

SeisImager/SWTM Manual Addendum

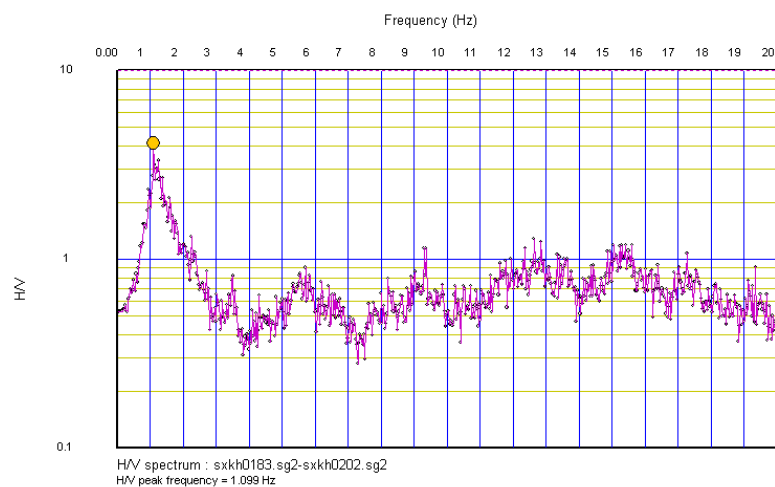
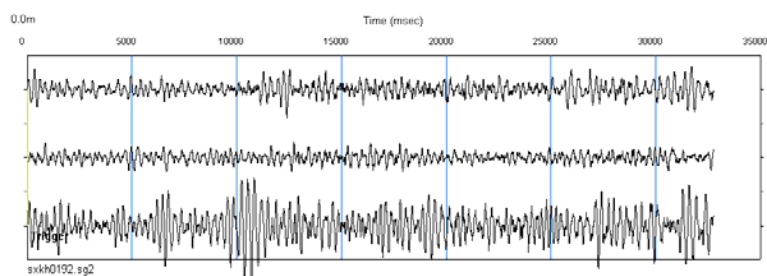
Windows Software for Analysis of Surface Waves

PickwinTM v. 4.4.1.0

WaveEqTM v. 2.5.1.5

Manual Addendum v. 2.0

April 2012



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1 - Introduction

The SeisImager/SW Manual Addendum provides description of the new H/V Spectrum Data Analysis Wizard and associated functions. The wizard automatically calls on specific functions from the Pickwin and WaveEq modules to walk you through the analysis process. The H/V Spectrum Data Analysis Wizard and associated functions are included in both the SeisImager/SW-1D and SeisImager/SW-2D packages.

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.

In this manual addendum, only the wizard and explanation of the specific Pickwin and WaveEq functions called on by the wizard are briefly covered. Detailed explanations will be included in the next release of the SeisImager/SW Manual.

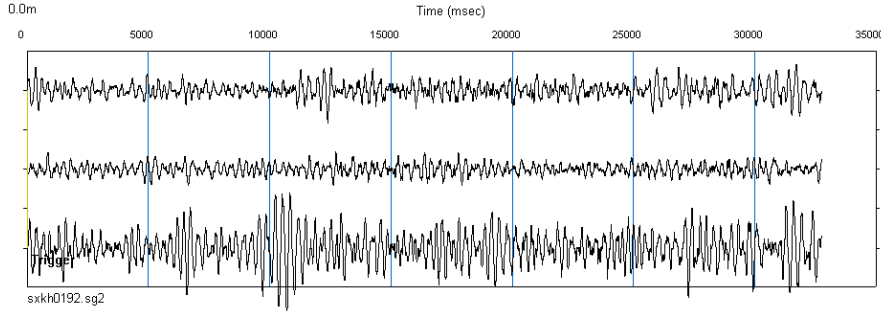
Some theory is touched on, but this manual is not meant to be a treatise on the H/V Spectrum method (also referred to as the Nakamura method). It is assumed that the user has a reasonable grasp of the main principals of seismology and mathematics in order to understand the principals behind the analysis techniques employed by the software.

We are very interested in your constructive criticism of both this manual and the software itself. Please contact us at seismicsales@geometrics.com with any comments you might have.

Note: All screens in this manual were captured in Windows XP Professional Edition or Windows 7. If you are running a different version of Windows, some dialog boxes may look slightly different than they appear here.

2 – Data Acquisition

A typical H/V spectrum dataset is shown below.



H/V spectrum analysis uses three-component (two horizontal and one vertical) ambient vibrations generated by cultural noise, traffic, factories, wind, wave motion, etc. The ideal sources of vibrations are steady, with a constant level. The fundamental assumption of H/V spectrum analysis is that the sources are located at an infinite distance and that the emanating waves are stable and isotropic (coming from all directions). In order to fulfill this assumption, H/V spectrum analysis requires a relatively long total recording period composed of a series of records. The deeper the investigation, the longer the total recording period must be (Table 1).

Depth of investigation	Sample interval	Maximum number of samples per file	Single file record length	Total number of files	Total recording period
<5 m	2 msec	16384	~32 sec	10	~5 min
2 to 30 m	4 msec	16384	~64 sec	10	~10 min
20 to 100 m	8 msec	16384	~128 sec	10	~20 min
>100 m	8 msec	16384	~128 sec	15	~30 min

Table 1. Typical recording periods depending on depth of investigation. The sample interval multiplied by the maximum number of samples per file gives the single file record length and the single file record length multiplied by the total number of files gives the total recording period.

Accordingly, the range of frequencies also relates to the depth of investigation (Table 2). Deeper investigation requires long-period geophones or seismometers.

Depth of investigation	Frequency	Sensor frequency
<5 m	>10 Hz	4.5 Hz
2 to 30 m	2 to 10 Hz	2 Hz
20 to 100 m	0.5 to 2 Hz	2 Hz, 1 Hz, or long-period seismometer
>100 m	0.1 to 0.5 Hz	Long-period seismometer

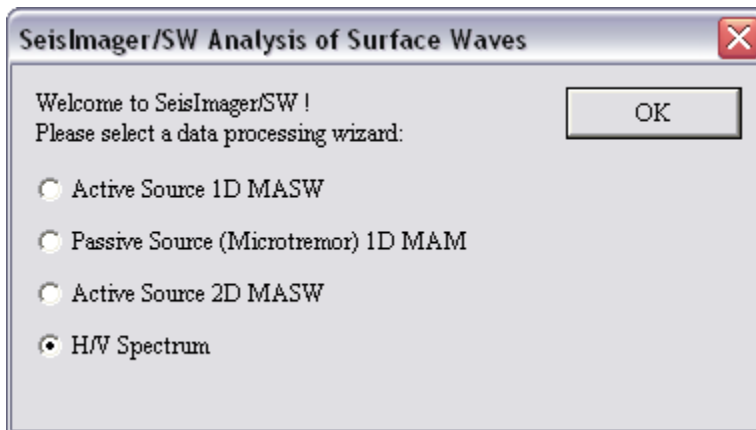
Table 2. Required frequency range and sensors depending on the depth of investigation

3 – H/V Spectrum Data Analysis Wizard

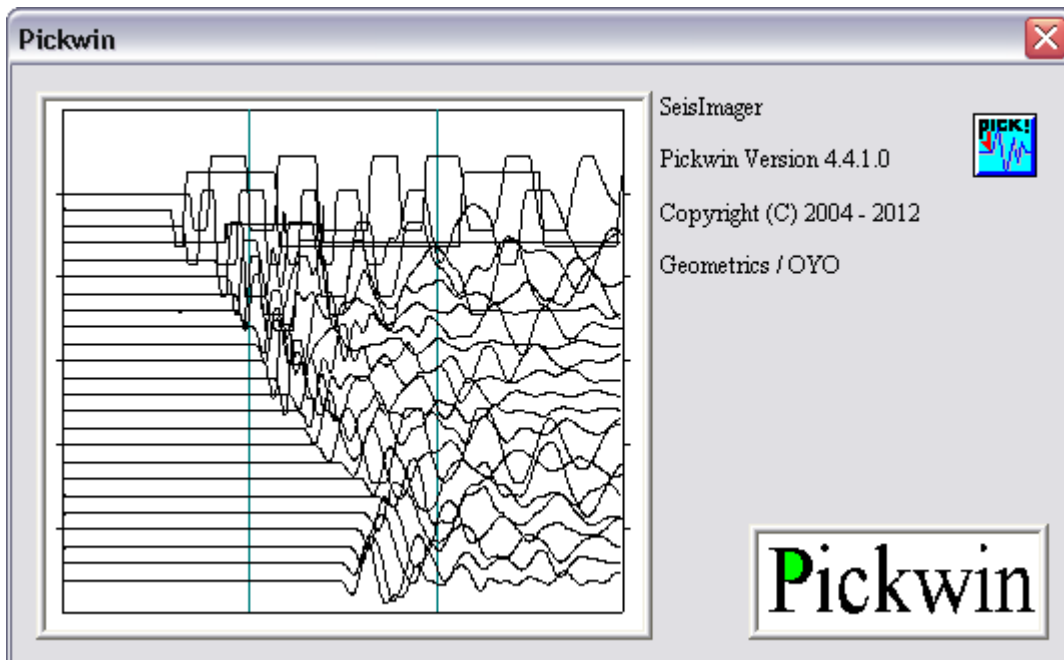
Double-click on the Surface Wave Analysis Wizard icon.



