SeisGram2K

File Menu

Select File…	select a file to open on disk
Open the Catalog…	select a file from the catalog
Open Web Location...	select a file on-line on 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

Seismogram info	display the station and event information for the selected seismogram
Align... to Active	align all seismograms to the time window of the selected seismogram
Align... to Global	align all seismograms within a time window encompassing all seismograms
Lock Alignement	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 Travel Time	enable/disable the theoretical phase arrival tool
Invert Colours	toggle the display of seismograms with inverted colours on black/white background
Grey Scale	toggle the display of seismograms with grey scale colours

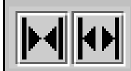
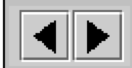
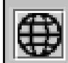
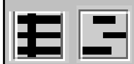
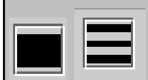
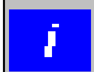
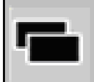
Utilities Menu

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
Hodo-local	tool to estimate the epicentral distance for a local earthquake (distance < 300km)
Hodo-tele	tool to estimate the epicentral distance for a distant earthquake (distance > 300km)
Theoretical Phases	display the theoretical phase arrival for selected wave types (PREM Earth model)

Help Menu

Help	display the program help information
About SeisGram2K	display the program information
Update	open on-line program support page on the Internet

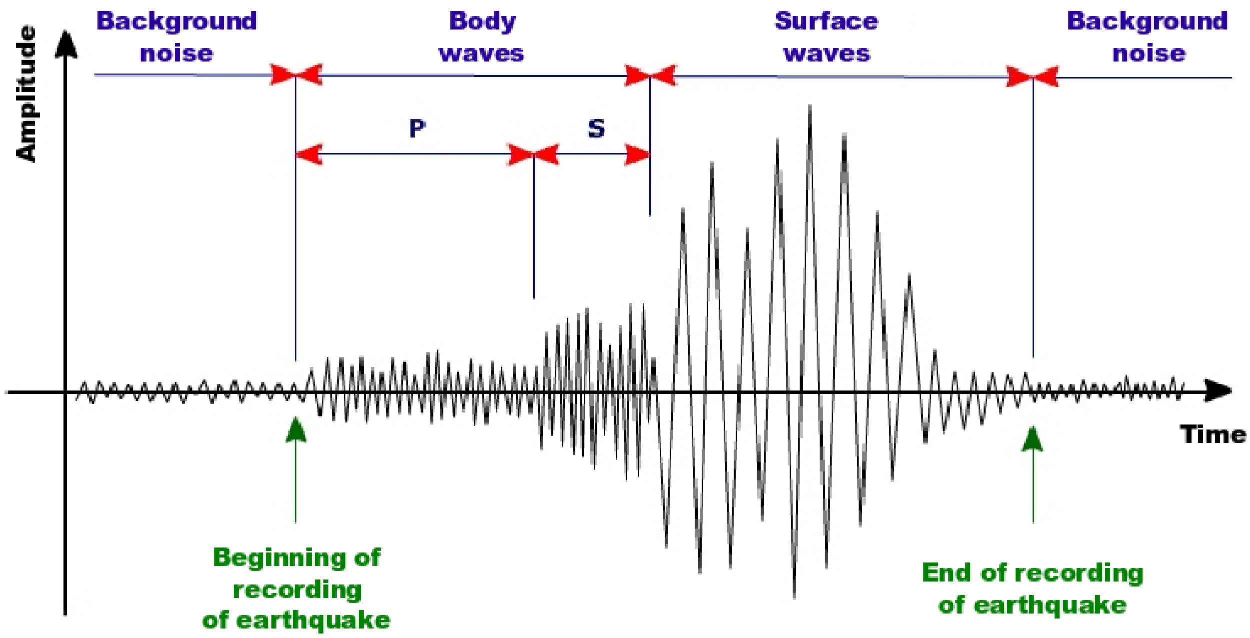
Buttons

	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 alignement during seismogram analysis
	display the selected seismograms or all seismograms in the full viewing window
	pick in time seismic phases and other features on the seismograms
	filter the selected seismograms within a specified frequency window (Hz)
	display the station and event information for the currently selected seismogram
	create a copy of the current seismogram in the viewing window
	tool to estimate the epicentral distance for a local earthquake (distance < 300km)
	tool to estimate the epicentral distance for a distant earthquake (regional or teleseismic, distance > 300km)
	display theoretical phase arrival times for certain seismic wave types (PREM Earth model)

