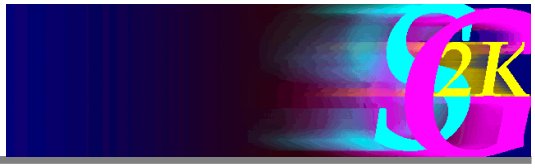
SeisGram2K-School Users Guide



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Contents

The SeisGram2K Program

Overview

The SeisGram2K Seismogram Viewer is a Java program for interactive viewing of earthquake seismogram traces locally or over the Internet.

SeisGram2K displays one or more sets of single trace or 3-component seismograms. The viewer supports: zooming, scaling and transformation of the seismograms; rotation of horizontal component traces; time and amplitude picking; animated, 3D particle motion display; time-domain integration and differentiation; interactive spectral and spectrogram displays; frequency-domain filtering, instrument removal and other processing; and much more.

SeisGram2K displays trace channels in one or more "trace-group" windows. Each trace-group window displays all of its traces with identical time and amplitude scales.

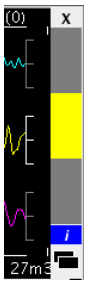
Most viewing and processing operations act on all traces in a trace-group. A trace-group may contain one or more channels from one or more stations or instruments. For trace-groups containing an orthogonal, three-component set of channels from a unique site, the rotation of horizontal components, an animated particle motion view, and a set of multi-component analysis tools are available.

Basic Interactive Viewing

Seismogram Group View

Zooming:	Press the left mouse button and drag the mouse slowly over the middle trace to form a zoom window. Release the left mouse button to apply the zoom.
Changing the Time Window:	Roll the mouse wheel, or click the left mouse button on the seismogram at two times (second after the first) to rescale the time window.
Resetting the Time Window:	Click the left mouse button at two times (second before first) to reset to the initial time window.
Selecting the Active Trace and Trace-Group:	Click on an inactive trace-group to select it as the active group. Click on one of the vertical bars to the right of the traces to select the active trace and trace-group.
Active Trace and Trace-Group operations:	See Seismogram Group View below.
Keyboard operations (active only when mouse focus is in a trace-group window):	Press the PageUp / PageDown buttons to change the active trace-group. Press the UP / DOWN arrow buttons to increase / decrease the amplitude of the traces in the active trace-group Press the LEFT / RIGHT arrow buttons to shift the time window to the left or right Press the HOME / END increase / decrease the width of the time window for the traces in the active trace-group

Seismogram Group Toolbar



X	close seismograms
<vertical bars on right>	selects a trace in the seismogram group
	display the station and event information for the currently selected seismogram trace
	create a copy of the current seismogram trace-group truncated in time at its current viewing window

Menus

File Menu

Select File…	open seismogram files on the local file system
Open Web Location...	specify seismogram files on the Internet
Open SeedLink…	create a connection to a SeedLink server and display specified seismograms
Open Bud dir…	browse for IRIS-Bud directory seismogram files locally or over the Internet
Close Active	close currently selected seismograms
Close All	close all seismograms
Save Active As...	save selected seismograms to disk
Duplicate Active	create a copy of the currently selected seismograms in the viewing window
Reset Active	reset currently selected seismograms to their initial state
Print...	print all visible seismograms
Snapshot	save an image of the entire viewing window
Exit	close the viewing window and exit the program

View Menu

Spectrum	open a spectral view (amplitude vs. frequency) for the selected trace
Spectrogram	open a spectrogram view (frequency vs. time) for the selected trace
Helicorder	display seismograms in multi-line, helicorder mode
Seismogram info	display the station and event information for the selected seismogram
Number trace groups...	set the maximum number of trace groups to display before scrolling
Full Window	toggles display of the selected seismograms in the full SeisGram2K window
Align time to... Active	align all seismograms to the time window of the selected seismogram
Align time to... Global	align all seismograms within a time window encompassing all seismograms
Lock Alignment	keep current seismogram time alignement during seismogram analysis
Full Window	display only the selected seismograms in the full viewing window
Viewing Toolbar	toggle the visibility of the viewing tools (amplitude, time alignment ...)
Analysis Toolbar	toggle the visibility of the analysis tools (pick, filter …)
Message Window	toggle the visibility of the message window
Enable Expert Mode	enable/disable expert features of SeisGram2K (Rotate, Travel-time, ...)
Invert Colours	toggles seismogram colours between normal and inverted colours
Grey Scale	toggles seismogram colours between coloured and greyscale

Utilities Menu

Language...	change the language of the user interface (English, French or Italien)

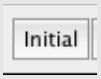
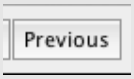
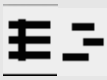
Header Editor	edit the station and event information for the currently selected seismogram
Enable Travel Time	enable display of theoretical phase arrivals (PREM Earth model)
EduCarte	open EduCarte at www.edusismo.org in your browser

Help Menu

Help	display the program help information
About SeisGram2K	display the program information
Update	open on-line program support page at www.edusismo.org in your browser

Principal Toolbars

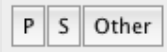
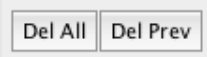
Viewing Toolbar

	increase or decrease the signal amplitude
	decrease or increase the time window width
	move backwards or forwards in time
	reset currently selected seismograms to their initial time and amplitude windows
	display currently selected seismograms with their previous time and amplitude windows
	align all seismograms within a time window encompassing all seismograms
	lock or unlock seismogram time alignment
	align signal amplitudes to the maximum visible amplitude
	display the selected seismograms or all seismograms in the full viewing window
	reset selected seismogram to its initial state (undo all)
	tools to estimate the epicentral distance: Hodo-local for a local earthquake (distance < 300km), or Hodo-tele for a distant earthquake (regional or teleseismic, distance > 300km)
	display theoretical phase arrival times for certain seismic wave types (PREM Earth model)
	open EduCarte at www.edusismo.org in your browser

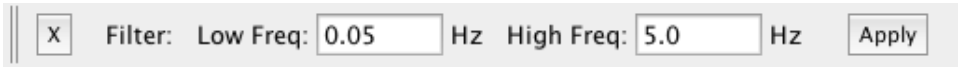
Analysis Toolbar

Pick...	open pick toolbar: pick in time seismic phases and other features on the seismograms
Filter...	open filter toolbar: filter the selected seismograms within a specified frequency window (Hz)
Transfer...	open transfer toolbar: convert selected seismograms from one instrument type to another
Spectrum	open a spectral view (amplitude vs. frequency) for the selected trace
Spectrogram	open a spectrogram view (frequency vs. time) for the selected trace
AmplitudeUnits	convert displayed amplitudes from instrument units to ground motion units for the selected trace

Pick Toolbar

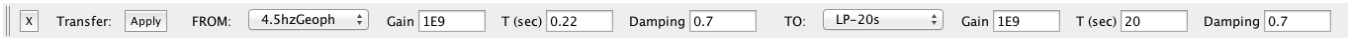
	pick at current cursor position P and S seismic phases and other features on the seismograms
	delete all picks or the previous pick

Filter Toolbar



Low / High Freq:	set the filter frequency window (Hz)
Apply	filter the selected seismograms with the specified frequency window

Transfer Toolbar (NERA)



Apply	apply the conversion with specified FROM and TO transfer functions for selected seismograms
FROM:	sets transfer function (instrument type, gain, period and damping) of currently displayed seismogram
TO:	sets transfer function (instrument type, gain, period and damping) of desired transformed seismogram

Rotate Toolbar

Angle:	set the rotation angle of the Y trace in degrees clockwise from North
<buttons>	Increment the rotation angle the specified number of degrees

