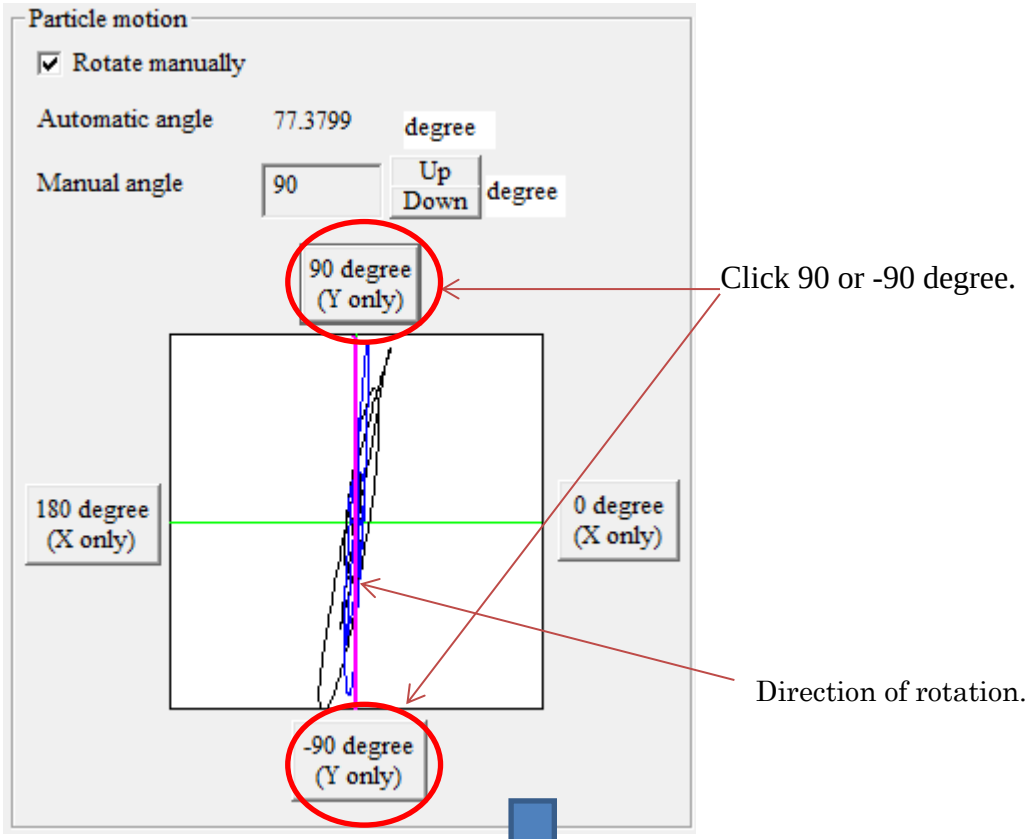
Rotation angle can be changed manually by *Up* and *Down* buttons.

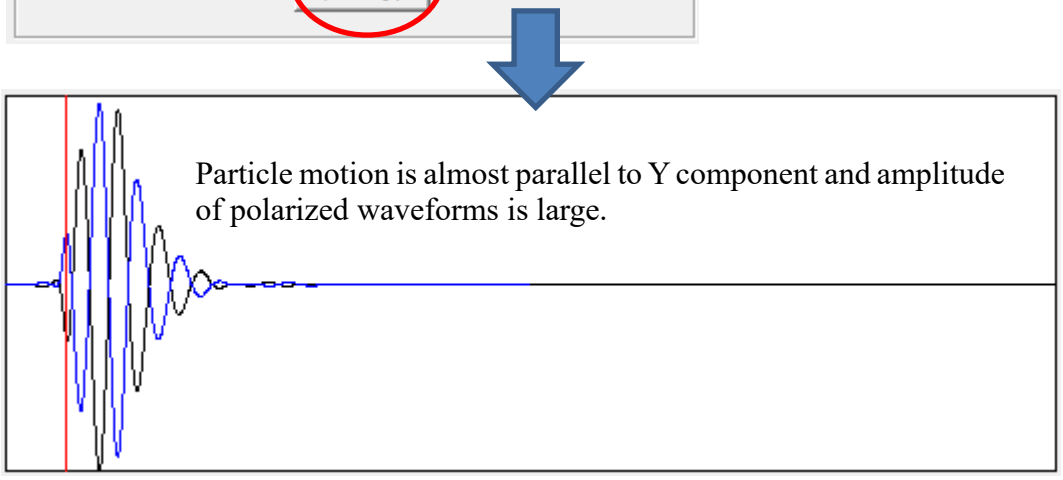


If you would like to us only X component, click 0 or 180 degree and only X component is used.



If you would like to us only Y component, click 90 or -90 degree and only Y component is used.



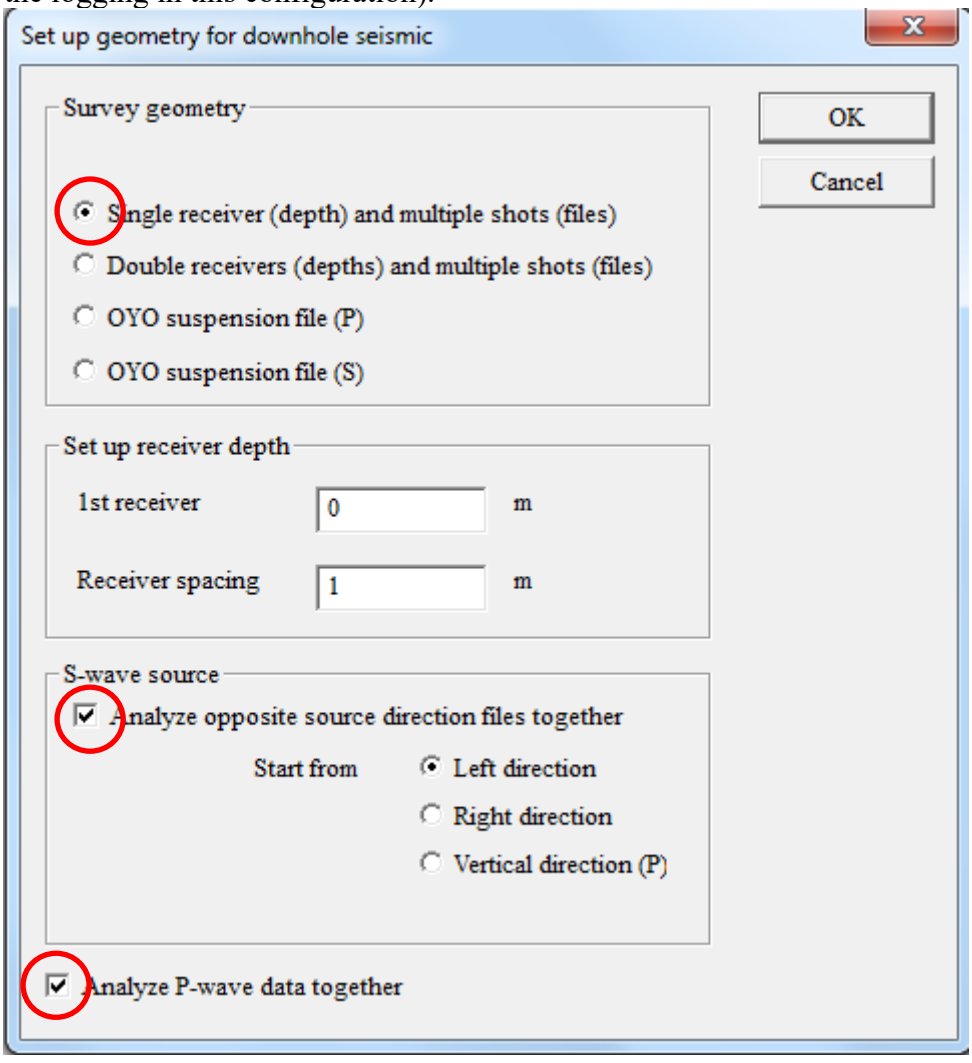


: Left hitting source
: Right hitting source

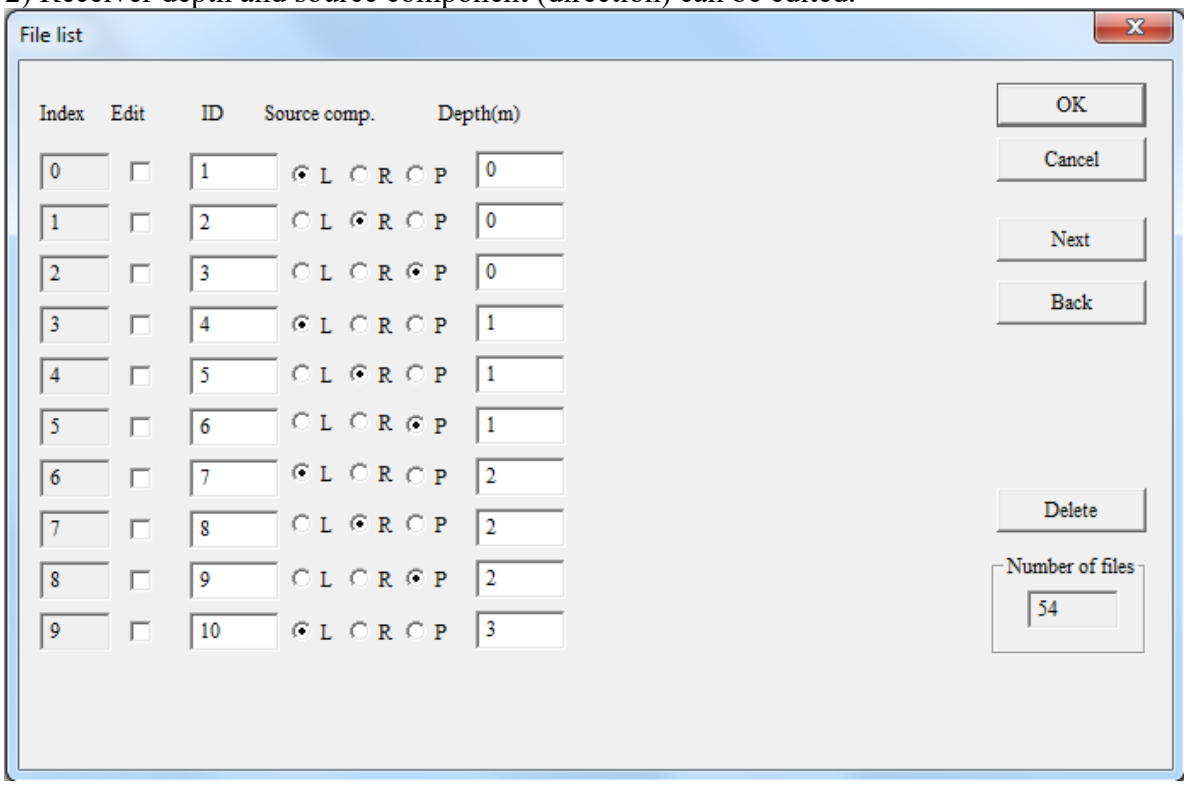
4.3.3 Analyzing P- and S-wave data together

If P-and S-wave data were recorded at same borehole, both data can be processed simultaneously as follows.

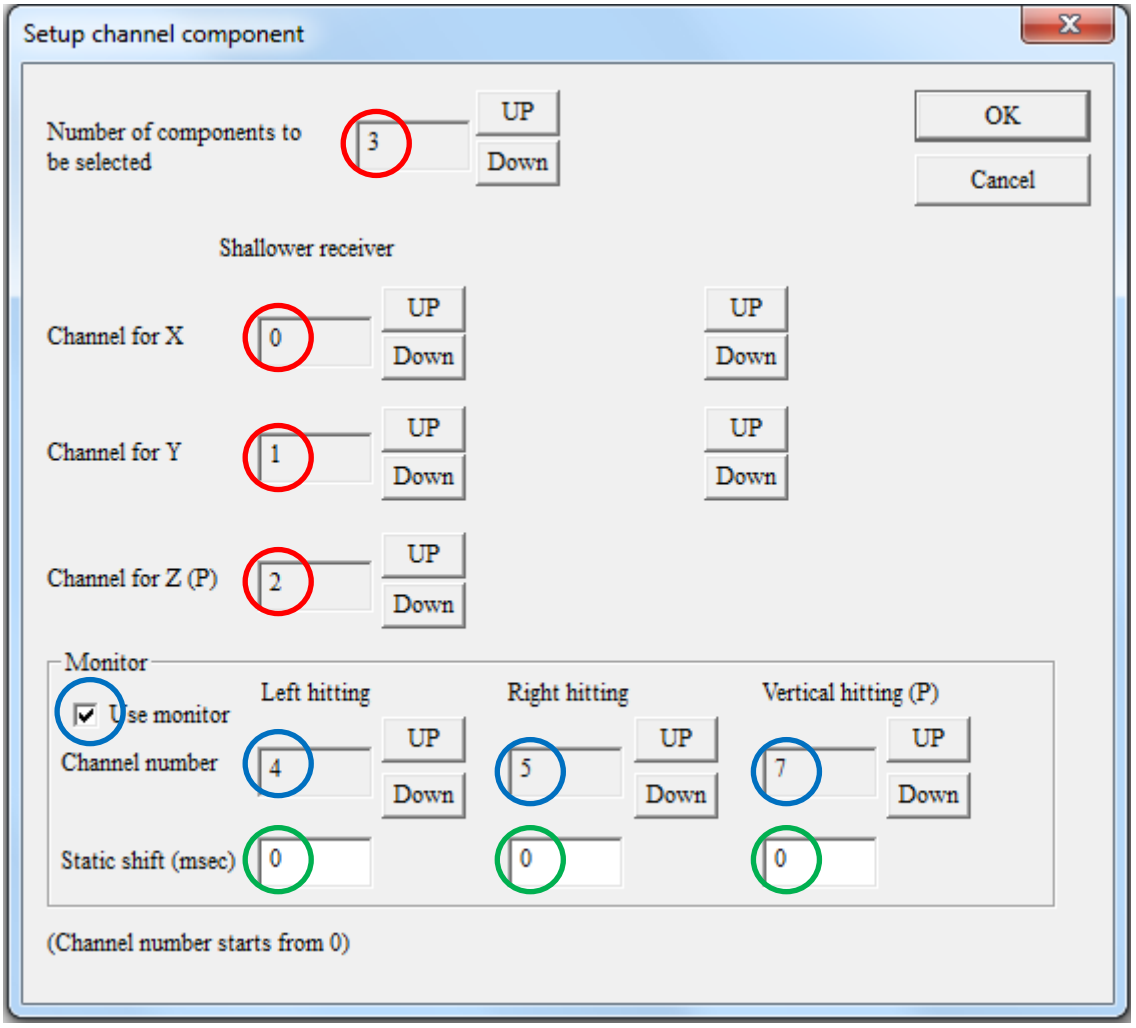
1) In the geometry setup:
Choose *Single receiver (depth) and multiple shots (files)*.
Check on *Analyze opposite source direction files together.*
Check on Analyze P-wave data together.
Set 1st receiver depth (top receiver) and receiver spacing. (Generally, receiver spacing and spacing of data acquisition assumed to be identical through the logging in this configuration).



2) Receiver depth and source component (direction) can be edited.



3) Select *Downhole, Setup component* and select components to be processed.
Set *Number of components to be selected* to three and set channel numbers to two horizontal components and one vertical component. Monitor geophone channels (and their static shift) can be set for three components individually. Check on *Use monitor* if you use monitor geophones.



4) To display S-wave form data, click the button. To display P-wave form data, click the button. See Section 5.1.4 for details.

4.4 Files used in analysis

Process and result of downhole seismic analysis are saved into three different types of files.

1) Original waveform files (SEG2)

These files contain original waveform data. The files are used by the first program Pickwin and list of files are saved into a File List (XML file). The waveform files and the XML file must be placed in a same folder.

2) File list (XML)

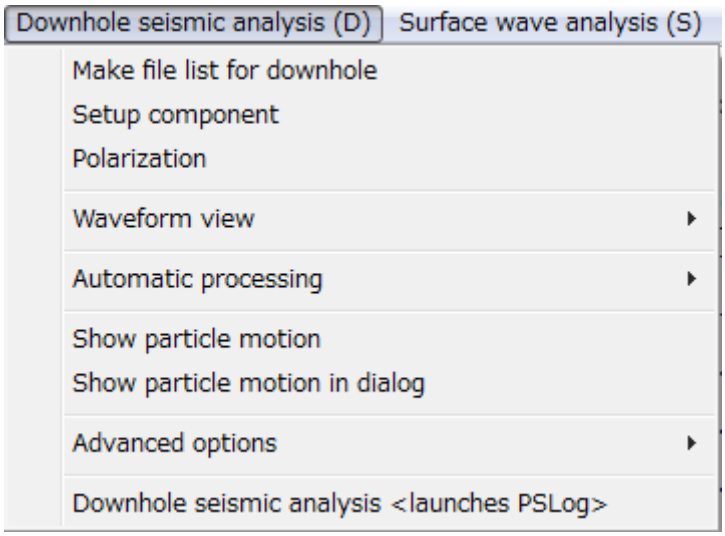
This XML file contains all information about waveform related processing, such as list of original waveform files, source-receiver configuration and channel number, rotation angle for polarization and picked first arrival. The file is used by Pickwin. You do not need to save processed waveform because all information is saved into the XML file list.

3) Analysis result (XML)

All processing information used in the second program PSLog is saved into another XML file. The file contains traveltime curves, source geometry (offset and elevation difference), layer boundary, velocity of each layer and plotting scales. P- and S-wave analysis results can be saved into same XML file or two different files.

5- The Pickwin module downhole analysis functions

Separate manuals exist for SeisImager/2D and SeisImager/SW, and due to the overlap of Pickwin with SeisImager/DH, reference is made to the SeisImager/2D and SeisImager/SW manuals for explanation of the common Pickwin menus.



5.1 Downhole seismic analysis Menu

The *Downhole seismic analysis* menu includes basic functions used for downhole seismic data analysis.

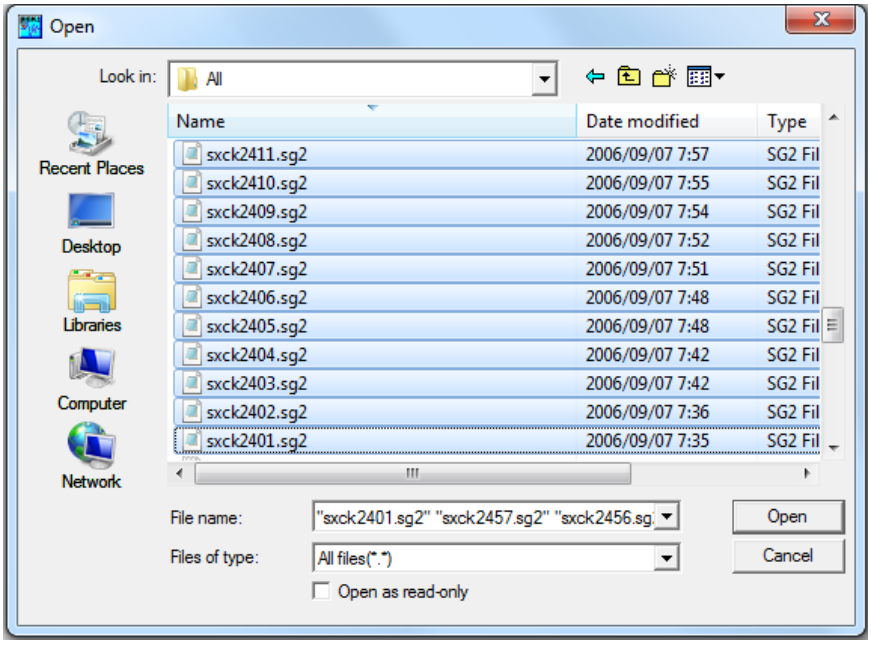
5.1.1 Downhole seismic analysis Menu: Make file list for downhole

A downhole seismic data analysis is generally started from this menu. A file list is an inventory of data files from any given survey and includes essential information for each waveform trace such as the associated field file identification number and receiver location. In downhole seismic data acquisition, multiple files are processed together generally and the data set must be input by making a file list.

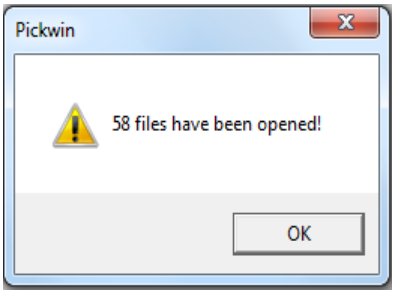
The file list is not only used in downhole seismic data analysis but also other seismic data analyses such as surface wave data analysis or seismic refraction analysis. General file list can be made by selecting File, Group (File list), Make file list. However, downhole seismic

data analysis requires unique information, such as source direction or receiver component, and this information can be easily given by *Make file list for downhole* under *Downhole seismic analysis* menu.

To make a list of files, select *Make file list for downhole.* After setting the Files of type, highlight the set of data files to be opened by using the *Shift* key to select a range of files or the *Control* key to select individual files. If *All files* is showing for the *Files of type* setting, take care not to inadvertently select non-data files as this will cause an analysis error.

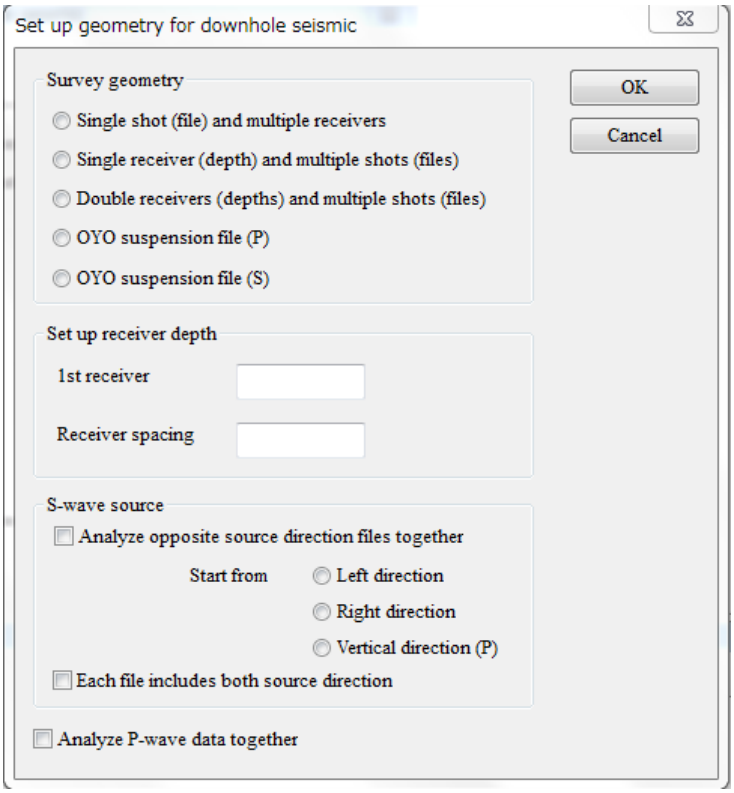


Confirmation that the files are input is displayed, clock *OK*.