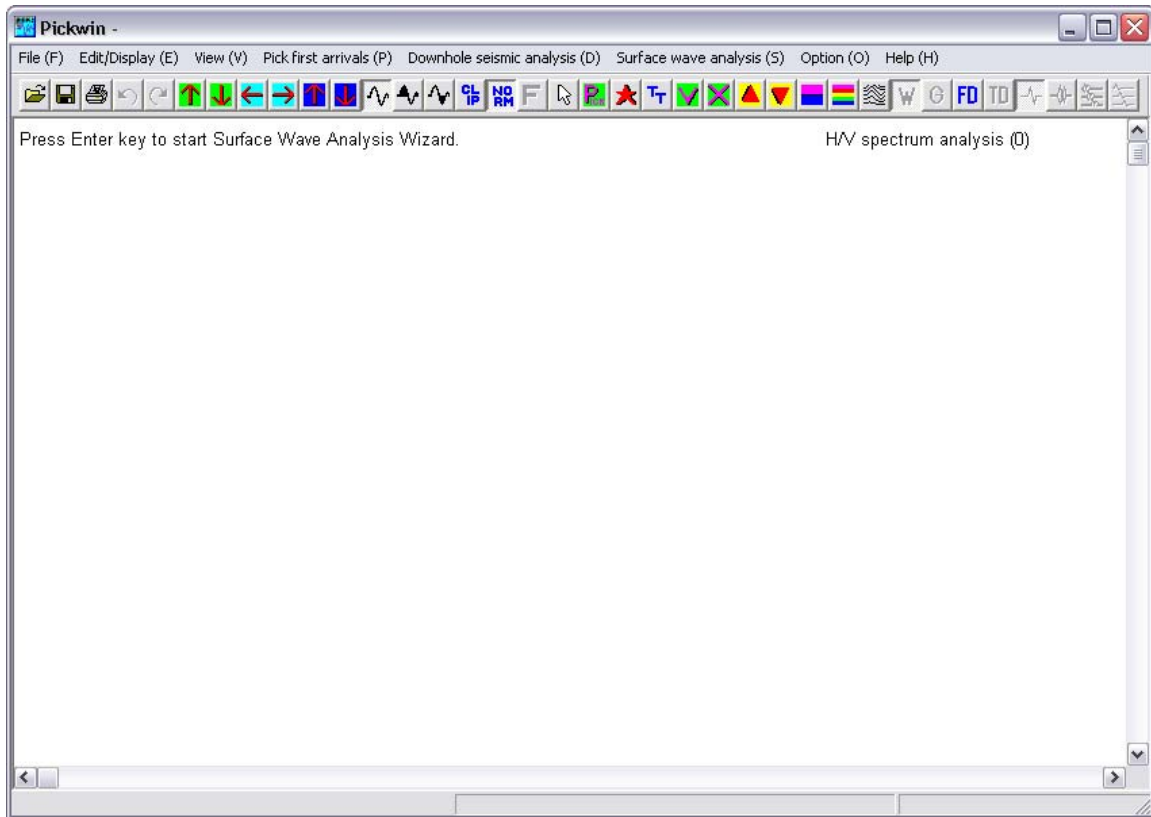
The *Welcome to SeisImager/SW* dialog box appears. Select *H/V Spectrum* and click *OK*.



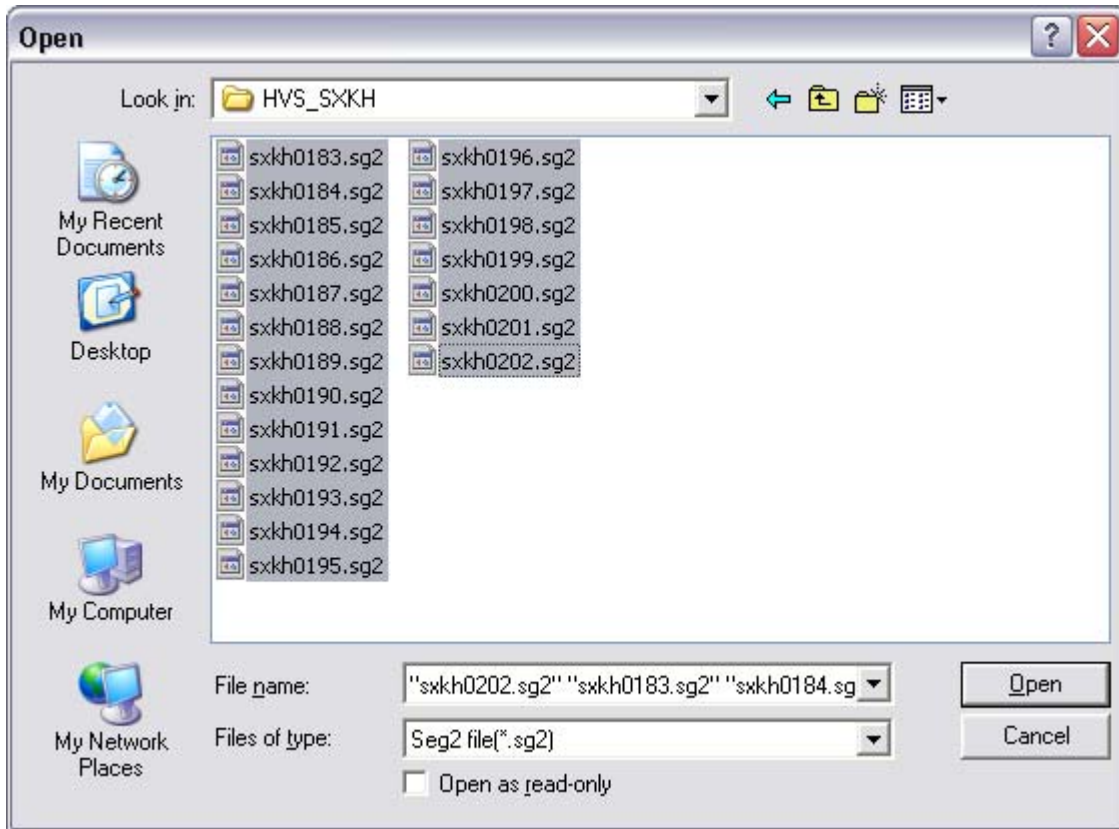
The Pickwin module is launched.



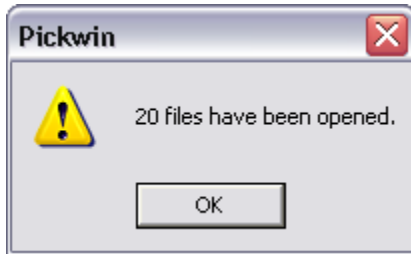
The main Pickwin window appears. The wizard calls functions from the *File* and *Surface Wave Analysis* menus. Press the *Enter* key as instructed in the upper left hand corner of the window to begin.