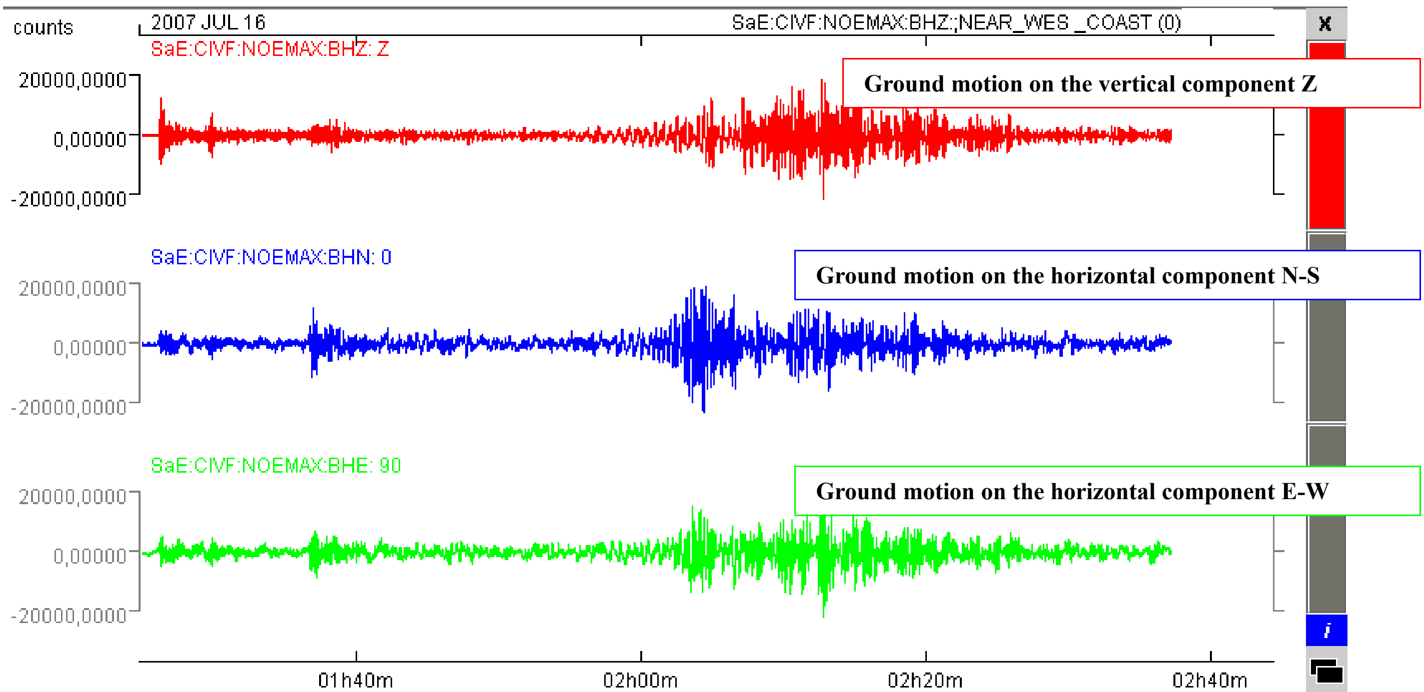
It is also possible to zoom the traces by drawing a rectangular window by dragging the mouse and by rotating the mouse wheel.

Reading 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.