Next, you will be prompted to set up the geometry. Fundamental survey geometry, receiver depth and source direction pattern must be set up here. As mentioned previous chapters, there are many pattern of source-receiver configuration in downhole seismic data acquisition. Fundamental source-receiver configuration can be set up using this dialog box.

Typical examples of setup are explained in Section 4.1 *Processing for P- and S-wave data with typical source-receiver configuration*.



1) Survey geometry (see Chapter 3.)

A) Single shot (file) and multiple receivers

Data acquisition using a multi-channel receiver (Figure 3).

B) Single receiver (depth) and multiple shots (files)

Data acquisition performed at each depth using a single depth receiver (Figure 6 or 9).

C) Double receivers (depths) and multiple shots (files) (Figure 13).

Data acquisition in which two different depth receivers, such as a cone penetrating probe, are recorded simultaneously.

D) OYO suspension file (PS)

Data acquisition using OYO suspension. Select this .

E) OYO suspension file (PS)

Data acquisition using OYO suspension. Select this for S-wave analysis.

2) Setup receiver depth

1st receiver is the depth of the first receiver. The *Receiver spacing* is the spacing between each receiver.

3) S-wave source

A) Analyze opposite source direction files together.

For analyzing left and right shots together in S-wave measurement, check this option and select one of following options for order of measurements. File list will be made

a) Start from left direction: Left -> Right (-> Vertical).

b) Start from right direction: Right (-> Vertical) -> Left.

c) Start from vertical direction (P): (Vertical) -> Left -> Right.

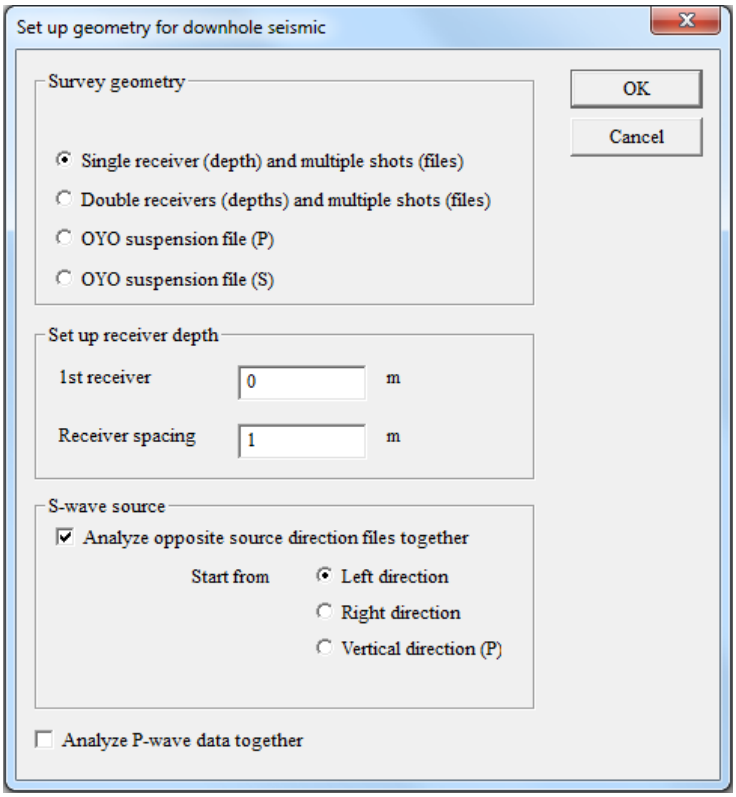
B) Each file includes both source directions.

If left and right shots are recorded to same file (Figure 12 and 13) in S-wave measurement using hold function of seismograph, cheek this option.

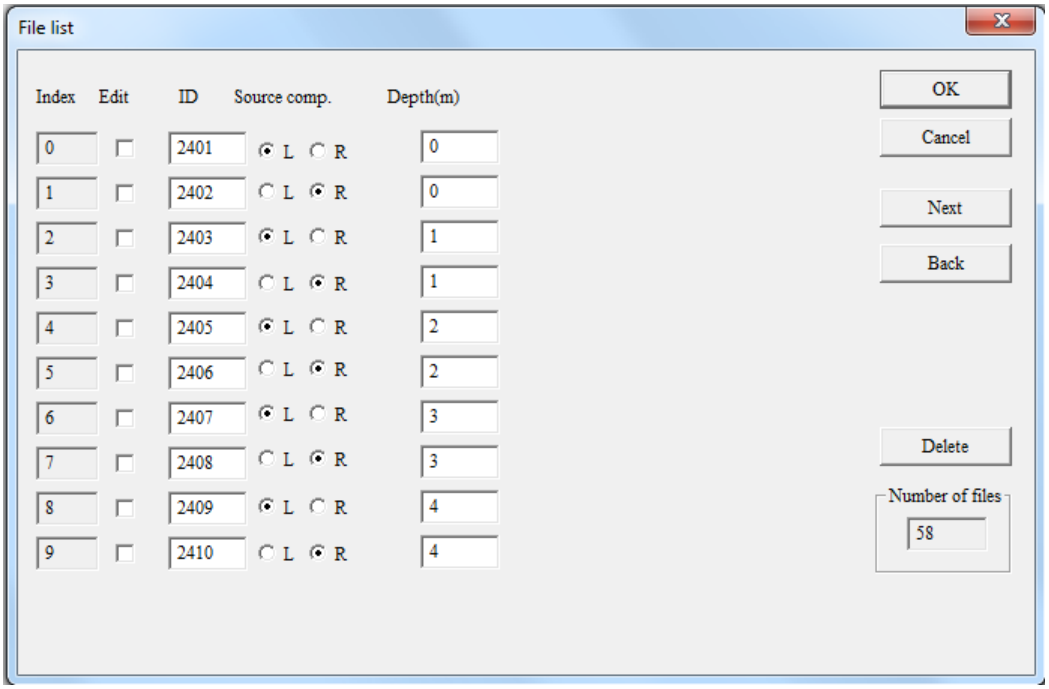
C) Analyze P-wave data together

Check this option for analyzing P- and S-wave data simultaneously.

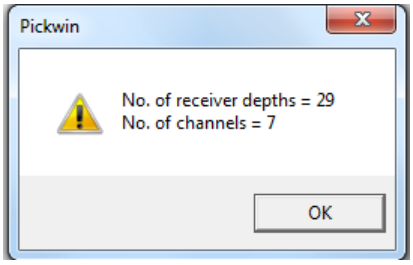
Setup shown below is an example of source- receiver configuration for S-wave data acquisition using single 3 components receiver.



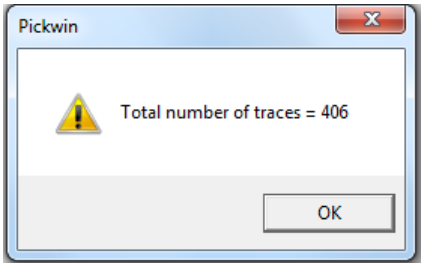
Click *OK* and the file list dialog box presents the data files listed by file ID. Confirm *ID*, *source component* and receiver *depth*. If acquisition order of source component (direction) of depth is irregular, they can be edited by manually.



Confirmation that the number of receiver depths and channels is displayed, click *OK*.

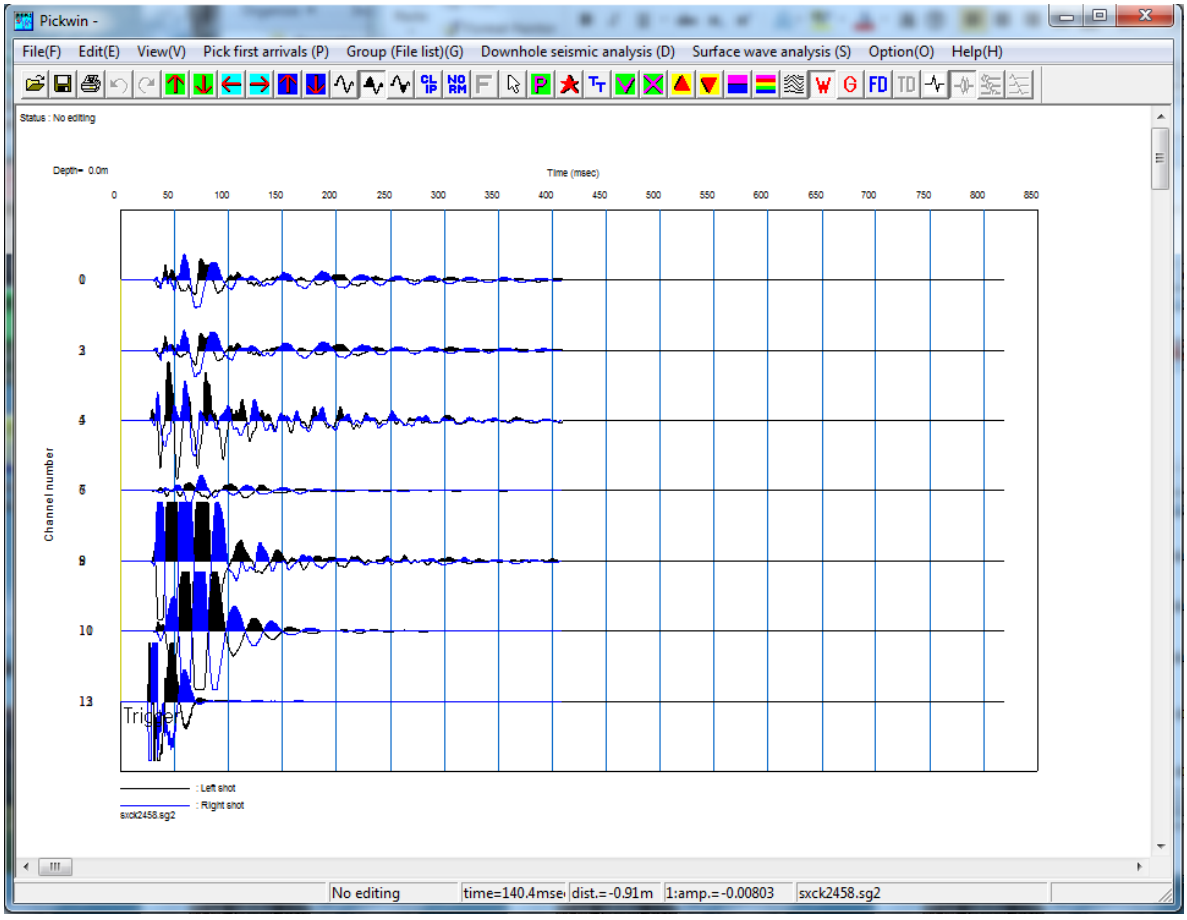


Confirmation that the number of files is displayed, click *OK*.



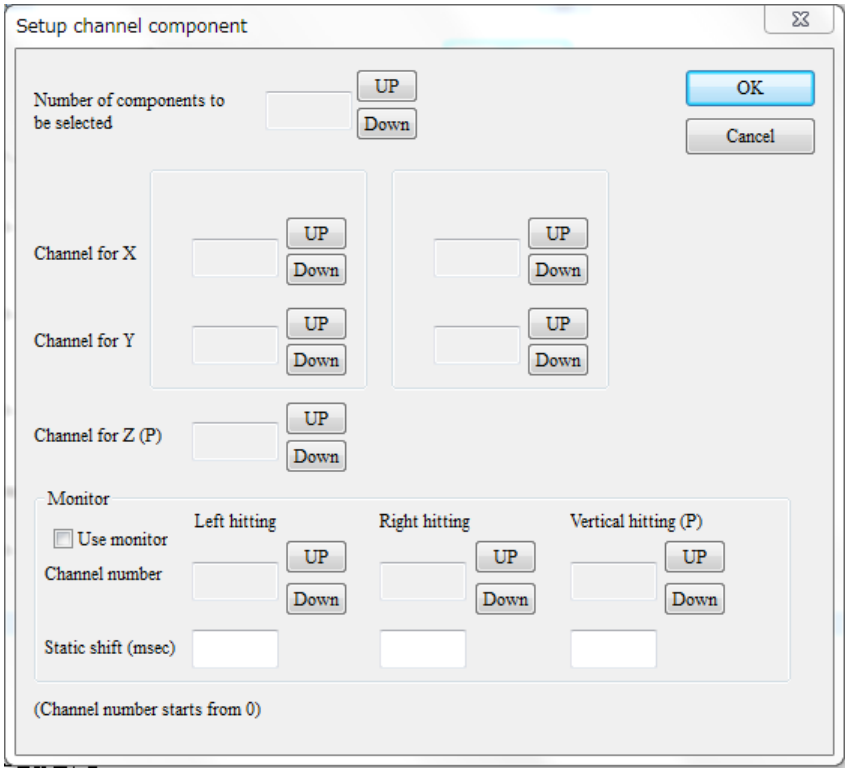
Confirmation that the traces are input is displayed, click *OK*.

Waveforms for left and right shots are displayed.



5.1.2 Downhole seismic analysis Menu: Setup component

Which channels will be used for analysis must be assigned before picking first arrival except a data acquisition using multi-channel (depth) receiver (method A).



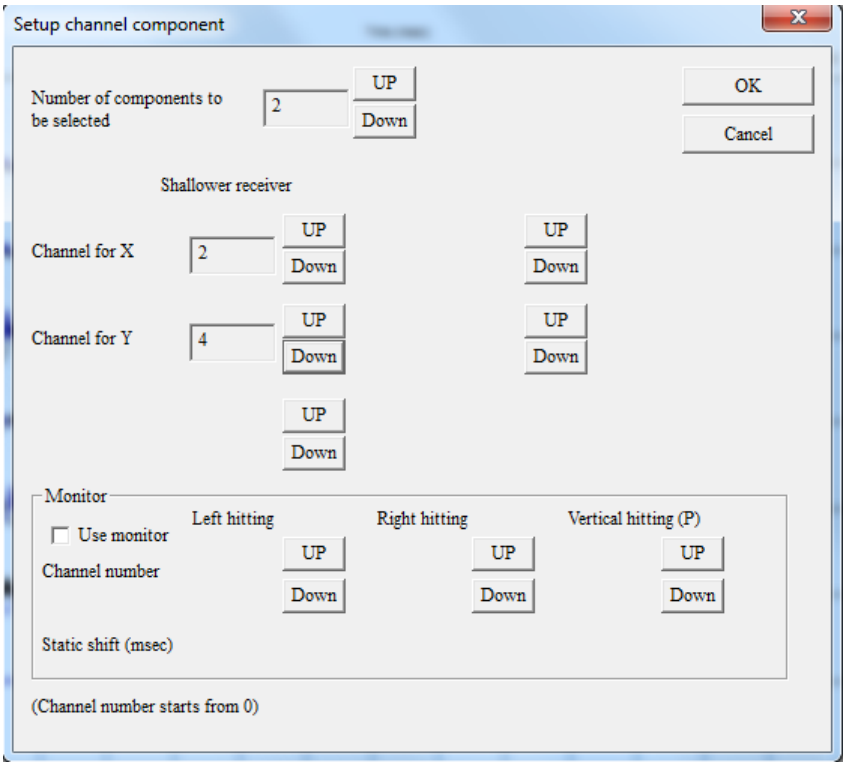
1) Number of components to be selected.
Set 1 for P-wave analysis or S-wave data acquisition using one direction shot.
Set 2 for S-wave analysis using two opposite direction shots.
Set 3 for analyzing P- and S-wave data simultaneously.

2) Channel for X, Y, Z
Set channel number to each component. **Channel number must start from 0 (i.e. 0, 1, 2….)**. Set both *Shallower receiver* and *Deeper receiver* for analyzing double receivers (method D). Set *Left hitting* and *Right hitting* for analyzing data that left and right shots are recorded to same file.

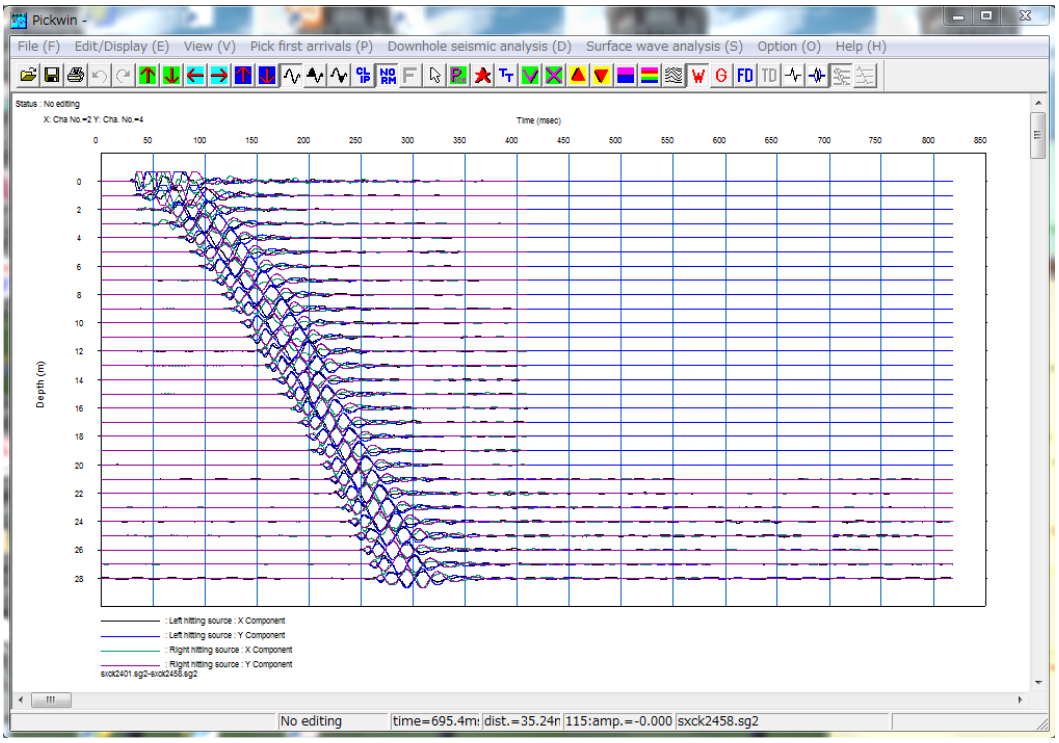
3) Monitor

Check *Use monitor* if first arrival time of monitor geophones are used for shot time shift. Assign channel number to each component. If shot time of monitor has static shift, set time shift to “Static shift” so that time shift t can be automatically corrected.

Setup shown below is an example of source- receiver configuration for S-wave data acquisition using single 3 components receiver.

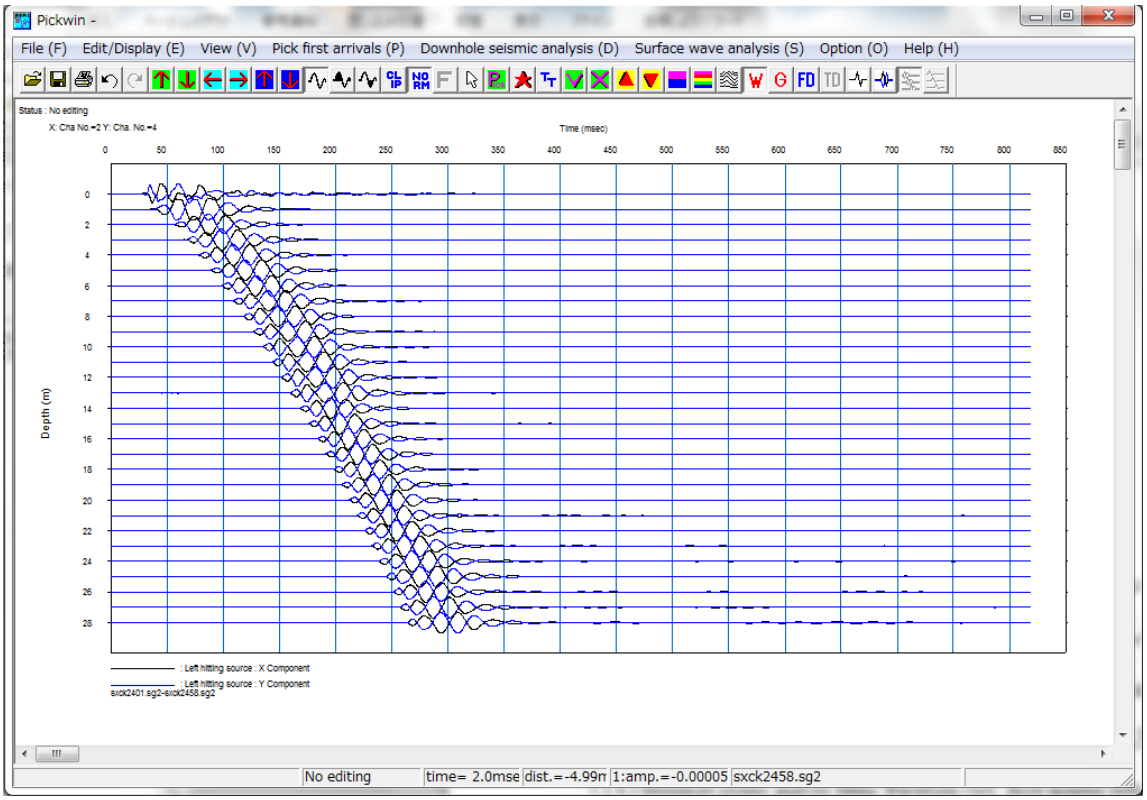


Click *OK* and waveform traces along a borehole are shown. At each depth, one trace will be shown when P-wave data is analyzed, two traces will be shown for S-wave data with single shot direction and four traces will be shown for S-wave data with opposite directions.



5.1.3 Downhole seismic analysis Menu: Polarization

Polarization processing is automatically applied to all traces when S-wave data using two horizontal components is analyzed. One trace will be displayed at each depth for single direction shots and two traces will be displayed for opposite direction shots. Rotation angles of each depth are automatically calculated by least square method. When opposite direction sources are analyzed together, one common rotation angle is applied to both direction shots. Figure shown below is the example of waveform data after polarization.

