GEOEXPLORER HVSR

Version 2.6.0

USER'S MANUAL

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Note: some features of the software may
have been changed in recent versions;
the basic functions described in the manual still apply.

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This software is produced for professional and research purposes. The use of the software for the purpose of recording geophysical data and / or assessment of risks and mechanical characteristics of soils is reserved for qualified and specialized personnel such as doctors of engineering, architecture, physics and geology, having also followed specialization courses in geophysics and structural calculation. All certifications regarding this material are the responsibility of the end user.
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PACKAGE:

1. **USB MEMORY KEY.**
2. **AN HARDWARE PROTECTION DONGLE WITH A SEALED RING INDICATING THE SOFTWARE SERIAL NUMBER.**

WARNING! DO NOT DAMAGE THE RING WITH THE SERIAL NUMBER, THE PRODUCT CAN NOT BE CHANGED OR UPDATED WITHOUT THE RING.

Index

1 Introduction

GeoExplorer HVSR is dedicated to the seismic signals processing using the HVSR (*Horizontal to Vertical Spectral Ratio*) technique.

The technique allows estimating the relationship between the spectrum of the horizontal components of the signal and the spectrum of the vertical component recorded by a single triaxial seismic station.

The operation must be performed on different portions of the signal, called windows, in order to obtain a population of statistically meaningful H/V ratios. Then, computing the average of all calculated ratios, it is possible to define the HVSR curve, or ellipticity curve, which is representative of the site under investigation.

The ellipticity curve allows to directly obtain the resonance frequencies of the site and to indirectly calculate the seismo-stratigraphic profile, through the operation known as inversion.

GeoExplorer HVSR is designed to make the processing simple and immediate, while leaving the professional user free to control the calculation parameters.

The most relevant features are:

- Automatic or manual selection of the windows, with **real-time updating of the HVSR curve**.
- **Optional transient exclusion** using amplitude thresholds.
- The size and location of the selected windows are adjustable with one-sample precision.
- Immediate verification of the **SESAME criteria** on any frequency of the curve.
- HVSR curve **stationarity** and **directionality** plots
- Plot of the spectrum of the single components.
- You can define a reference stratigraphy, **calculate the corresponding synthetic HVSR curve** and compare it to the HVSR curve currently processed.
- Plot of the stratigraphic profile and **calculation of the S waves equivalent velocity** at a given depth, taking into account the offset of the foundations.
- Customizable graphical displays.
- **Report** in *pdf* format.
- Optional **instrumental correction**.
- Seismic signal **audification**.

2 Main window

The following figure shows the program main window.

The menu items and the controls that load and display a seismic signal are highlighted.

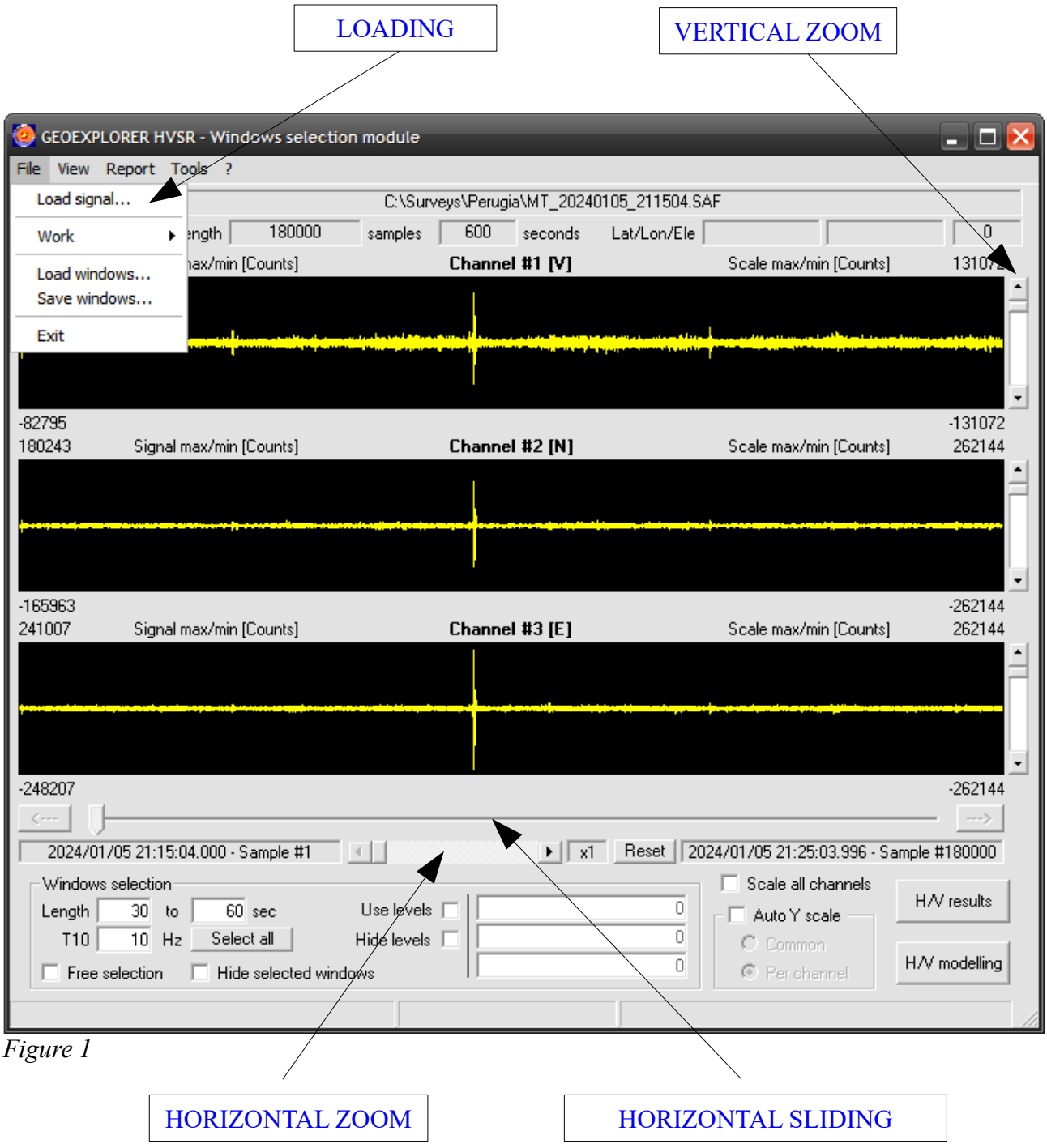

Figure 1

2.1 Signal loading

The *File* → *Load signal* item of the main menu opens the standard "Open file" dialog window.

The program loads seismic files in different formats such as *SAF* (SESAME ASCII format), *SEG* and *GSE*.

The boxes at the top of the main window show some basic information on the signal:

- *File path*: full path of the loaded file.
- *SPS*: sampling frequency.
- *Length*: file length, in number of samples (samples) and in seconds (seconds).
- *Latitude*, *longitude*, *elevation*: information on the location of the acquisition site.

In the main window shown above, the first plot represents the signal of the vertical component, the second one the horizontal component N-S and the third one the horizontal component E-W.

> *N.B. When you load files created using instruments of manufacturers other than SARA electronic instruments is very important to make sure the channels are correctly identified in the file and are loaded in the correct order.*

2.2 Signal display options

After loading the signal, the scroll bars on the right of the graphics change the plot vertical scales.

If checked, the box *Scale all channels* indicates that the vertical scale should vary simultaneously on all the three channels when you operate on anyone of them.

The box *Auto Y scale* enables the automatic vertical scale and disables the scrollbars. The automatic scaling adjusts the vertical zoom to show the entire signal amplitude in the available space. If the option *Common* is selected, the vertical scale will be the same on all the three channels according to the channel which reaches the greater amplitude. If the option *Per channel* is selected, the vertical scale will be individually set on each channel based on its own maximum amplitude.

The numerical labels above and below the left part of each channel indicate the signal maximum positive and negative amplitudes. The unit is indicated in brackets next to the label *Signal max/min*.

