



# eqWave

**USER MANUAL**

**2.18**

**Environmental Systems & Services Pty Ltd**

8 River Street  
Richmond, Victoria  
Australia 3121

Phone: +61 3 8420 8999

Fax: +61 3 8420 8900

[www.esands.com](http://www.esands.com)

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## Introduction

eqWave displays digital waveform files created by the Yerilla and Kelunji series of seismic recorders, and files extracted from other sources.

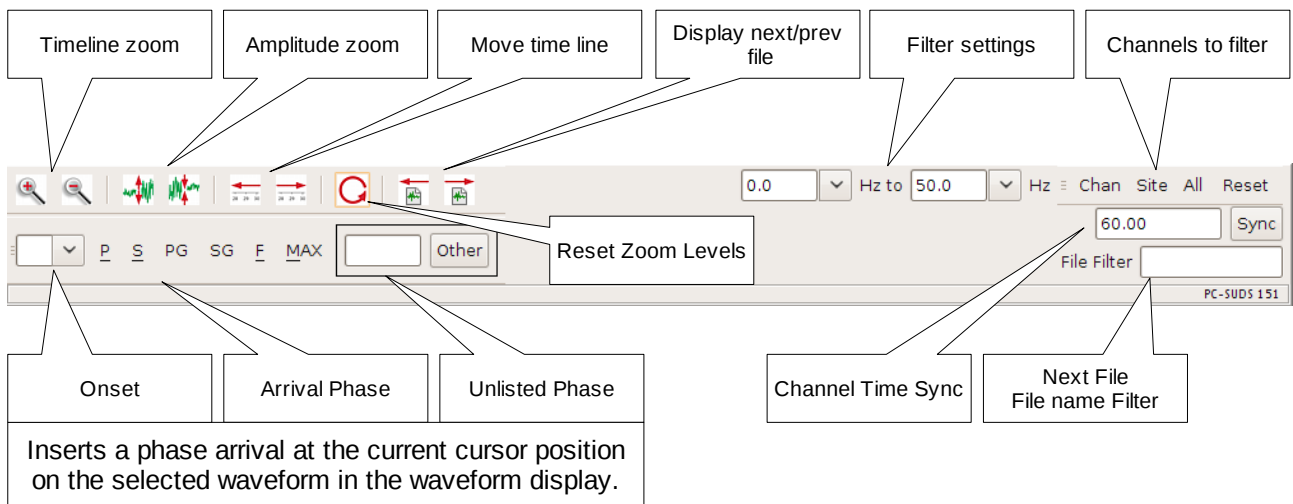
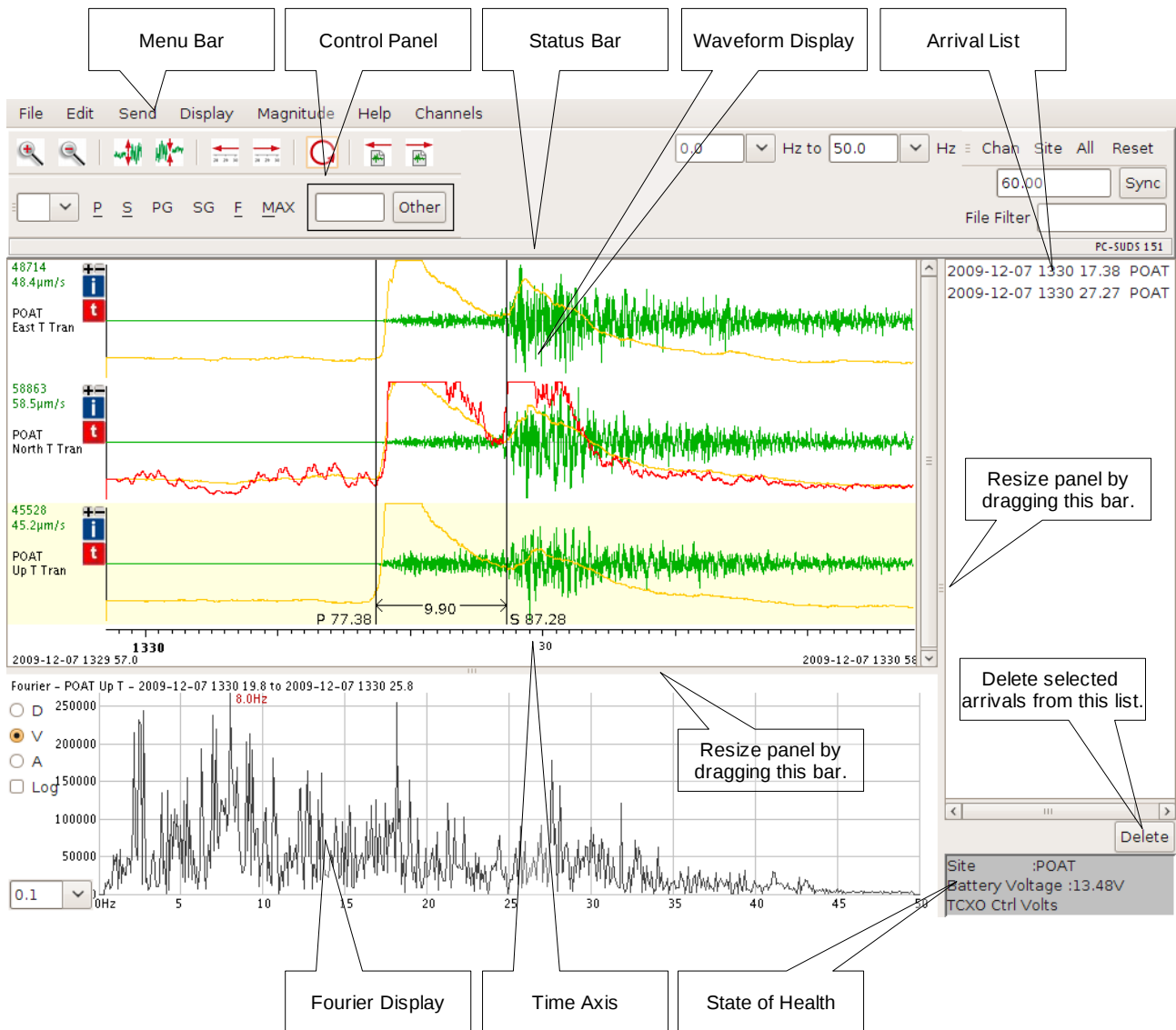
The Formats that can be read are:

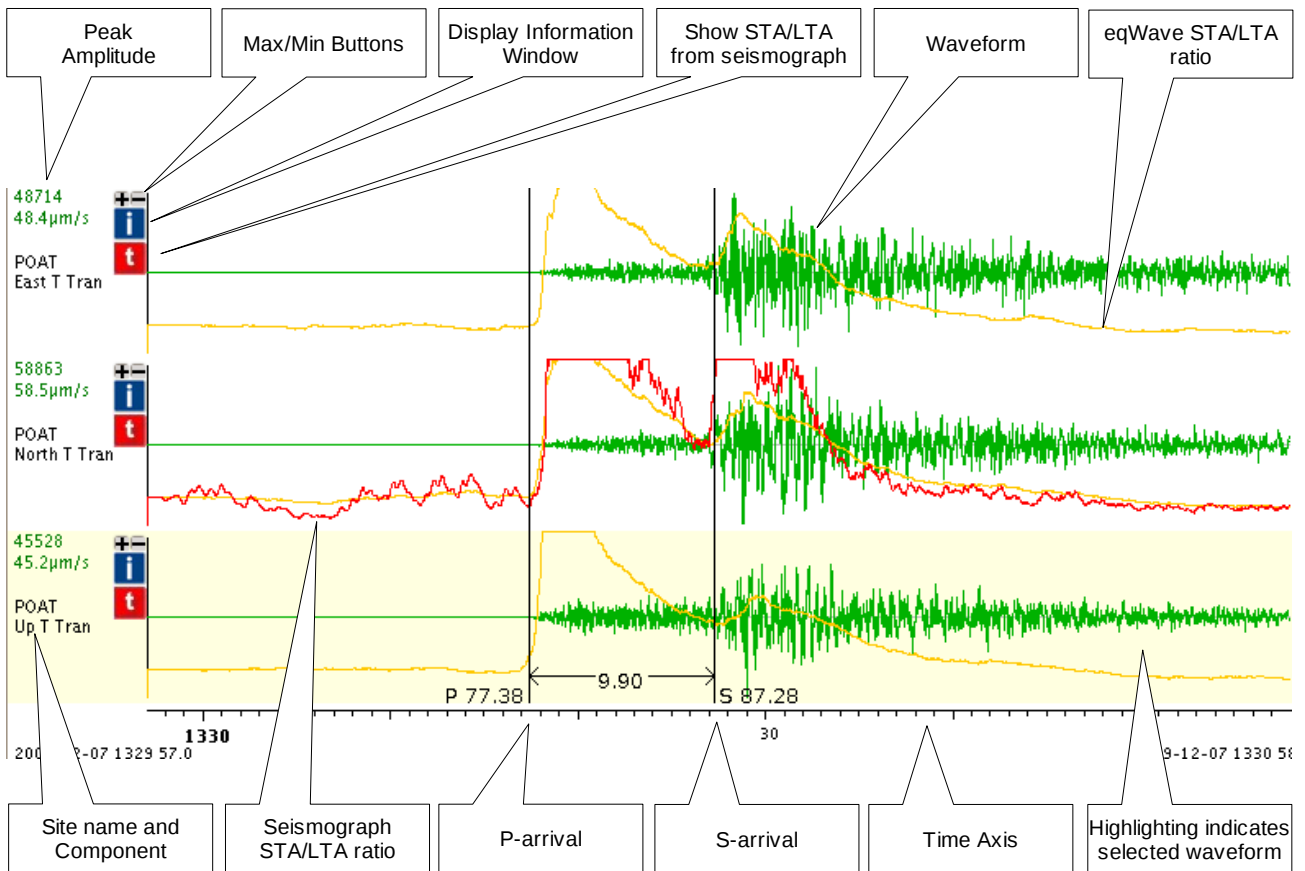
- PC-SUDS.
- Kelunji Classic KA1 & KA2.
- Yerilla.
- GSE.
- CSS.
- Tabulated Text.
- Kelunji Bulk files.
- Files that have been compressed using Gzip (ie, have a .gz extension) are automatically decompressed.