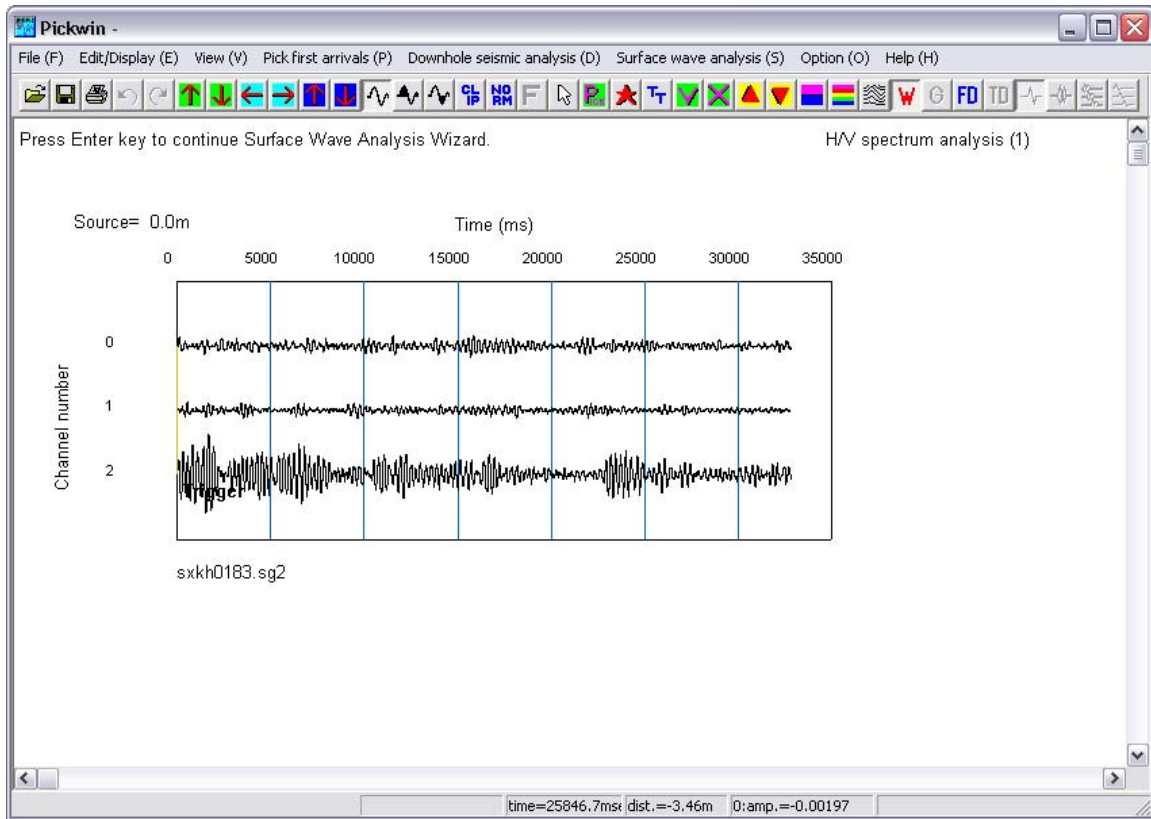
The first step is to input the dataset; all the dataset files are input at one time. Use the *Shift* key to highlight the first through last file in the dataset and click *Open*.



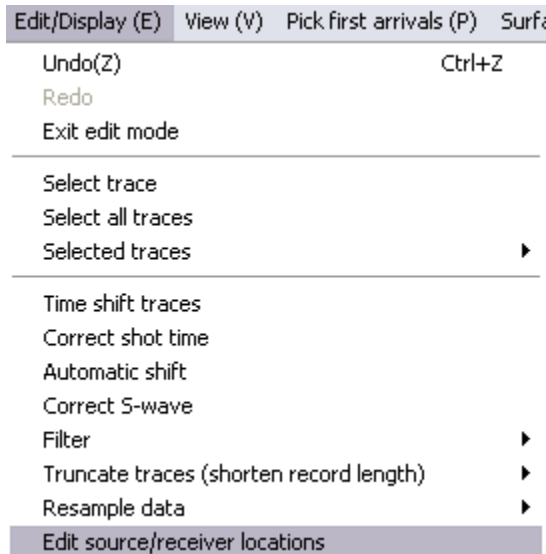
Once the selected files are open, click *OK*.



The first in the group of waveform files is displayed.

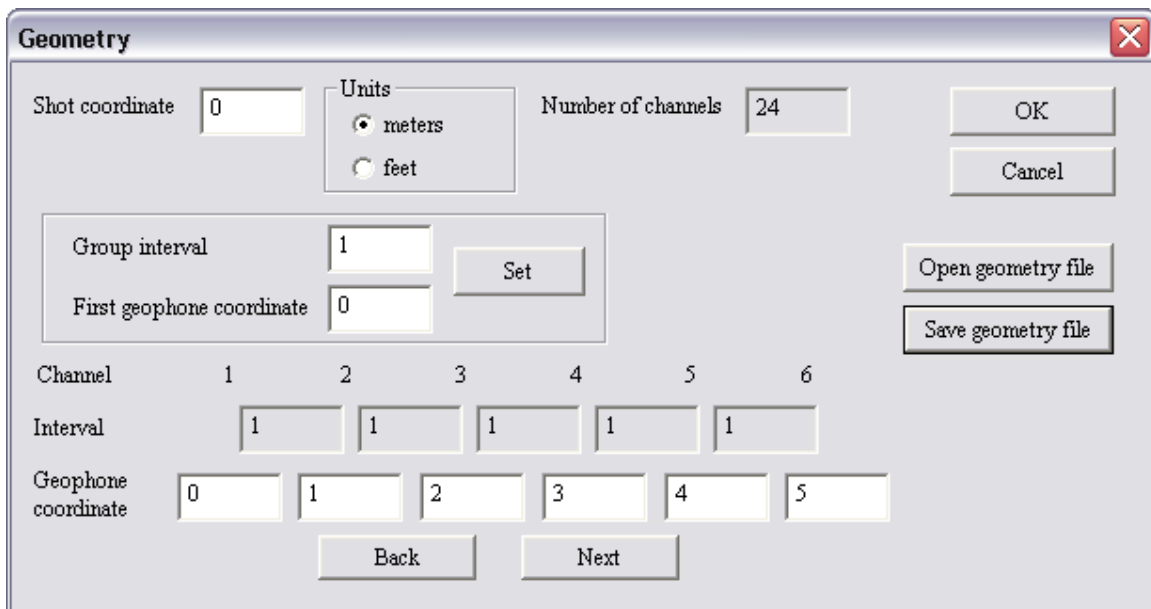








If the unit labels displayed are incorrect, select the *Edit/Display* menu, *Edit source/receiver locations*.

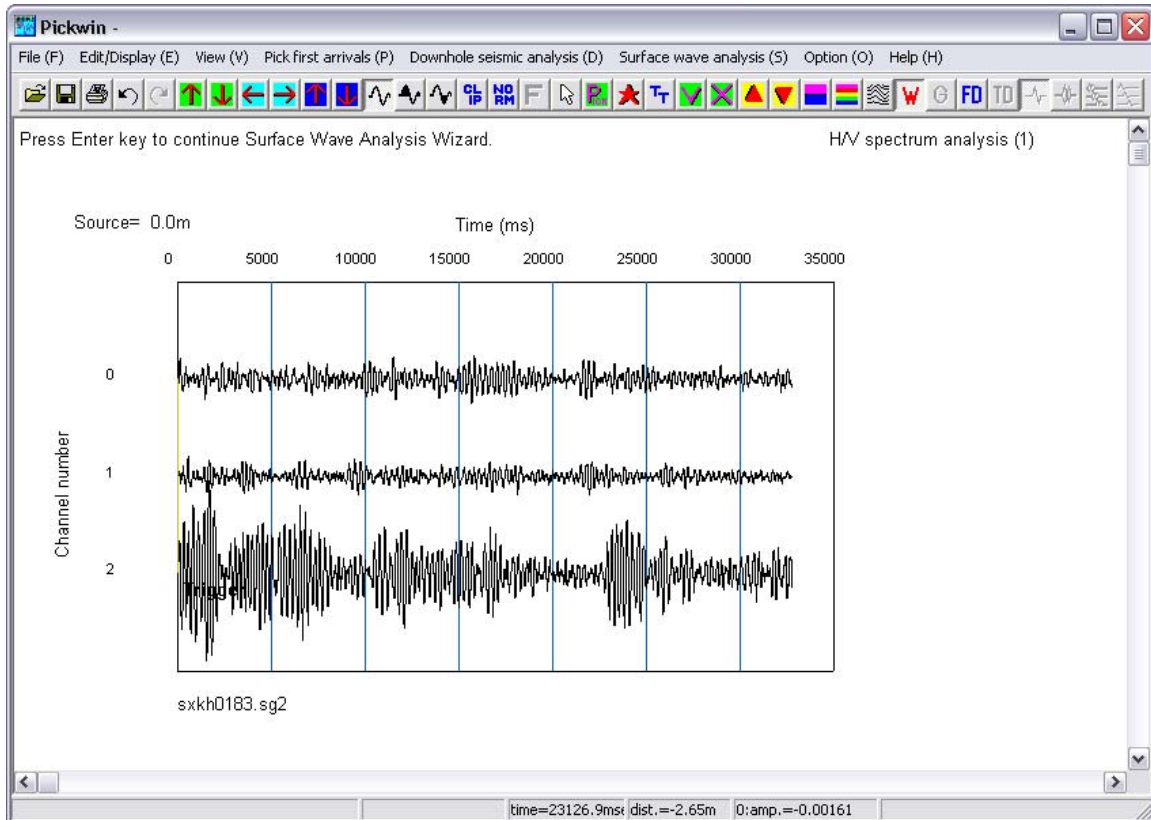


The *Geometry* dialog box appears and the *Units* setting allows selection between *meters* and *feet*. The *Units* setting will affect the unit labels shown in the dialog boxes. Once set (and Pickwin is closed), the assigned units will be recalled for subsequent uses of the wizard. (It is necessary to close Pickwin to register the new *Units* setting. At the end of the wizard, simply close Pickwin to register the new *Units* setting.)