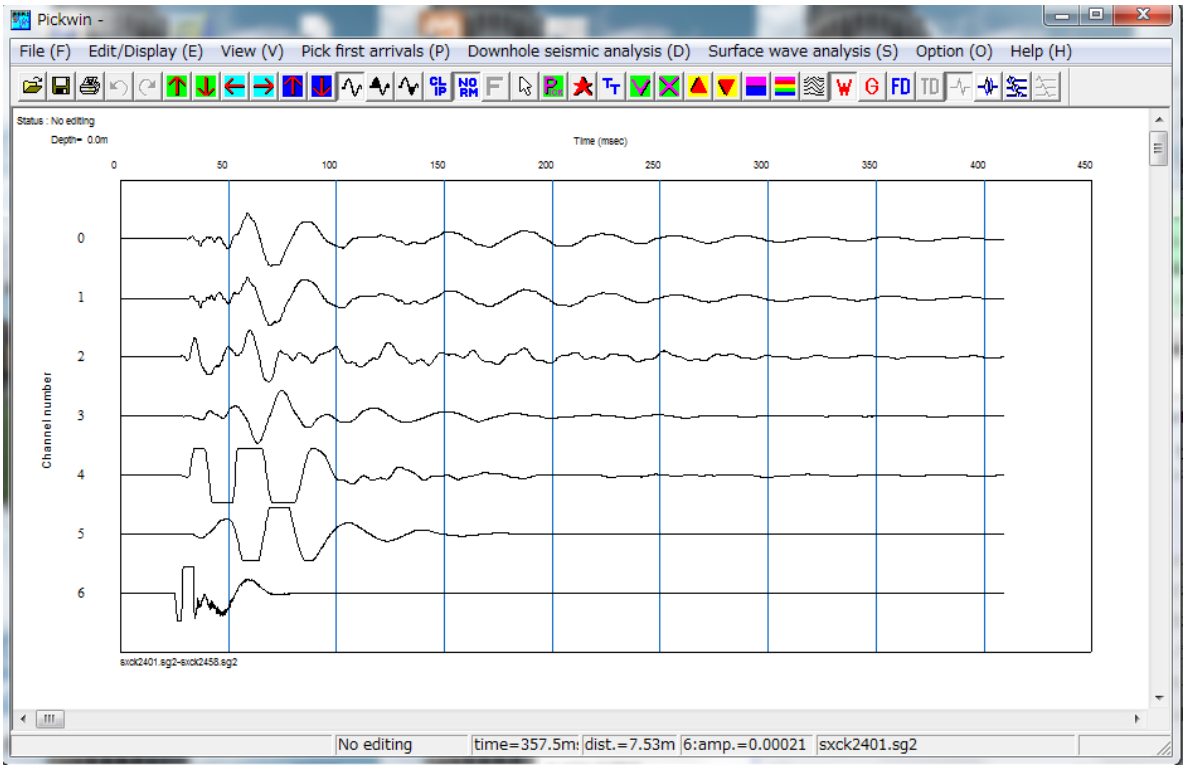


5.1.4 Downhole seismic analysis Menu: Waveform view

Several waveform display option can be selected in downhole seismic analysis.

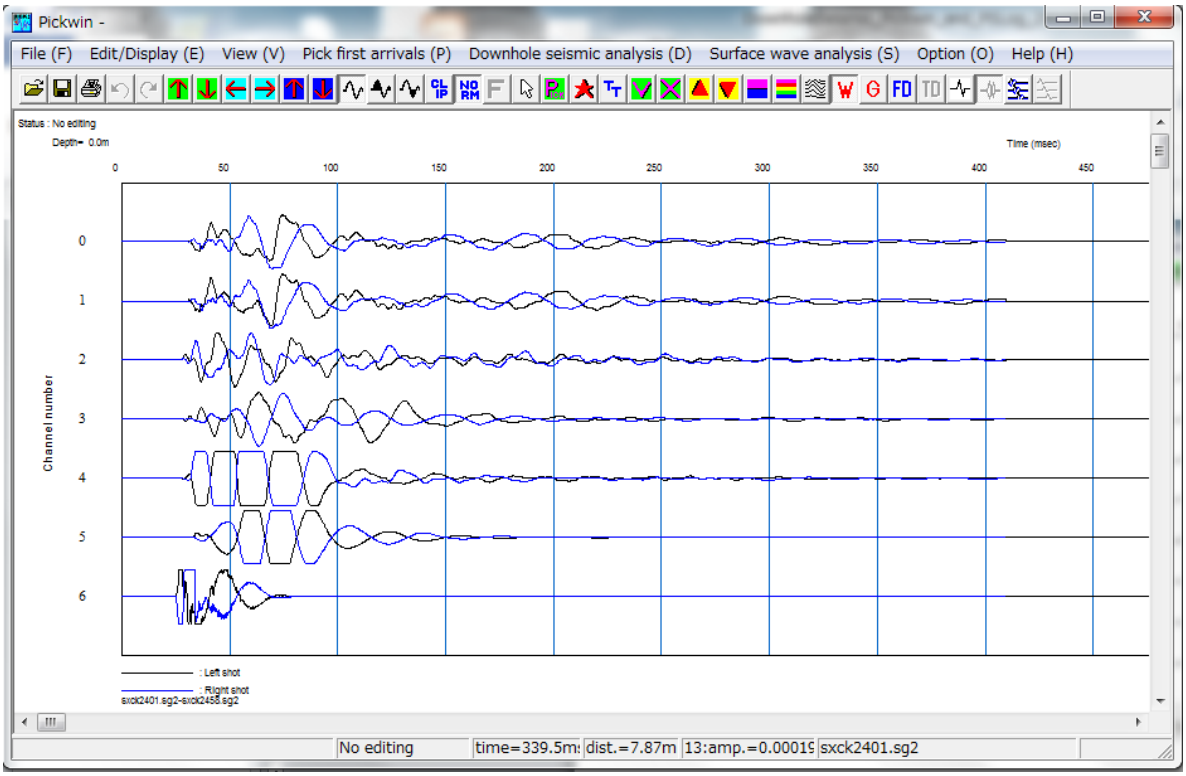
5.1.4.1 Downhole seismic analysis Menu: Waveform view: Show each original file

An original single waveform file by one shot is displayed. Use and buttons to scroll depth of files.



5.1.4.2 Downhole seismic analysis Menu: Waveform view: Show L and R files

Opposite shot direction files are displayed together. Use and buttons to scroll depth of files.



5.1.4.3 Downhole seismic analysis Menu: Waveform view: Show edited waveform

Extracted waveform traces along a borehole are displayed. If P- and S-wave data are processed simultaneously, S-wave data will be displayed.

5.1.4.4 Downhole seismic analysis Menu: Waveform view: Show P waveform

If P- and S-wave data are processed simultaneously, P-wave data will be displayed.

5.1.4.5 Downhole seismic analysis Menu: Waveform view: Show monitor (left)

If monitor geophone channel for left shot is assigned in *Setup channel component dialog,* waveform traces of the monitor channel for all depth are displayed.

5.1.4.6 Downhole seismic analysis Menu: Waveform view: Show monitor (right)

If monitor geophone channel for right shot is assigned in *Setup channel component dialog,* waveform traces of the monitor channel for all depth are displayed.

5.1.4.7 Downhole seismic analysis Menu: Waveform view: Show monitor (P-wave)

If monitor geophone channel for vertical shot is assigned in *Setup channel component dialog,* waveform traces of the monitor channel for all depth are displayed.

5.1.5 Downhole seismic analysis Menu: Automatic processing

Automatic processing is applied to the analysis of S-wave data using a multi-channel (double) receiver (D) and S-wave data using OYO suspension. In these analyses, edited waveform can be scrolled by  and  buttons. Automatic processing will automatically apply following wave processing to next waveform data.

5.1.5.1 Downhole seismic analysis Menu: Automatic processing: Polarization

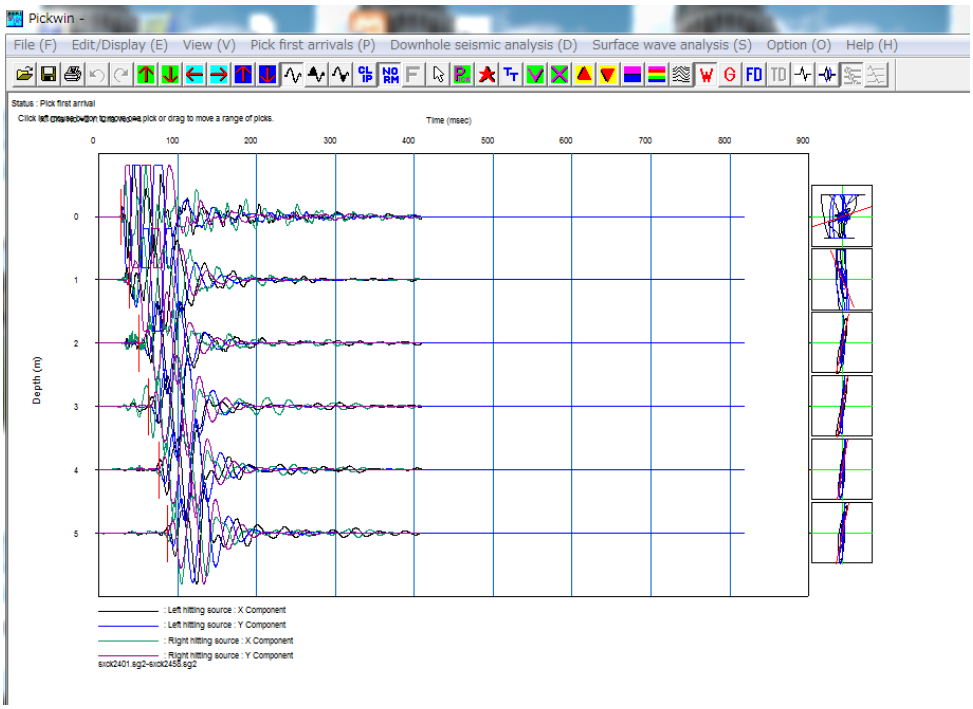
Polarization (*see 5.1.3 Downhole seismic analysis Menu: Polarization*) is automatically applied to scrolled waveform data.

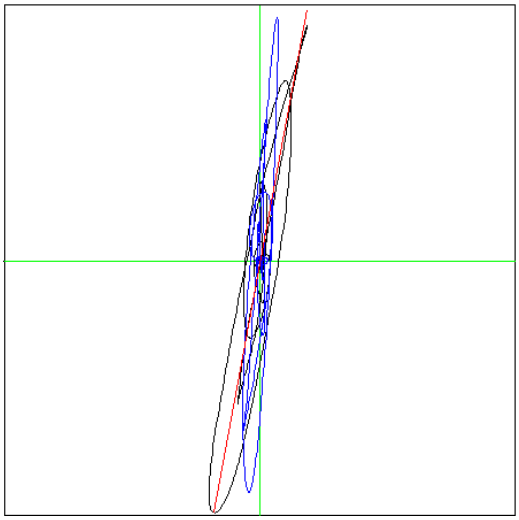
5.1.5.2 Downhole seismic analysis Menu: Automatic processing: Shift

Ideally, the first shear wave arrival times will be identical for both records. However, it is often the case that they are not – one is often shifted slightly in time. This is quite common when the shear wave source consists of a long plank of wood or other non-point source. To correct the S-waves to coincide at the same arrival times, click on *Correct S-wave* in the *Edit/Display* menu. See details in *3.2.9 Correct S-wave* in SeisImager/2D manual. When downhole seismic S-wave data with double receivers (such as seismic cone or OYO suspension) and opposite direction sources is analyzed, Correct S-wave is automatically analyzed.

5.1.6 Downhole seismic analysis Menu: Show particle motion

Particle motion is a plan view of receiver motion. When analyzing S-wave data, particle motion can be displayed at the right of waveform display. You can switch displaying particle motion or not by this menu. Example of particle motion is shown below.





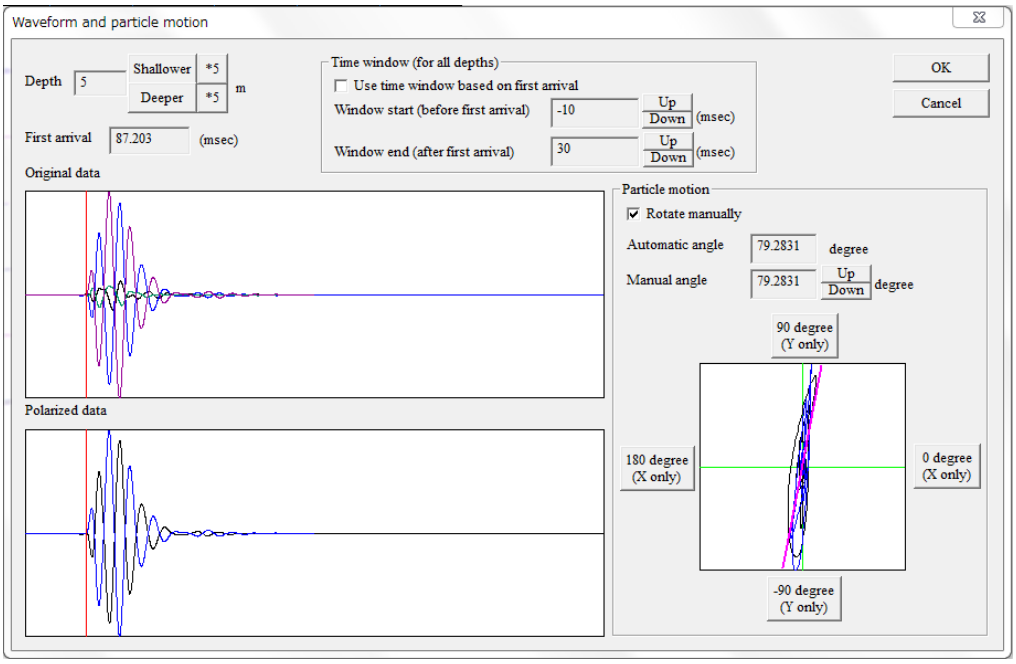
Particle motion of left hitting

Particle motion of right hitting

Direction of polarization

5.1.7 Downhole seismic analysis Menu: Show particle motion in dialog

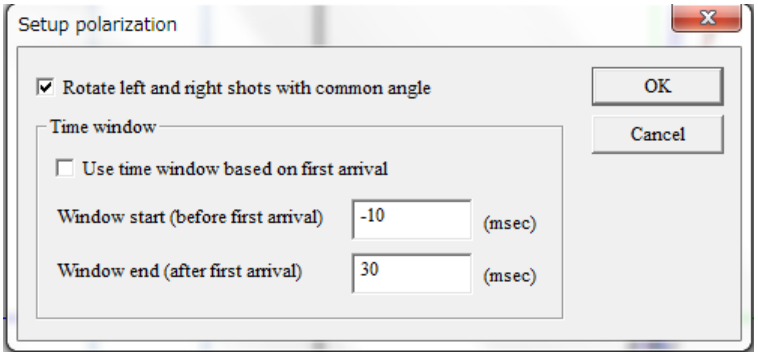
Particle motion described above can be displayed larger in separate dialog box as shown below. Rotation angle can be manually set by using this dialog box. Time window of particle motion for calculating rotation angle can be also set. Using this dialog box, detailed parameters for polarization can be manually set to each trace.



5.1.8 Downhole seismic analysis Menu: Advanced options:

5.1.8.1 Setup polarization and particle motion parameters

Detailed parameters for polarization calculation and particle motion display can be set in a dialog box shown below. This setting is applied to all traces and manual setting will changed.



1) Rotate left and right shots with common angle

When opposite direction shots are analyzed together, one rotation angle is determined from two opposite shots or two rotation angles are determined to each direction. Check this option if you use common angle for both shots.

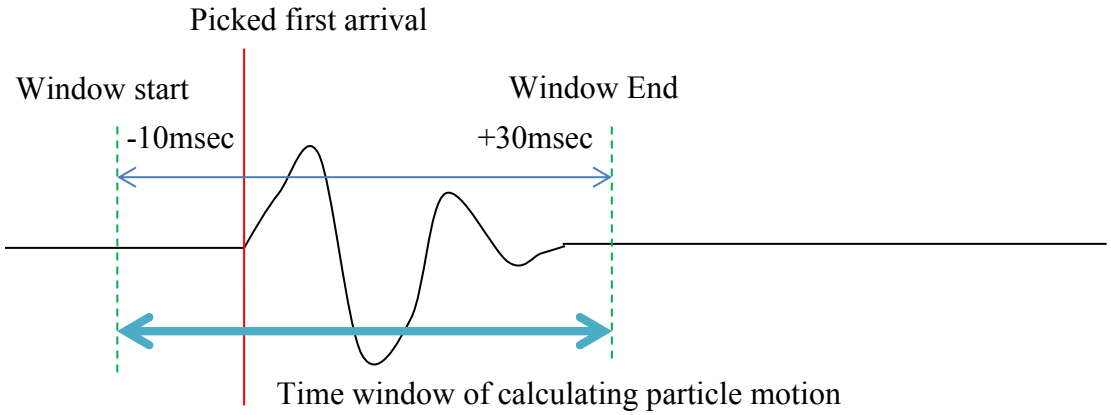
2) Time window
A) Use time window based on first arrival

Check this for applying time window to the calculation of particle motion for determining rotation angles. Time window can be set based on picked first arrival time.

B) Window start
Start of time window based on first arrival time. Negative value means before the first arrival.

C) Window end
End of time window based on first arrival time. Positive value means after the first arrival.

Start, end and first arrival time can be summarized as shown below.



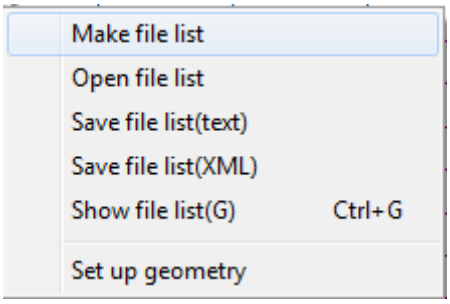
5.1.9 Downhole seismic analysis Menu: Downhole seismic analysis <launches PSLog>

Once the first arrivals are picked in Pickwin, the picks are held in memory for import to PSLog. PSLog is used for detailed editing, analysis and making figures for final report. PSLog can be opened separately and can read in XML file that contains first arrival data. But this single step is the easiest way to automatically launch PSLog and import a traveltime curve just picked in Pickwin as well as waveform traces.

To automatically launch PSLog and import the traveltime curves from Pickwin, select *Downhole seismic analysis <launches PSLog>*.

5.2 Group (File list) menu

Group (File list) menu contains functions for opening, saving and editing the file list. See SeisImager/SW manual for details.



5.2.1 Make file list

Do not use this menu for making file list for downhole seismic analysis.

5.2.2 Open file list

To open an existed file list, select *Open file list*.

5.2.3 Save file list (text)

Do not use this menu for downhole seismic analysis.

5.2.4 Save file list (XML)

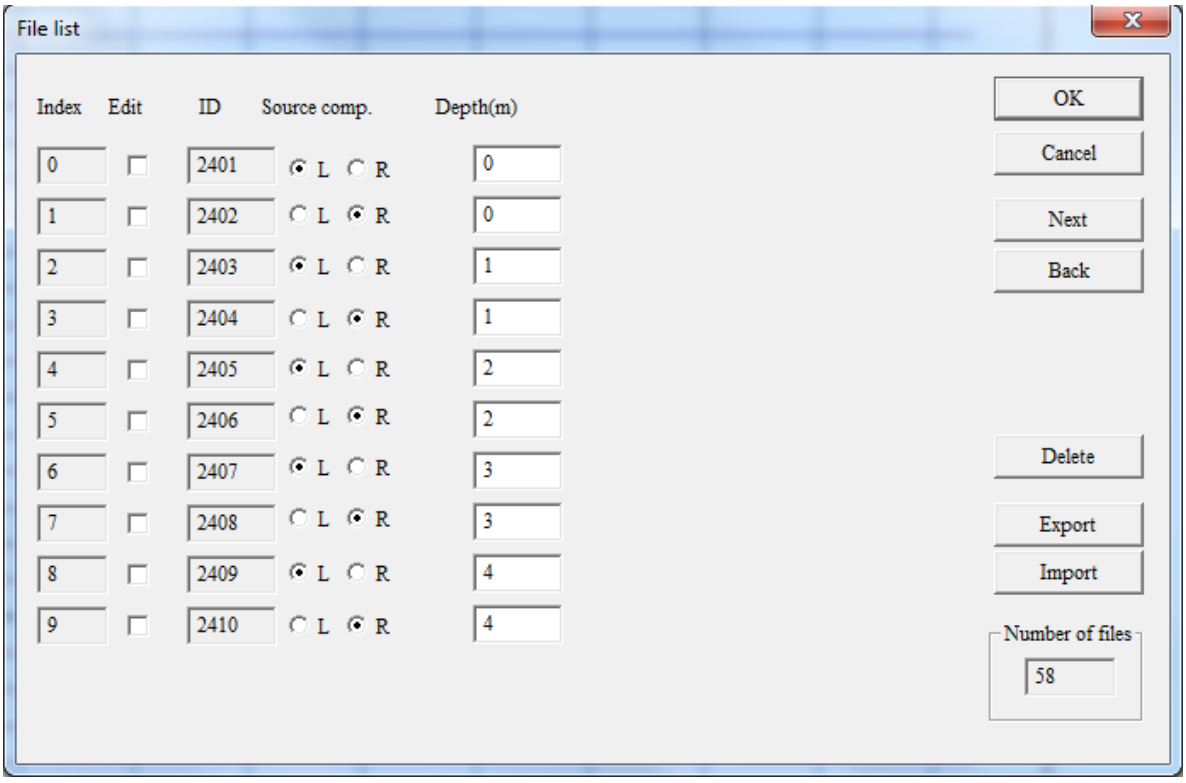
To save the current file list, select *Save file list (XML)*.

5.2.5 Show file list

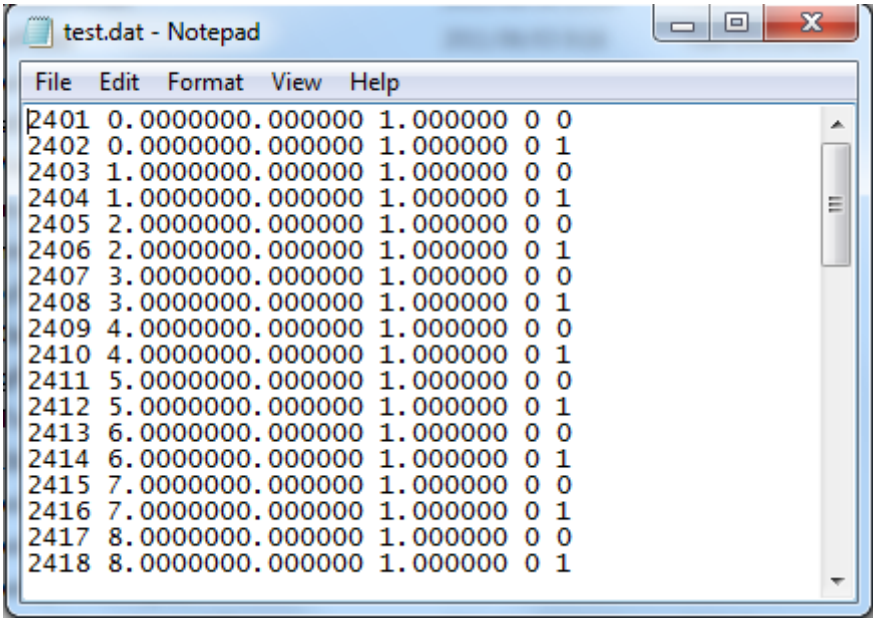
To show and edit the current file list, select *Show file list* or press the *Ctrl+G*. Source component and receiver depth can be edited.

5.2.6 Set up geometry

Do not use this menu for downhole seismic analysis.