You can use eqWave to:

- Load and view waveform data.
- View waveforms from multiple stations in a single file or waveforms from a sequence of files.
- Split bulk waveform files into individual files.
- Merge multiple waveform files into one file.
- Zoom, pan, and scale the display.
- Filter the waveform data using high and low band pass filters.
- Compute the Fourier transform of a selected segment of waveform.
- Display state of health information about a seismograph site at a particular instant in time.
- Pick the arrival times (e.g. P, S and data such as the finish time of the event, maximum amplitude and frequency).
- Save the original or filtered waveform data and the picked arrival times.
- Estimate local Richter magnitude.

# Annotated eqWave Window





## eqWave Menus at a Glance

Menu	Menu Item	Description
File	Open	Open a seismogram or bulk file, in a new window if a file is already open.
	Open & Close	Open a seismogram and closing the currently open file.
	Merge	Merge two or more files together.
	Save	Save the current file.
	Save As	Save the current file specifying its name and format.
	Save Fourier	Save the Fourier values in text formatted file.
	Next	Load the next (by date) seismogram in the current working directory.
	Back	Load the previous (by date) seismogram in the current working directory.
	Print	Print the current seismogram.
	Close	Close the current seismogram.
	Quit	Quit eqWave.
Edit	Copy Arrivals	Copy any arrival picks for pasting into eqFocus.
	Clip	Remove (clip) minimised waveforms.
	Remove Spike	Remove spikes from the seismogram.
	16 to 32 bit fix	Some early model Kelunji recorders clipped signal data at 16 bits, this option attempts to reconstruct this data.
Send	Set Path	Set the folder where arrivals will be saved using the <i>Send Arrivals to Folder</i> option.
	Send Arrivals to Folder	Saves a PC-SUDS formatted file containing only arrival information.
Display	Zero Correction	Centre displayed waveforms about the Zero axis.
	Amplitude Grouping	Display some or all waveforms at the same amplitude range by: <ul style="list-style-type: none"> <li>• All</li> <li>• Site</li> <li>• Individual</li> </ul>
	Acceleration Units	Display acceleration channel units as m/s/s or g.
	Pressure Units	Display pressure channel units as dB or Pa (blast monitoring only)
	Show S-P	Show S-P arrival times.
	Sort by Site code	Display the waveforms in order of site code (alphabetical).
	Sort by P Arrival	Display the waveforms in order of P arrival times.
	Set up STA/LTA...	Set up the STA/LTA ratio which is displayed as the amber line for each waveform.
Display Vector Sum	Display the vector sum for a selected channel group.	
Channels	Properties	Open the <i>Properties</i> dialogue window for the selected channel
	All	Show all channels from all sites contained in the current file.
	Vertical	Only show vertical channels from all sites in the current file.
	<i>Site List</i>	The site code for sites contained within the current file are listed here. Selecting a particular site code shows only the waveforms from that site.
Magnitude	Estimate ML	If there is sufficient information (recorder response, P, S, and MAX arrivals) open the <i>Estimate Magnitude</i> dialogue window to display an estimate of ML magnitude.
Help	About	Show the version of eqWave and JRE being used.

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## View the waveforms

### *Specify the waveform file*

You can open a single waveform data file, scan through a series of waveform files, split a bulk waveform file and merge a number of waveform files.

### Opening a waveform file

Select Open from the File menu.

- Locate and select the name of the file that you want to open. eqWave displays the waveform file. Alternatively, the file can be opened by dragging and dropping the file icon onto **eqWave**.

### Displaying a waveform file

#### To open in a new window

Select *Open* from the File menu, then locate and select the waveform file.

eqWave displays the waveform/s in a new window.


#### To open in the current window

Select *Close & Open* from the File menu, then locate and select the new waveform file.

eqWave replaces the waveform/s in the current window with the newly selected waveform.

#### To scan through a sequence of waveform files

eqWave can identify the next or previous waveform file in the sequence based on the file name date stamp.