The numerical labels above and below the right side of each channel indicate the upper and lower limits of the current vertical scale. The unit is indicated in brackets next to the label *Scale max/min*.

The unit is taken from the uploaded file. If the file does not contain it then the program uses the default unit, *count*.

The slider below the plots moves the signal in the horizontal direction. This control is enabled only if the horizontal zoom is also enabled, which is adjusted with the scroll bar below. The box just to the right of the scroll bar contains the zoom level. The two larger boxes on both sides of the bar show the position of the first and the last samples of the signal portion currently represented and the time to which they are related.

You can horizontally zoom over an arbitrary portion of the signal double clicking with the left mouse button on the point where you want the zoom to begin, dragging and releasing the mouse to the end point. During the operation a frame appears above the selected portion.

Even the mouse wheel can be used to modify the signal representation, after clicking on the plot where to operate. The wheel scrolling allows to horizontally move the signal, such as when the slider is used but with a greater detail, one sample at a time. Scrolling is only effective if the horizontal zoom is active and is useful when the zoom is deep and you want to fine-tune the display portion.

If, instead, the wheel is simultaneously moved and pressed, you will change the signal vertical scale, such as using the vertical scroll bars on the right of the signals. The function is enabled only when the automatic vertical scale is not active.

Using the *View → mode* menu item you can exchange between the *Geophysics* (default mode) and *Engineering* view modes. The *Engineering* mode inverts the order of the channels explained in the section 2.1, showing them in the following order: X (E-W component) on the first graph, Y (N-S component) on the second, Z. This option also inverts the frequency axis of all the graphs of the program that show the signal in the frequency domain, representing it in seconds (*[s]*) instead of Hertz (*[Hz]*).

2.3 Windows selection

To select a portion of the signal and use it as a window for the HVSR processing, just click on the signal on any of the three plots with the left mouse button on the point where you want to begin the selection, drag and release on the point where you want the window to end.

The following figure shows a signal where two windows have been selected and a further selection is in progress.

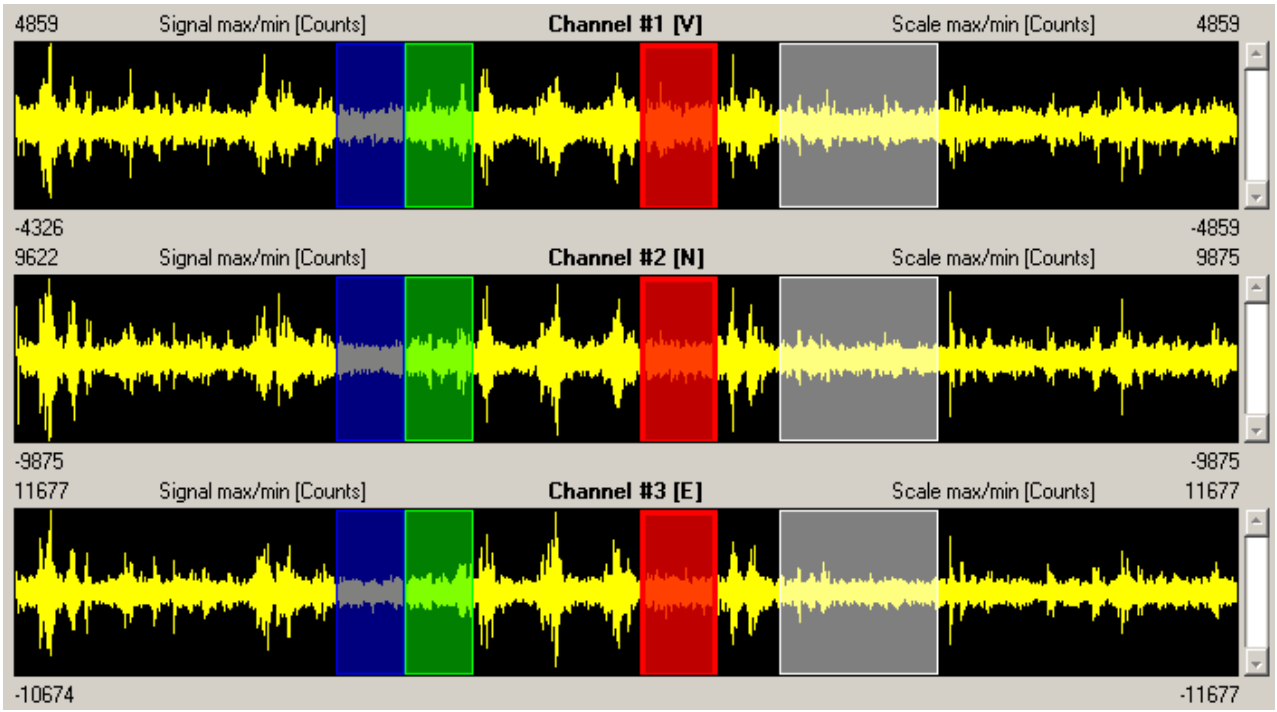

Figure 2

The selection is made according to the parameters contained in the fields of the *Windows selection* box.

The *Length* fields indicate the minimum and maximum window lengths in second. To select windows of the same length, set both fields with the same value.

The *T10* fields allows to set the minimum window lengths inserting the lower frequency that you want to reliably analyze (T10 frequency, according to the SESAME protocol). The content of the *Length* fields will change according to the inserted frequency.

The three fields on the right allow to indicate, channel by channel, the amplitude threshold beyond which the signal should be discarded. These thresholds are considered if the box *Use levels* is checked.

The threshold positions, the green lines on the plot, can be moved with the UP/DOWN buttons, after clicking with the mouse on the plot of interest. Wanting more precision, it is possible to click with the middle mouse button (or the scroll wheel) on the point where to set the threshold.

The *Hide levels* box operates on the signal display, hiding the green lines that represent the thresholds.

In the same way, the *Hide selected windows* box hides all the selected signal windows.

The *Free selection* box, if checked, informs the program to ignore any length parameter or threshold, allowing you to select windows of any length.

Clicking the *Select all* button you will select the entire signal; the windows will be chosen according to the current settings.

Pressing the *Select all* button when the *Free selection* box is checked selects only one window that covers the entire signal. This is not recommended because the H/V ratio calculation would require a substantial period of time (dependent on the signal length and on the settings of the calculation, some tens of seconds in the case of a standard signal and processing parameters).

To move, resize or delete a window, simply click on it to select it, then use the keyboard keys:

- RIGHT/LEFT: one-sample shift.
- PAGEUP/PAGEDOWN: one-second shift.
- SHIFT+RIGHT/SHIFT+LEFT: one-sample enlargement or shrinking.
- SHIFT+PAGEUP/SHIFT+PAGEDOWN: one-second enlargement or shrinking.
- CANC: window elimination.

You can also exclude a window from the elaboration clicking on it with the right mouse button and selecting the item *Exclude window*.

The *File → Load windows* menu item loads the windows to select from a text file. The selected files must have been previously saved through the *File → Save windows* menu item, that saves in a text file the currently selected windows.

2.4 Work files

The work files can be used to save the elaboration status and reload it later.

These files contain:

- reference to the signal file
- reference to the file that contains the list of the selected windows
- H/V curve calculation parameters
- selected f0 frequency
- reference to the file that contains the ground model
- equivalent velocity calculation parameters
- report generation parameters, including references to the report photos

The extension of a work file is *.hvs* and its name is automatically chosen by the software based on the current time. When saving you only need to select the folder where to save the work, that will contain the work file and where all the other referenced files will be copied. To copy, move or send the work, simply act on the entire folder, which contains all the files relating to the specific work.

Due to the way this work saving mechanism works, each folder can only contain one work file. To update a work, simply select for saving the same folder from which it was loaded, responding affirmatively to the request to overwrite the existing work.

To act on the work files use the items of the menu *File → Work*.

Load a work file using the menu item *File → Work → Load*, selecting the folder that contains it.

Use the menu item *File → Work → Save* to save the current software state in a work file, selecting the folder that will contain the work files and all the related files.

Every time you load or save a job the program updates a list with the last 10 jobs used. From the menu item *File → Work → Last* you can access this list, to quick load the most recent jobs.