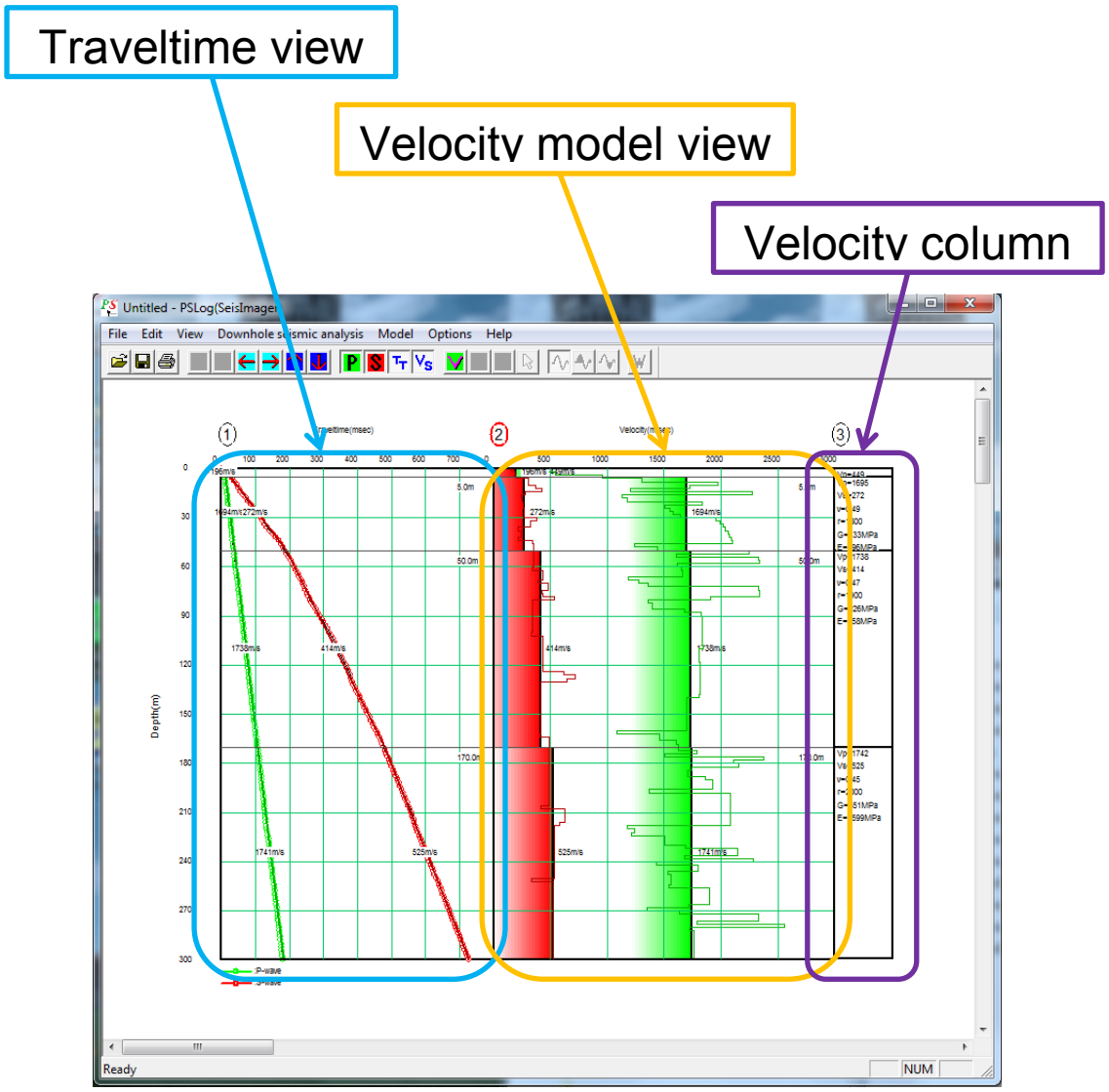
To edit the current file list manually using other software, such as Excel or Notepad, export a list to a text file by clicking the *Export* button. Edit the file using Excel or Notepad and read it again by clicking the *Import* button. Example of exported text file is shown below.



First column is ID and second column is receiver depth. You do not need to change third and fourth columns. The last column indicates source component and 0, 1 and 2 mean left, right and vertical, respectively.

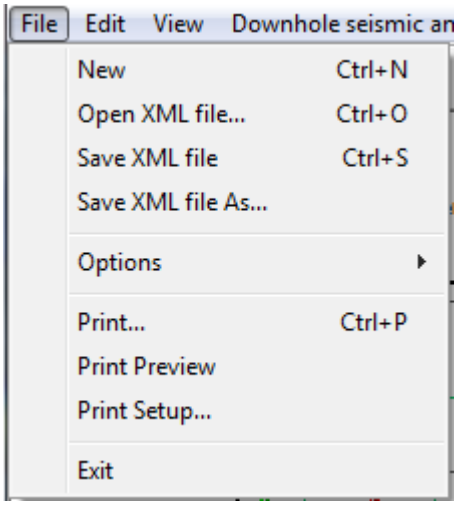
6- The PSLog module functions

PSLog calculates velocity models from first arrivals picked by Pickwin and displays traveltime curves and velocity models of downhole seismic data. Its display mainly consists of two figures, such as traveltime curves (traveltime view) and velocity models (velocity model view).



6.1 File Menu

The file menu includes functions for opening and saving PSLog result files and printing.



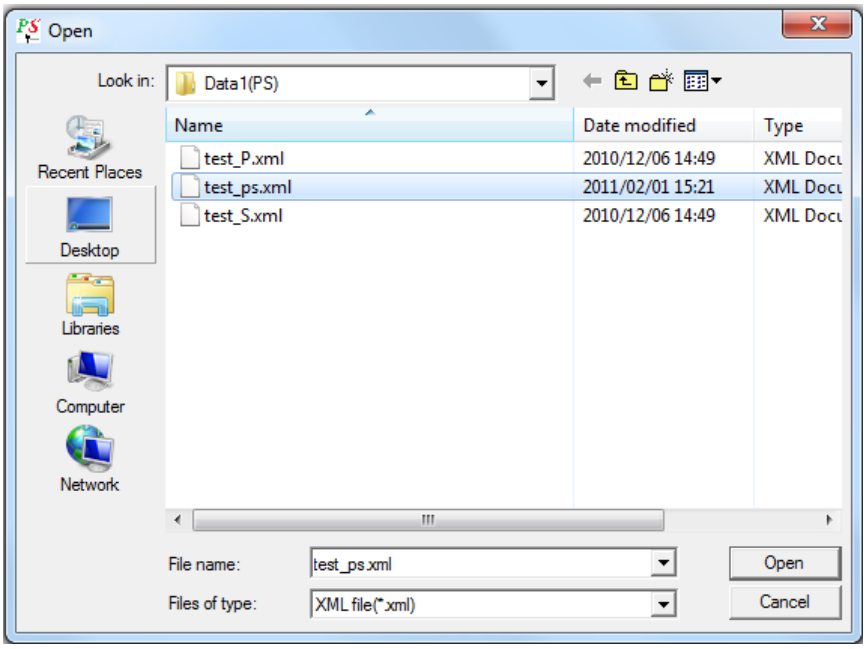
6.1.1 File Menu: New

Clear all data.

6.1.2 File Menu: Open XML file

To open an analyzed result previously saved with the extension *.xml*, select *Open XML file*.

Highlight the file and click *Open*.



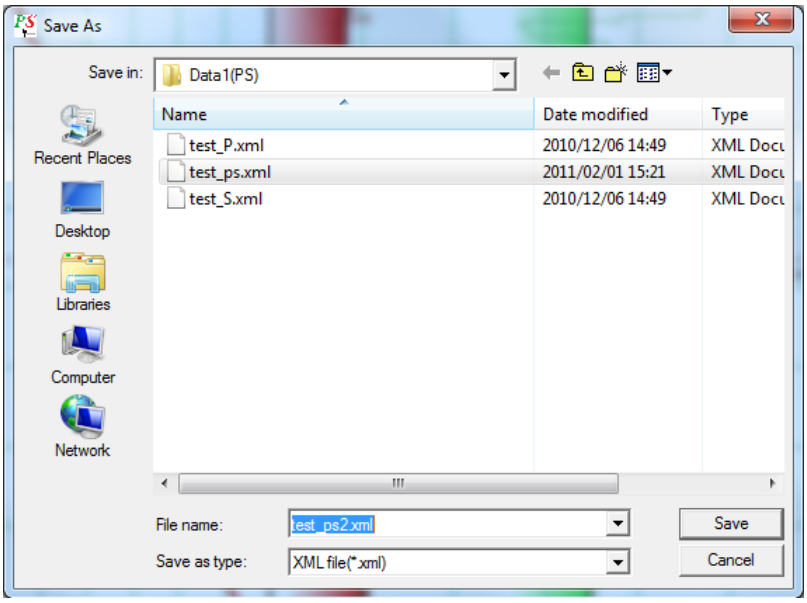
6.1.3 File Menu: Save XML file

To save a logging data into the current XML file, select *Save XML file as*. A logging data can be saved at any time in the processing flow and will reflect the extent of results at the time of save.

6.1.4 File Menu: Save XML file as

To save a logging data into a new XML file, select *Save XML file as*. A logging data can be saved at any time in the processing flow and will reflect the extent of results at the time of save.

Assign file name with the extension *.xml* and click *Save*.

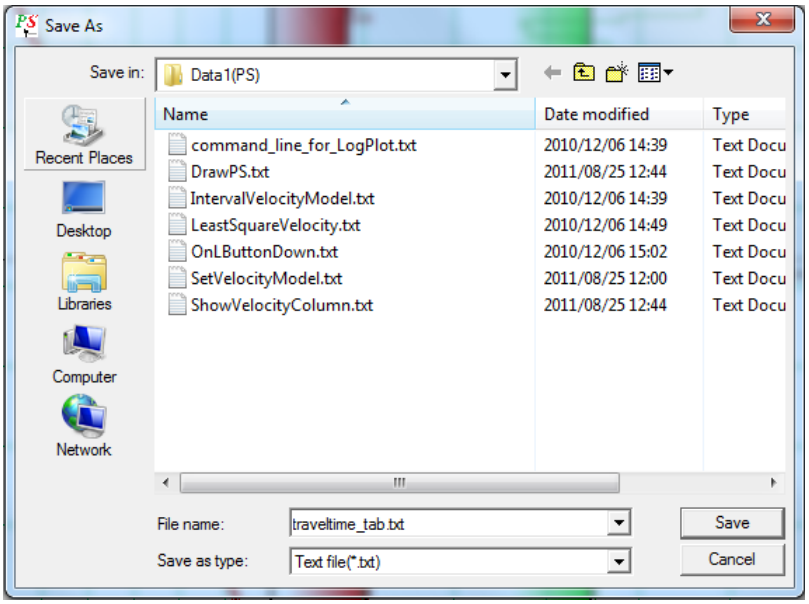


6.1.5 File Menu: Options

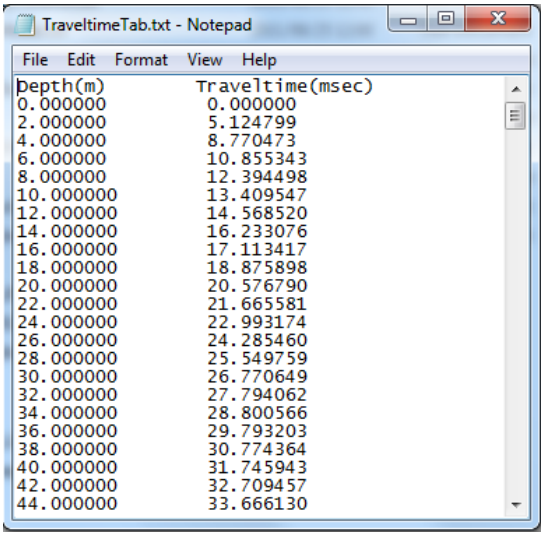
6.1.5.1 File Menu: Options: Save traveltimes in tabular form (*.txt)

To save the final traveltime curve of a logging data in tabular form, select *Save traveltimes in tabular form (*.txt)*.

Assign a file name with the extension *.txt* and click *Save*.



The file is simple text file with Depth and Traveltime.

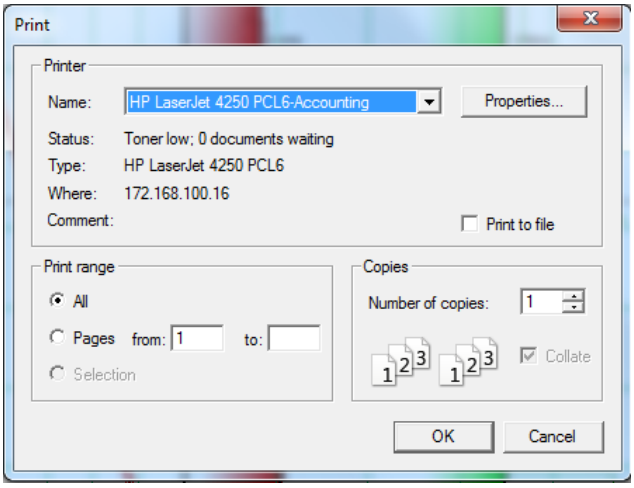


6.1.5.2 File Menu: Options: Japanese standard format (MLTI)

This function is under development and cannot be used right now.

6.1.6 File Menu: Print

To print the current PSLog display, choose *Print,* press Ctrl+P or click the button.



6.1.7 File Menu: Print preview

To display the print image, choose *Print preview*.

6.1.8 File Menu: Print Setup

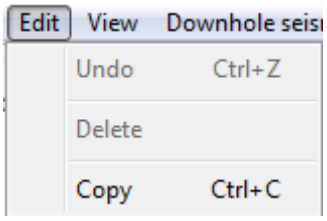
To set up printing parameters, choose *Print setup*.

6.1.9 File Menu: Exit

To close PSLog, choose *Exit*.

6.2 Edit Menu

The Edit menu contains a function for copying graphical displays to the clipboard.



6.2.1 Edit Menu: Undo

This function is under development and cannot be used right now.

6.2.2 Edit Menu: Delete

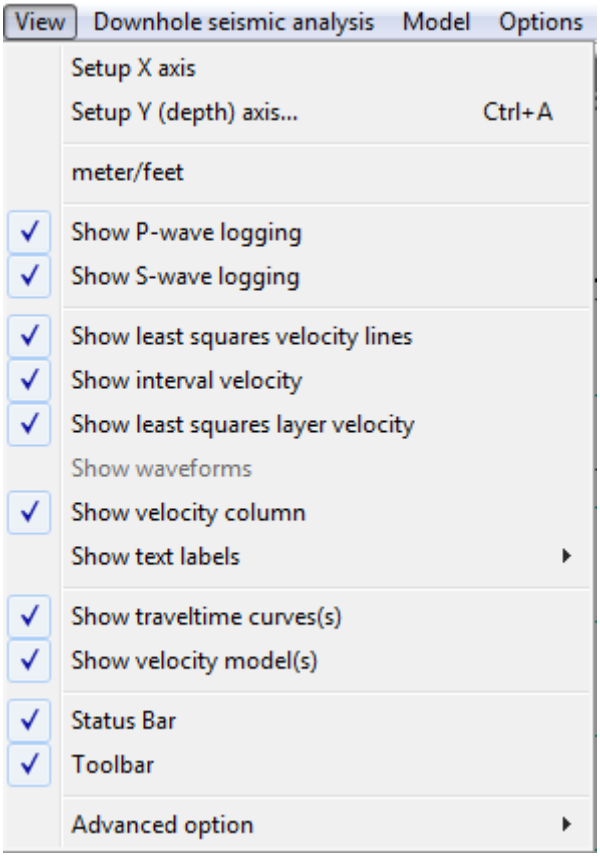
This function is under development and cannot be used right now.

6.2.3 Edit Menu: Copy

To copy the current display to the clipboard for pasting Word or other program, select *Copy* or press Ctrl+C.

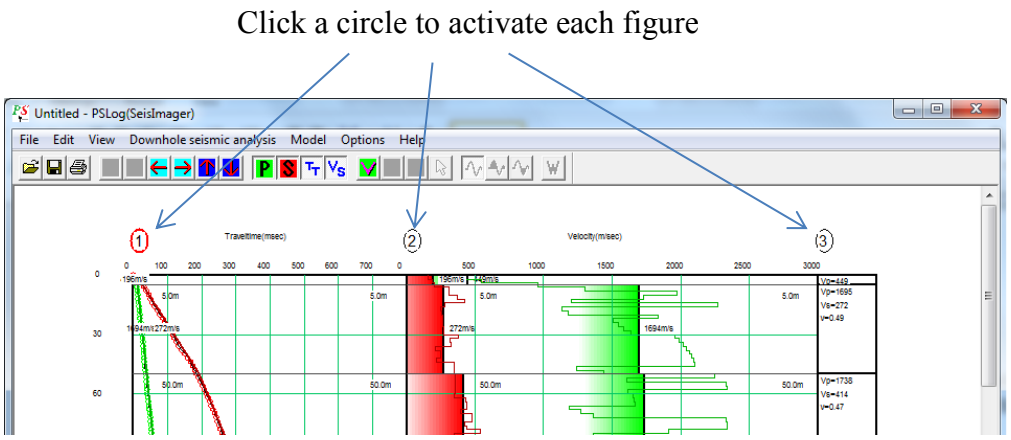
6.3 View Menu

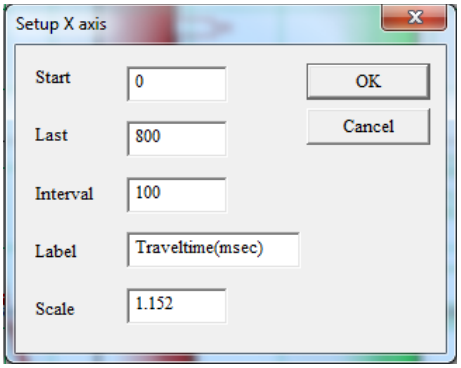
The *View* menu includes functions to configure scales, select contents to be displayed and alter display.



6.3.1 View Menu: Setup X axis

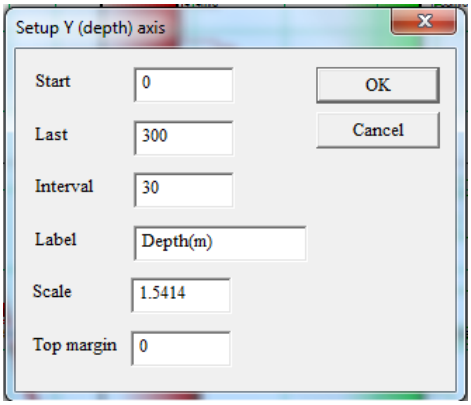
To configure X (horizontal) axis scales on a traveltime curve and velocity model, choose a figure whose axis is changed by clicking circle and index number at the left top of figures firstly. Then select *Setup X axis*.





6.3.2 View Menu: Setup Y (depth) axis

To configure Y (depth) axis scale, select *Setup Y (depth) axis*. An identical scale setting is applied to all figures.

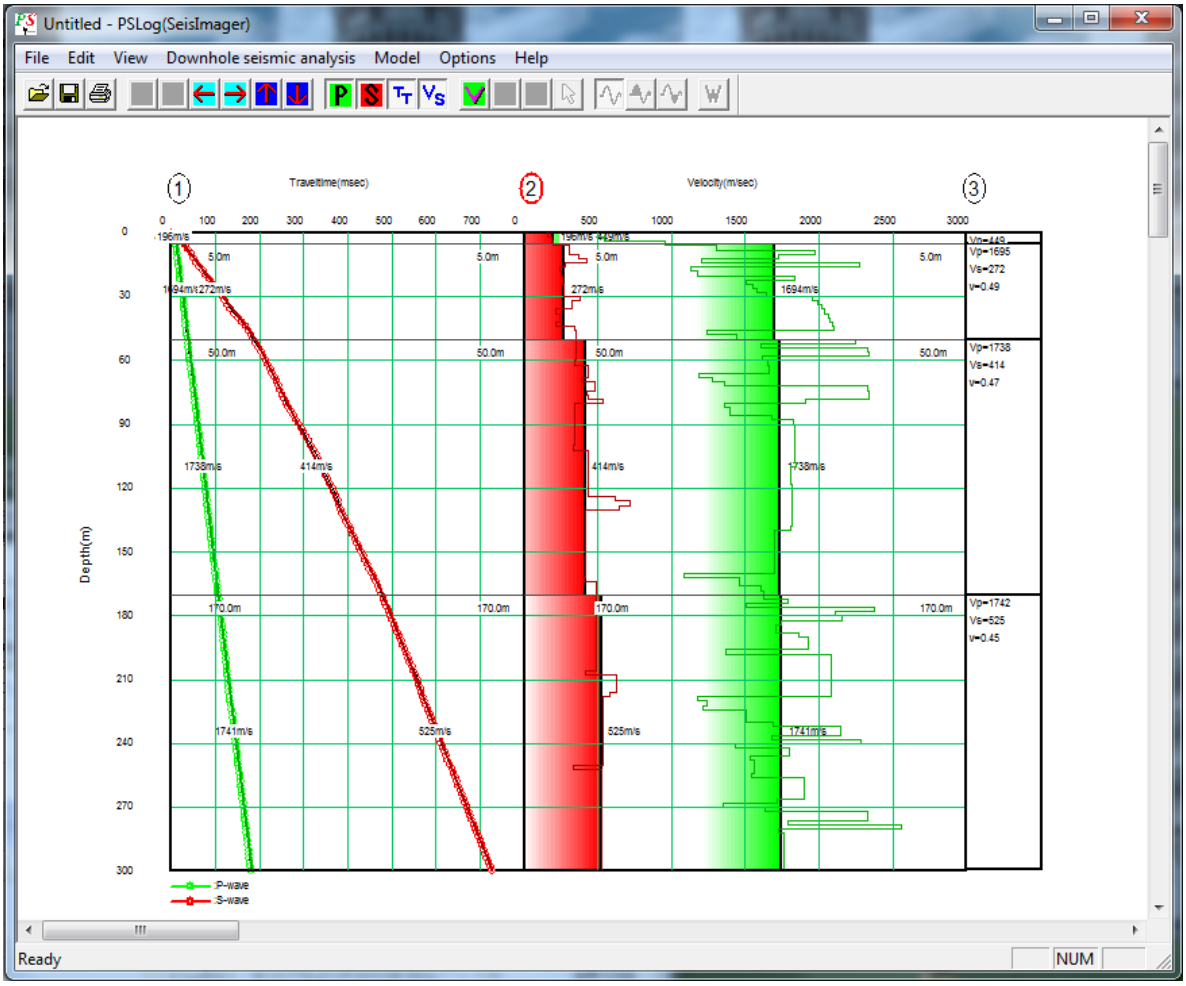


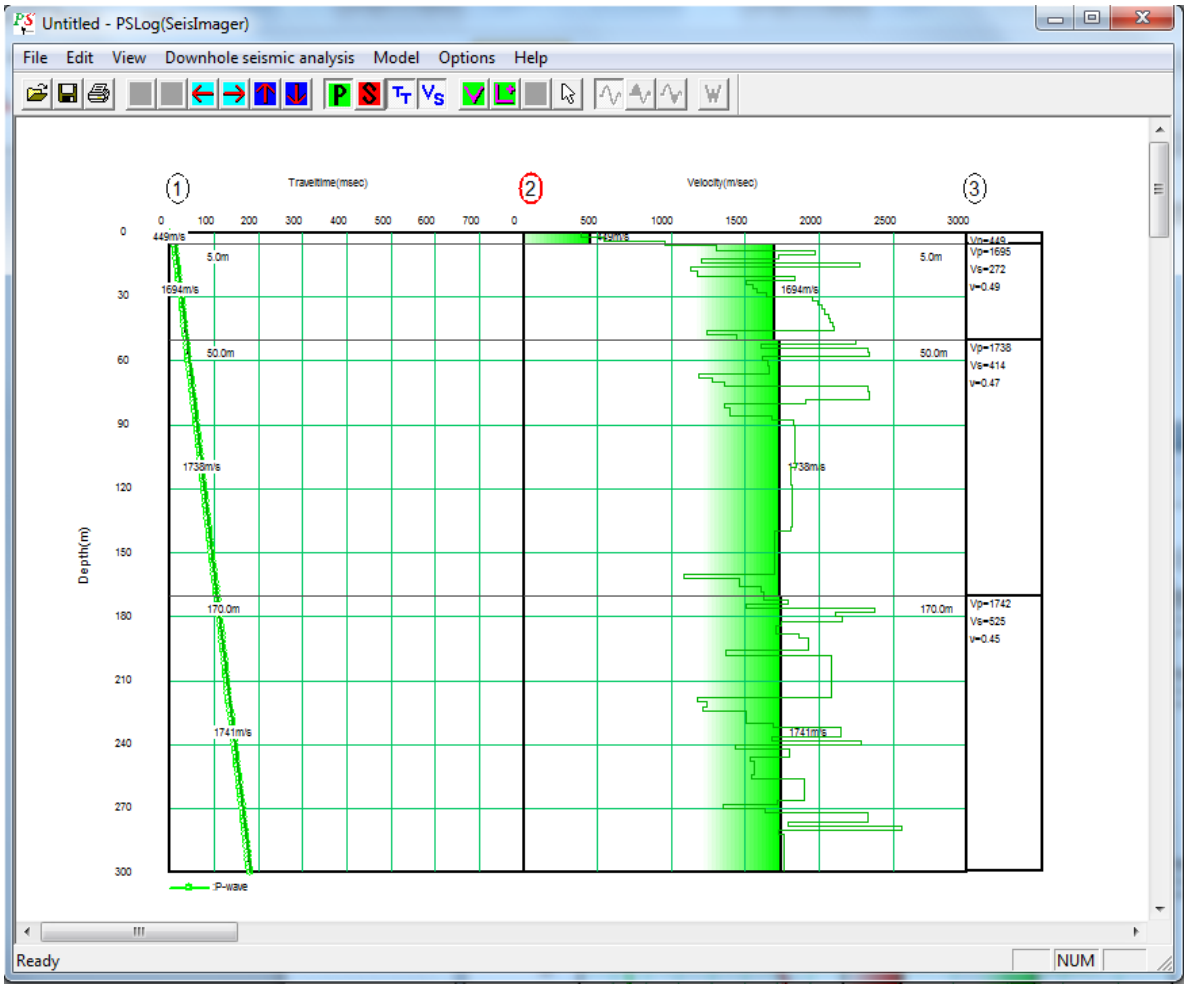
6.3.3 View Menu: meter/feet

Select the desired unit labels by switching *meter/feet*. The setting is reflected in the display labels, dialog box labels, and default values where applicable.