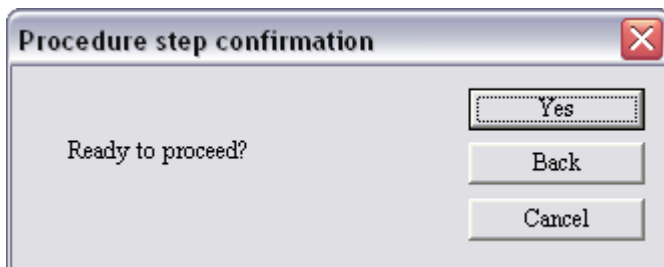
The *Geometry* dialog box also reports the source and receiver coordinates saved in the file header at the time of acquisition. This is non-applicable for H/V spectrum datasets. Click *OK* when done.



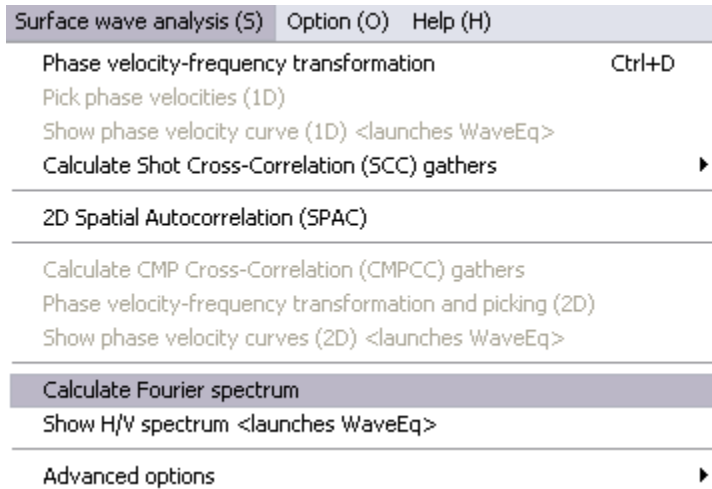
In the waveform view, the settings can be modified to optimize the display. All of these settings are common with SeisImager/2D for refraction data processing; refer to the SeisImager/2D manual included on the SeisImager CD for complete explanation. The main functions needed are the *Waveform amplitude*   buttons (or the up and down arrow keys), the *Horizontal scale*   buttons (or the right and left arrow keys), and the *Vertical scale*   buttons (or the Shift+up and Shift+down arrow keys). When done, press the *Enter* key to continue.



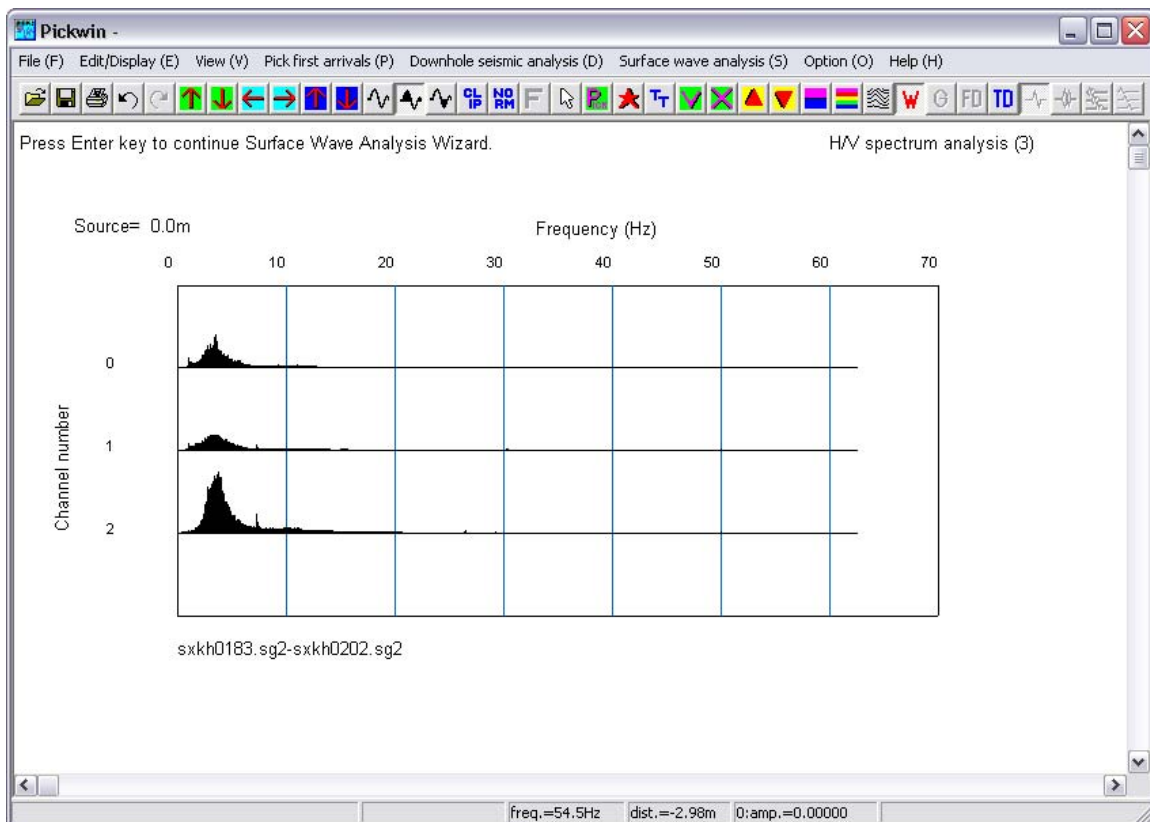
Click *Yes* when ready to proceed.



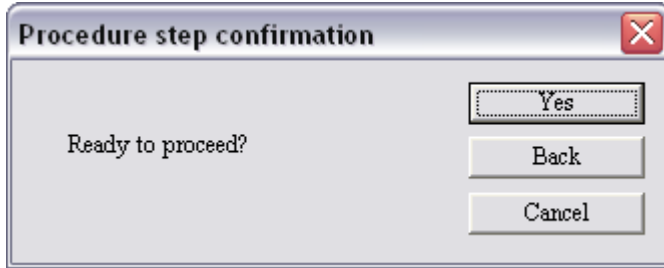
Next, the Fourier spectrum for each trace is calculated. To run this function outside of the wizard, select the *Surface wave analysis* menu, *Calculate Fourier spectrum*.



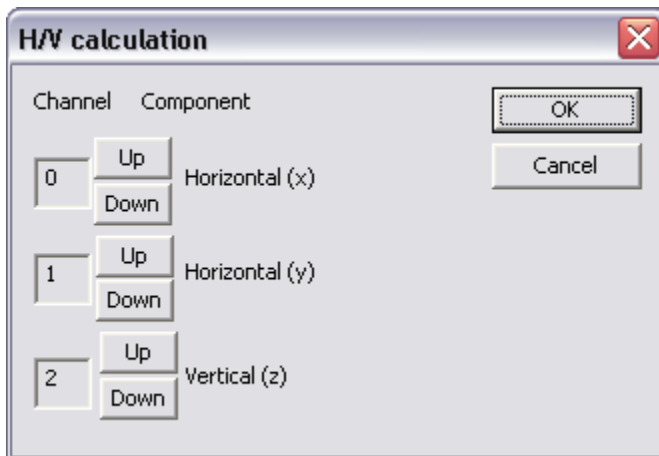
Once the calculation is complete, the spectra are displayed. The display may be adjusted using the same functions noted above. Press the *Enter* key to continue.



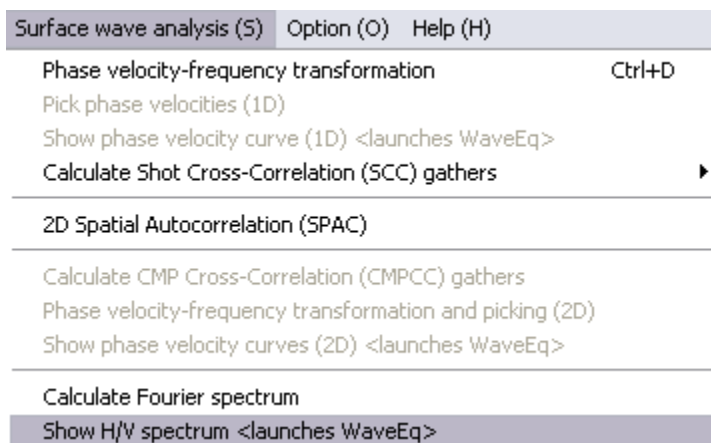
Click *Yes* when ready to proceed.