The menu item *File* → *Work* → *Search* opens the following window, that allows to search for the work files.

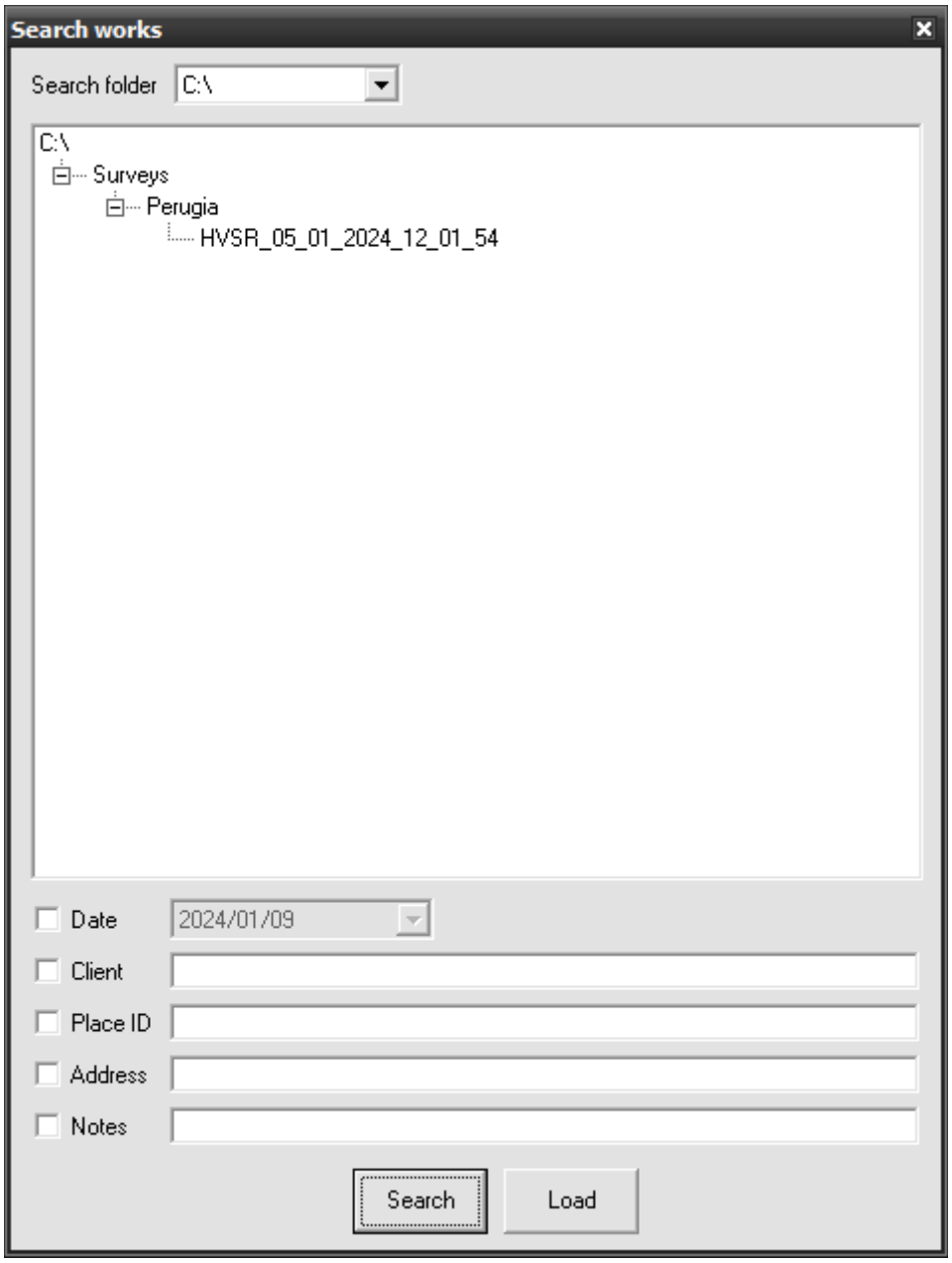

Figure 3

The *Search folder* drop-down list allows you to select the folder where to search, if the "*Select folder...*" item is selected, or to search an entire drive.

It is recommended to perform the full search only on local drives, where it typically completes within a few seconds, while a full search on a network drive may take a long time.

The *Date*, *Client*, *Place ID*, *Address* and *Notes* boxes allow you to restrict the search only to the works that contain the value indicated in the specific parameter and are used only if the check next to the box is enabled.

These parameters can be stored in the work file through the report generation settings window.

2.5 Menu items and other buttons

The menu item *File* → *Load signal* opens a signal file for the elaboration, as explained in the section 2.1.

The items of the *File* → *Work* menu allows to save, load and search for work files, as explained in the section 2.4.

The *File* → *Load windows* and *File* → *Save windows* menu items respectively load and store a file containing the positions of the selected windows and if they are used for the calculation of the H/V curve. Usually there is no need to explicitly use these menu items as this file is generated and saved automatically when the work file is saved.

The *File* → *Exit* menu item closes the program.

The items of the *View* → *Mode* menu allows to select the view mode between the *Geophysics* and *Engineering* mode, as explained in the section 2.2.

The *View* → *Reset windows positions* menu item restores all the windows to their original sizes and positions; this could be useful, for example, when one or more windows are loaded into a position outside of the screen and are no longer usable.

The *Report* menu items allows preparing and generate a report, as will be shown later in the section 7.

The *Tools* → *H/V results* menu item opens the window that shows the H/V ratio calculation results. You can also open it using the *H/V results* button in the lower right corner of the main window.

The *Tools* → *H/V modelling* menu item, or the *H/V modelling* button, open the window for the modelling of the synthetic ellipticity curve and the fitting of the experimental curve.

The *Tools* → *Seismograms player* menu item opens the signal audio player, that will be described in the section 8.1.

The *Tools* → *Response files* menu item opens the window for selecting the response files to be associated with the signal, channel by channel. They will be used for the optional instrumental correction, as will be explained in the section 3.2.

The *?* → *About* menu item shows the version and the credits of the program.

3 HVSR processing

To view the result of the HVSR processing on the selected windows just click on the button *H/V results* in the lower right corner of the main window.