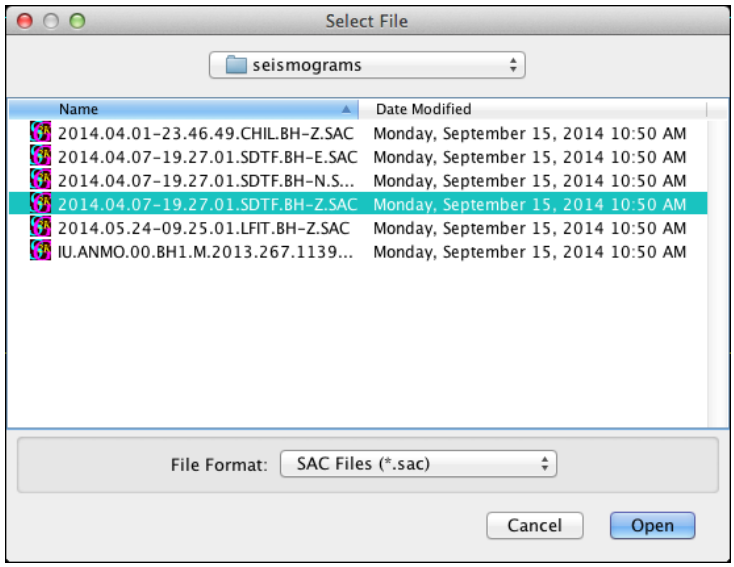
Phases Toolbar

To: (h, m, s)	Sets the origin time (To) for the event
D:	Sets the distance from the event to the station
H:	Sets the depth of the event
Options...	Displays the Theoretical Phase Arrival Dialogue
SaveAsPicks	Convert the theoretical arrivals to picks which can be edited using the Pick Toolbar
Ray Info	Displays information on the ray (path through the Earth) for each displayed phase

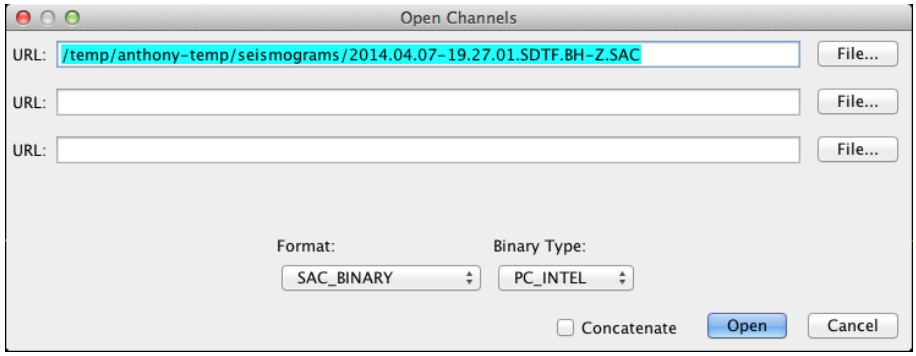
Dialogues

Select File Dialogue

Select one or more files to open in two steps. First, select a file format filter, the directory and a file or files to open, and press Open:



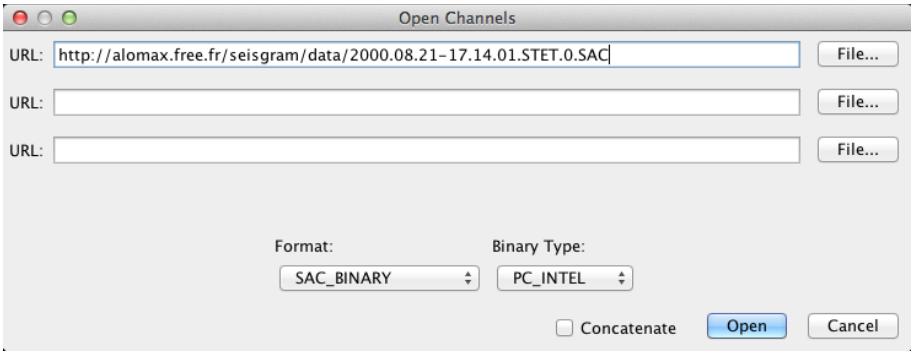
Second, confirm the file URL's, file format and binary type and press Open.



Use the “concatenate” button to combine a sequential set of data files into one seismogram trace.

Open Web Location Dialogue

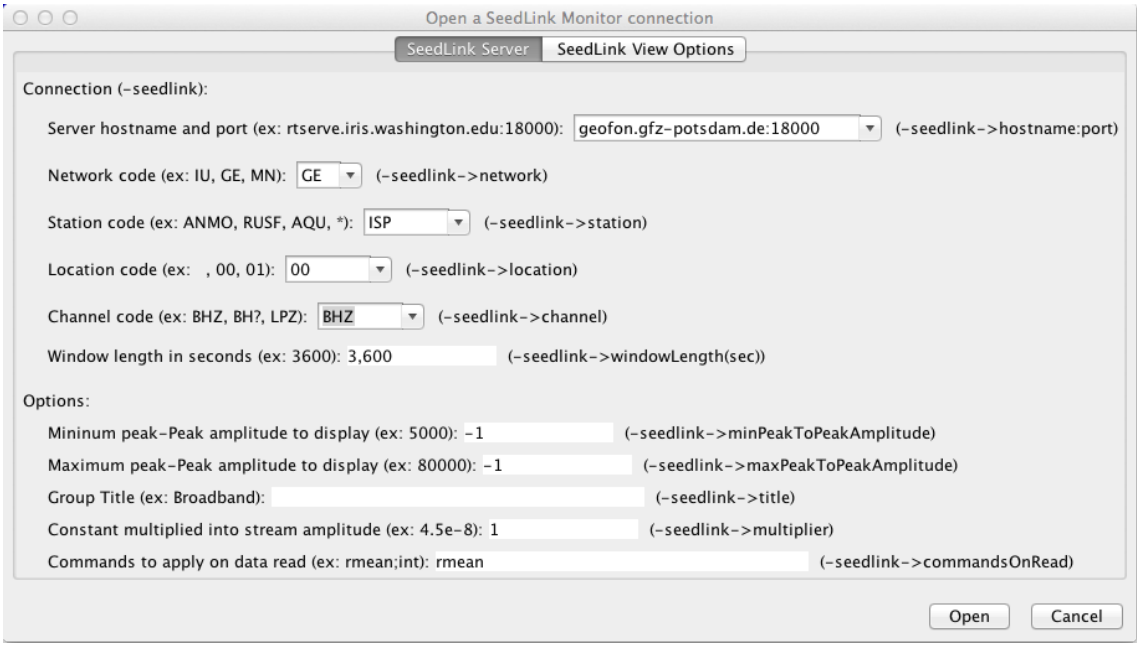
Enter one or more data file URL's, confirm the file format and binary type and press Open.