6.3.4 View Menu: Show P-wave logging P

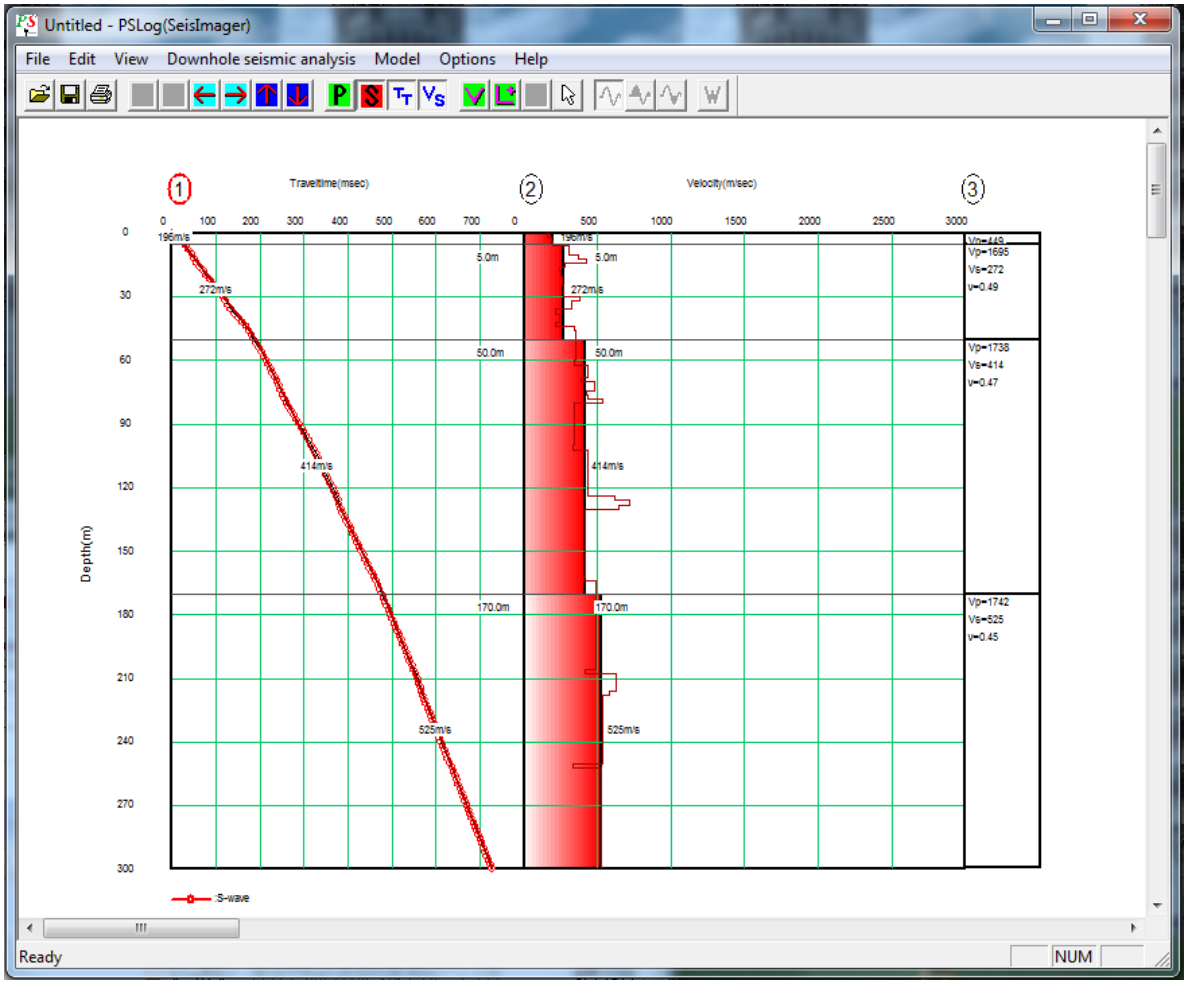
You can select which logging to be shown by switching *P-wave logging* and *S-wave logging* or the P and S buttons. To display P-wave logging data, check *P-wave logging* or push the P button. Examples of P- and S-wave logging display and P-wave logging display are shown below.




Untitled - PSLog(SeisImager)
File Edit View Downhole seismic analysis Model Options Help
Traveltime(msec)
Velocity(m/sec)
Depth(m)
449m/s
5.0m
1694m/s
50.0m
1738m/s
170.0m
1741m/s
Vp=1695
Vs=272
v=0.49
Vp=1738
Vs=414
v=0.47
Vp=1742
Vs=525
v=0.45
P-wave
Ready
NUM

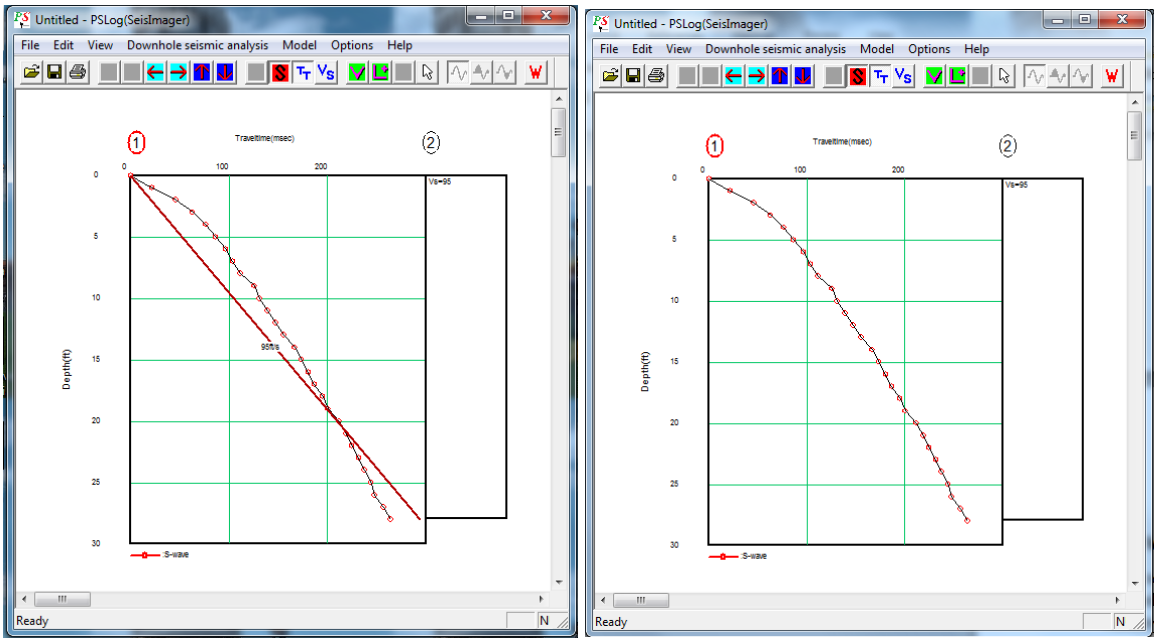
6.3.5 View Menu: Show S-wave logging

To display S-wave logging data, check *S-wave logging* or push the button. Example of S-wave logging display is shown below.



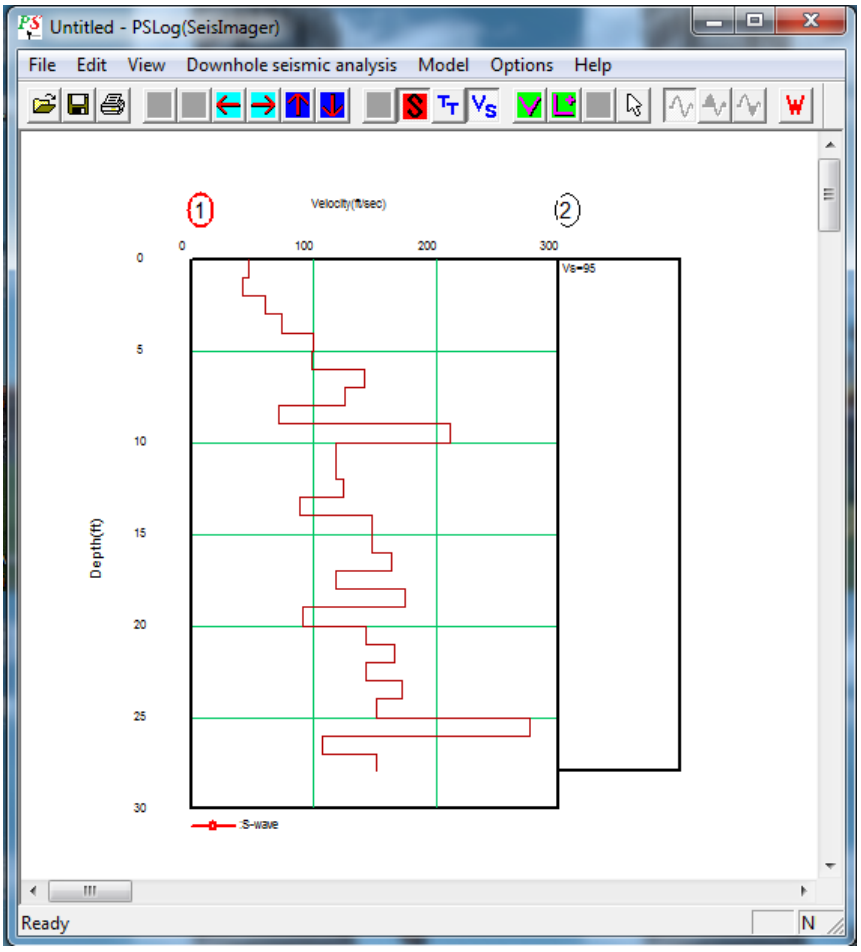
6.3.6 View Menu: Show least squares velocity lines

Least squares velocity lines are linear velocity lines that indicate a velocity of each layer. The velocity of each layer is calculated by a least square method. Selecting *Show least squares velocity lines* will display or hide linear velocity lines.



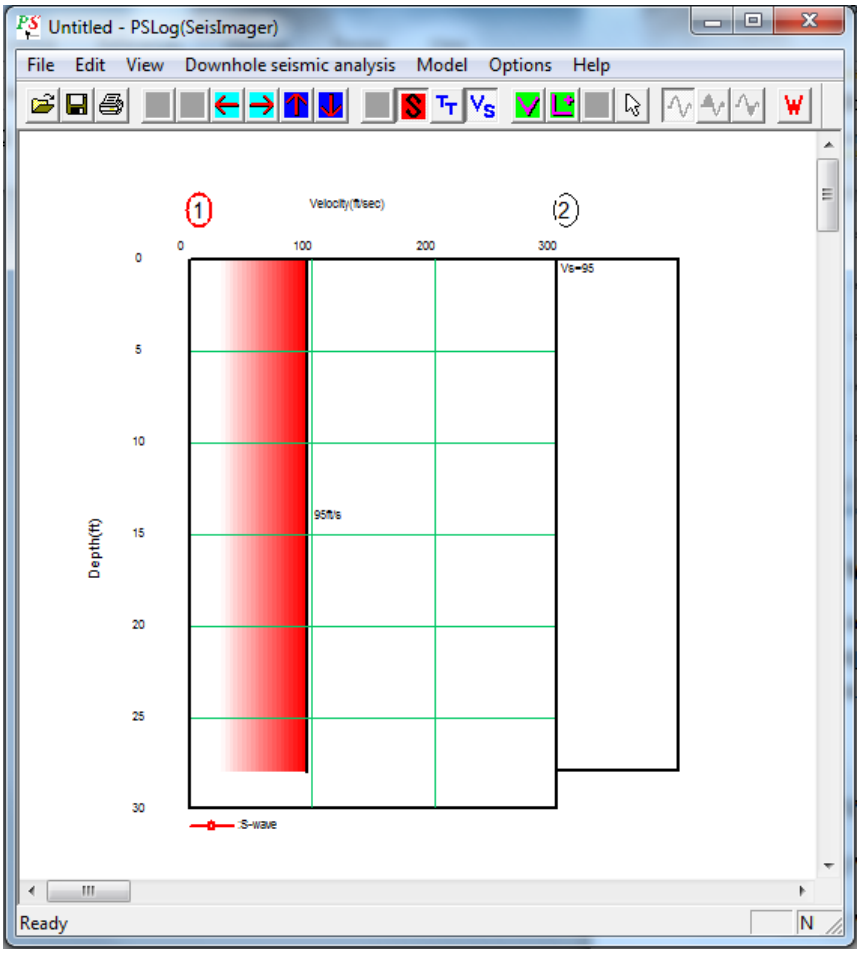
6.3.7 View Menu: Show interval velocity

Interval velocity means velocities calculated from each couple of traveltimes and they are shown as polylines on a velocity model view. Selecting *Show interval velocity* will display or hide interval velocity.



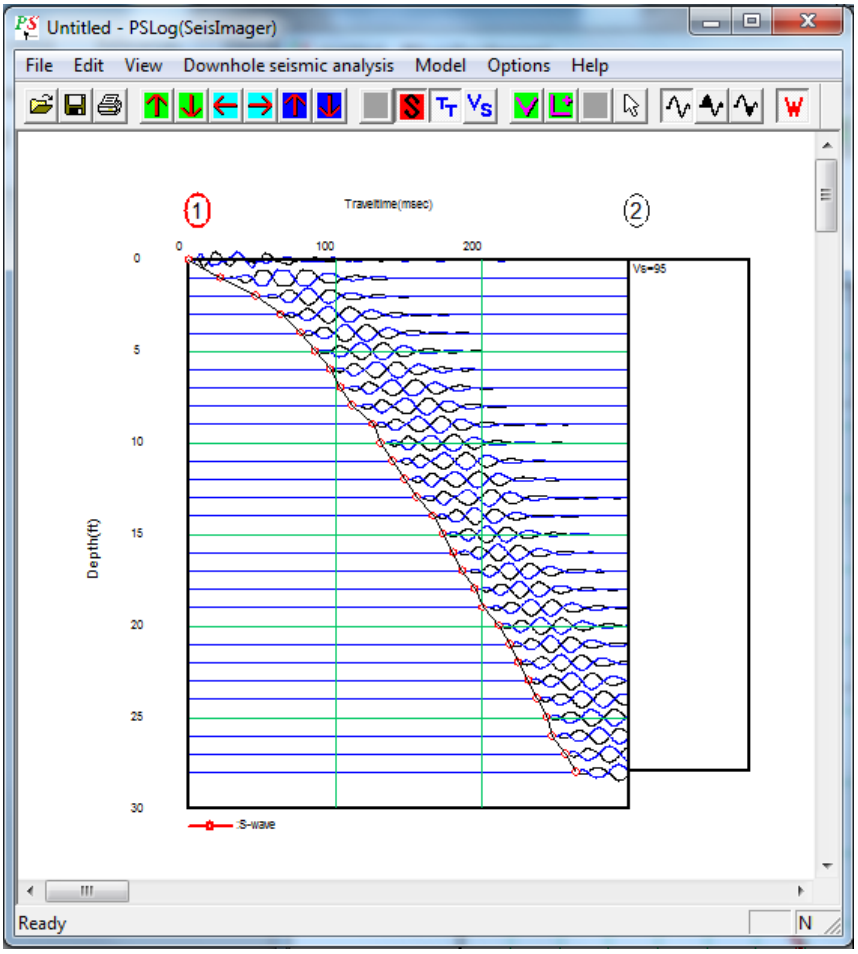
6.3.8 View Menu: Show least squares layer velocity

Least square layer velocity is a velocity of each layer calculated from traveltime curve by a least squares method. It is shown as a vertical line with color shading. Selecting *Show interval velocity* will display or hide interval velocity.



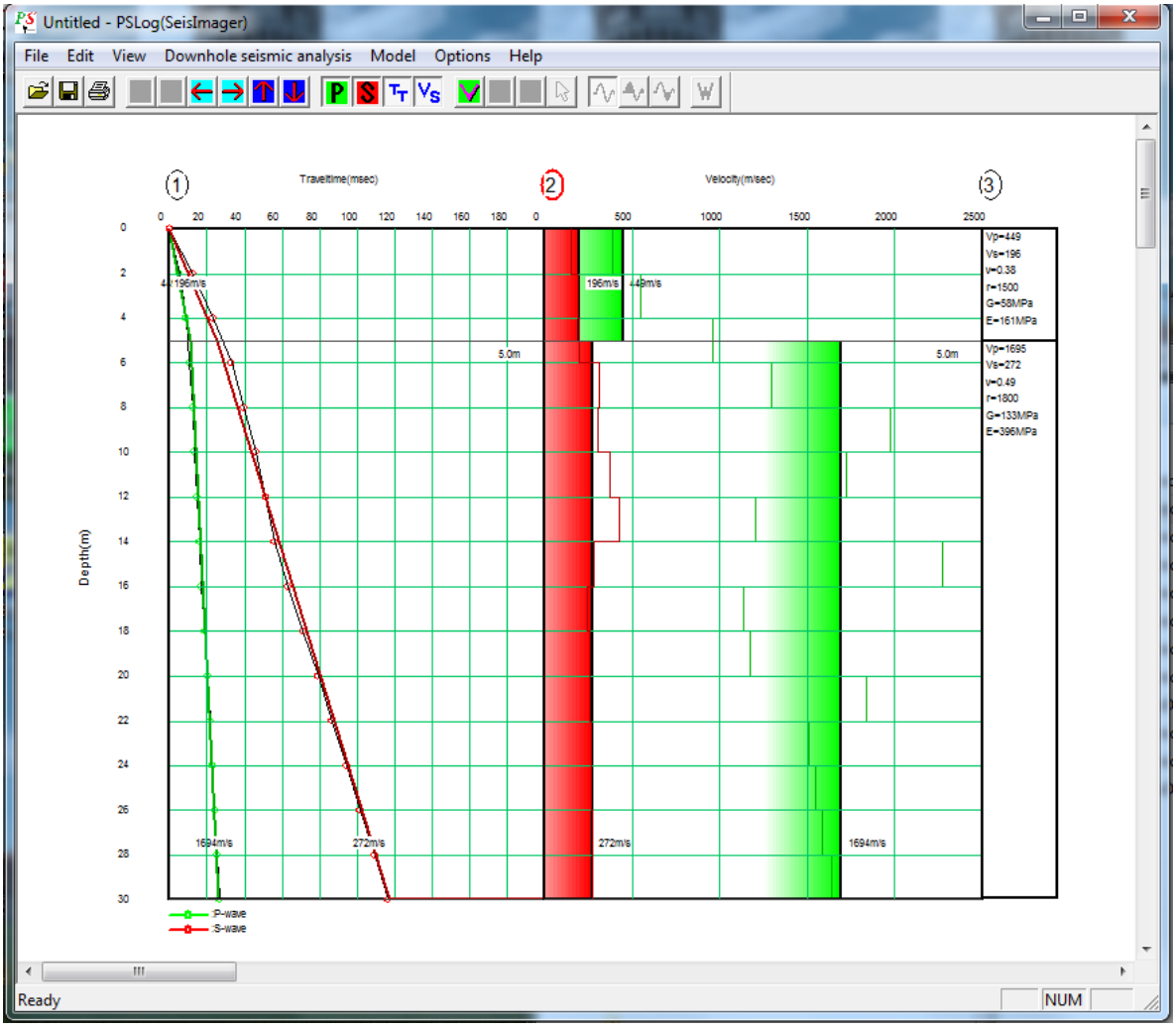
6.3.9 View Menu: Show waveforms

If a logging data includes waveform data, it can be shown on traveltime view. Selecting *Show waveforms* or clicking the button will display or hide waveform data. Waveform data can be imported in PSLog from Pickwin when you launch PSLog from Pickwin by selecting *Downhole seismic analysis <launch PSLog>* in *Downhole seismic analysis* menu. Imported waveforms cannot be edited in PSLog.