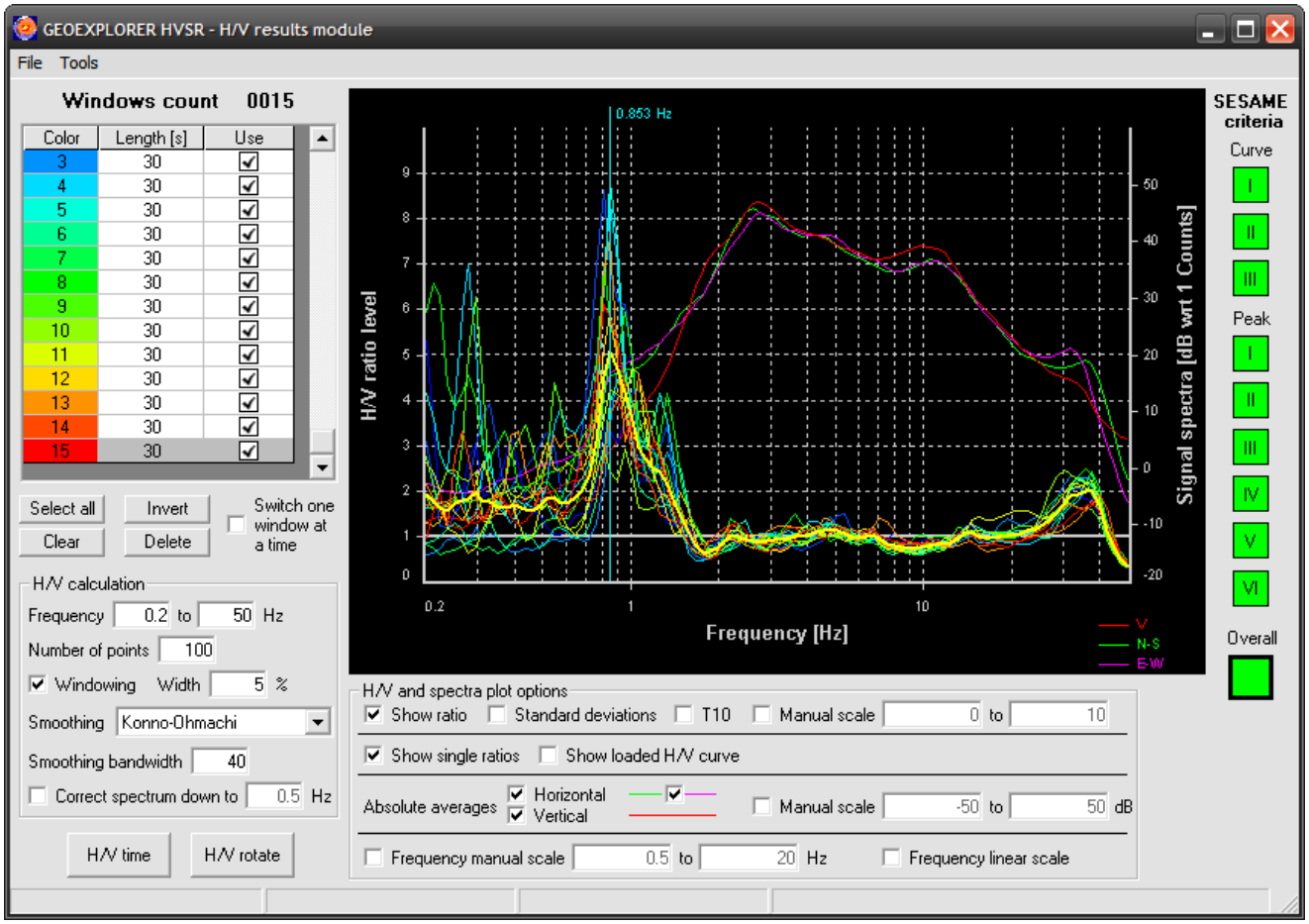

Figure 4

If the window is open, the plot of the processing changes dynamically based on the signal windows selected in the main window.

3.1 Windows management

The grid on the upper left corner shows the selected windows and their length. It is possible to exclude them temporarily from the processing clicking on the corresponding box in the *Use* column.

The *Select all* button selects again all the windows, if some were excluded. The *Clear* button unchecks all the windows, while the *Invert* button inverts the selection.

The *Delete* button deletes the selected windows. It should be used with caution since it is not possible to undo this operation; any deleted window must be selected again in the main

window.

The *Switch one window at a time* box forces the selection of a single window at a time, to understand how each window contributes to the average HVSR curve. When the box is checked, it is possible to change the only selected window using the arrow keys on the grid, without clicking on the *Use* boxes.

3.2 Calculation parameters

The *H/V calculation* frame contains the processing parameters. Any change in these parameters triggers the recalculation of the H/V curve.

The *Frequency* boxes contain the minimum and maximum frequencies within which the curve will be calculated, while the field *Number of points* indicates the number of points of the curve, chosen with logarithmic spacing.

The *Windowing* box indicates whether the windowing operation must be carried out. This operation has the purpose to stabilize the calculation of the spectrum, and consists in multiplying the signal with an appropriate mathematical function. The function applied in this case is known as *Tukey window* (or *tapered cosine window*). The parameter *Width* indicates the width of the applied windowing in relation to the size of the entire signal window.

The *Smoothing* field allows to choose the algorithm used to perform the smoothing of the signal. The available algorithms are *Konno-Ohmachi*, triangular with a window of constant size and triangular with a window of size proportional to the frequency. It is also possible to choose to not smooth the signal. The *Smoothing bandwidth* field adjusts the width of the smoothing window.

The box *Correct spectrum down to* indicates whether the instrumental correction is active and the lowest frequency it should reach. The frequencies below the set one will be corrected with the same factor used for the indicated frequency. The instrumental correction option is available only if the response files have been selected, in the window shown using the *Tools → Response files* item of the menu of the main window.

3.3 Customizing the display

The *H/V and spectra plot options* box shows or hides the various curves and changes the scale, both horizontal and vertical.

The *Show ratio* box acts on the H/V average curve, while the *Standard deviations* box shows or hides the confidence curves. The *T10* box, if selected, displays a red band on the left side of the graph starting from the T10 frequency corresponding to the shortest window among those currently selected. For example, if the shortest window is 40 seconds, the red band will start from the frequency 1/(40/10) = 0.25 Hz. The box and fields *Manual scale* on the left allow to manually adjust the vertical scale of the H/V curves.

The *Horizontal* and *Vertical* boxes act on the spectra of the individual components. If the box without description on the right of the *Horizontal* box is selected, the spectra of the two horizontal components will be shown separately (green line for the N–S component, magenta line for the E–W), otherwise it will be shown the average of them. The box and fields *Manual scale* on the left allow to manually adjust the vertical scale of the spectra of the individual

components.

The *Show single ratios* box shows or hides the H/V curves of the different windows selected on the signal. The *Show loaded H/V curve* box shows or hides any reference H/V curve loaded via the *File → Load H/V curve* menu item.

The box and fields *Frequency manual scale* act on the horizontal axis scale. Obviously it is not possible to extend the scale on frequencies beyond those indicated in the *H/V calculation* frame. The *Frequency linear scale* box changes the representation of the horizontal graphic scale from logarithmic to linear.

3.4 SESAME criteria check

You can select the frequency to be used for the verification of the SESAME criteria clicking on the plot with the left mouse button. This frequency can be changed clicking on another point on the plot or using the RIGHT/LEFT arrow keys.

The nine squares placed vertically on the right of the plot give a visual indication of the criteria fulfillment. Hovering the mouse cursor over each square and waiting a few seconds a tooltip appears, showing the criteria current value and the threshold value. The tenth square indicates whether the criteria are globally respected (all the three in the first group and at least five out of six of the second group).

3.5 Refining the windows selection

It is possible to visually select the windows to exclude from the elaboration, holding down the CTRL key, clicking on the chart with the left mouse button and dragging it while holding down the button, thus selecting a rectangular area. All the curves of the individual windows that will fall within the area will be excluded from the processing. This function is enabled only when the *Show single ratios* box inside the *H/V and spectra plot options* frame is checked.