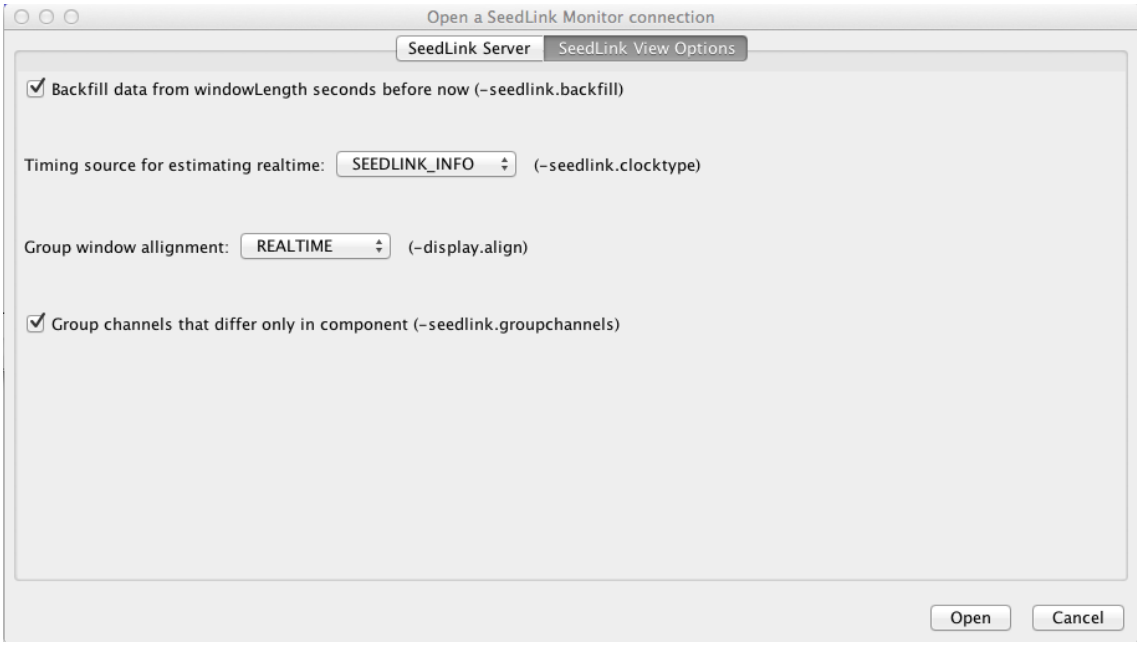
Use the “concatenate” button to combine a sequential set of data files into one seismogram trace.

Open SeedLink Dialogue (NERA)

The Open SeedLink dialog allows specification of a connection to a SeedLink Server to open one or more seismogram channels for real-time display in SeisGram2K SeedLink Monitor. In the main, “SeedLink Server” panel of the dialog, choose a server hostname and port, and then, sequentially, the desired network, station, location and channel codes. For some servers SeisGram2K will provide a pull-down list of available choices for these codes, otherwise, you must enter accurately a server hostname and port, and the network, station, location and channel codes. You can also enter the window length to display and several options controlling the scaling, labelling and processing of the data.

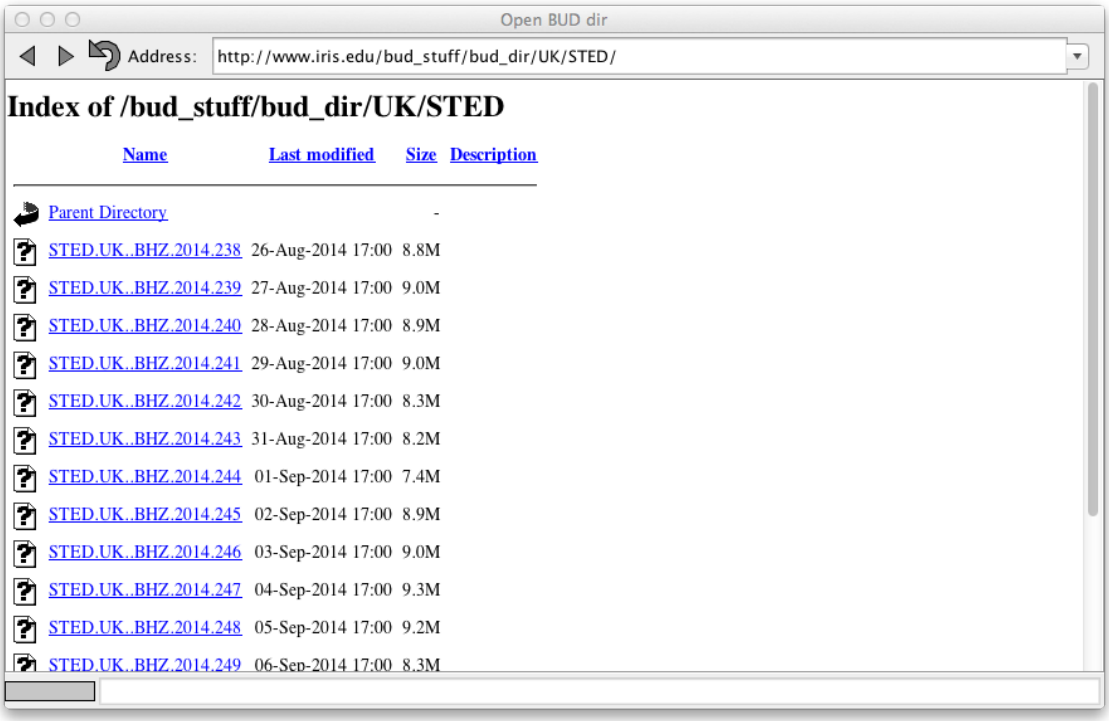


The “SeedLink View Options” panel of the dialog, allows set specific SeedLink and SeisGram2K display options:

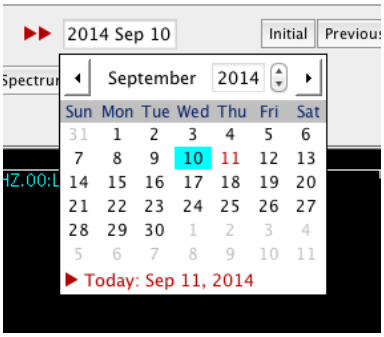


Open Bud Dir Dialogue (NERA)

The Open Bud Dir dialog allows the browsing of an IRIS Bud format directory structure locally or over the internet.



When a seismogram trace data file is clicked, SeisGram2K loads and displays the trace data the file. You can then scroll or jump in time beyond the limits of the selected data file, and SeisGram2K will find and display the necessary data from the available data in the Bud directory. SeisGram2K also provides a calendar tool to jump in time to display data in the Bud directory:

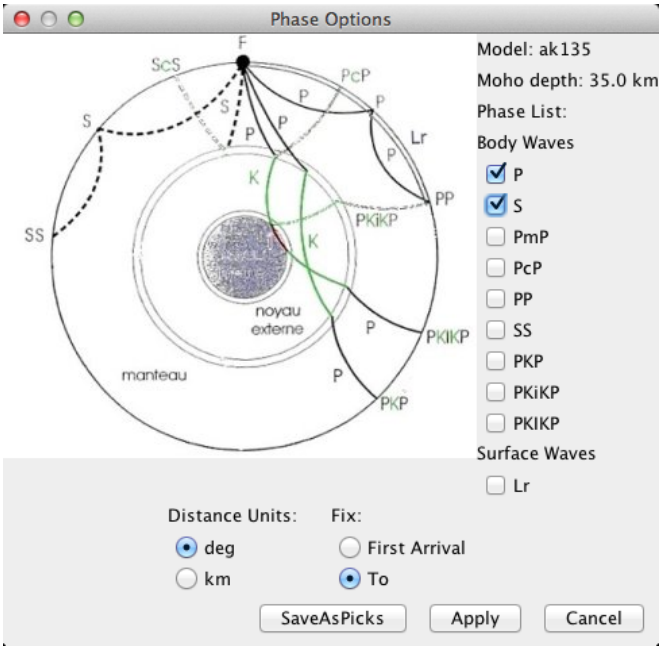


Note that the loading and update of data from a Bud directory may be slow, depending on the size of the data files, the amount of data required, and the speed of the connection to the Bud directory.

It is useful to activate Helicorder view mode when large time windows (e.g. several hours or more) of data from a Bud directory is displayed.