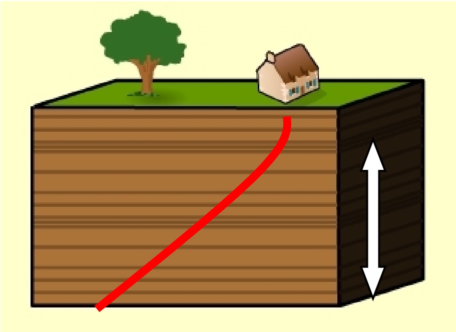


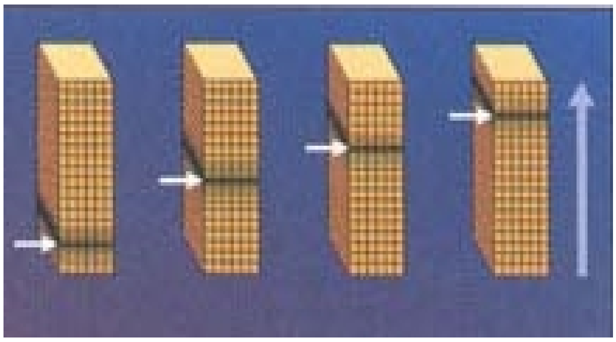
Seismometers installed at the Earth's surface record the ground motion in three directions: vertical motion and horizontal motion in the East-West and North-South directions. These are called three-component seismometers. For each recorded earthquake there can therefore be three seismogram traces.



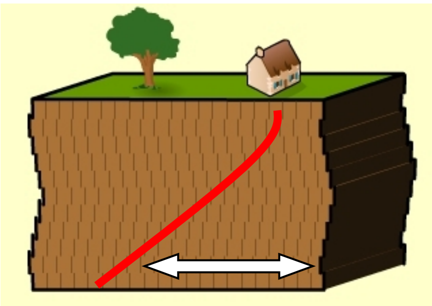
The horizontal axis of the graph shows time while the vertical axis show the instantaneous ground velocity (en counts – unit proportional to the ground velocity).

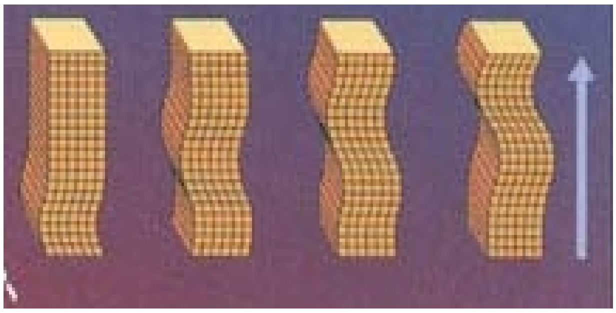
The propagation characteristics of body waves deep in the Earth result in the P waves being strongest on the vertical component while the S waves are most visible on the horizontal components.





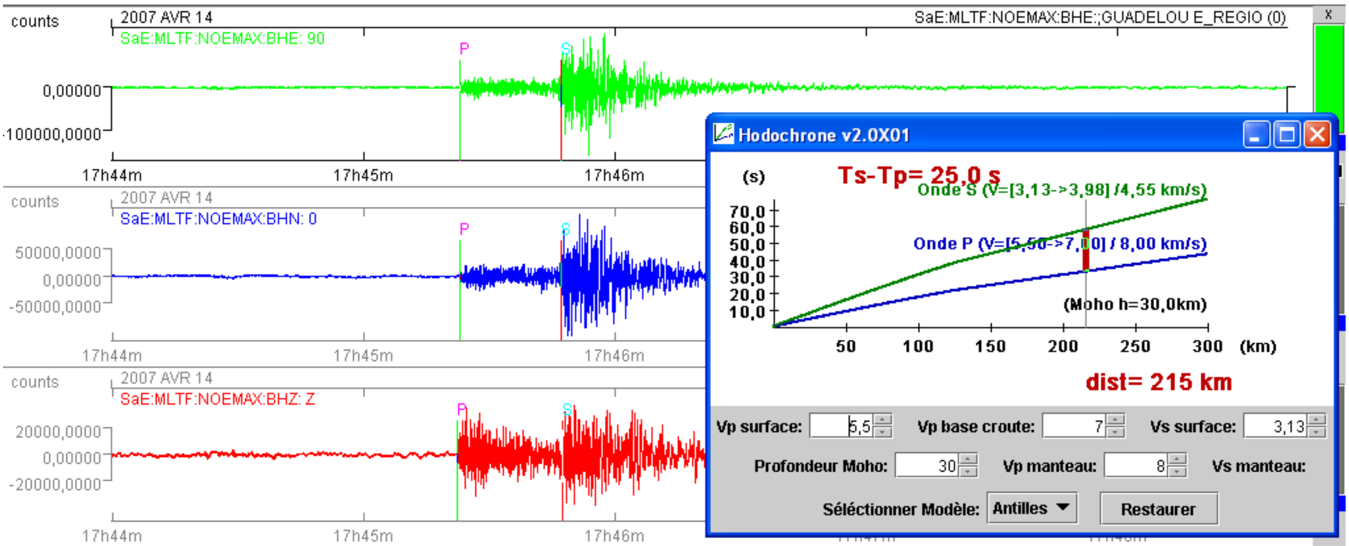
P waves or **primary waves** are also called compressional or longitudinal waves. The ground displacement caused by their passage consists of successive dilatations and compressions. This displacement is parallel to the direction of propagation of the waves. These are the fastest and thus the first waves 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.