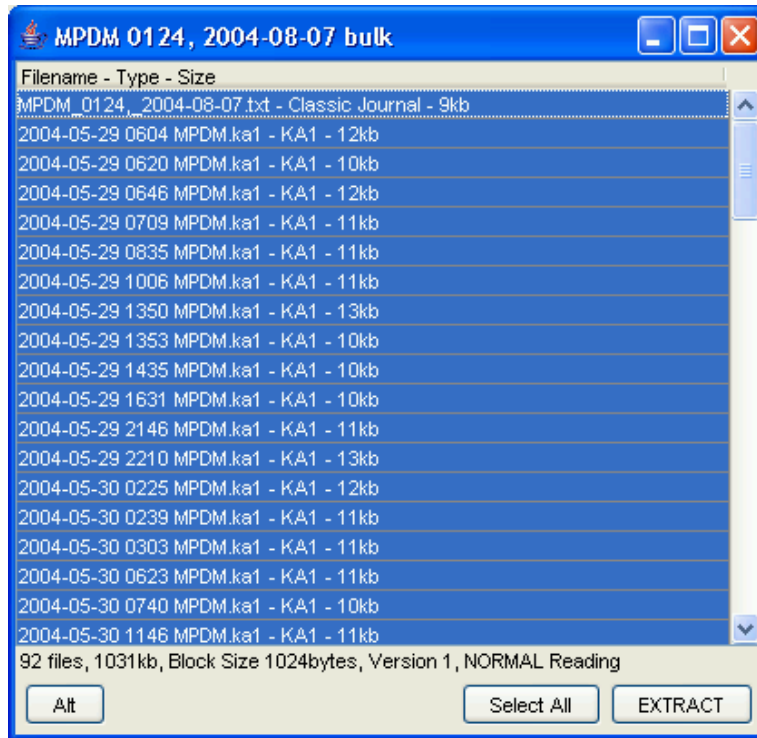
To scan forwards through the sequence select Next (Ctrl+N) from the File menu, or click the  icon on the tool bar (specifying a site code in the *File Filter* field only load the files for the specified site in the current directory).

To scan backwards select Back (Ctrl+B) from the File menu, or click the  icon on the tool bar.

## Extracting waveform files from a Bulk file

A bulk file is generated by Kelunji classic and D-series seismographs manufactured by ES&S

- Select Open from the File menu.
- Locate and select the name of the Bulk file that you want to open.
- A list of the waveform files located within the bulk file is displayed.



### The Alt Button

- If the Bulk file seems corrupted and cannot list all its files, then click on the “Alt” button. This will use a different technique for determining the files contained in the Bulk file.
- select the files you wish to open.
- Select one file, or choose multiple files by using the following key-mouse combinations.

Key Combination	Files Selected
Left-click	One individual file
Shift-click	A range of (consecutively listed) files
Ctrl-click	Multiple individual files

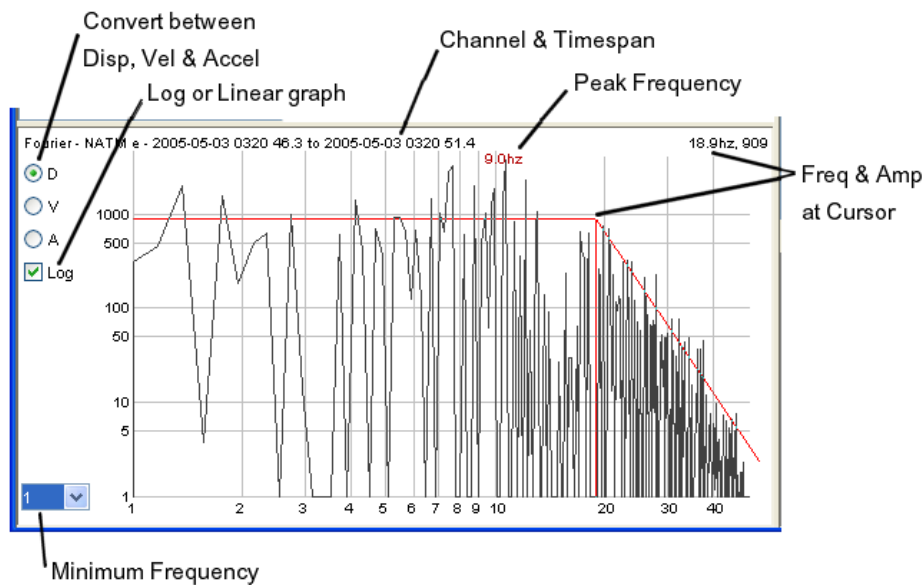
- Click EXTRACT
- Use the Choose Folder dialogue box to locate and specify the folder to store the extracted waveforms.
- Click the window's close box

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## Merging waveform files

- With an existing waveform on display, select Merge from the File menu.
- Locate and select the name of the file that you wish to include in the current display. Click the Open button.
- eqWave will merge the files on one display, provided the waveforms are less than 60 minutes apart.
- Alternatively, hold down the Ctrl key while dragging the file to be merged and dropping it onto the current window.

## The Fourier Display Panel



To access the Fourier Display Panel, drag the bottom edge of the Window Panel upwards.

The Fourier Display can be used to determine the frequency content and dominant frequency of the waveform or of a section of the waveform.

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## Adjusting the display

You may want to adjust the waveform display so that you can more easily pick arrivals. Adjustments include:

- Scan the waveform to find events
- Adjusting the displayed Timespan
- Selectively hide channels that are not of interest
- Increasing or decreasing the waveform display amplitude

The eqWave control panel contains a number of buttons that enable you to adjust the waveform display.