Theoretical Phase Arrival Dialogue

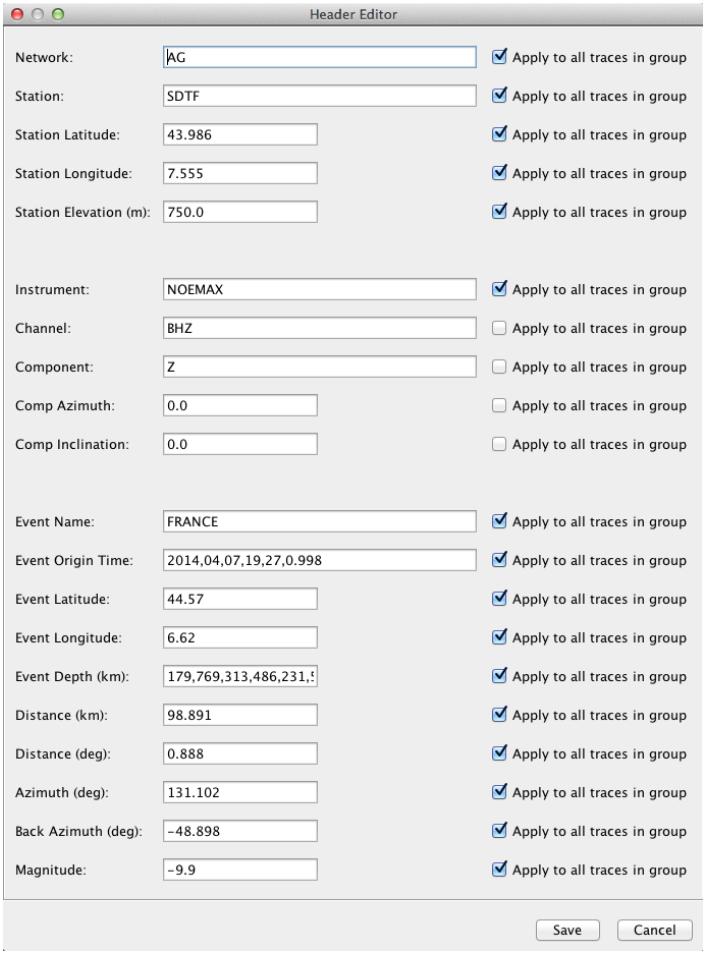
Use this dialogue to select the theoretical phase types to display on the seismograms:



Select one or more body or surface wave phase types to display on the seismograms. Select the Distance Units for the Phases Toolbar and if the time of the First Arrival or the origin time (To) is fixed when changes are made in the Phases Toolbar. Press Apply to display the theoretical arrivals on the seismogram. Press SaveAsPicks to convert the theoretical arrivals to picks which can be edited using the Pick Toolbar.

Header Editor Dialogue

Use the header editor to edit the header information for individual seismogram trace and trace-group:

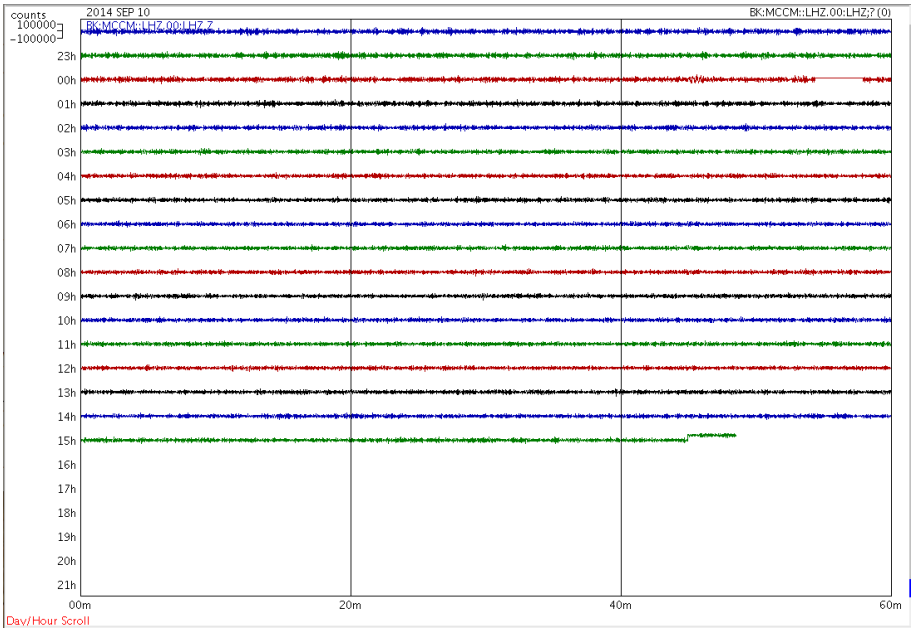


Select “Apply to all traces in group” to make changes for all seismogram traces in the active trace-group.

Additional View Modes

Helicorder View Mode (NERA)

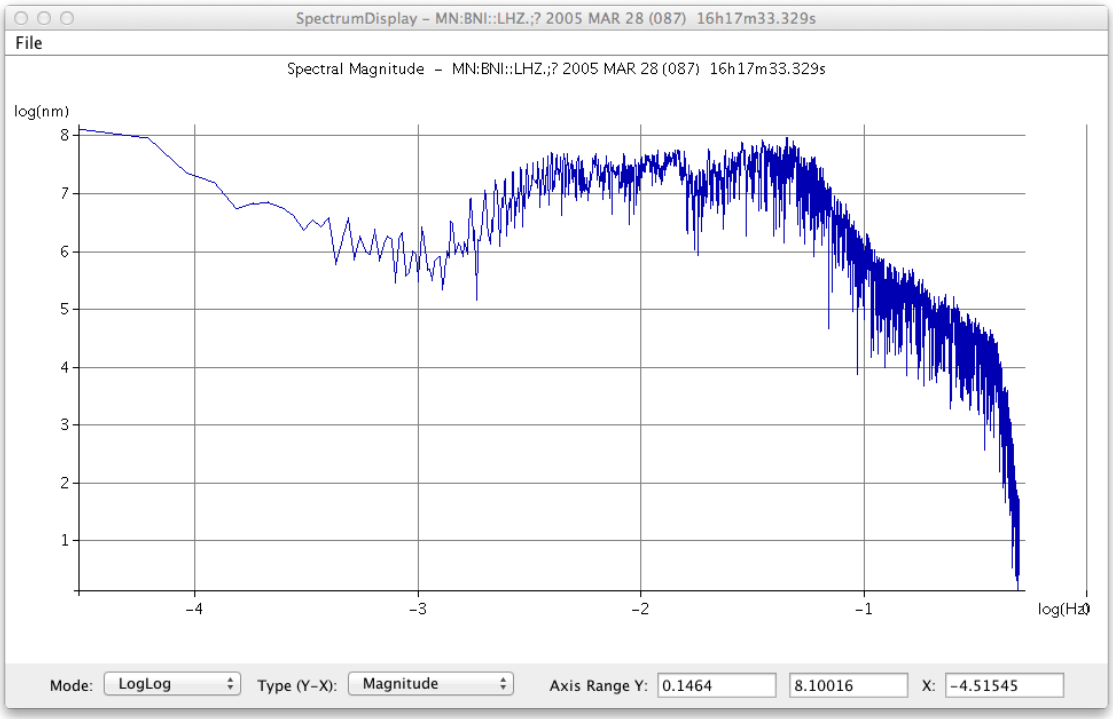
In this mode, the available seismogram data in each trace-group is displayed in 24 rows of one hour each, representing 1 day of data, much like a traditional, paper, “helicorder” seismogram. Helicorder view mode is useful when large time windows of data are displayed.