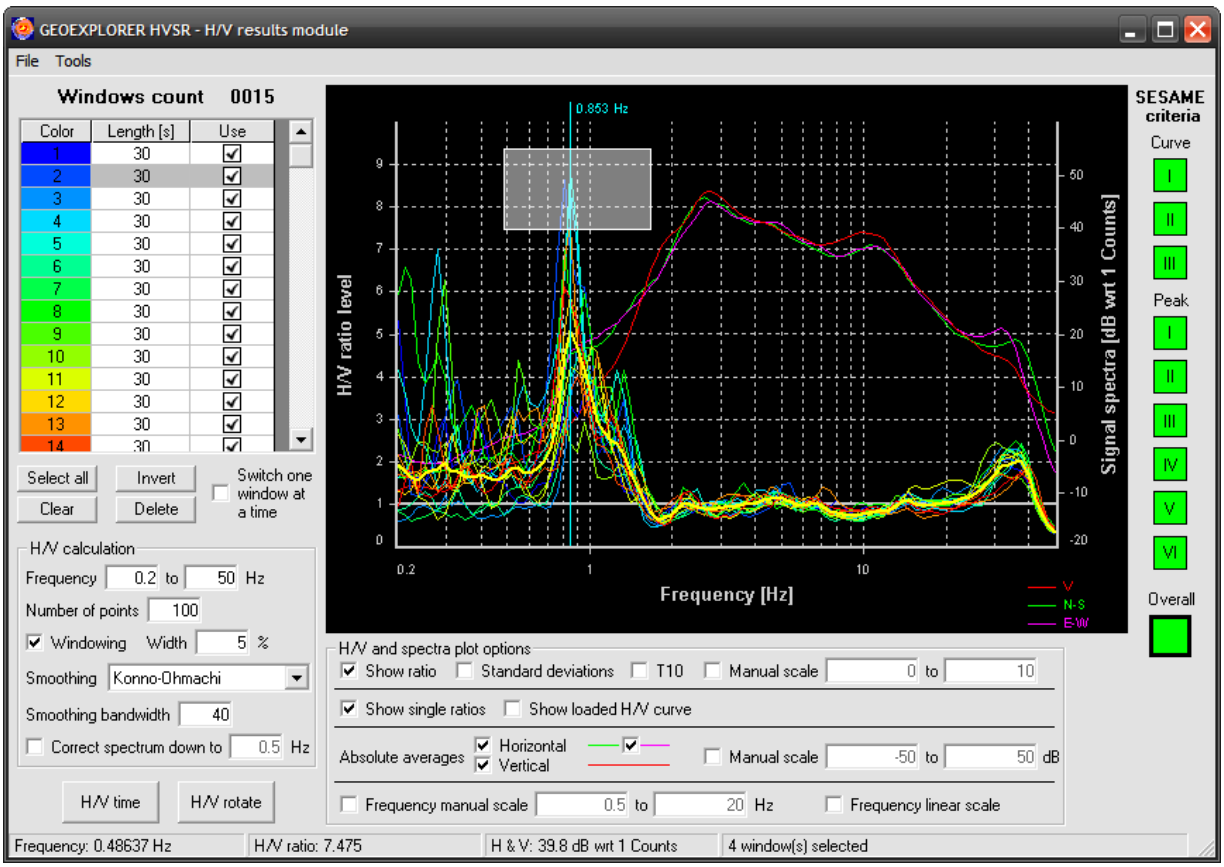

Figure 5

3.6 Menu items and other buttons

The *File → Load H/V curve* menu item loads the H/V curve from a "*.hv*" format file. Such format is the same textual format used by the Geopsy software. If the *Show loaded H/V curve* box is selected, the loaded curve is shown on the chart together the current H/V curve.

The *File → Save H/V curve* menu item saves the current H/V curve in a "*.hv*" file, compatible with Geopsy.

The *Tools → H/V time* menu item opens the window with the graphic of the curve persistence. You can also open it with the *H/V time* button in the lower left corner.

The *Tools → H/V rotate* menu item, or the *H/V rotate* button, open the window with the graphic of the curve directionality.

4 Directionality and persistence

The directionality and persistence plots allow understanding if the H/V curve calculated is generated using signal coming from all the directions, and the situation is stable for all the duration of the survey. In both plots the ordinate axis represents the frequency and the color indicates the amplitude of the H/V ratio, as reported by the legend on the right. The abscissa axis of the directionality plot represent the direction, from North clockwise, while the abscissa axis of the persistence plot represent the time. The triangular light blue marker, present on both plots, highlights the frequency selected on the HVSR processing window for the verification of the SESAME criteria.

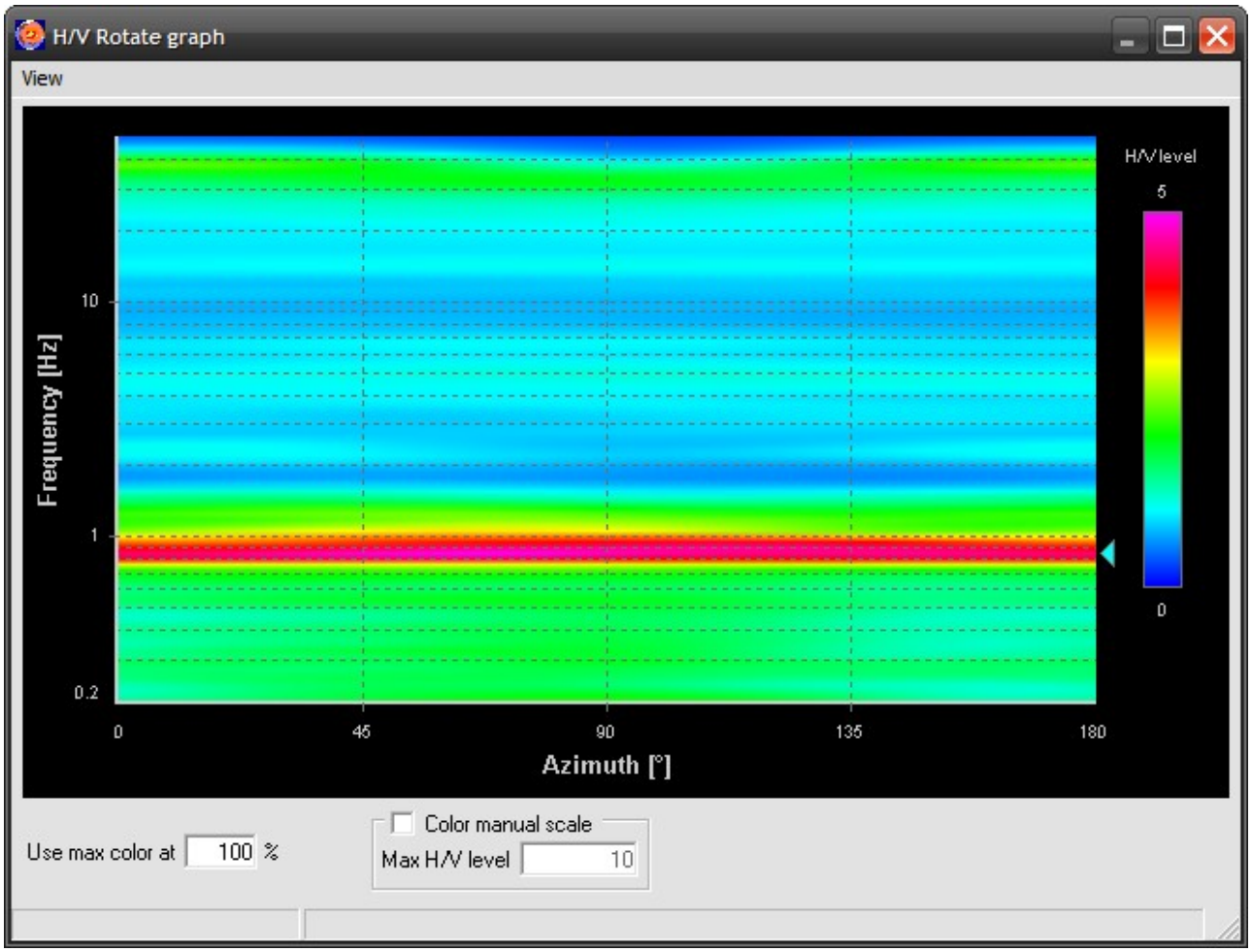

Figure 6: Directionality plot

The directionality plot shows the intensity of the H/V ratio calculated using only the selected windows of signal. A horizontal band uniformly colored between two frequencies indicates that the vibrations originate with the same intensity from all the directions in that range of frequencies. When the coloring of a horizontal band changes, it means that the vibrations have a predominant origin from the direction with the colors corresponding to a higher H/V level.