## Changing the display amplitude (vertical axis scale)

You can increase or decrease the vertical size of the waveform display amplitude by adjusting the scale on the vertical axis.

Do this after you have made all other adjustments to the display.

NOTE: Each time you make other adjustments to the display, such as minimize a channel, zoom in, or apply a filter, eqWave recalculates the peak amplitude and adjusts the scale of the vertical axis accordingly.

### To increase the display size of the waveform

Click the Increase Wave Size button  or type: Alt - Up Arrow

eqWave reduces the amplitude value of the of the vertical axis, and plots the expanded waveform.

### To decrease the display size of the waveform

Click the Decrease Wave Size button  or type: Alt – Down Arrow

eqWave increases the amplitude value of the vertical axis, and plots the contracted waveform.

## Amplitude Grouping

The Amplitude Grouping options are found under the Display menu and allow for some or all waveforms to be displayed at the same amplitude.

### Display All waveforms at the same amplitude

- In the Display menu, under Amplitude Grouping, select All.
- eqWave displays all waveforms at a scale equal to that of the largest waveform amplitude in the original display.

### Site

- To display only those waveform channels from the same site at the same scale, chose Site from the Display menu.

### Individual

- To display or return waveforms to their original amplitude scale, choose Individual from the Display menu.

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## Zooming in on a time interval

Use the zoom buttons  on the control panel to zoom in or out.

When you zoom in or out, eqWave scans all channels to identify the maximum and minimum/peak amplitude for the specified time interval. eqWave adjusts the vertical scale of all channels to suit this peak amplitude.

### To zoom in (enlarge the display)

Click the **Zoom In** button  or type: Alt – Page Up

Each time you click this button, eqWave will halve the time span, and redisplay the channels. The zoom will be centred about the current cursor position.

### To zoom out (reduce the display)


Click the **Zoom Out** button  or type: Alt – Page Down

Each time you click this button, eqWave will double the time span and redisplay the channels. The zoom will be centred about the current cursor position.

### To zoom in on a specific time interval

- Hold down the right mouse button and highlight the required time interval. Alternatively, hold down the Control key and drag over the area of interest.
- Click the Zoom In button

### To restore the display to the default scale

Click the Default Time span button  or type: Alt - Enter

## Panning the display to view earlier or later time intervals

### To view an earlier time interval

Click the Move Time Back button 

The waveform will scroll to the right to display an earlier section of the waveform.

### To view a later time interval

Click the Move Time Forward button 

The waveform will scroll to the left to display a later section of the waveform.

## Displaying and hiding waveforms

### To view a single channel

Click the Maximize Wave button [+] to expand the waveform of the selected channel to fill the waveform display.

Click the Minimize Wave button [-] to return to the multi-channel display.

### To hide individual channels

Click the Minimize Wave button [-] to hide the waveform of the selected channel.

Click the Maximize button [+] to redisplay the channel's hidden waveform.

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### To Permanently Remove unwanted channels

Select *Clip* from the *Edit* menu.

### To sort the display order of channels

Use the **Display** menu to sort the order of channels alphabetically by sitecode or in order of the P arrival time.

To:	Use:
To view vertical channels only	Select <b>Vertical</b> from the Channels Menu.
To view all channels from one site	Select a <b>Site Code</b> from the Channels Menu.
To view all channels	Select <b>All</b> to display all channels.

## Zero Correction

The purpose of Zero Correction is to centre displayed waveforms about the Zero axis. This is done by finding the average of the waveform sample values, and then adjusting the waveform vertically by the result.

- Select None for no Zero Correction
- For Zero Correction calculated using only the waveform currently displayed, select Displayed in the waveform display panel.
- For Zero Correction calculated using the entire waveform, even if only a portion is displayed, select All.

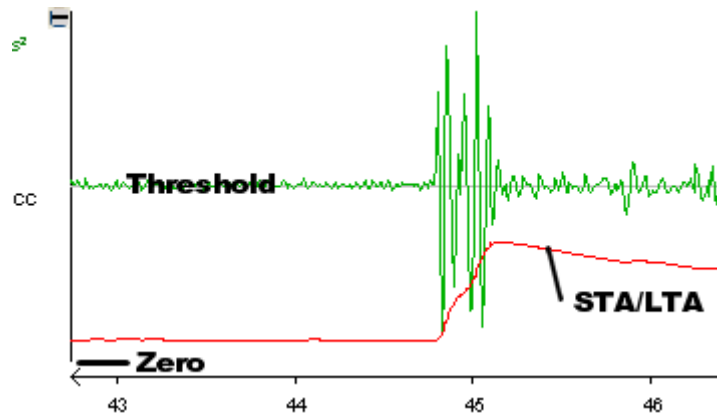
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## Setting STA/LTA

### The STA/LTA ratio

The STA/LTA (short term average/long term average) ratio can be displayed as a red line on the waveforms, as an aid to picking arrivals, and examining how changes in setting would affect triggering in eqLogger or the seismograph.