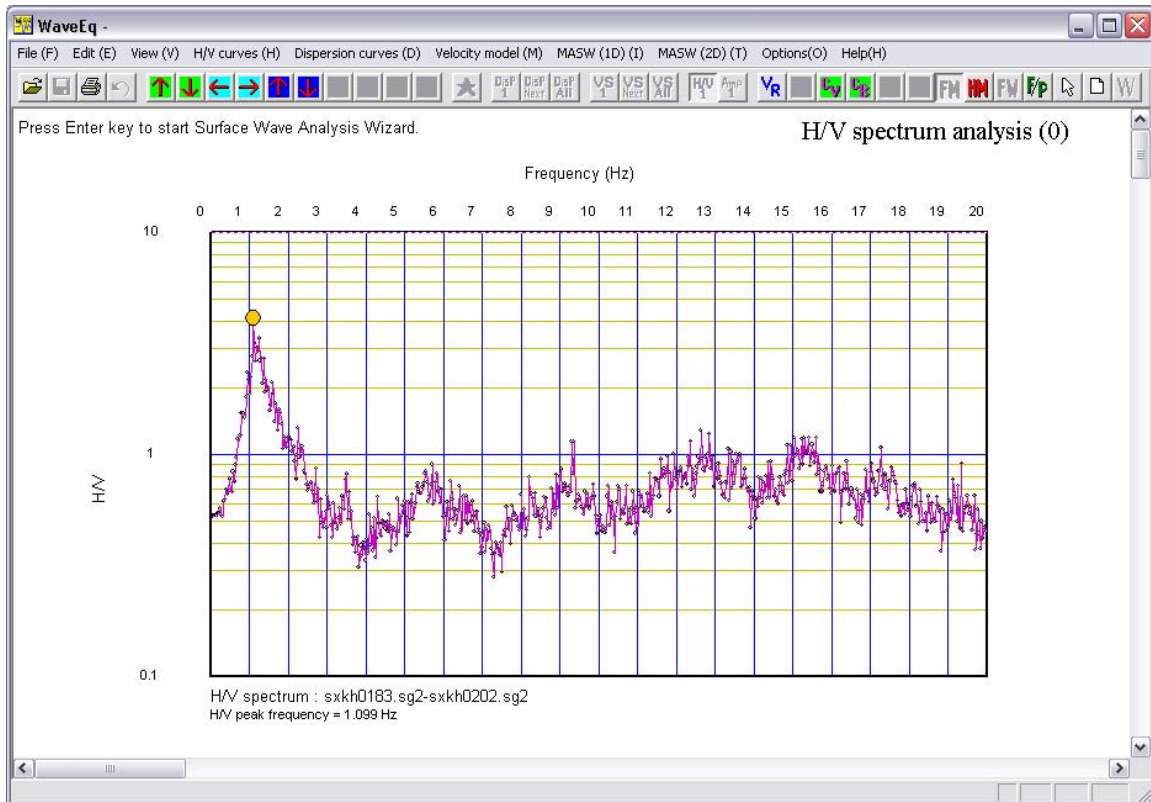
Next, a channel number is assigned to each component. By viewing the *Channel number* axis in the spectra display in Pickwin, the default values of 0, 1, and 2 can be confirmed. If they need to be changed, use the *Up* and *Down* buttons to select the appropriate values. Click *OK* when ready to proceed.



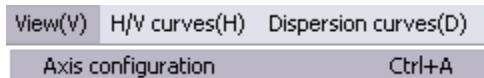
Next, using the Fourier spectra, the H/V spectrum is calculated and displayed in WaveEq. To run this function outside of the wizard, select the *Surface wave analysis* menu, *Show H/V spectrum* <launches WaveEq>.



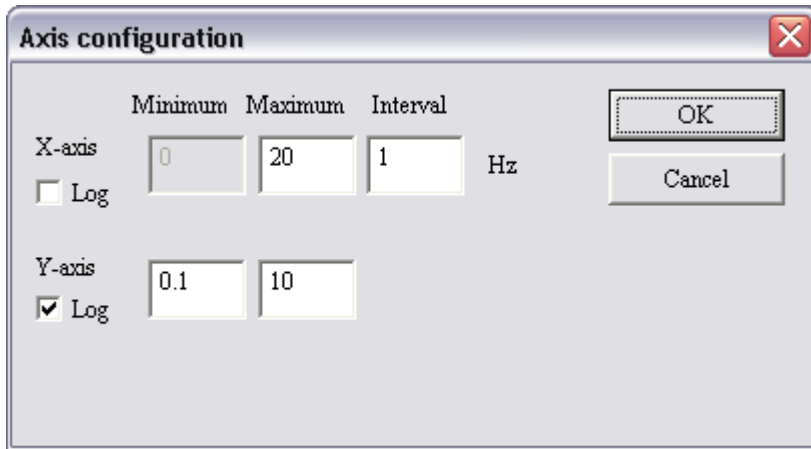
On the H/V spectrum plot, the peak frequency is identified by a yellow-colored circle, with the numerical value reported at the bottom.



If the plotting scales need adjustment, select the *View* menu, *Axis configuration* or press Ctrl+A.



Enter the desired values for the *X-axis* and *Y-axis Minimum, Maximum, and Interval*. Click *OK* when done.



The image shows a dialog box titled "Axis configuration" with a close button (X) in the top right corner. The dialog is divided into two sections: "X-axis" and "Y-axis".

X-axis section:

- Labels: "Minimum", "Maximum", "Interval", and "Hz".
- Input fields: "0", "20", and "1".
- Checkbox: "Log" (unchecked).
- Buttons: "OK" and "Cancel".

Y-axis section:

- Input fields: "0.1" and "10".
- Checkbox: "Log" (checked).

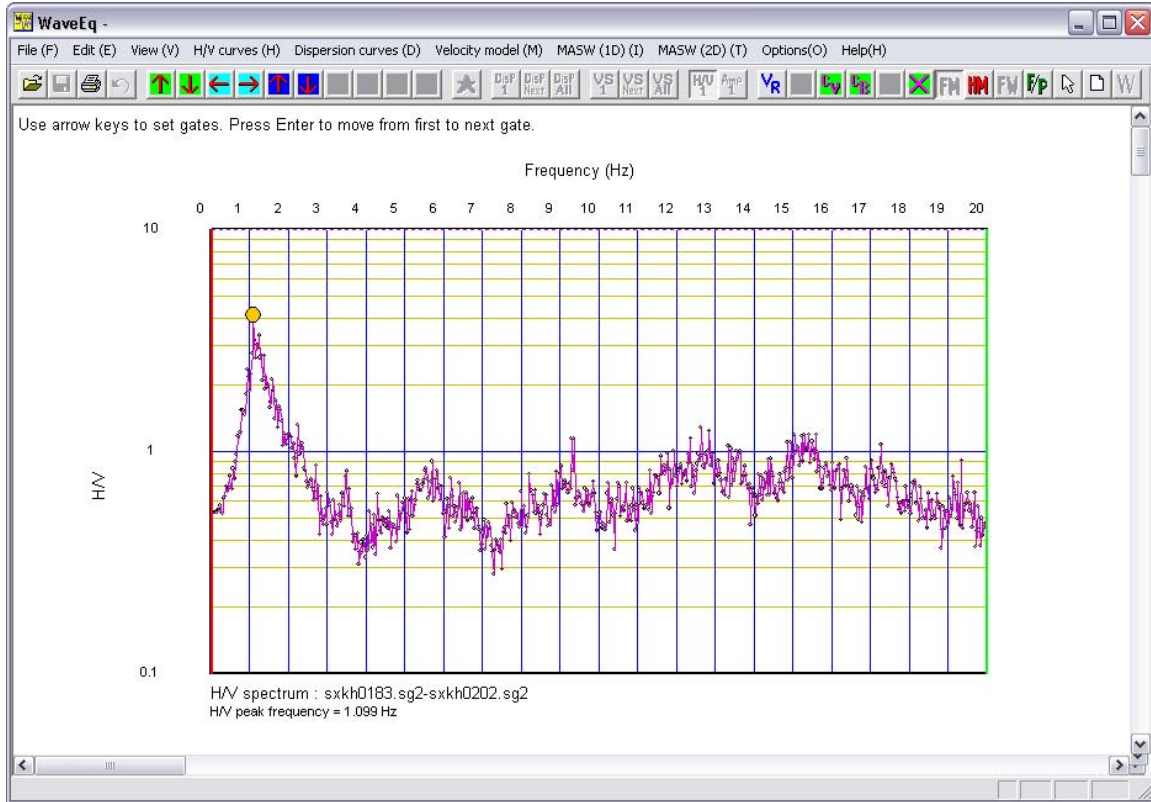
Next, the H/V spectrum curve may be edited as needed. Lower frequency data contains information about greater depths and higher frequency data contains information about shallower depths (Table 3).