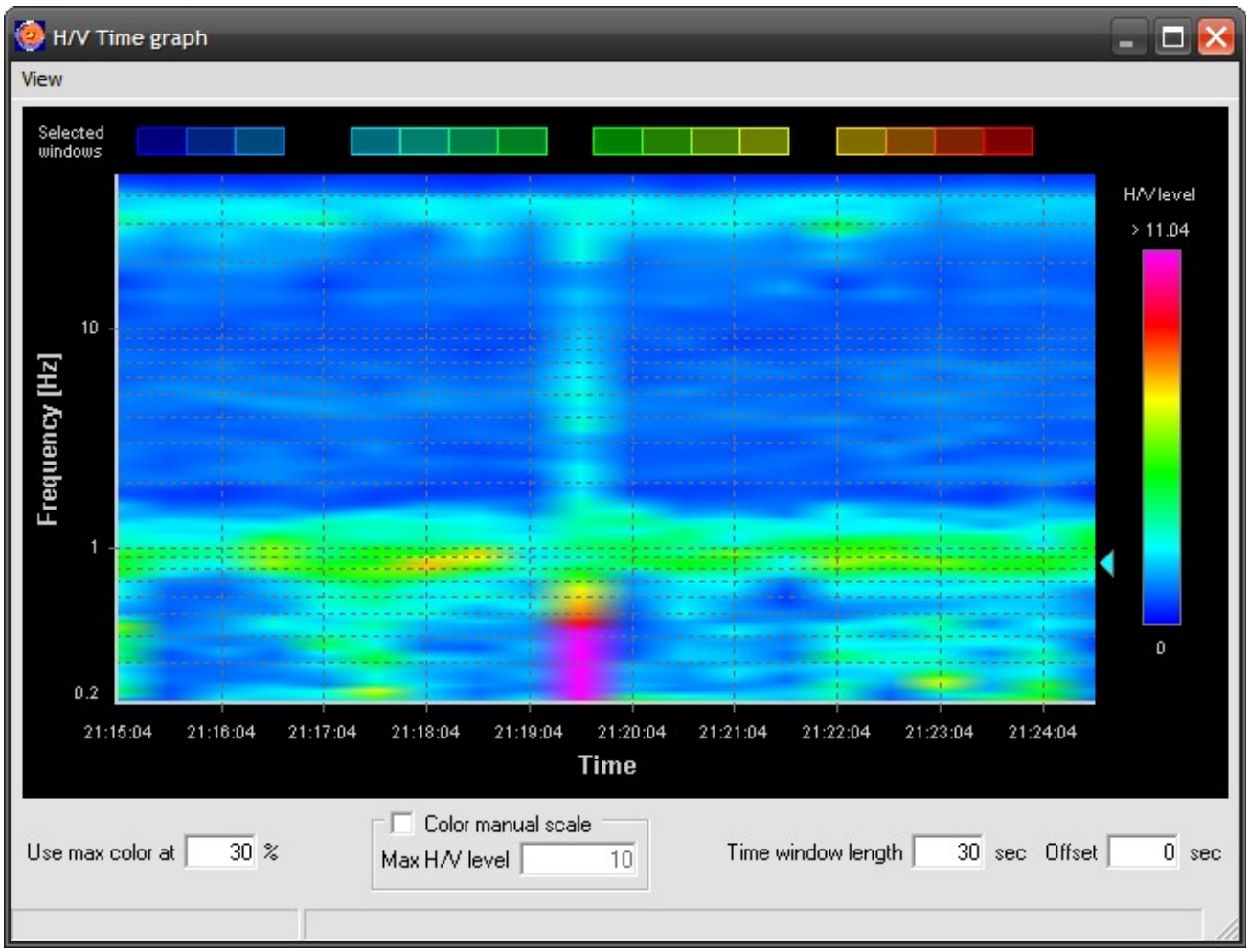

Figure 7: Persistence plot

The persistence plot is obtained splitting the signal into windows of same length, regardless of the selection made by the user. You can discard a portion of the data from the initial part of the signal.

The upper part of the persistence plot shows the position of the selected windows in relation to the represented time. Clicking on a window with the right mouse button, it shows a contextual menu with just one item, *Exclude window*, which allows to immediately exclude the window from the processing.

The *Use max color at* field indicates to use the color that represents the maximum amplitude to draw all the amplitudes ranging from the maximum to that one corresponding to the maximum amplitude reduced by the indicated percentage.This setting allows to better view the low amplitudes, especially when there is an amplitude much greater than the others.

The *Color manual scale* box, together with the *Max H/V level* field, have a similar purpose: set here the value beyond which all amplitudes are represented with the maximum amplitude color.

The persistence plot window contains two additional controls: *Time window length*, to set the size of the signal windows used to generate the plot, and *Offset*, to set the initial portion to discard.

Any changes made to the windows selection or to the calculation parameters are not applied in real-time on the directionality and persistence plots. The *View* → *Refresh* menu item updates the plot based on the current processing status.

5 Stratigrapihc profile modelling

The *H/V modelling* button, in the lower right corner of the main window, opens the window that allows to build the model of the stratigraphic profile from the experimentally elaborated H/V curve.

In the figure below the experimental H/V (or ellipticity) curve is represented with a yellow line; it can be the one currently calculated or a curve loaded from a file. In the same figure, the synthetic ellipticity curve (green line) is calculated and shown according to the inserted stratigraphy.

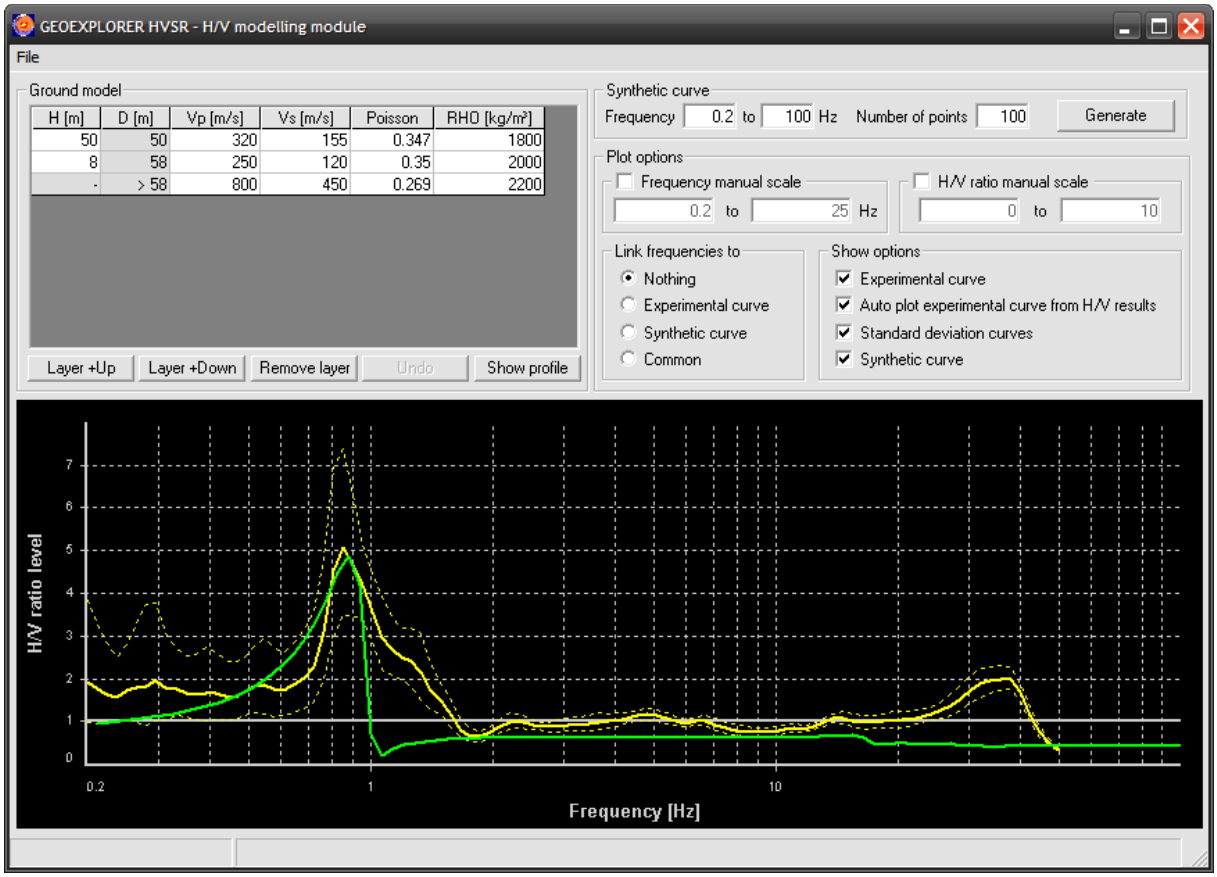

Figure 8

5.1 Inserting the stratigraphy

In the *Ground model* frame you can insert and edit the information about the stratigraphy that will be used by the program to generate the synthetic ellipticity curve.