The graph is drawn with the value 0 at the base of channel, and the threshold value at the centre line.




### Setting the STA/LTA ratio

To display the STA/LTA ratio line, select Setup STA/LTA in the Display menu and tick On in the STA LTA window.



- The STA is calculated by getting the average of the zero corrected, positive amplitudes of samples within the window time, in seconds.
- For example, entering 1.5 will create a 1.5 second STA window time. The default is 2 seconds.
- The LTA is calculated in the same way as STA. Default = 20 seconds.
- The STA/LTA ratio is calculated by dividing STA by LTA.
- To prevent very high STA/LTA ratios when LTA is small, a **damping** number can be added to LTA.
- Set the STA/LTA ratio value at which a trigger is declared by entering a ratio in the **Threshold** value.
- The waveform can be pre-filtered with band pass filter values before calculating the STA/LTA Ratio.

A STA/LTA ratio trace can be displayed using the recorder settings (for echo and echo pro recorders only) by clicking on the  button to the left of the waveform.

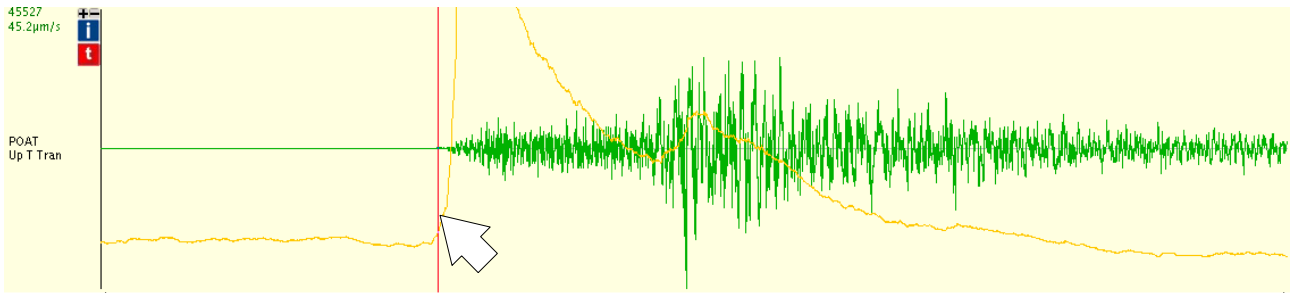
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## Processing waveform data

### *Viewing waveform data*

Click on a waveform.

eqWave displays a vertical line across the waveforms to mark your cursor position, the channel name, and the time and amplitude at that point



### *Arrival times*

#### **Picking Arrival Times**

Move the cursor over the waveform and click on the desired site and time.

Select Polarity and Onset from the pull down menu.

Click the button that corresponds to the arrival type you want to pick or enter another phase and press the 'Other' button.

eqWave displays

- A line on the waveform representing the selected arrival
- Station, arrival type and time below the time axis
- Time, station and arrival type in the Arrivals List Panel
- S-P times, when both P and S arrivals are picked, and when the Show S-P option in the Display menu has been selected
- The duration time, if both P and F are picked

#### **Deleting Arrivals**

- Open up the Arrival List Panel.
- Select an Arrival in the list.
- Click the Delete Button.

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## Filtering waveforms

### Applying band pass filters

The band pass filter removes data outside the specified frequency range. This can remove the effect of spikes or noise in the data.



Click on a Channel that you wish to filter, select the High and Low Pass Frequencies then click either the **Chan**, **Site** or **All** button (**Reset** removes the filter), to filter either the single Channel, all the Channels for that Site, or All the Channels.

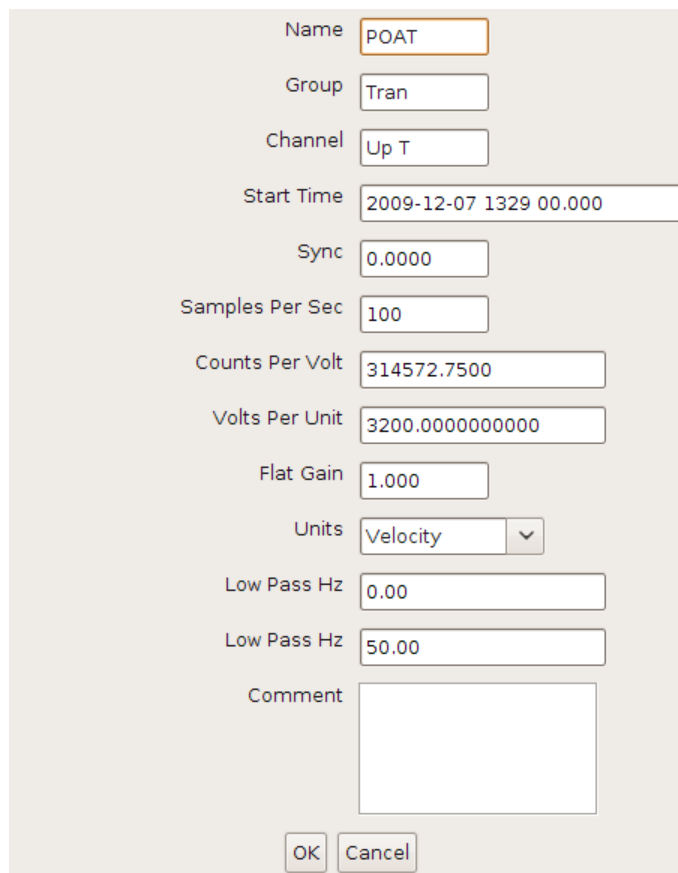
The filter is performed using a Fourier Transform, setting the unwanted frequencies to a value of zero, then transforming back into a time series.