Frequency	Depth of sampling
0.1 to 0.5 Hz	>100 m
0.5 to 2 Hz	20 to 100 m
2 to 10 Hz	2 to 30 m
>10 Hz	<5 m

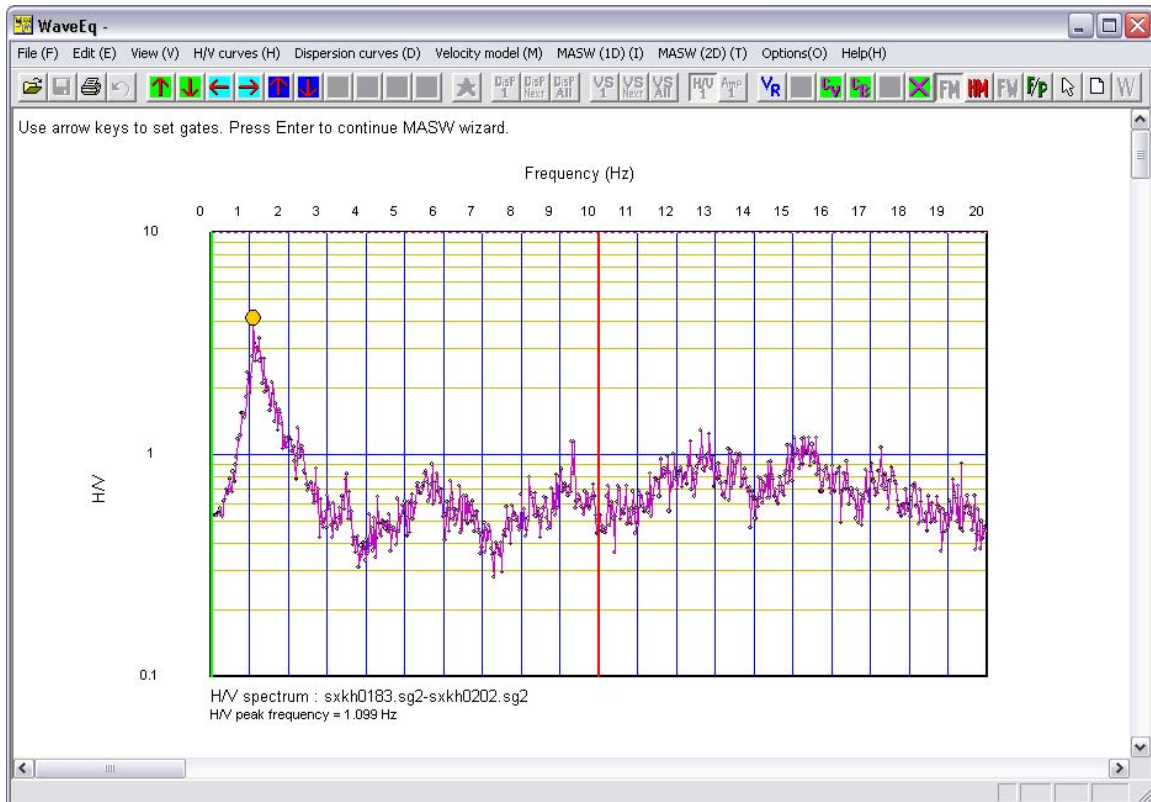
Table 3. Frequency related to depth of sampling.

H/V data outside of the frequency range of interest has no meaning and it is recommended that it be removed. Press the *Enter* key to activate an editing gate.

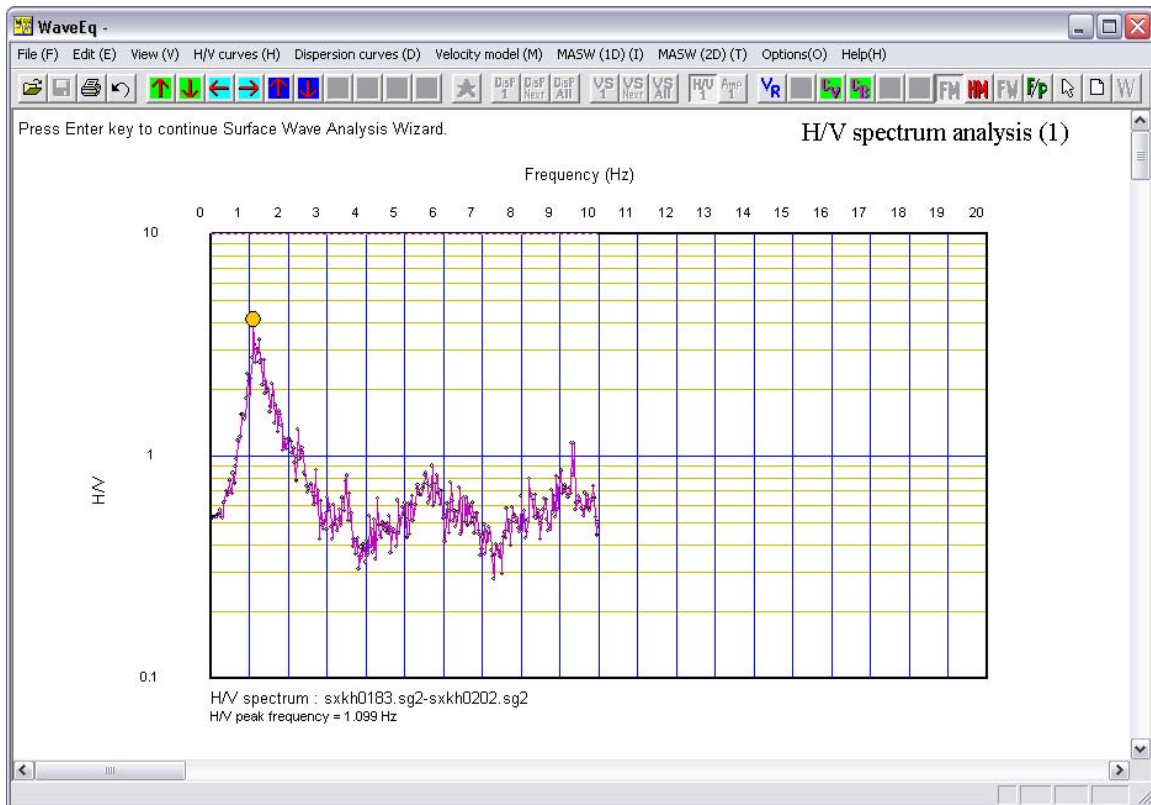
Follow the instructions in the upper left-hand corner of the window. The red gate is the active gate. Use the *right arrow* key to position the gate at the frequency, H/V point up to which you want to delete.



Press the *Enter* key to activate the right-hand side gate and position it the same way using the *left arrow* key.

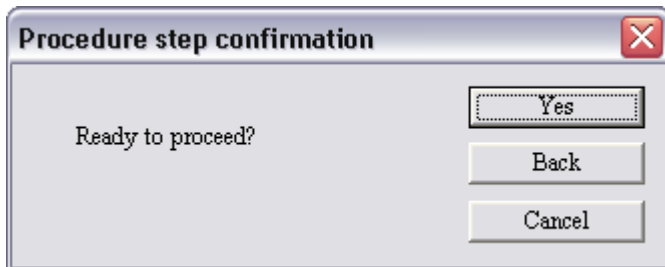


Press the *Enter* key when done.