The stratigraphy grid contains the stratigraphic data organized in the following columns:

- *H [m]*: height of the layer.
- *D [m]*: layer depth.
- *VP [m/s]*: VP of the layer.
- *VS [m/s]*: VS of the layer.
- *Poisson*: Poisson ratio of the layer.
- *RHO [kg/m^3]*: density of the layer.

Each row of the grid corresponds to a layer; the last line corresponds to the bedrock.

To populate the grid just select the cell you want to edit and enter the desired value: any previous value will be overwritten and the outline of the cell will become thicker. To stop inserting just move on to another cell, using the mouse or the arrow keys, or press the ENTER key.

Note that you can only insert numeric values (including the point as decimal separator) in the grid cells. Furthermore, the cells with gray background can not be changed: the value of the cells in the depth column is in fact derived from the height of the layer, and the thickness of the bedrock is assumed to be infinite.

To change the content of a cell without removing the existing value, select the cell and press F2. To cancel the edit and restore the content the cell had before the change, press the ESC key.

The content of a cell can be blocked to avoid to accidentally modify it. Select the cell and press the space key, or click on the cell with the right mouse button and select the *Lock cell* item from the contextual menu. The locked cells are highlighted with a red background. To unlock a locked cell you will have to perform the same actions, with the difference that the menu item to be selected is named *Unlock cell*.

Initially, the grid does not contain any layer. The *Layer +Up* and *Layer +Down* buttons insert a new layer above or below the row containing the currently selected cell. The *Remove layer button* removes the selected layer.

The *Undo* button undoes any change made to the grid, both entire rows inserted or removed and the values of the individual cells.

The *Show profile* buttons opens the graph of the speeds profile, which will be discussed in detail in the section 6.

5.2 Generation of the synthetic curve

Using the *Synthetic curve* frame you can generate the synthetic ellipticity curve.

In the *Frequencies* fields you can set the start and the end frequencies between which the curve will be calculated, while the *Number of points* field indicates its number of points.

The *Generate* button computes and shows, if enabled, the synthetic ellipticity curve corresponding to the current stratigraphy.

5.3 Display parameters

In the *Plot options* frame you can change the display settings of the curves.

The *Frequency manual scale* and *H/V ratio manual scale* boxes change respectively the horizontal and the vertical graphic scale.

The options in the *Link frequencies to* frame automatically set the horizontal scale so that you can see in full both the experimental and synthetic curves, only one of them or just the parts in common.

The *Experimental curve*, *Standard deviation curves* and *Synthetic curve* boxes show or hide the relative curves. The *Auto plot experimental curve from H/V results* box indicates whether the experimental curve to display must be the one currently calculated or that one loaded from file, if any.

5.4 Menu items

The *File* → *Save ground model* menu item saves the current stratigraphy in a text file, while the *File* → *Load ground model* menu item loads the stratigraphy from a previously saved file.

The *File* → *Load experimental curve* item loads the experimental H/V curve from a "*.hv*" format file.

The contextual menu of the stratigraphy grid also contains the *Copy grid image to the clipboard* item, besides the already mentioned *Lock cell* and *Unlock cell* items, that copies the grid image to the Windows clipboard.

6 Velocity profile chart

The window of the velocity profile chart is shown clicking the *Show profile* button on the window of the stratigraphic profile modelling.

The plot shows the profile of the velocity of the P and S waves at different depths.

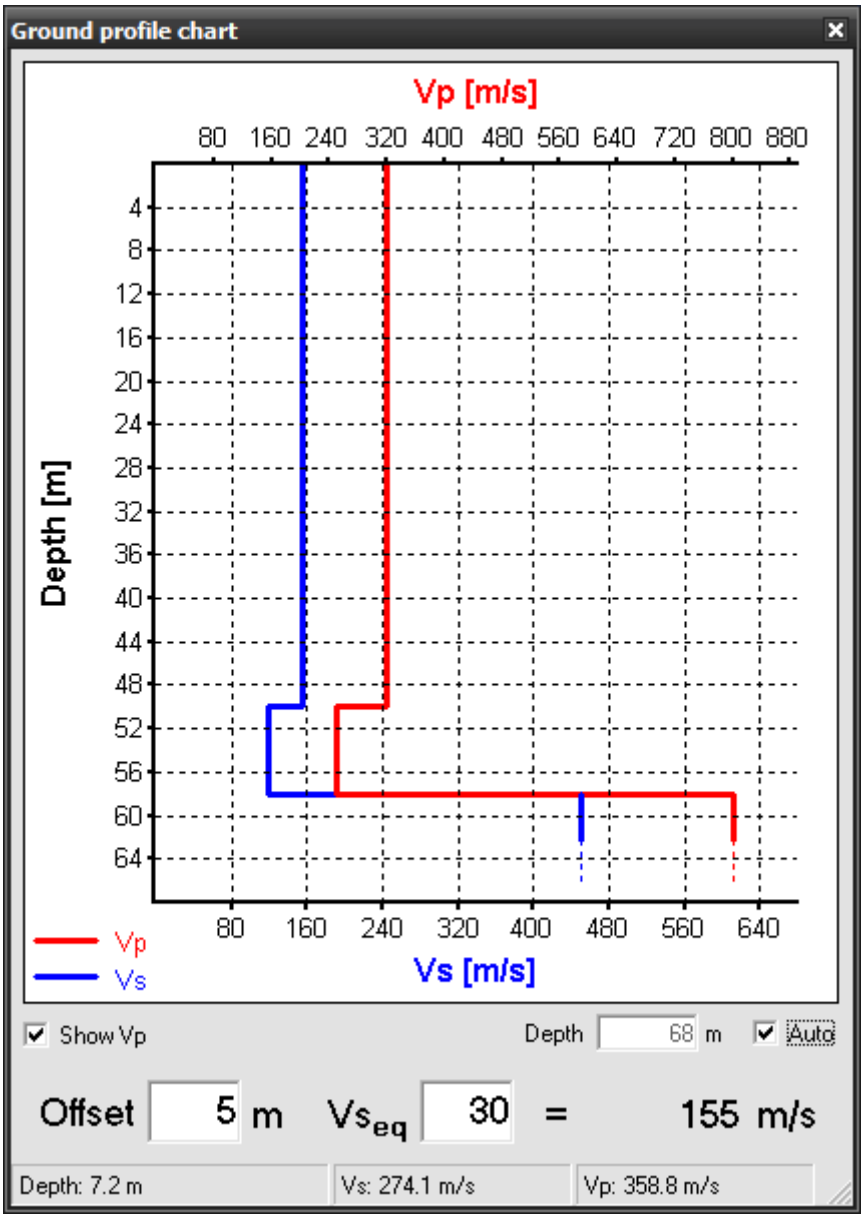

Figure 9

The abscissa axis shows the velocity of the S waves in m/s, its scale is shown at the bottom of the graph. If the Vp are displayed, the abscissa axis also represents the P waves velocity in m/s, and its scale is shown at the top. The values spacing is different for the two velocity so that they are properly displayed, avoiding as much as possible to superimpose them.

The ordinate axis represents the depth in m.

The *Show Vp* box shows or hides the representation of the P waves velocity.

The *Auto* box enables or disables the depth automatic scaling. When this view is disabled, it is possible to reduce the maximum depth displayed typing the desired value in the *Depth* box.

The *Offset* and *Vs* fields allow calculating the equivalent velocity of the S waves at a given depth, possibly discarding some meters from the surface (offset). For example, to calculate the equivalent velocity of the first 30 meters discarding 3 meters from the surface just enter “3” in the field *Offset* and “30” in the field *Vs*, then calculating the equivalent velocity of the layers in the range 3–33 meters.

7 Report

To generate the elaboration report just click on the *Report* → *Generate report* item of the menu of the main window: you can insert and edit some descriptive data of the survey in the window that will be shown; these data will appear on the first page of the report.

You can also add up to two image files at the report.