The filter values are stored in the PC-SUDS file when saved. The samples in the waveform are not changed, so that it can be restored to its unfiltered state.

### Setting waveform properties

To change many of the basic attributes of a waveform, such as its name and start date, Click on the wave in the Waveform Display Channel.

Select **Properties** from the **Channels** menu.



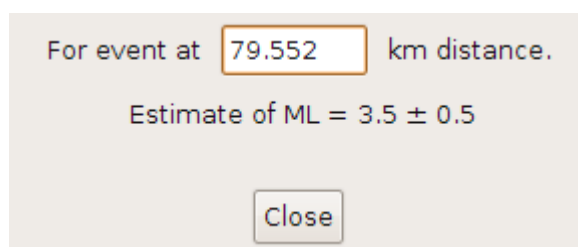
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## Estimating Magnitudes

The Kelunji Echo and EchoPro recorders save response information with the PC-SUDS files they create (both triggered and continuous files). With this information it is possible to calculate an estimate of ML (local Richter) magnitudes.

To estimate the ML magnitude you will need to at least select a maximum amplitude and frequency pick (a MAX pick), P arrival and S arrival (to estimate distance):

- Select the vertical channel of the waveform to use to calculate the magnitude estimate.
- Pick a P arrival
- Pick an S arrival
- Pick a MAX arrival
- Open the *Estimate magnitude* dialogue from the *Magnitude* menu:

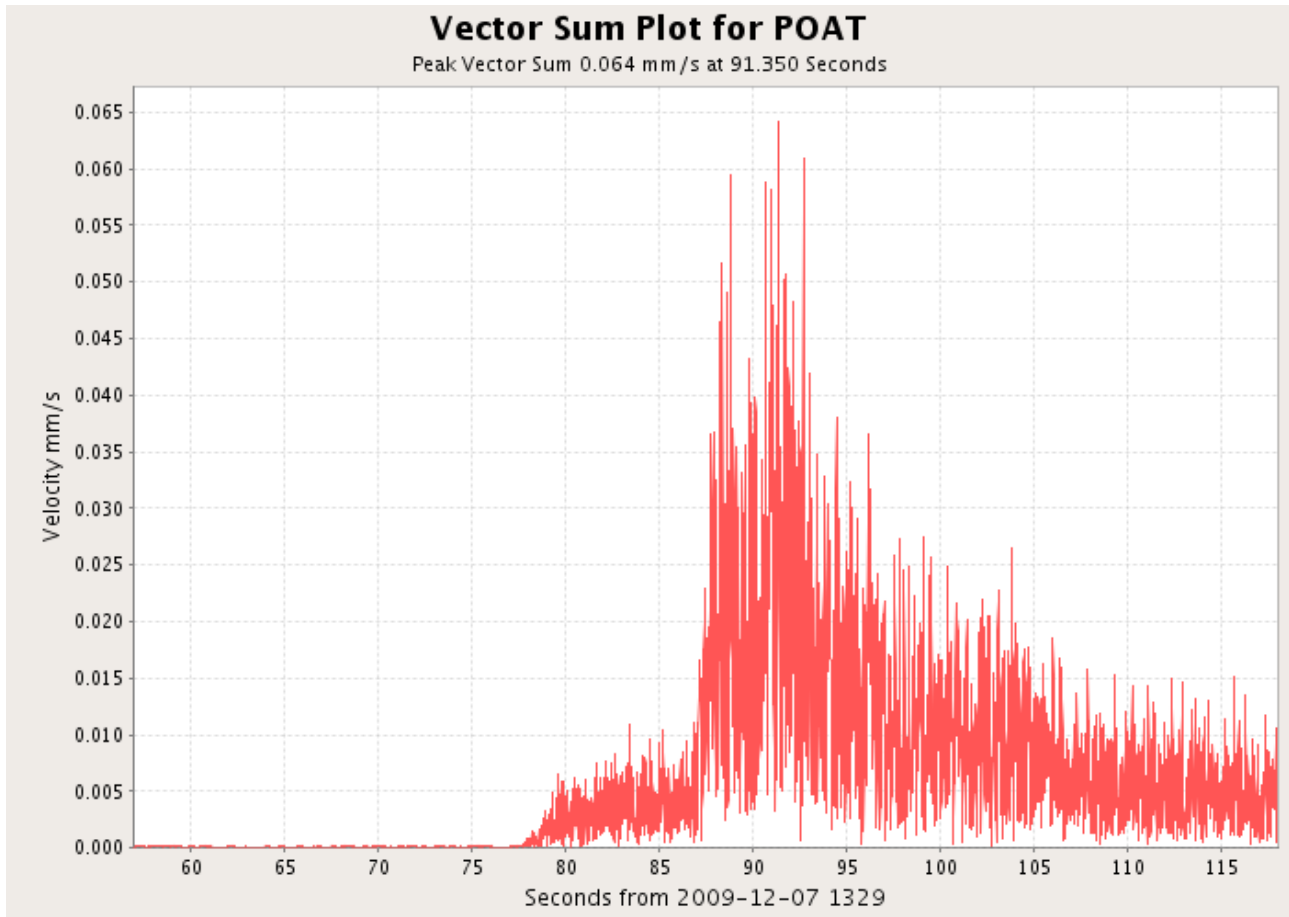


- If necessary you can specify a different distance and the magnitude will be recalculated with the new distance as you type it.
- Uses 8m/s to calculate distance which may or may not be applicable to your geological setting.

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## Vector Sum Plot

The Kelunji Echo and EchoPro recorders save response information with the PC-SUDS files they create (both triggered and continuous files). With this information it is possible to calculate a vector sum using the three components from the transducer:



To create a vector sum plot:

- Select a waveform within the channel group of interest.
- Select *Display Vector Sum* from the *Display* menu to display the vector sum window.

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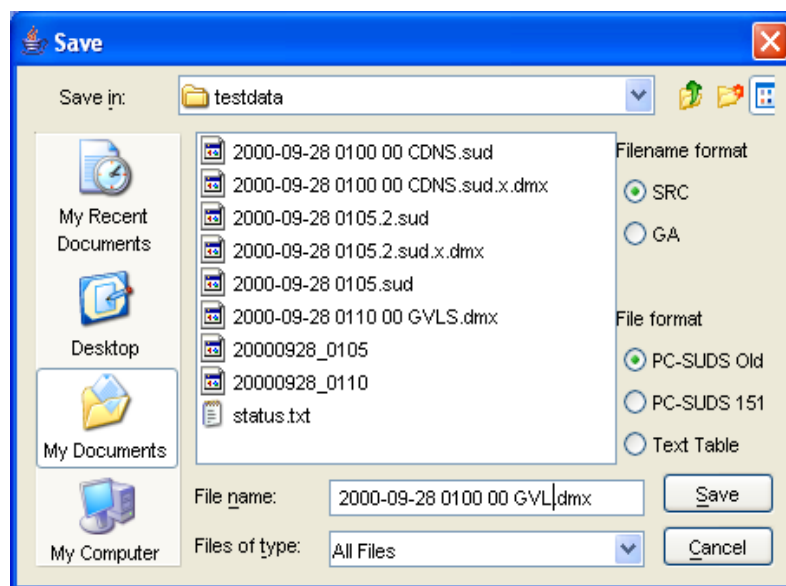
## Save and Print

### Save options

eqWave allows waveform data and arrivals to be saved in a number of formats and for use in other programs.

### To save waveform files

Select Save from the File menu.



Files can be saved as:

- Old PC-SUDS 1.4 format.
- PC-SUDS 1.5.1 format, which includes added fields for naming sites and channels
- Text Table format, which is useful for importing into a Spreadsheet.
  - The text file contains comments explaining the meaning of the header information, data values are in recorder counts.

The Filename can be automatically formatted according to 2 conventions:

- SRC format, e.g, **2005-09-22 0351 10 GVL.dmx**
- GA format, e.g., **GVL05265\_035110.dmx**

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## To save the Fourier data

The Fourier data can be saved by selecting **Save Fourier** in the **File** menu.

eqWave saves the Fourier data as a tabulated text file, allowing easy importing into a spreadsheet.

## Printing from eqWave

With the desired waveform on display, select Print from the File menu.

## Exporting saved data

### *Writing files of arrivals to another directory*

You may want to store picked arrivals in a specific directory ready for another program to read. The arrivals are stored in PC-SUDS format (no waveform data, only arrival information).

### To set the path of the directory

- Select **Set Path** from the **Send** menu.
- Use the Select Directory file dialogue to locate the directory.
- Click Select Directory.

### To save the arrival data in the directory

- Select **Send Arrivals To Folder** from the **Send** menu.
- Locate the directory
- Click **OK**. eqWave displays an Arrivals Sent information box.

## Exporting Arrivals to eqFocus

Arrivals can be copied and pasted into eqFocus by selecting **Copy Arrivals** from the **Edit** menu, then in eqFocus select **Paste** from the **Edit** menu of eqFocus.

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## Quitting eqWave

### *Closing the display window*

To close the current window select **Close** from the **File** menu.

eqWave closes the display but remains active.

### *Quitting eqWave*

Select **Quit** from the **File** Menu, or select **Close** when the current window is empty.

eqWave will display a Quit? dialogue box.

Select Yes to quit, or select No if you want to continue.