Many standard SeisGram2K mouse and toolbar viewing and analysis tools can be applied in Helicorder view model. When the data is windowed or zoomed to an interval much less than 1 day, the display automatically returns to standard view mode so the seismogram can be more easily analysed. Returning to a larger window of data automatically restores Helicorder view mode.

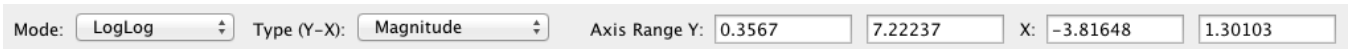
Spectrum Analysis View Mode

When Spectrum view is selected, a new window with a spectral display for the selected seismogram is displayed.



The spectral display by default shows the magnitude of the amplitude (Y axis) of each frequency component (X axis) in the displayed seismogram window. Other types of display for the Y axis are: signal phase, real component, imaginary component, and spectral density. The Spectrum View Toolbar provides options for the type and presentation of the display.

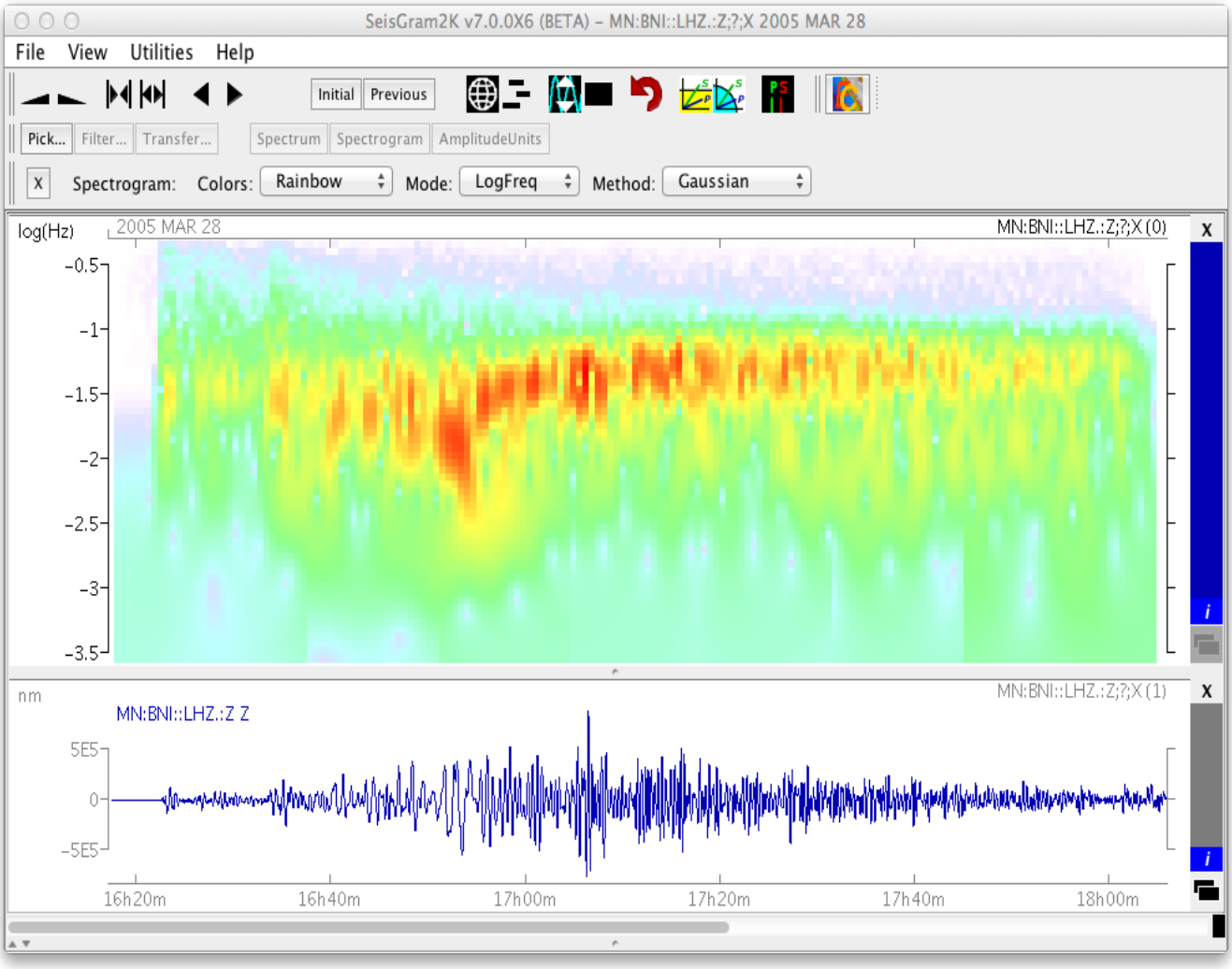
Spectrum View Toolbar



Mode:	sets the spectrum display mode (linear or logarithmic frequency and time binning)
Type:	sets the quantity to display on the Y axis
Axis Range Y/X:	sets the minimum and maximum range for the Y and X axes

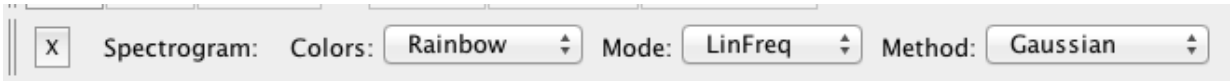
Spectrogram Analysis View Mode (NERA)

When Spectrogram view is selected, a new window with a spectrogram display and the selected seismogram is displayed. The spectrogram and seismogram are aligned in time (X axis), and many standard SeisGram2K mouse and toolbar viewing and analysis tools can be applied.



The spectrogram display shows the signal amplitudes as a colour intensity plotted as a function of time (X axis) and frequency (Y axis). The Spectrogram Toolbar provides options for the type and presentation of the display.