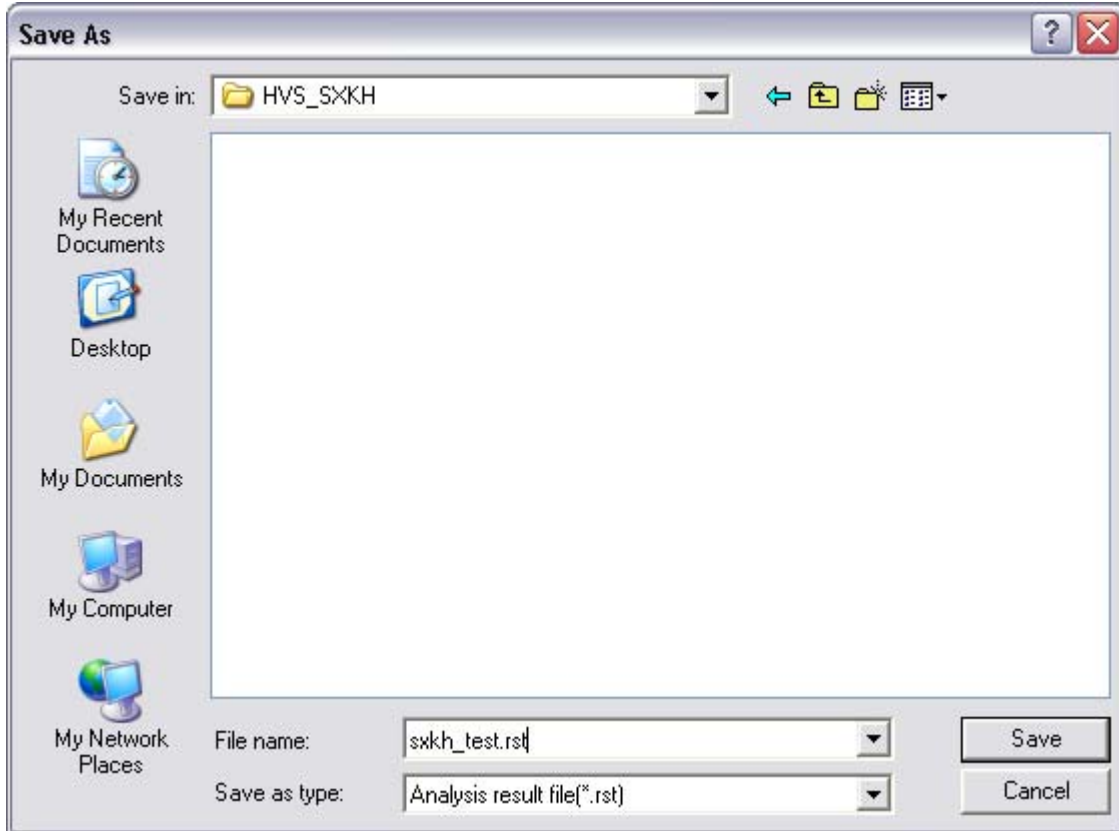


Press the *Enter* key to continue.

Click *Yes* when ready to proceed.



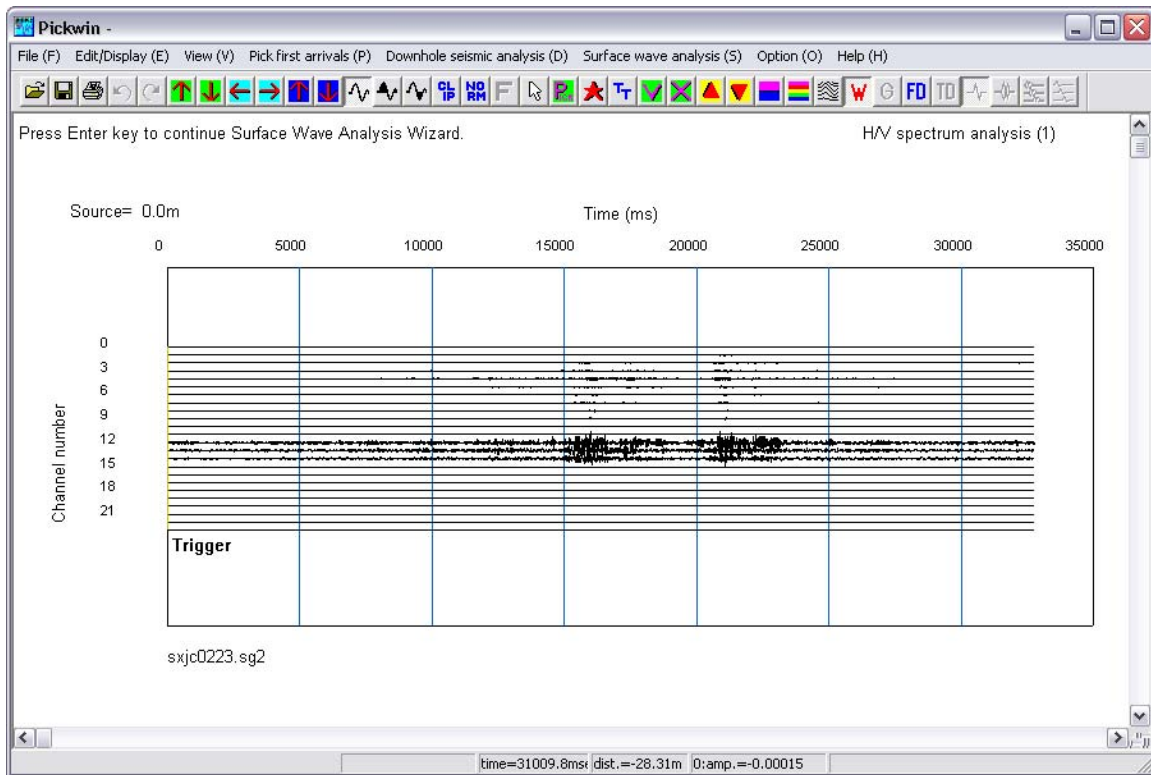
Lastly, save the result. Assign a file name with the extension *.rst* and click *Save*.



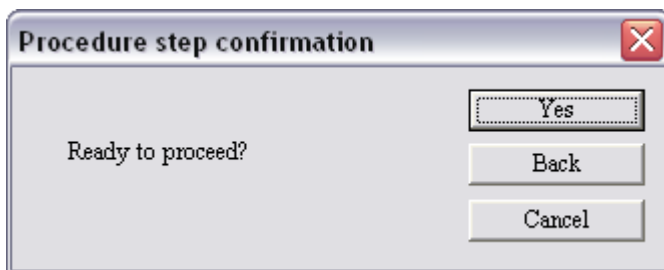
This completes the H/V Spectrum Data Analysis Wizard.

If the records in a dataset contain more than three traces, before the H/V spectrum is calculated the extra traces must be deleted. The wizard automatically detects the extra traces and prompts you to delete them.

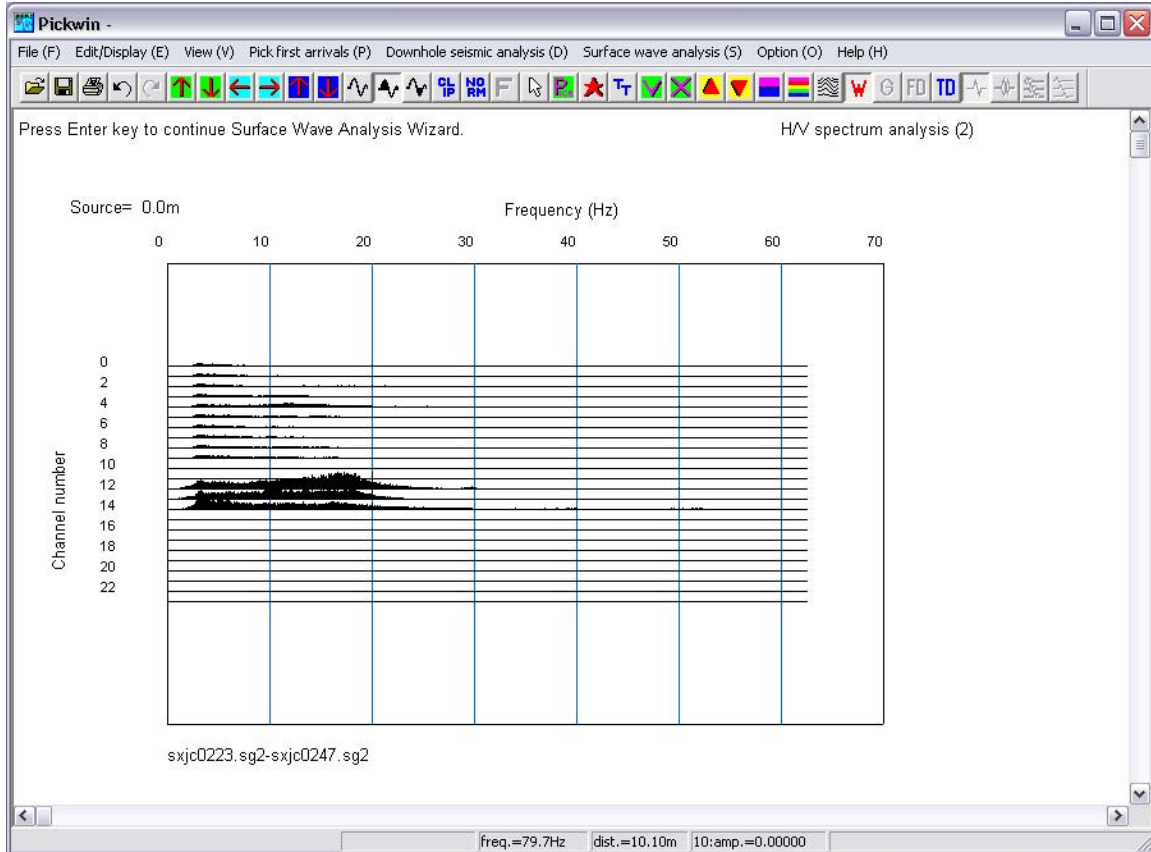
The file below shows 24 traces, where 21 traces are system noise and 3 traces are signal from two horizontal geophones and one vertical geophone. Press the *Enter* key to continue.