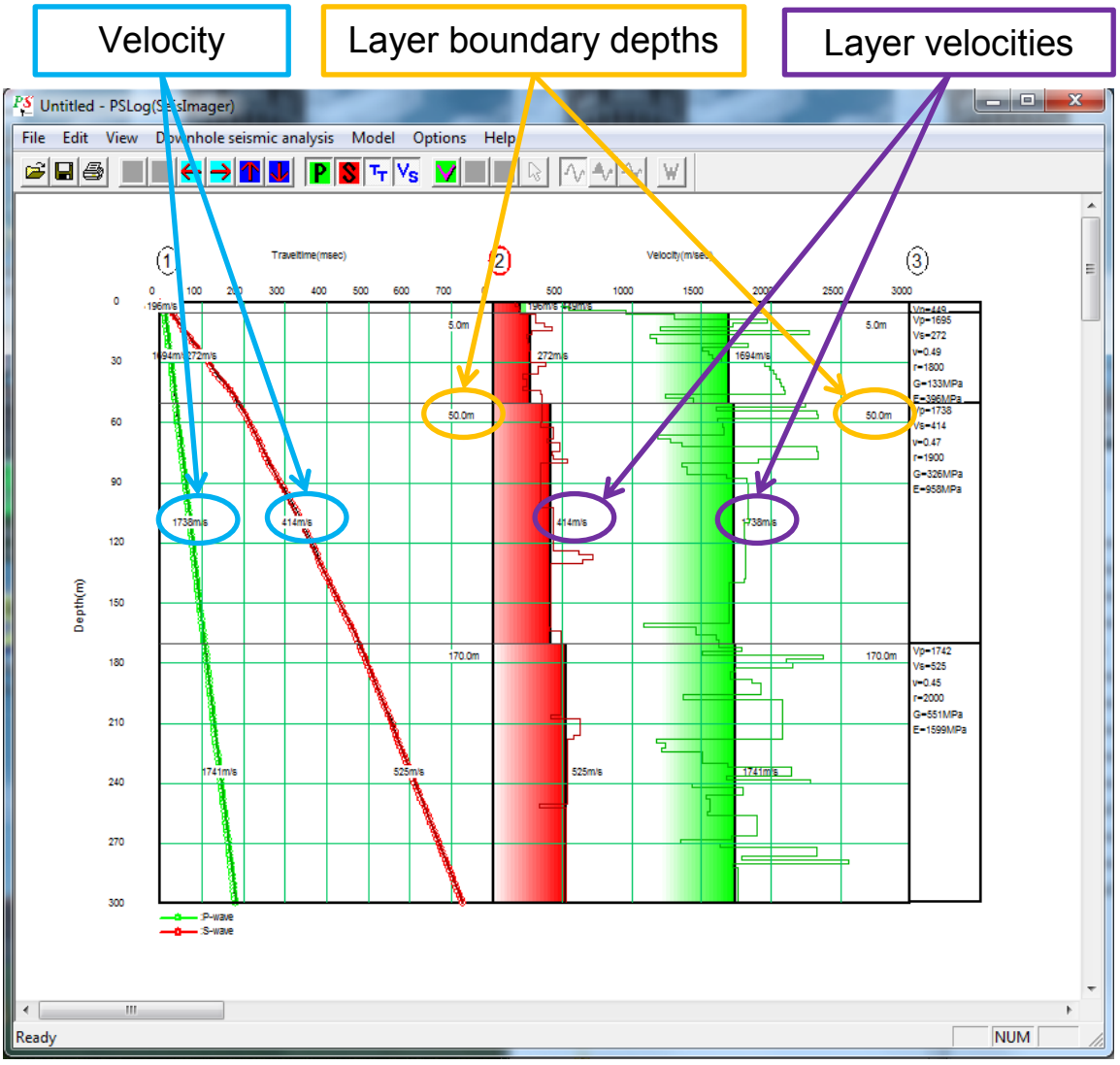
6.3.10 View Menu: Show velocity column

Velocity column is a right end column in which velocities, poisons ratio, density and elastic moduli (Share modulus (G) and Young's modulus (E)) can be shown. Selecting *Show velocity column* will display or hide a velocity column. In order to display elastic moduli, densities of layers must be set *by Show layered model* in *Model* menu (see Section 6.5.1).



6.3.11 View Menu: Show text labels

Text labels are texts showing velocities or depths on traveltime view or velocity model view.



6.3.11.1 View Menu: Show text labels: Velocity lines

Selecting *Velocity lines* will display or hide text labels of velocity lines.

6.3.11.2 View Menu: Show text labels: Layer velocities

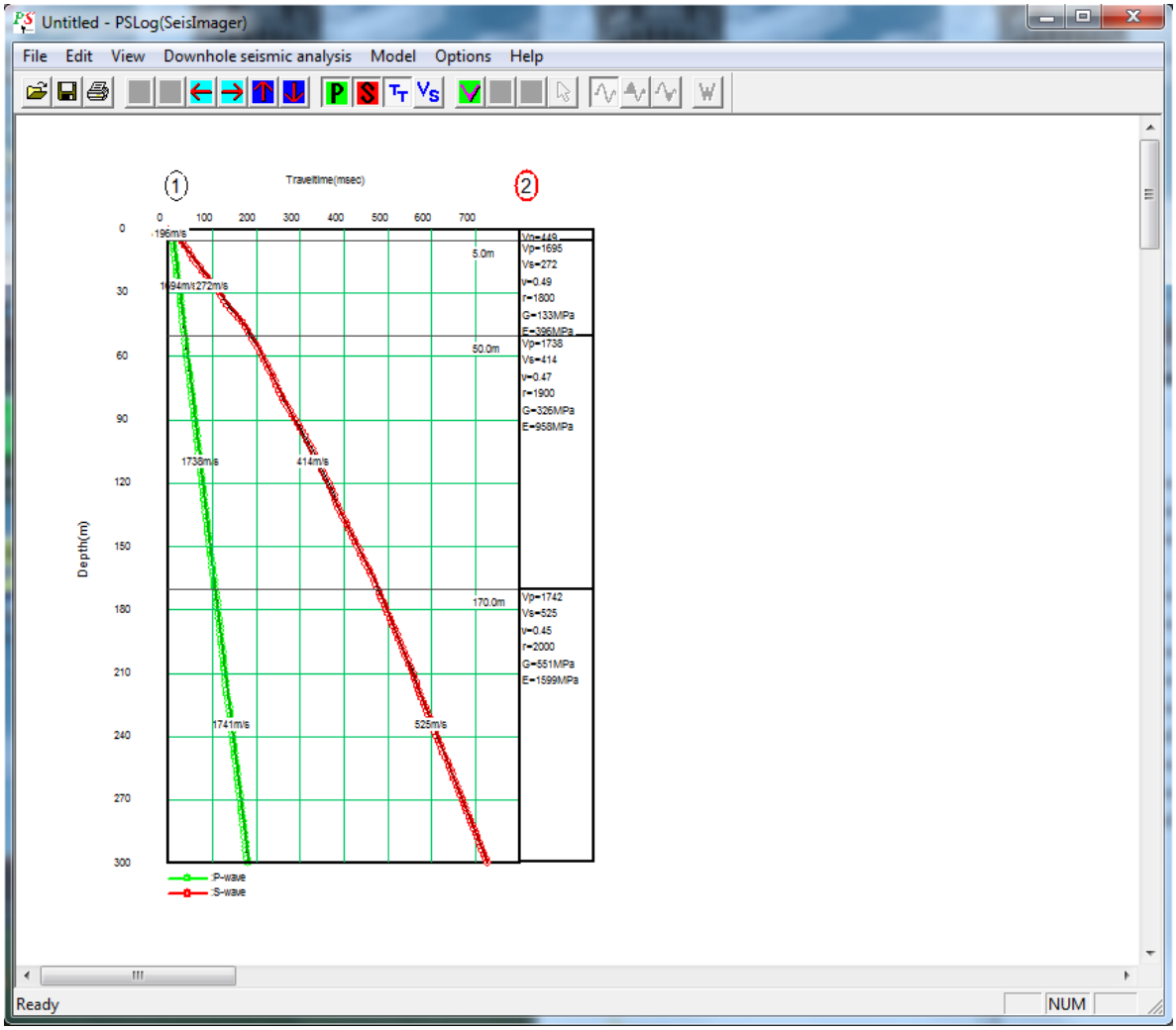
Selecting *Layer Velocities* will display or hide text labels of layer velocities.

6.3.11.3 View Menu: Show text labels: Layer boundary depths

Selecting *Layer boundary depths* will display or hide text labels of layer boundary.

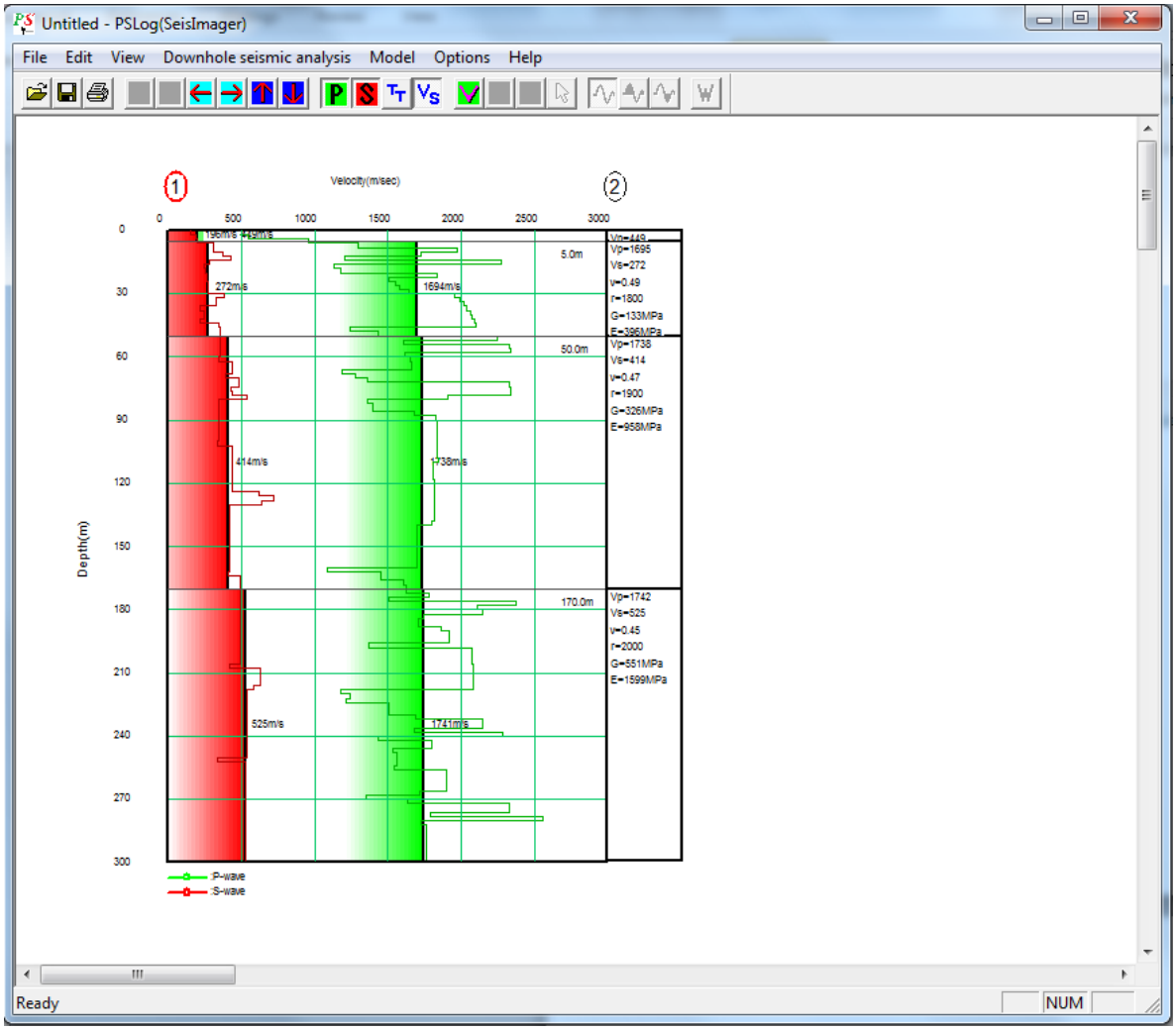
6.3.12 View Menu: Show traveltime curve (s)

Selecting *Show traveltime curve (s)* or clicking the button will display or hide traveltime view.



6.3.13 View Menu: Show velocity model (s)

Selecting *Show traveltime curve (s)* or clicking the button will display or hide velocity model view.



6.3.14 View Menu: Status bar

Selecting *Status bar* will hide or display Status bar.

6.3.15 View Menu: Toolbar

Selecting *Tool bar* will hide or display Tool bar.

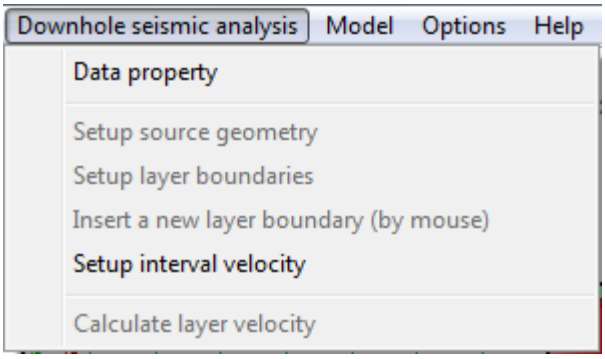
6.3.16 View Menu: Advanced options

6.3.16.1 View Menu: Advanced options: Reset text positions

At first, text label position is automatically assigned. Text label positions can be changed manually by a mouse. Selecting *Rest text positions* will re-assign all text positions automatically.

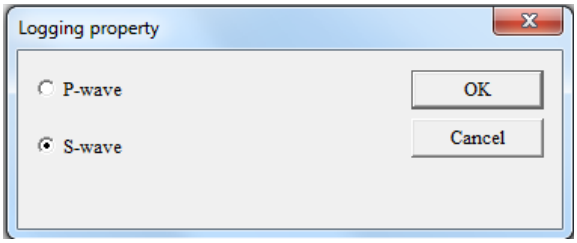
6.4 Downhole seismic analysis Menu

The *Downhole seismic analysis* menu includes functions for analyzing traveltime data.



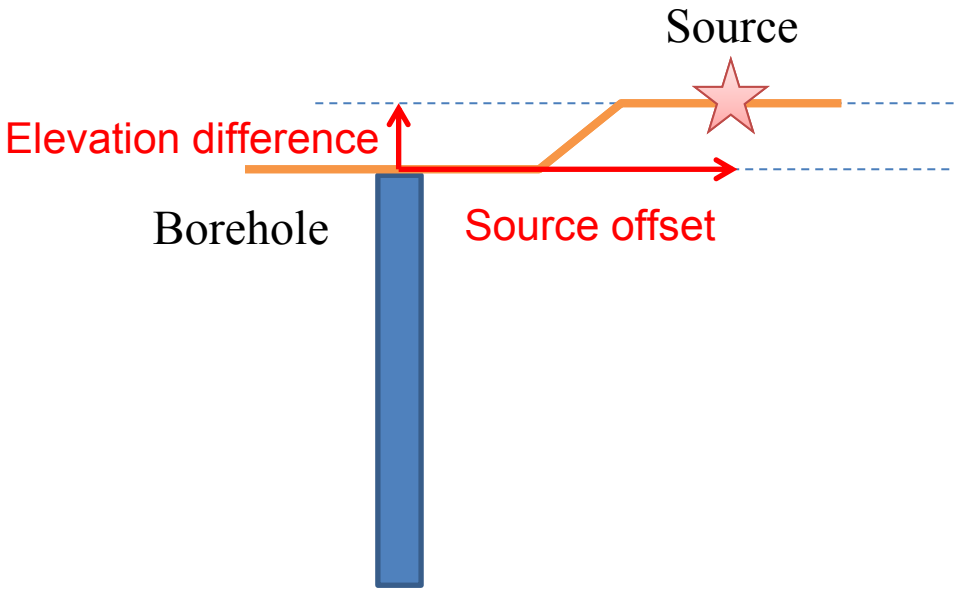
6.4.1 Downhole seismic analysis Menu: Data property

A logging data was assigned either P- or S-wave data when it is imported from Pickwin. To switch P- or S-wave, select *Data property*.

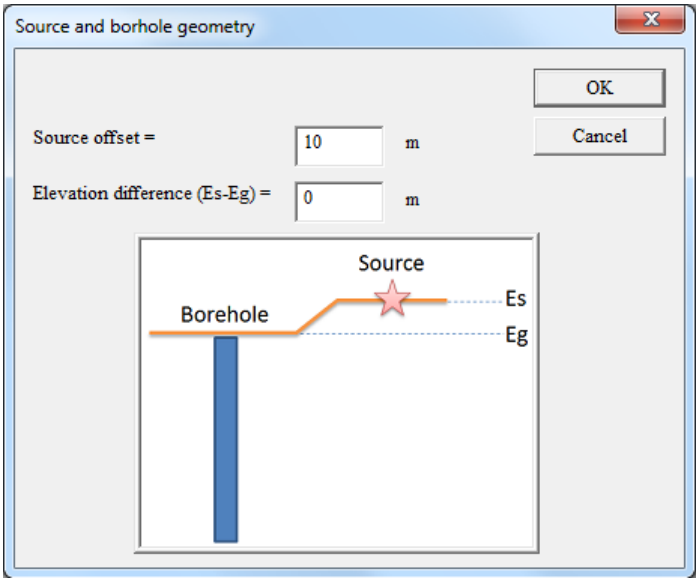


6.4.2 Downhole seismic analysis Menu: Setup source geometry

Source geometry means relative distance from a top of borehole to source. Distance can be set as vertical and horizontal distance as shown below. Source offset can be positive or negative value. Sign of horizontal distance has no meaning. Make sure correct sign must be assigned to elevation difference as shown below. Elevation difference must be positive if source is higher than top of borehole.

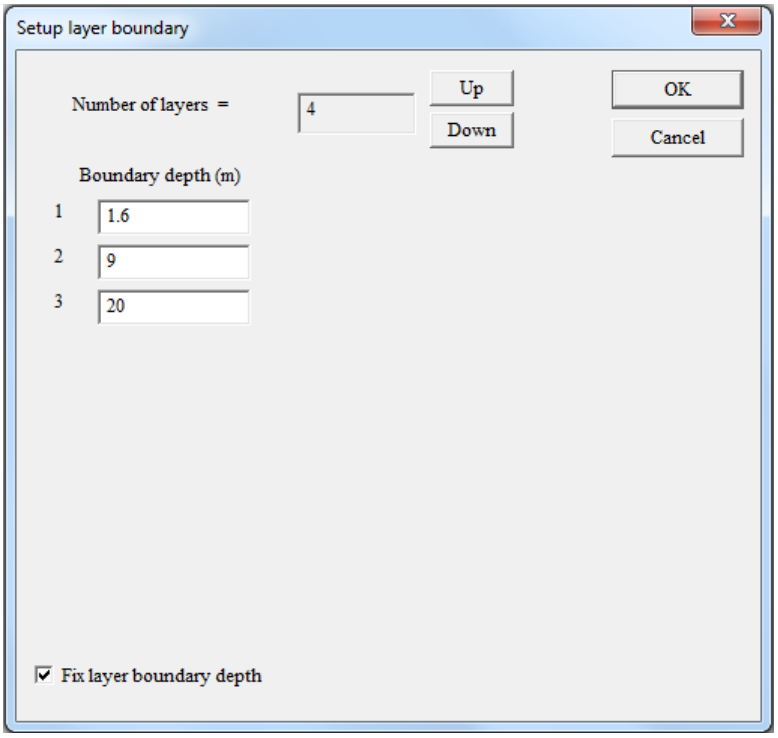


Source geometry must be set when logging data is imported from Pickwin. To see or change source geometry, select *Setup source geometry*.



6.4.3 Downhole seismic analysis Menu: Setup layer boundaries

To set up layer boundary, select *Setup layer boundary*. A velocity of each layer is automatically calculated from traveltime by a least squares method.



1) Number of layers

Number of layers can be set between from 1 to 20.

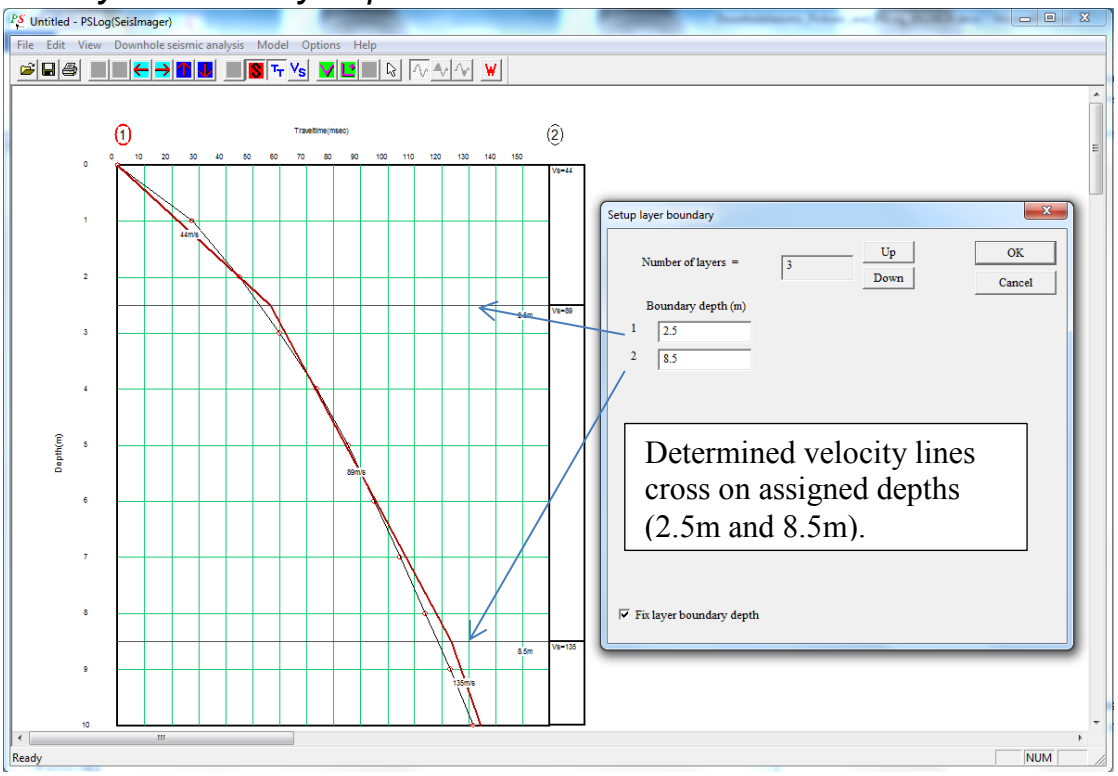
2) Boundary depth

Boundary depths must be ordered from shallow to deep.