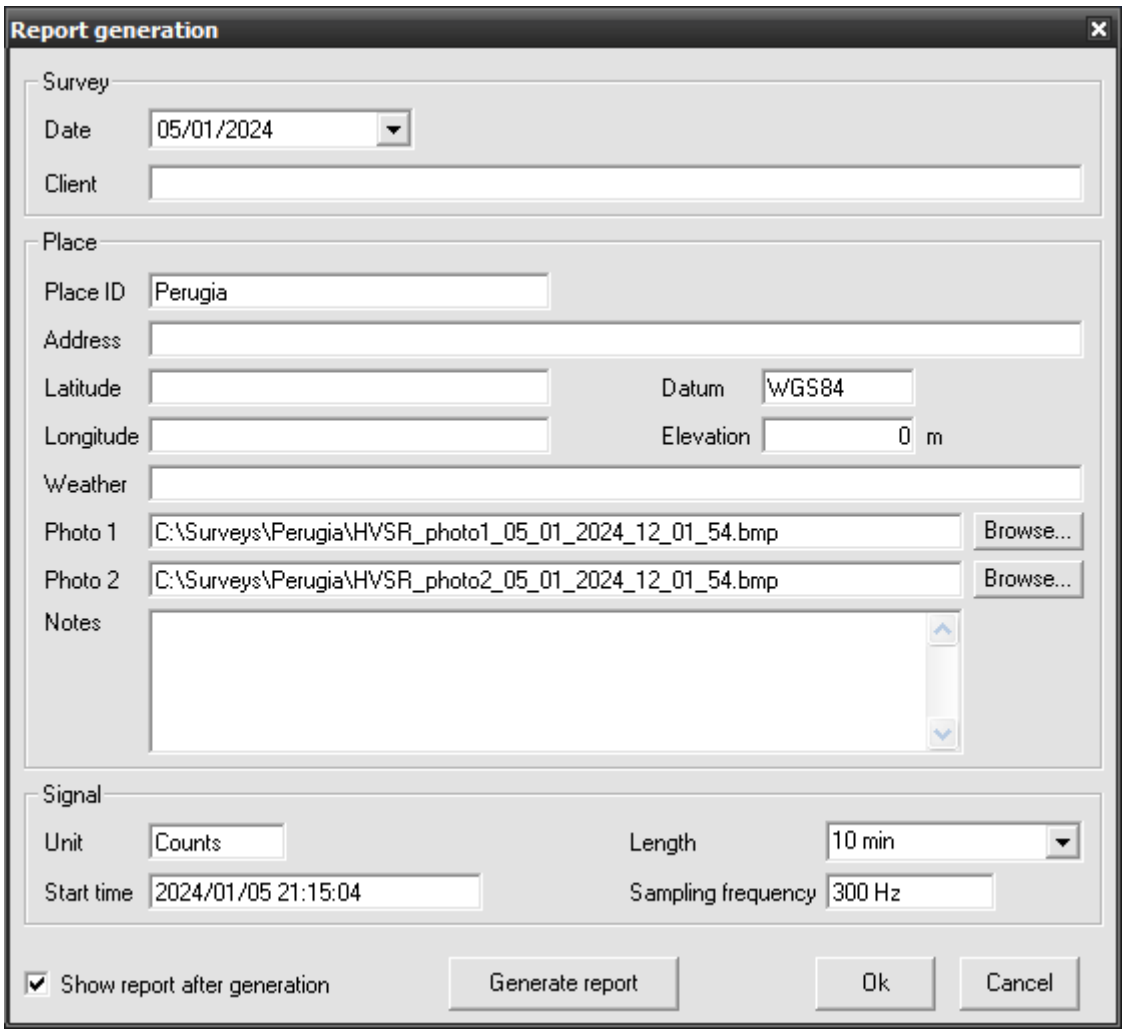

Figure 10

The report is generated in the *pdf* format.

The *Generate Report* button starts the report generation.

If the *Show report after generation* box is checked, the program shows the report once its generation is completed, using the system default program for the *pdf* files opening.

The *Ok* and *Cancel* buttons should instead be used if this window is opened only to enter the report parameters, without generating the report. The *Ok* button stores the data in the program settings, so that they can be inserted into the work file, while the *Cancel* button discards any

changes made.

The *Report* → *Settings* item of the menu of the main window allows instead to enter the parameters that should be the same for all the surveys (for example the instrument type or the sensor type).

8 Other tools

8.1 Audio player

The *Tools* → *Seismograms player* item of the menu of the main window opens a window that allows you to listen the sound of the loaded signal (signal audification).

The audio player can be useful to verify the quality of the signal, especially to detect human generated noise which are not visible by a simple observation of the seismogram.

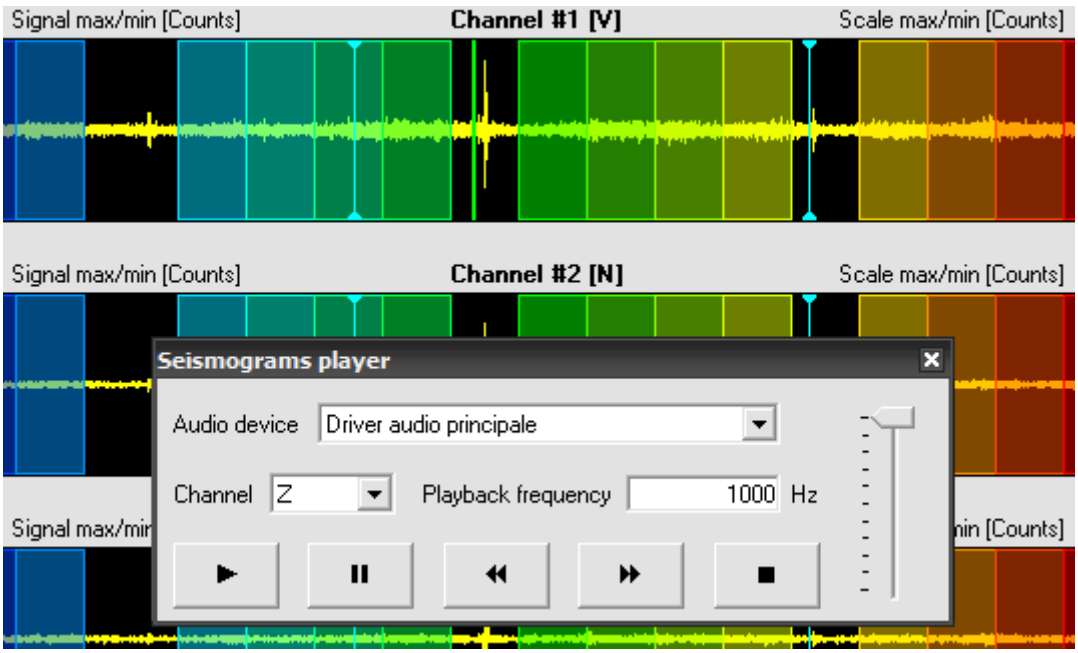

Figure 11

Select in the *Audio device* drop-down the audio device for the sound playback.

Select in the *Channel* field the channel to be played, while set in the *Playback frequency* field the playback frequency; adjust the volume using the slider on the right.

The buttons along the bottom side of the window perform the standard functions of any media player: *Play*, *Pause*, *Rewind*, *Fast forward* and *Stop*.

A green vertical marker flowing on the graph of the played channel is displayed during playback, as shown in the figure (the graph of channel V).

When the audio player window is open the contextual menu of the signal graphs provides the following functions:

- *Play from here*, which allows you to start or move audio playback to a specific point of the seismogram, even on a channel other than the one currently playing.
- *Set marker*, to set the position of signal markers (represented as blue vertical lines in the figure) which can be used, for example, to identify the portions of the signal that contains non-visible noise.

When clicking with the right mouse button over a marker is instead shown only the *Remove marker* item, to delete a previously set marker.

These markers are also stored in the work file.

8.2 Response files

The *Tools* → *Response files* menu item shows the window for the selection of the response files, where each channel must be associated with its own file.

The colored box next to each file indicates whether the file contains valid data (green) or not (red).

9 Common functions

All the program graphs have a contextual menu displayed clicking with the right mouse button above the plot.

The *Copy image to the clipboard* item copies the plot to the Windows clipboard so you can paste it into any other application.

The *Save as image file* item saves the plot as an image file in different formats.