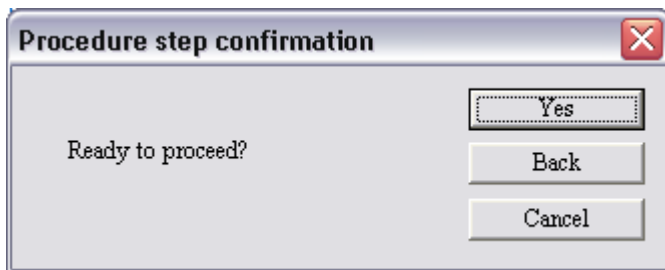
Click *Yes* when ready to proceed.



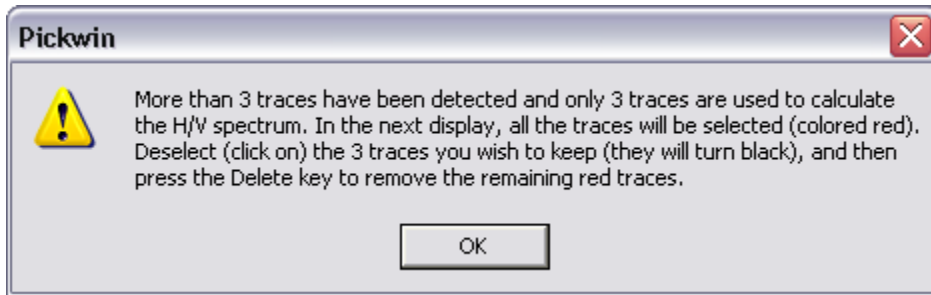
Next, the Fourier spectra are calculated. Press the *Enter* key to continue.



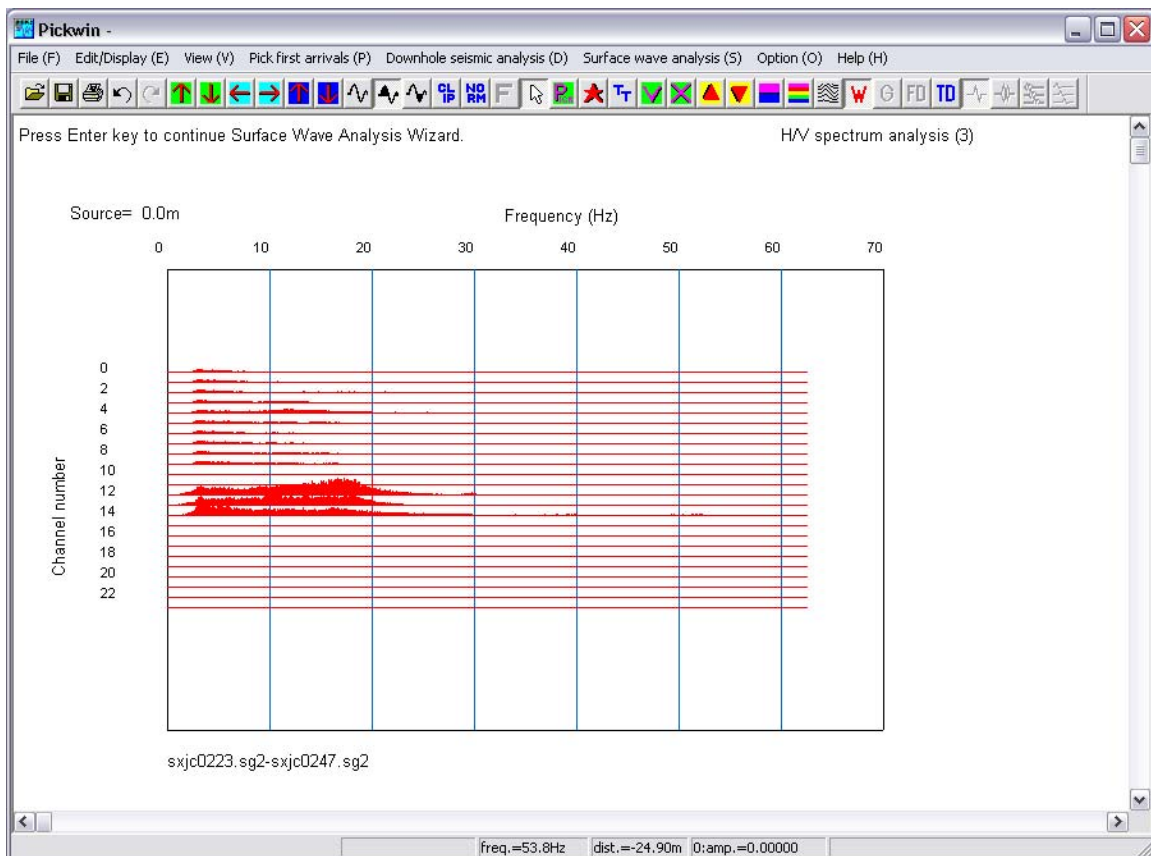
Click *Yes* when ready to proceed.



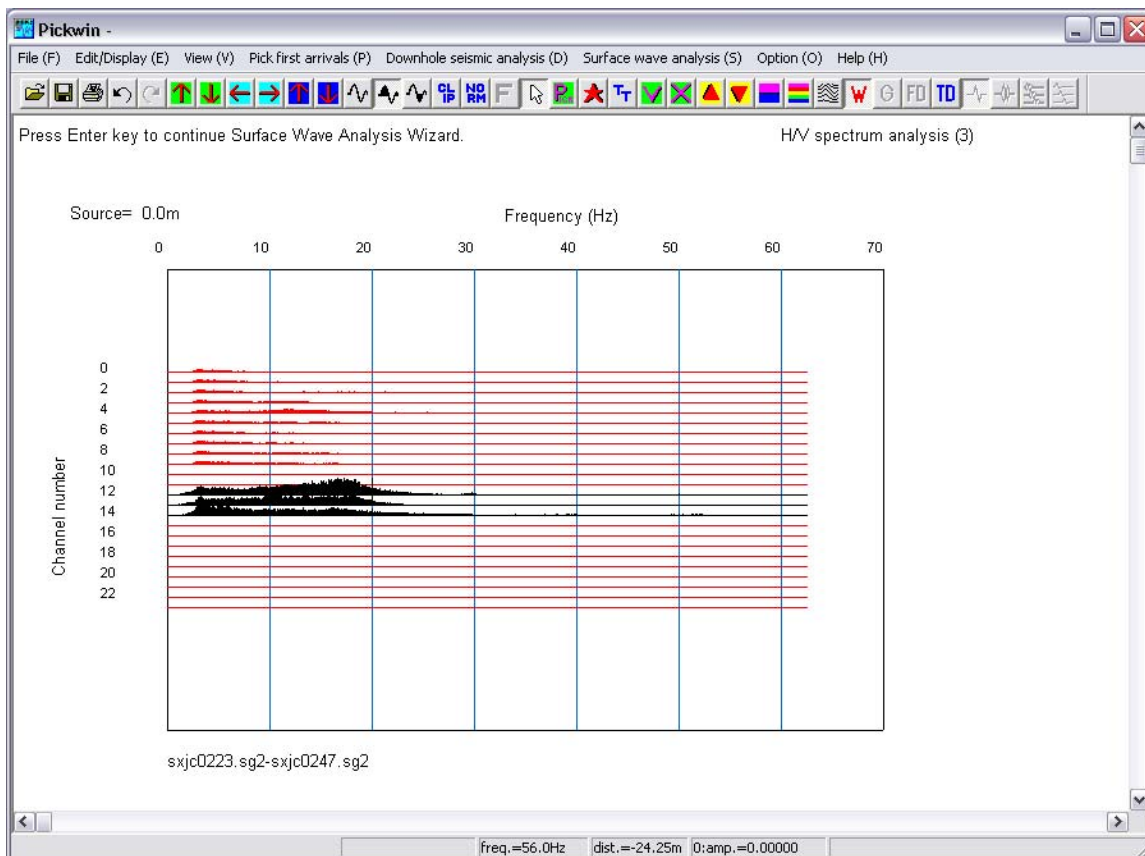
Next, you will be presented with instructions on how to separate the traces (spectra) you wish to keep.



Click *OK* and all the traces will appear colored red (selected).



Click on (deselect) the three traces you wish to keep (they will turn black).



Then press the *Delete* key to delete the remaining traces. The three desired traces will remain.