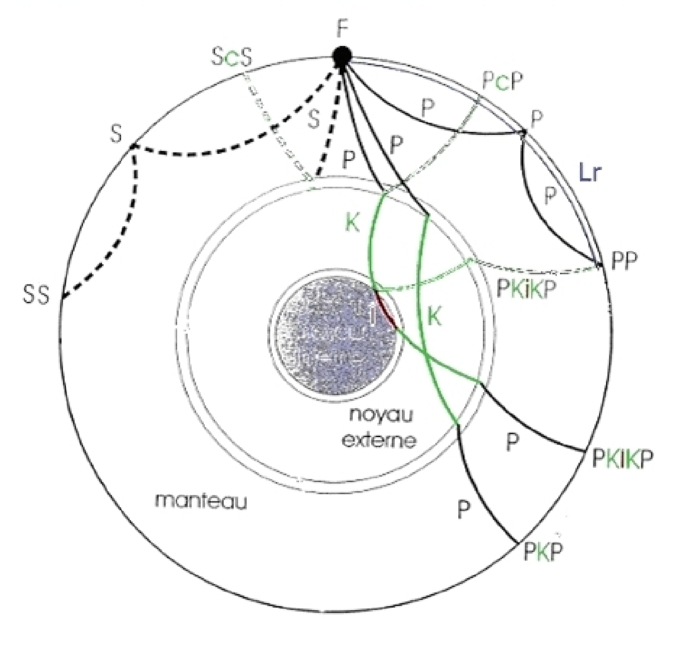


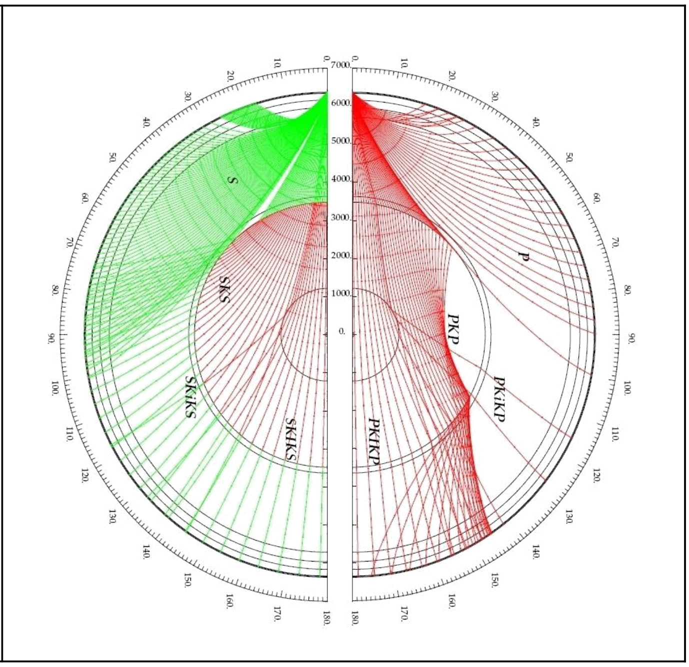
S waves or **secondary waves** are also called shear or transverse waves. The ground displacement caused by their passage consists of shearing motion perpendicular to the direction of propagation of the waves. These waves do not propagate in liquids, in particular, they cannot pass through the liquid,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