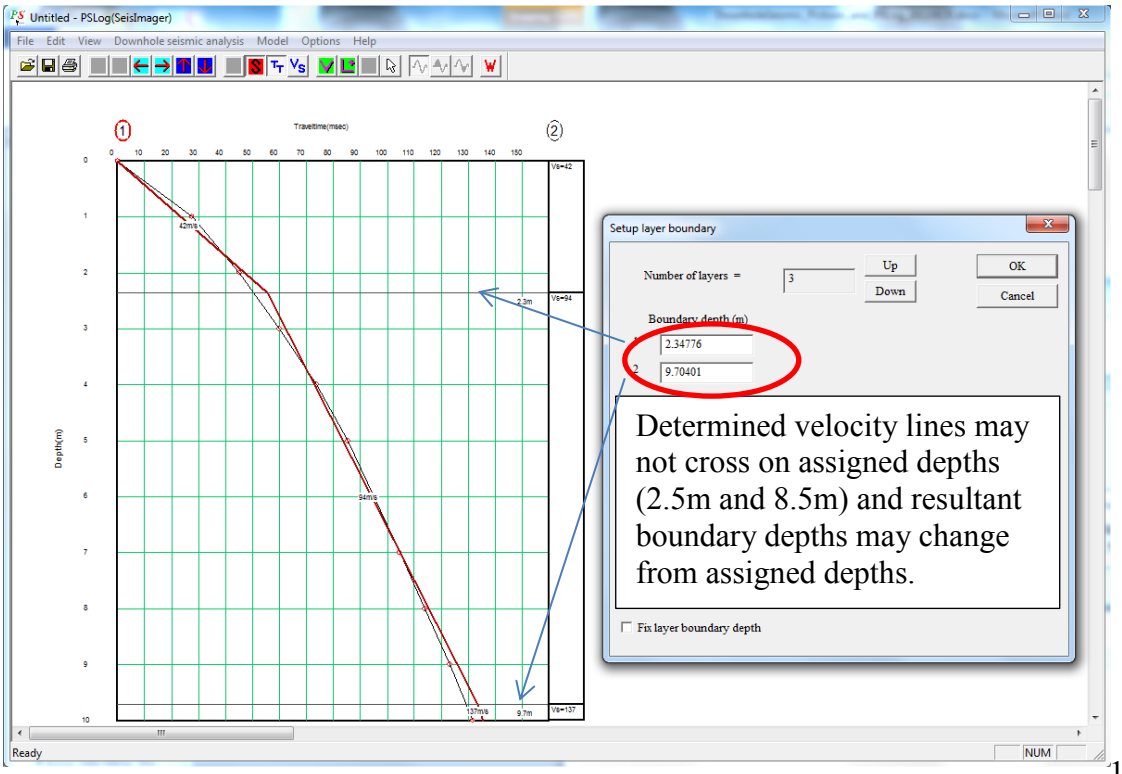
3) Fix layer boundary depth

When this option is checked, velocity lines obtained by a least squares method cross exactly on the assigned depth. Otherwise, velocity lines may not cross on the assigned depth.

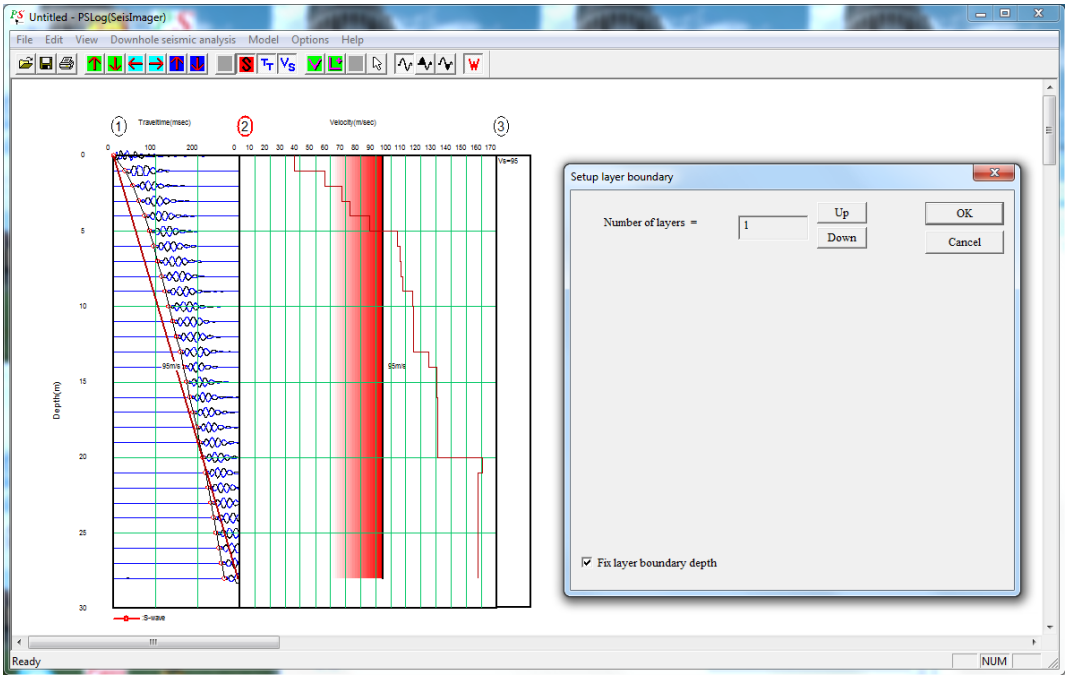
Fix layer boundary depth is On



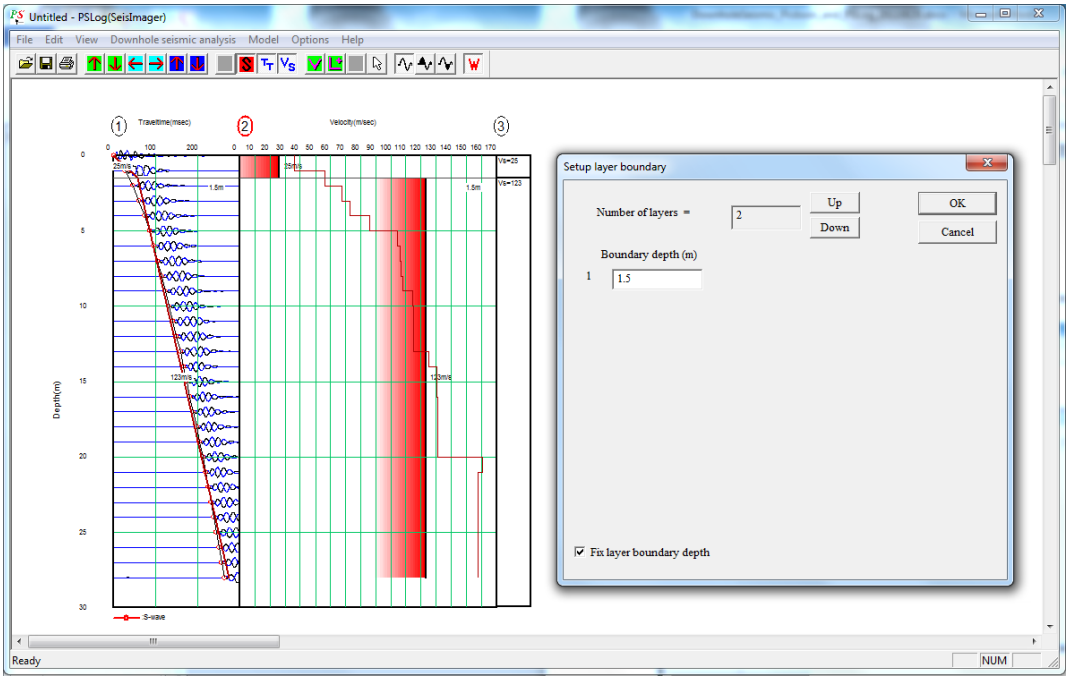
Fix layer boundary depth is Off



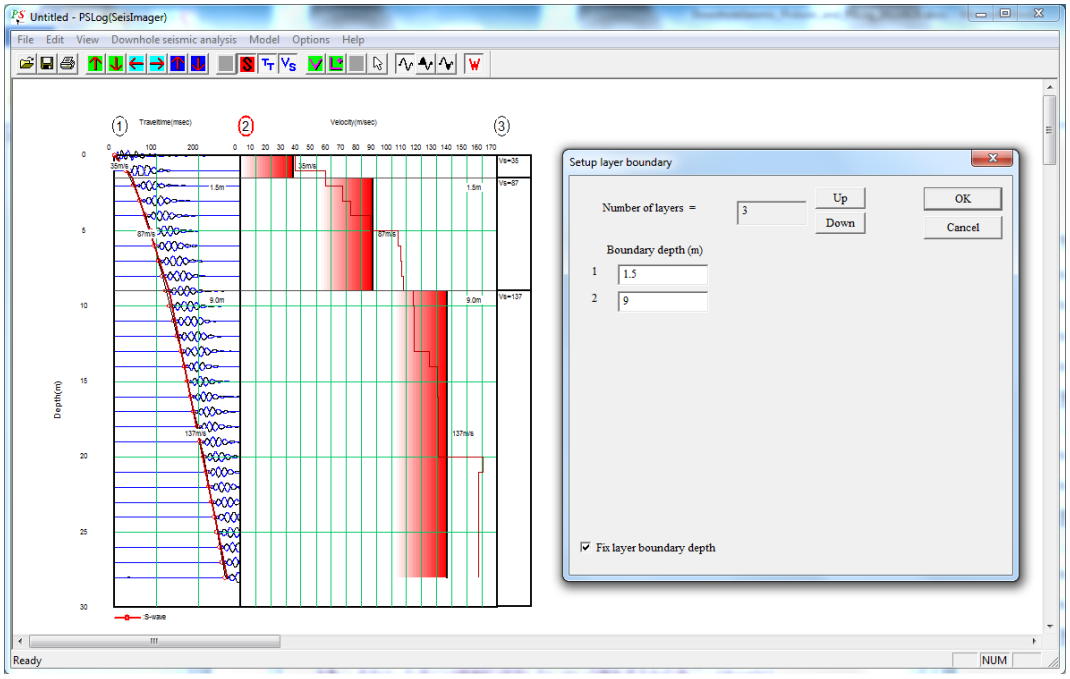
When traveltime data is imported from Pickwin, number of layer is set to 1.



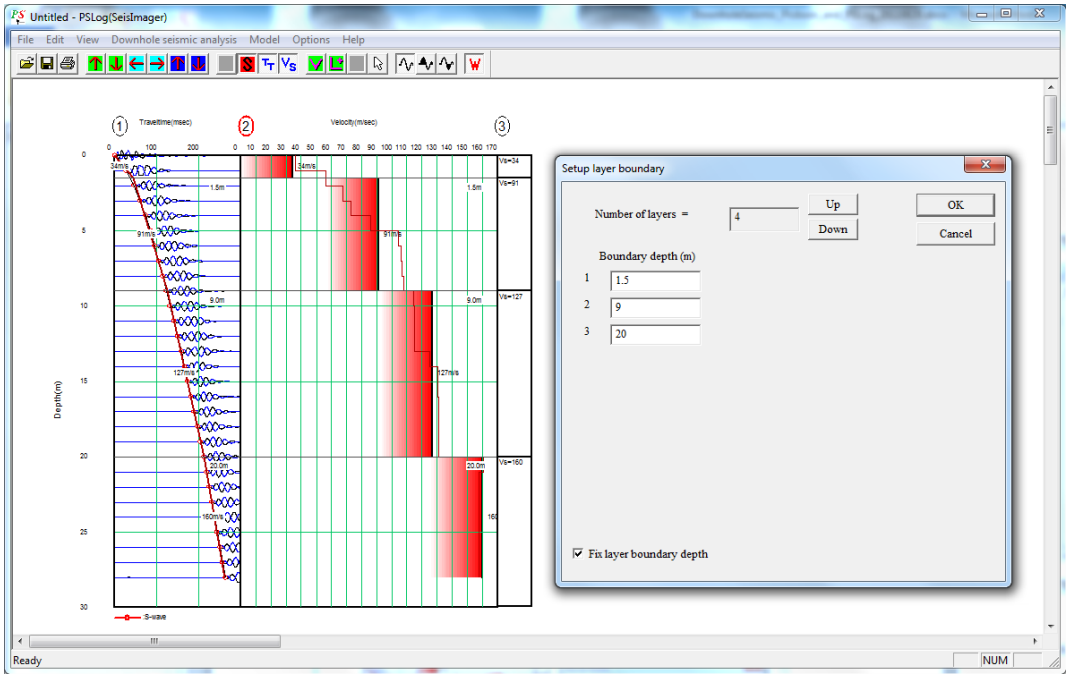
Example of increasing layer is shown below. When second layer is added with *Fix layer boundary depth* option.



When third layer is added with *Fix layer boundary depth* option.

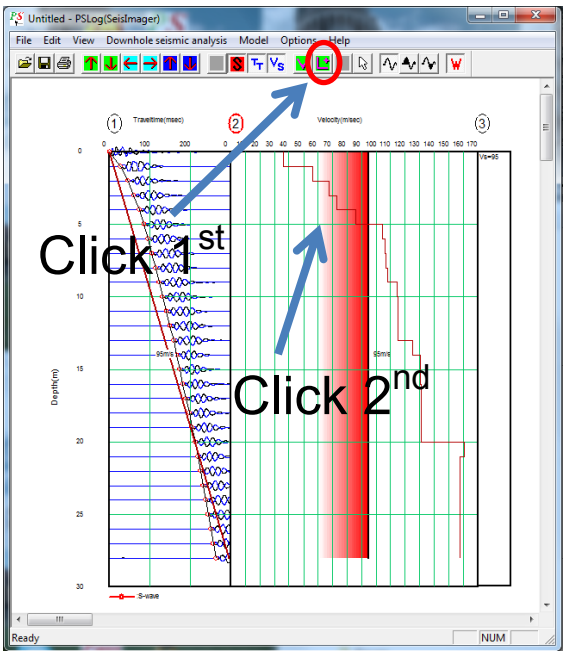


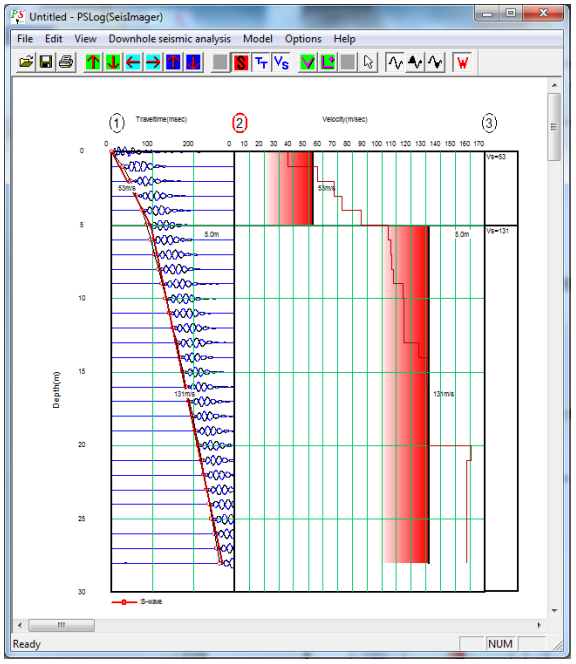
When forth layer is added with *Fix layer boundary depth* option.



6.4.4 Downhole seismic analysis Menu: Insert new layer boundary (by mouse)

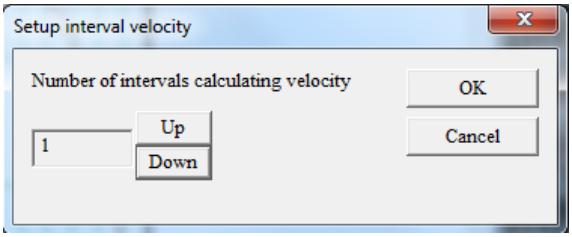
To insert new layer boundary, select *Insert new layer boundary (by mouse)* or click and click a depth that you would like to insert a new layer.



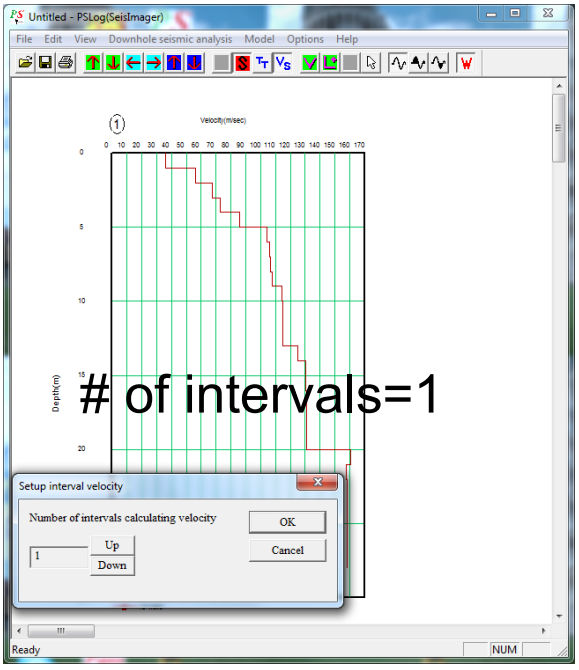


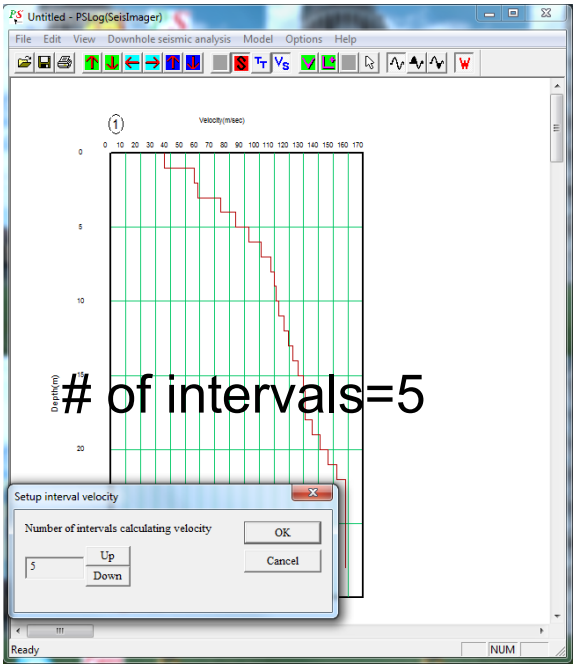
6.4.5 Downhole seismic analysis Menu: Setup interval velocity

Interval velocity means velocities calculated from each couple of traveltimes and they are shown as polylines on a velocity model view. An interval velocity is calculated from only two traveltimes and may be too bumpy. The interval velocity can be smoothed by applying a median filter. To apply the median filer, select *Setup interval velocities*.



Smoothness of the median filter is defined as a number of intervals for calculating the median value. The number of intervals must be odd and start from 1. The number of intervals of 1 means that no filter is applied. Increasing intervals makes the interval velocity smoother.



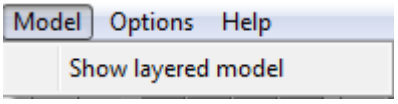


6.4.6 Downhole seismic analysis Menu: Calculate layer velocity

To calculate layer velocity for each layer by a least squares method with current parameters, select Calculate layer velocity. Generally, the layer velocities are automatically re-calculated when parameters are changed and you do not need perform this menu.

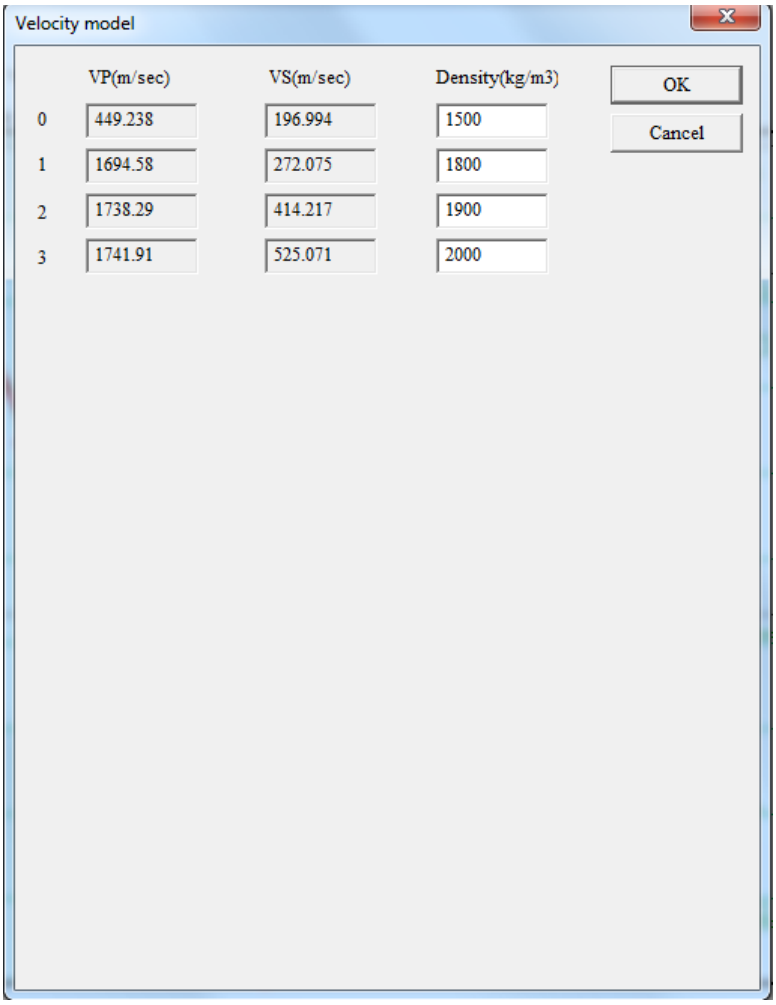
6.5 Model Menu

The *Model* menu includes functions for a editing a velocity model.



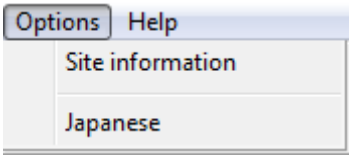
6.5.1 Model Menu: Show layered model

To show and edit a velocity model, select *Show layered model*. Density of each layer can be set with this function. Density is used for calculating elastic moduli, Share modulus (G) and Young's modulus (E), shown in a velocity column (see Section 6.3.10).



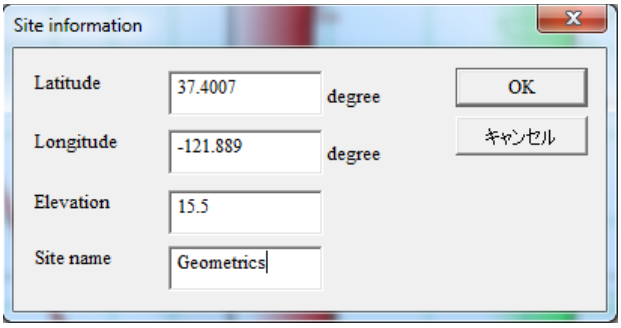
6.6 Options Menu

The *Option* menu includes data and display settings.



6.6.1 Options Menu: Site information

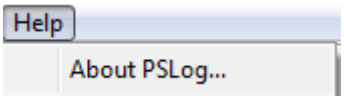
Site location, latitude, longitude and elevation, and site name can be stored in XML file. To set site location and name, select *Site information*. Negative latitude means southern hemisphere and negative longitude means the west longitude.



6.6.2 Options Menu: Japanese

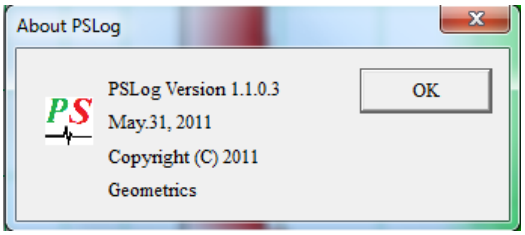
The program language can be converted between English and Japanese. To convert from English, check Japanese. Obviously, this is not recommended unless you want to use the software in Japanese and have the necessary version of Windows. If symbols appear in various places, it is likely that the language is not set to English and Windows is unable to render the program in Japanese.