Spectrogram Toolbar

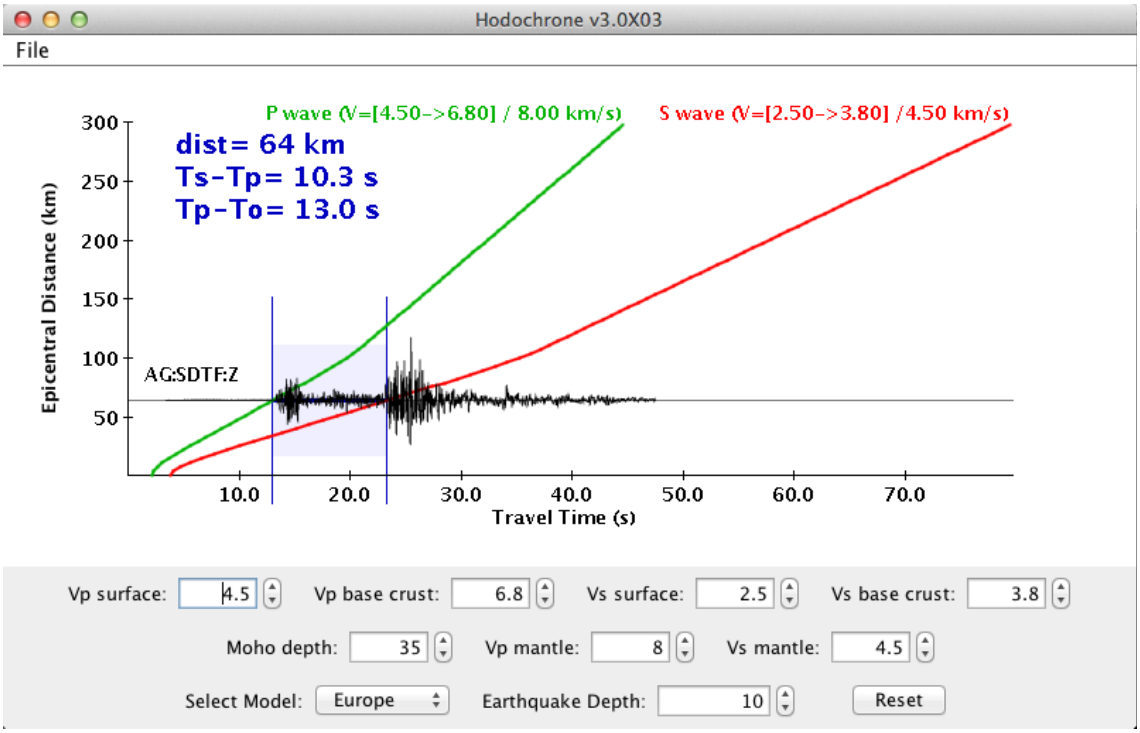


Colors:	sets the spectrogram colour palette
Mode:	sets the spectrogram display mode (linear or logarithmic frequency binning)
Method:	sets the spectrogram, narrow-band frequency filtering algorithm (Gaussian: non-causal Gaussian filter; Butterworth: causal filter; Amplitude: non-causal filter)

Additional Tools

Hodochrone Travel-time Graph (NERA)

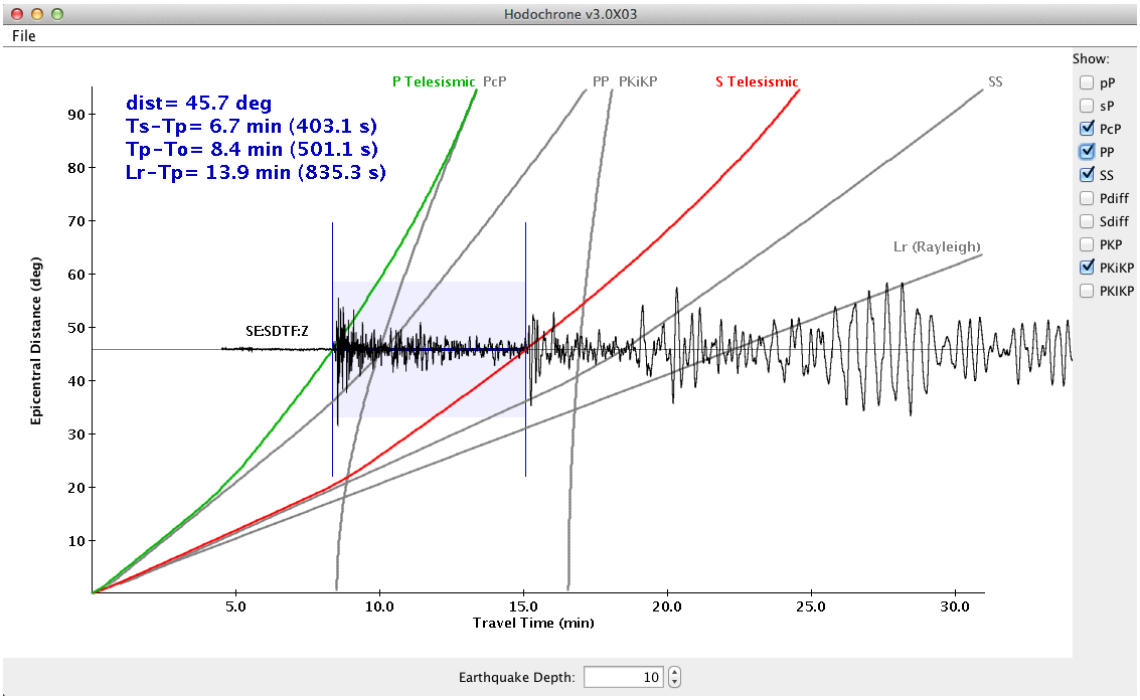
The Hodochrone travel-time graph allows interactive matching of observed wave arrival energy with theoretical phase travel-times for a specified seismic wave velocity model:



The tool shows, for standard wave types (e.g. P and S), curves of predicted travel-times after the origin time of an earthquake at a range of epicentral distance from the earthquake source. The seismograms from the active trace-group are plotted over the travel-time curves, and can be positioned over the travel-time curves with the mouse to match arrival energy on the seismograms to the travel-time curves. The corresponding distance of the station from the earthquake epicentre, and the differential travel-times Ts-Tp and Ts-To are displayed.

In Hodocrhone for local events, which uses a flat-layered velocity model, the parameters of the velocity model and the earthquake depth can be adjusted interactively in the dialogue below the graph.

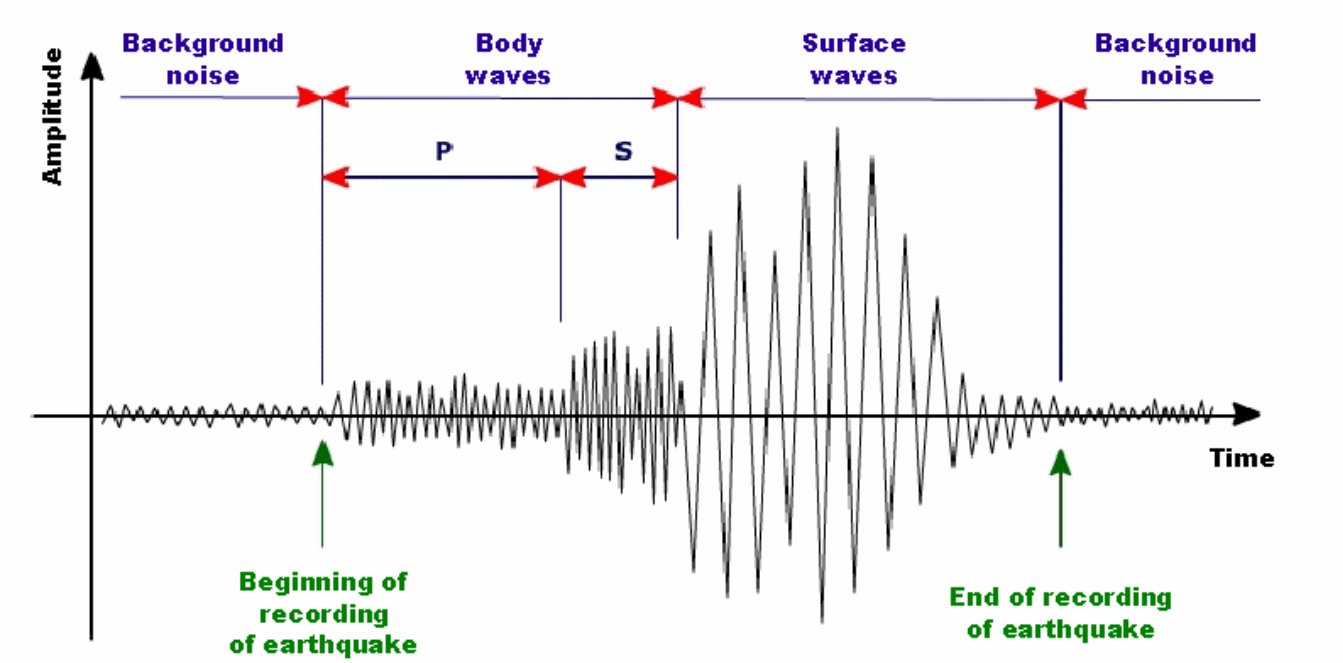
In Hodocrhone for distant, teleseismic events, which uses a spherical-Earth velocity model, the earthquake depth can be adjusted interactively in the dialogue below the graph, and the displayed wave types can be selected to the right of the graph:


Hodochrone v3.0X03
File
dist= 45.7 deg
Ts-Tp= 6.7 min (403.1 s)
Tp-To= 8.4 min (501.1 s)
Lr-Tp= 13.9 min (835.3 s)
P Telesismic
PcP
PP
PKiKP
S Telesismic
SS
Lr (Rayleigh)
SE:SDTF:Z
Epicentral Distance (deg)
Travel Time (min)
Show:
pP
sP
PcP
PP
SS
Pdiff
Sdiff
PKP
PKiKP
PKIKP
Earthquake Depth:
10

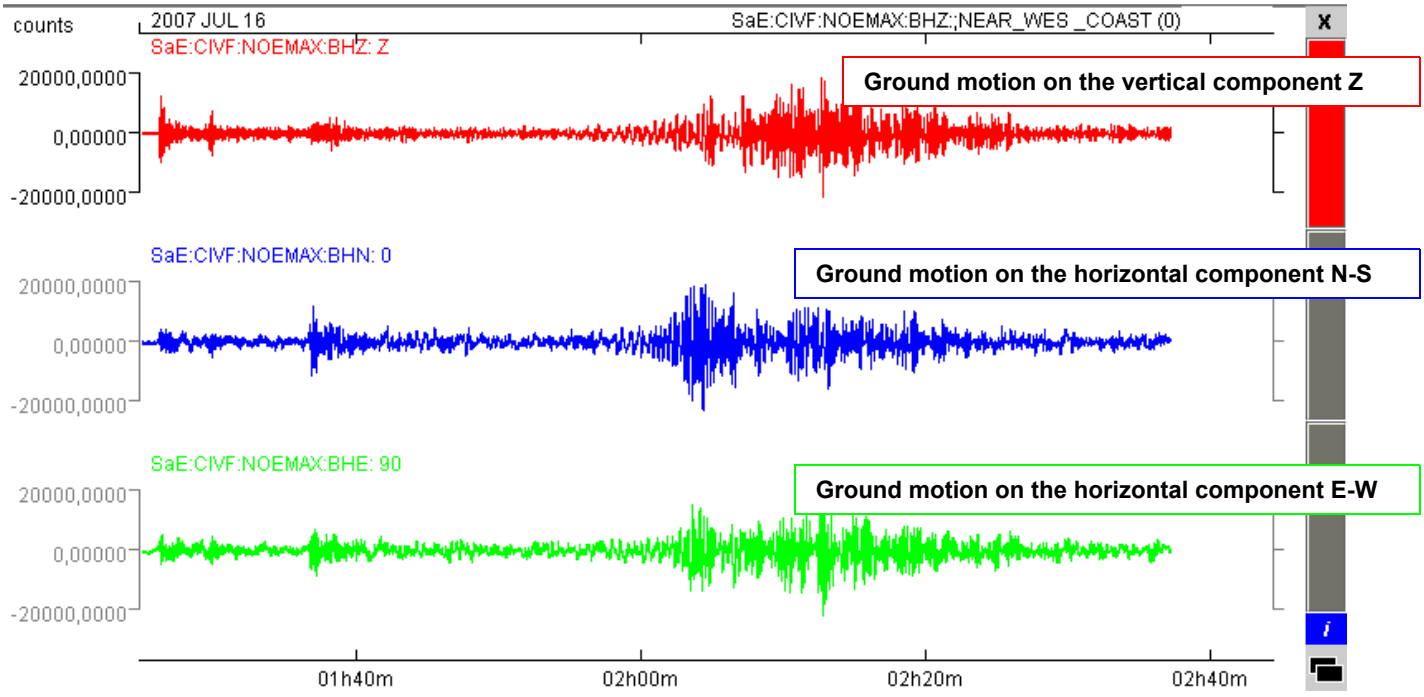
Working with seismograms

Understanding a seismogram

A seismogram is a graphical representation of the ground movement following the arrival of wave trains that have travelled from an earthquake source. There are two basic wave types: P, S and other body waves, which pass through the deeper parts of the Earth, and slower moving, surface waves.

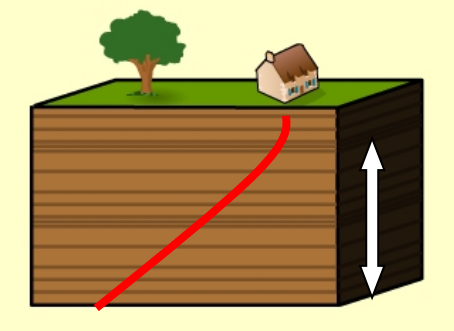


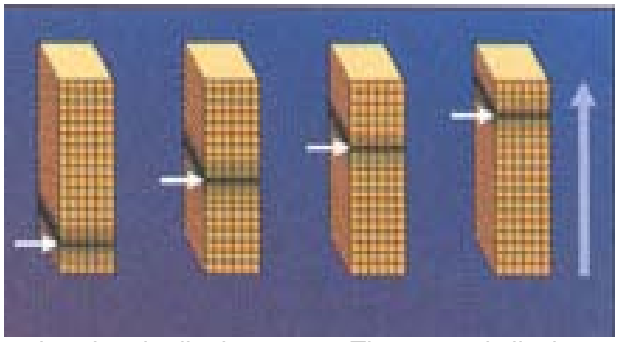
Seismometers installed at the Earth's surface record the ground motion in three directions: vertical motion and horizontal motion in the East-West and North-South directions. These are called three-component seismometers. For each recorded earthquake there can therefore be three seismogram traces.



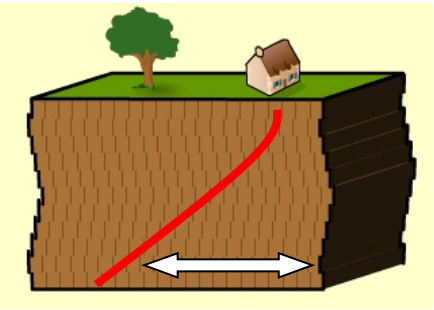
The horizontal axis of the graph shows time while the vertical axis show the instantaneous ground velocity (en counts – unit proportional to the ground velocity).

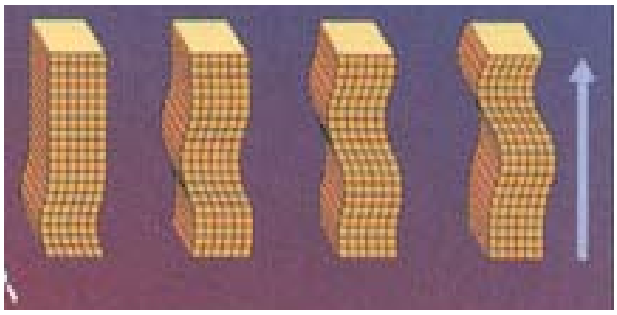
The propagation characteristics of body waves deep in the Earth result in the P waves being strongest on the vertical component while the S waves are most visible on the horizontal components.





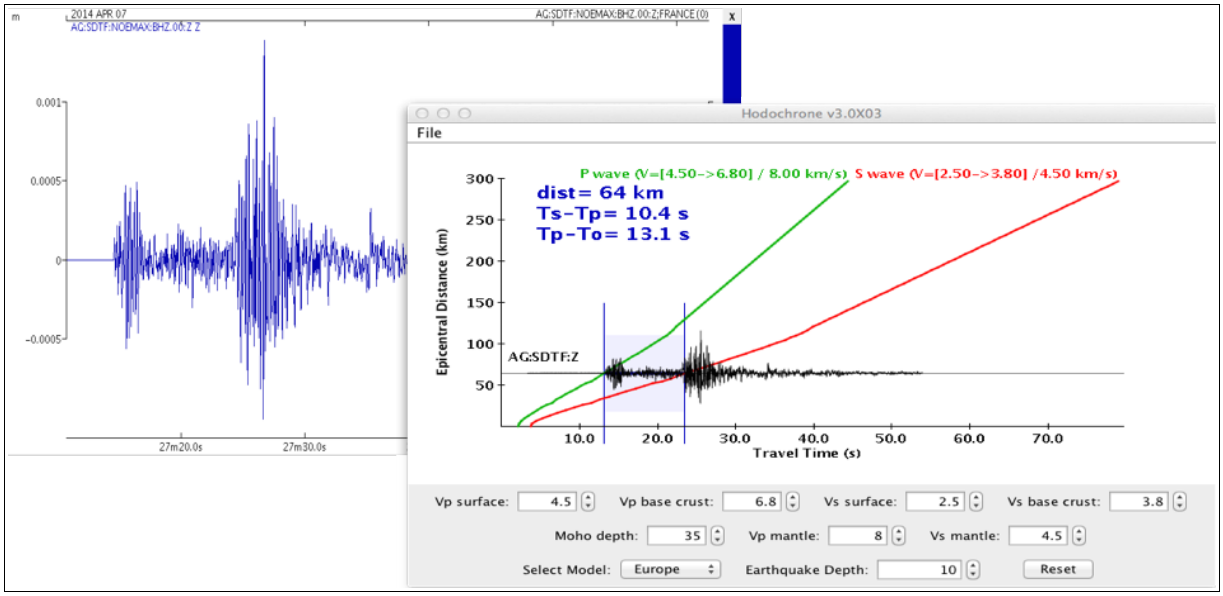
P waves or **primary waves** are also called compressional or longitudinal waves. The ground displacement caused by their passage consists of successive dilatations and compressions. This displacement is parallel to the direction of propagation of the waves. These are the fastest and thus the first waves that are recorded on the seismograms. These waves are the cause of a gentle rumbling that may be heard at the beginning of an earthquake.



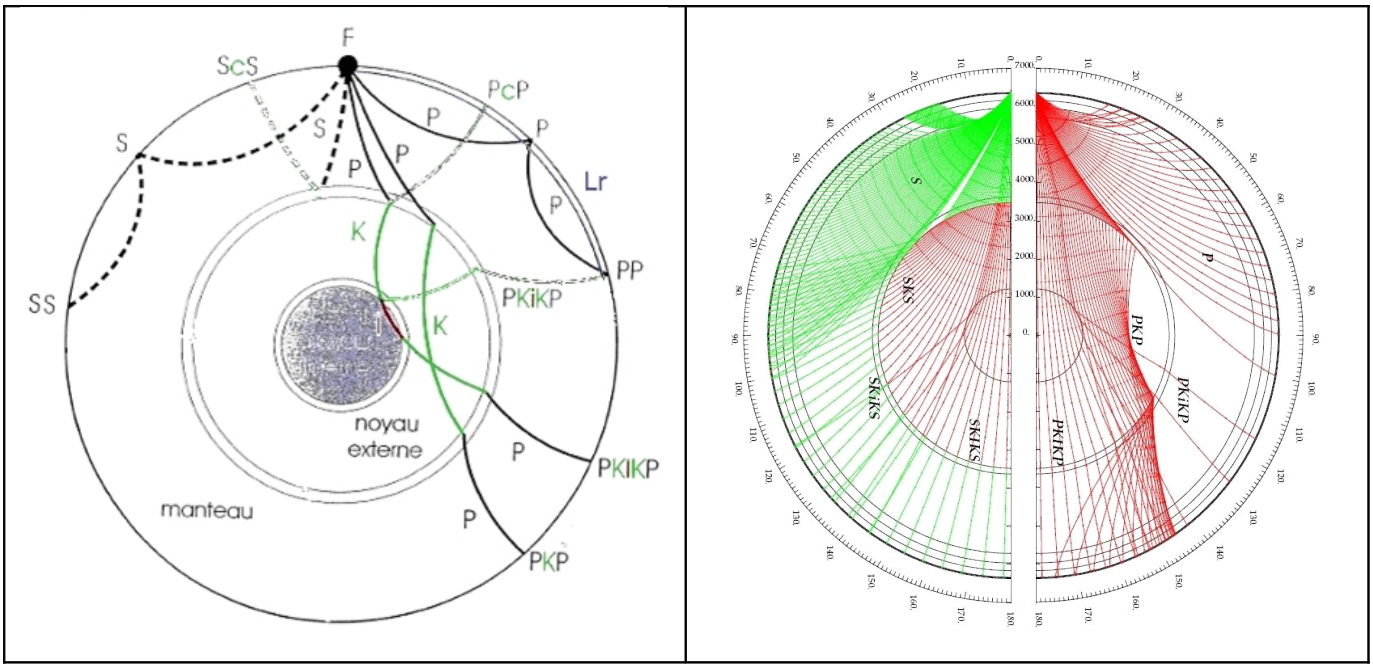


S waves or **secondary waves** are also called shear or transverse waves. The ground displacement caused by their passage consists of shearing motion perpendicular to the direction of propagation of the waves. These waves do not propagate in liquids, in particular, they cannot pass through the liquid, outer core of the Earth.

Because of these differences in ground motion between the wave types, the examination of three-component seismograms makes it easier to identify the waves. In addition, the difference in time between the arrival of P and S waves (Ts-Tp) is indicative of the distance travelled by the waves. For the case of earthquakes that are nearby and shallow, the epicentral distance can be easily determined using the 'Hodo-local' tool in SeisGram2K.



Seismic sounding of the Earth



PREM Earth Model (Preliminary Reference Earth Model, Dziewonski & Anderson 1981)

Body waves (P and S) pass through the interior of the Earth. The characteristics of this propagation give information about the physical properties of the medium traversed, in the same manner that X-rays give an understanding of the interior of the human body.

In seismology, the source is an earthquake and the receiver is a seismometer which records the ground motions. On these recordings many types of waves can be distinguished based on their forms and frequency content. When many stations are available (a seismic network), a single earthquake can be recorded at many points on the Earth. Then it is possible to identify on each seismogram the arrival times of different wave types and to infer the ray paths and the speeds of the waves between one point and another.

The speed of propagation of seismic waves increases with depth in the Earth, for this reason the wave paths or rays are curved. The presence of the core at the center of the Earth leads

to complications in the ray paths. In particular, there is a region of the Earth, called a shadow zone, where the P wave ground motions are weak or zero. This zone is situated between 105° and 142° of angular distance from the epicentre. There is a shadow zone because the P rays that arrives at 105° passes tangent to the core-mantle discontinuity (Gutenberg discontinuity); the ray that passes slightly deeper is called PKP, it is refracted two times (on entering and leaving the core) and emerges at the Earth's surface at 183°. Deeper rays emerge at smaller and smaller angular distances down to 142°, and there is an absence of the PKP phase between 105° and 142° (shadow zone).

However, there are still waves that arrive in the shadow zone, they are weak, resulting from ray paths that include reflections or traversals on or through the Earth's inner core. Different phases are identified depending on the ray path: PKiKP which has a reflection at the boundary between the inner and outer core (Lehman discontinuity), or PKIKP which traverses the inner core and is refracted by the various discontinuities.

There are also PP, SS and related wave paths which travel entirely within the mantle but are reflected at the Earth's surface before reaching the recording station.