6.7 Help Menu



6.7.1 Help Menu: About PSLog

The Help menu reports the software version information.



6.8 Button Bar Function

The PSLog button bar functions not already discussed in association with specific menu functions are explained in this section.

6.8.1 Button Bar: Enlarge waveform amplitude and Reduce waveform amplitude.

To enlarge or reduce waveform amplitude, click the *Enlarge waveform amplitude* and the *Reduce waveform amplitude* buttons. The associated keyboard shortcuts are *Shift* and the up allow and the down allow keys, respectively.

6.8.2 Button Bar: Reduce horizontal scale and Enlarge horizontal scale.

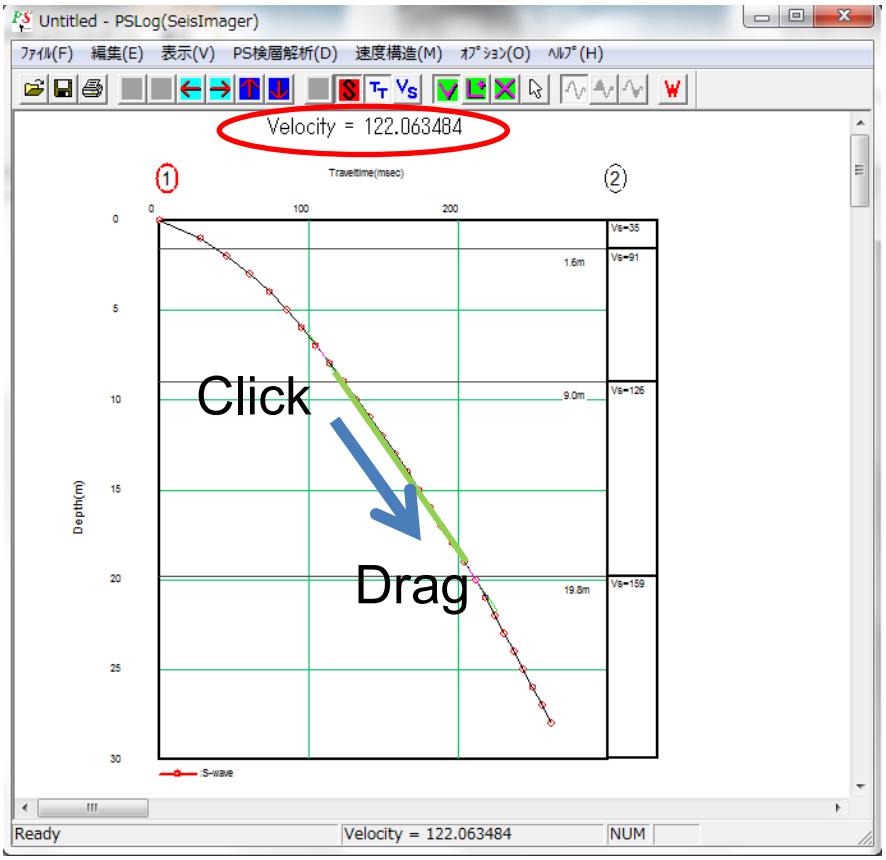
To reduce or enlarge horizontal scale, click the *Reduce horizontal scale* and the *Enlarge horizontal scale* buttons. The associated keyboard shortcuts are the left allow and the right allow keys, respectively.

6.8.3 Button Bar: Enlarge vertical scale and Reduce vertical scale.

To enlarge or reduce vertical scale, click the *Enlarge vertical scale* and *Reduce vertical scale* buttons. The associated keyboard shortcuts are the up allow and the down allow keys, respectively.

6.8.4 Button Bar: Linear velocity line

To measure the velocity of a series of traveltimes, click on *Linear velocity line* button. Next, left click at the beginning of the series, and drag the cursor to the last traveltime in the series. Velocity is shown at the top of display as shown below.

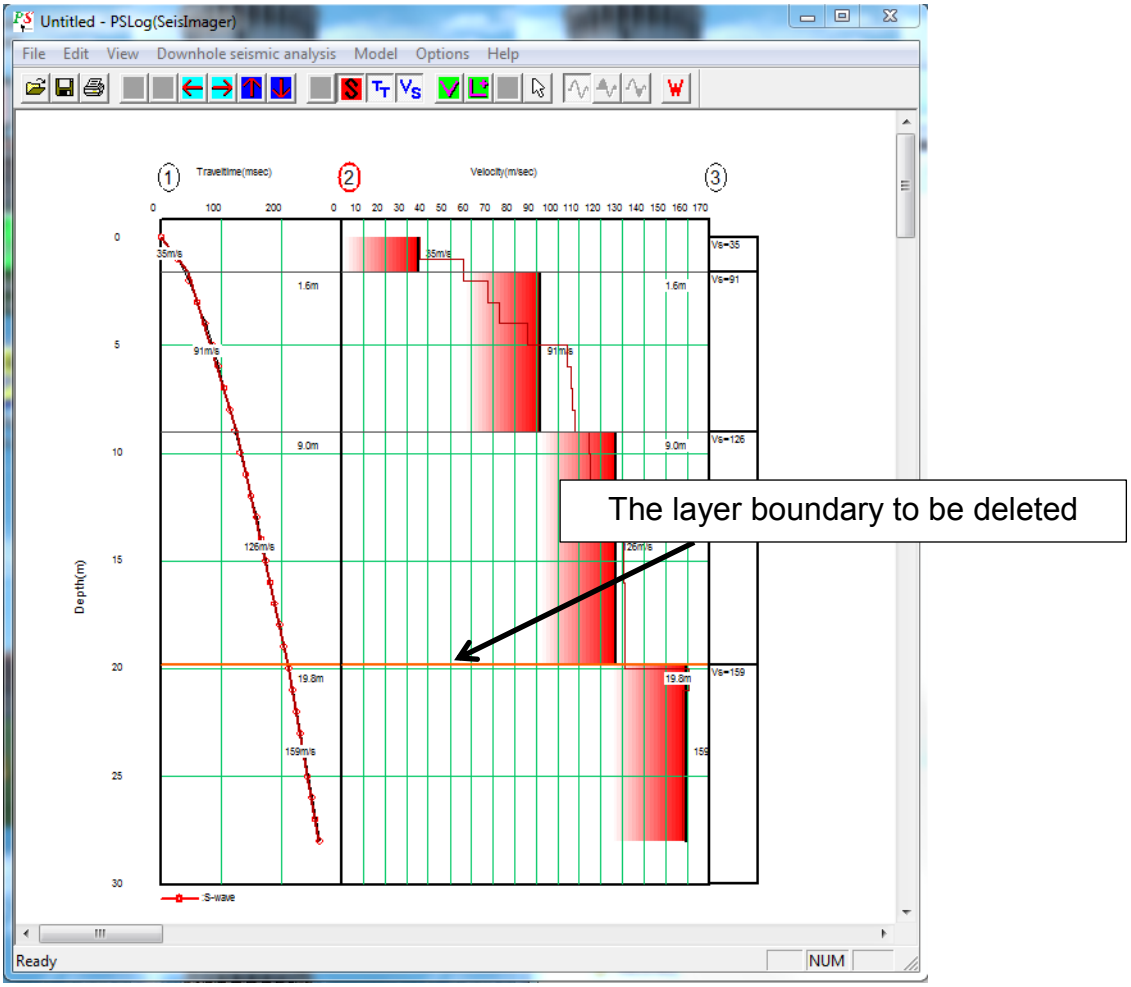


6.8.5 Button Bar: Exit edit mode

To exit from any edit mode, click the *Exit edit mode* button or press the *Esc* key.

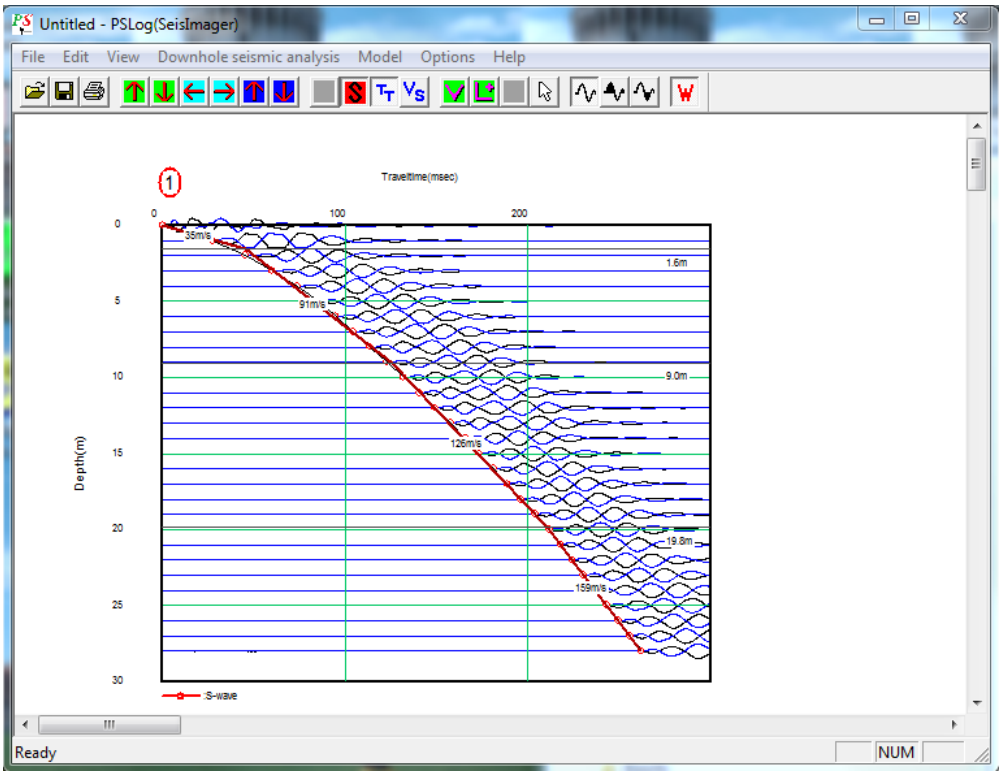
6.8.6 Button Bar: Select layer boundary

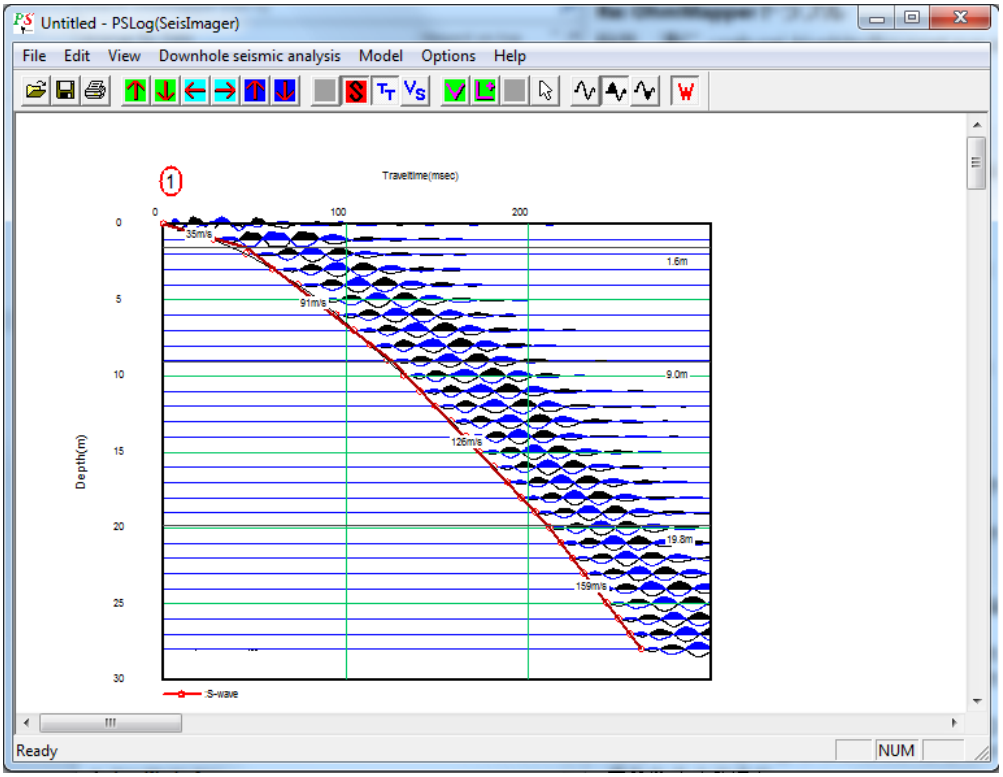
To delete a layer boundary, click the *Select layer boundary* button and click the layer boundary to be deleted. The color of the clicked layer boundary turns to red and press the *Delete* key.

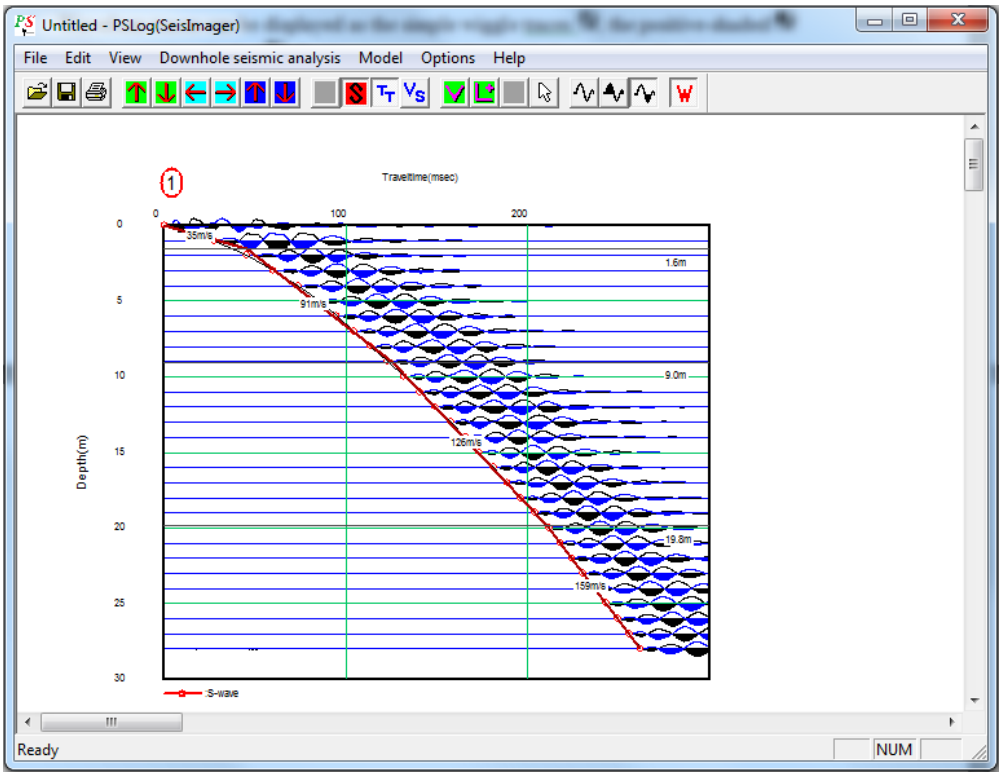


6.8.7 Button Bar: Trace Shading

Waveform traces can be displayed as the simple wiggle traces, the positive-shaded and the negative-shaded. To change trace display, click the trace shading buttons. Examples of trace displays are shown below.


Untitled - PSLog(SeisImager)
File Edit View Downhole seismic analysis Model Options Help
Traveltime(msec)
0
100
200
Depth(m)
0
5
10
15
20
25
30
35m/s
91m/s
126m/s
159m/s
1.6m
9.0m
19.8m
S-wave
Ready
NUM


Untitled - PSLog(SeisImager)
File Edit View Downhole seismic analysis Model Options Help
Traveltime(msec)
0
100
200
Depth(m)
0
5
10
15
20
25
30
35m/s
91m/s
126m/s
159m/s
1.6m
9.0m
19.8m
S-wave
Ready
NUM

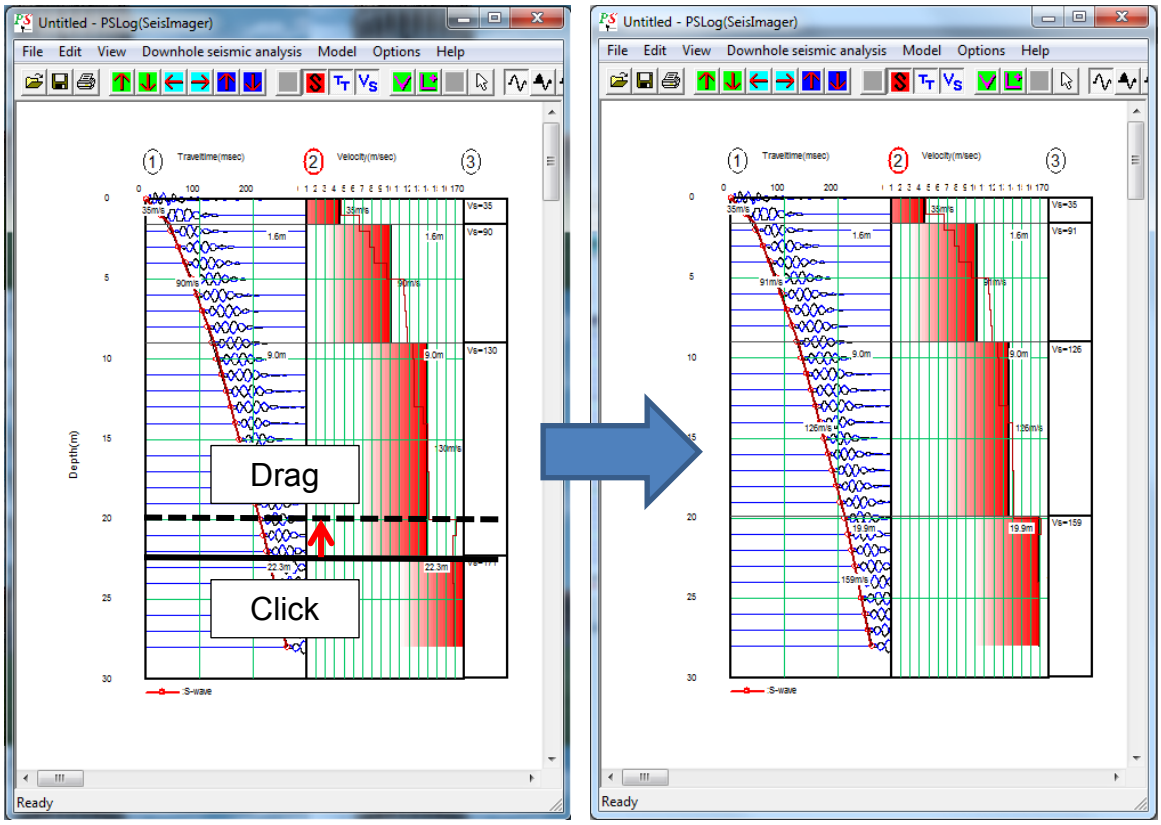

Untitled - PSLog(SeisImager)
File Edit View Downhole seismic analysis Model Options Help
1
Traveltime(msec)
0
100
200
Depth(m)
0
5
10
15
20
25
30
35m/s
91m/s
126m/s
159m/s
1.6m
9.0m
19.8m
S-wave
Ready
NUM

6.9 Other Operation Using Mouse

PSLog operations using mouse are explained in this section.

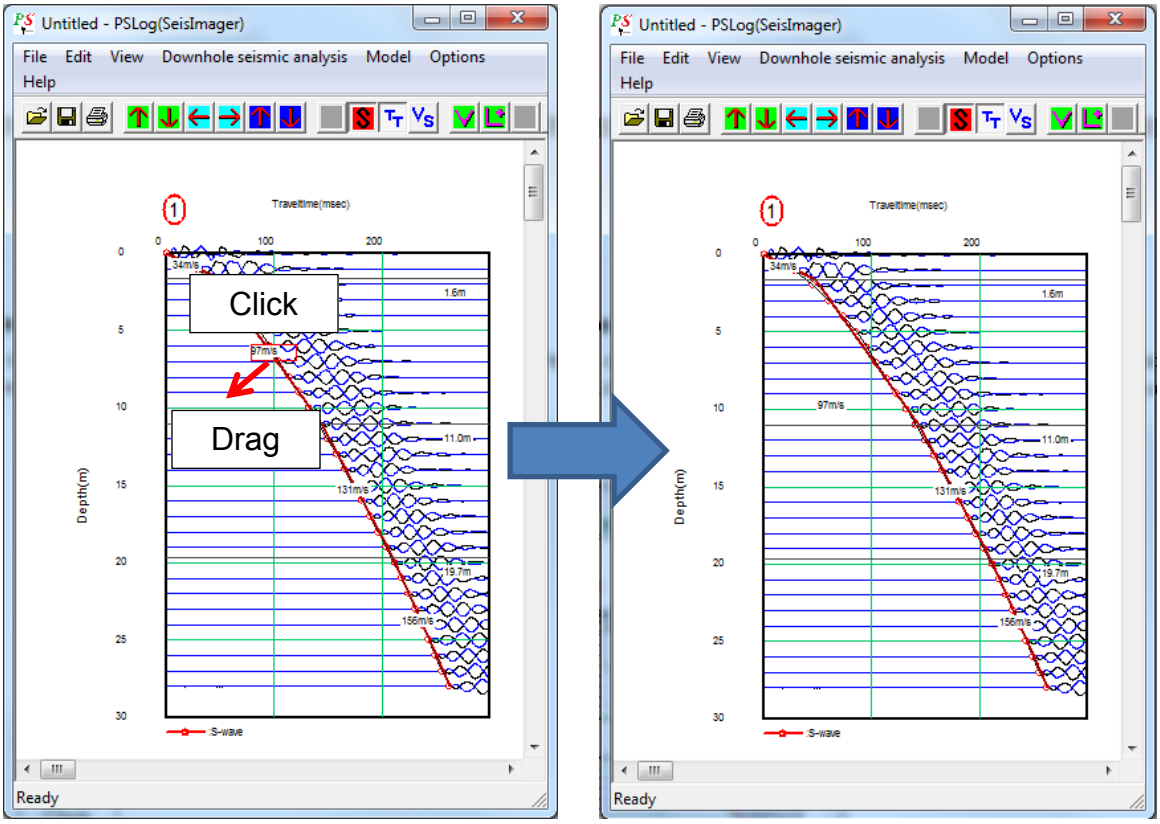
6.9.1 Move layer boundary

Existed layer boundaries can be moved by a mouse. To move layer boundaries, click a layer boundary line and drag it to the depth to be moved with pressing the mouse button and release the button.



6.9.2 Move text label

All text labels can be moved by a mouse. To move text labels, click a text label (the label is surrounded by red rectangle) and drag it to the depth to be moved with pressing the mouse button and release the button. Moved text labels can be automatically set again by selecting *Reset text position*, in *Advanced options* of *View* menu.



6.9.3 Delete layer boundary

To delete layer boundaries, click the *Select layer boundary* button and click the layer boundary to be deleted. The color of the clicked layer boundary turns to red and press the *Delete* key (see Section 6.8.6).