

# **Seismology Instruction with AmaSeis**

## **installation and use of the AS-1 seismometer**

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**IRIS** Seismographs in Schools Program  
[www.iris.edu](http://www.iris.edu)

### Overview

Seismology offers unique opportunities to enrich earth science and physics curriculum. This document was created to assist teachers getting started in the exciting field of educational seismology. It provides a general overview of assembly, installation and configuration of the AS-1 educational seismometer using the AmaSeis software developed by Alan Jones.

As the educational seismology community continues to grow, resources are continually developed and refined. The AmaSeis software program is updated and improved. Additional software programs are under development to integrate with AmaSeis and AS-1 data. Today, there are many tools for teachers using real-time seismic data in the classroom.

This document will remain an introductory document to help teachers get started collecting and using real-time data in the classroom. Additional documents on advanced features in AmaSeis and other software packages are available on the SpiNet website.

### Acknowledgements

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If you have questions or comments about this manual please email:  
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# 1

## Getting Started

### Introduction

The AS-1 System was designed and built to make the science of seismology accessible to individuals and schools at a reasonable cost. With the AS-1 seismometer, you will be able to record and analyze earthquakes. In the classroom, the instrument will allow students to watch a quake roll in as it is occurring. Students will be able to watch a current event unfold, long before the media reports begin.

The AS-1 seismometer combined with the AmaSeis software allows real-time recording of seismic events and simplifies data analysis. The AmaSeis software automatically stores the ground movements so that the earthquake can be extracted and analyzed at a later time. The AS-1 System will record local quakes as small as magnitude 3.5 at a distance of 150 km, and quakes magnitude 6.5 or larger that occur anywhere in the world.

This manual will take you through the setup, software installation, and use of your AS-1 System. It will also give you an introduction to seismogram interpretation and analysis.

### Seismometer Location

There are two important location considerations:

- Seismometer

Find a suitable location for the seismometer, preferably where local vibrations from people or machinery are at a minimum. Vibrations can be caused by air conditioning units, traffic, construction, or weather. The vibrations, called seismic noise, can hide seismic signals from smaller events. The best surface for the seismometer is a concrete or stone floor, in a location free of extreme temperature variations. A back room or storage closet out of the way is an ideal location for the instrument for optimal recordings. The seismometer can be out on display in a public place so that students can see it in operation, but the trade-off is that fewer earthquakes may be detected because of increased local vibration.

- Computer Display

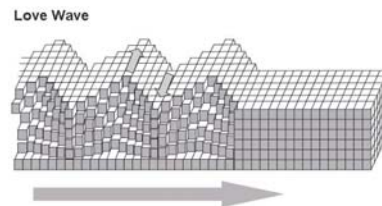
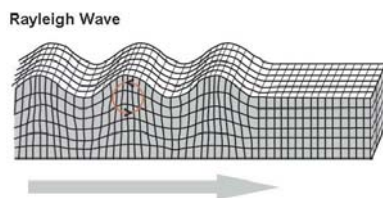
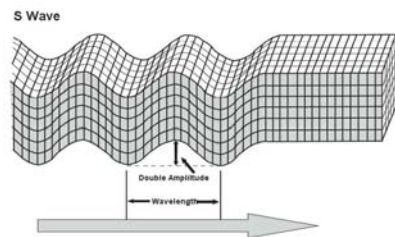
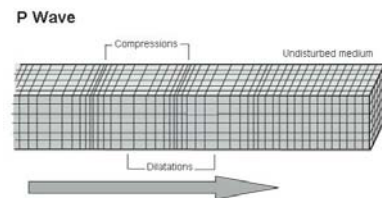
The computer display showing the real-time data does not need to be close to the seismometer. The AS-1 is shipped with a 7 m (22 ft) paired shielded coaxial cable. This cable length can be increased, allowing freedom of placement. We have purchased a 21.5 m (70 ft) cable from a local electronics store and used it without loss of signal. If a replacement cable is used, a connector end will need to be soldered to the replacement cable (also available from most electronics stores). Ideally, place the computer display in a prominent location either a classroom or public area where data can be monitored.

### Seismology Overview

Earthquakes are caused by the sudden movement of blocks of the Earth's crust. Such movement involves the fracture of brittle rocks and the movement of rock along the fractures. A fracture in a rock along which movement occurs is called a fault.

When an earthquake occurs, it releases energy in the form of waves that radiate from the earthquake source in all directions. The different types of energy waves shake the ground in different ways and also travel through the earth at different velocities.

- The fastest waves, and therefore the first to arrive at a given location, are **P waves** (Primary waves) or compressional waves. Like sound waves, they move by alternately compressing and expanding material in the direction of motion.
- The next significant waves to arrive are the **S waves** (Secondary waves). They travel through the earth moving material up and down and side to side perpendicular to the direction on motion.
- The last to arrive are **Surface waves**, which travel slower than P and S waves and move the ground like a rolling ocean wave (**Rayleigh**) or side to side like a S wave (**Love**).



The distinction between types of wave motions is important because it determines what will be recorded on a seismometer. The AS-1 is a vertical component seismometer, which means that it records waves that displace the ground in a vertical direction only. Thus, we can expect to record P, S, and Rayleigh waves. Since Love waves move horizontally we will not be able to record them on this seismometer.

What can you expect to see in the AS-1 recording? Often the quality of the record will allow you to pick out each of the waves, but other times there may be noise on the seismogram that makes it difficult to distinguish the arrivals. See the **Tips for Picking P, S, and Surface Waves** section for examples of picking wave arrivals.

# Seismometer Assembly

# 2

## Packing List

The seismometer should arrive partially assembled.

- 1 Boom arm with washers
- 1 Base with support post and attached spring and pickup coil
- 1 Damping fluid container
- 1 Interface box with 9-pin signal cable
- 1 Paired shielded coaxial cable
- 1 Power supply box
- 8 1 ½ inch diameter washers
- 1 Bubble level



Base



Damping Fluid Container  
Washers  
Bubble Level



Boom Arm



Paired shielded coaxial cable



Power Supply Box



Interface Box

## Seismometer Assembly

1. Unpack the box completely and identify the parts from the packing list.
2. Tighten the coil to the base plate of the seismometer. The coil should be upright perpendicular to the base and may require tightening and or bending to orient correctly. Tighten the bolt that holds the magnet to the boom arm.

3. Place the base of the seismometer on a level surface. The base contains three leveling screws (Figure 1). Use the bubble level and adjust the leveling screws as needed. Check the level of the base both front-to-back and side-to-side.



Figure 1

4. Remove the tape from the knife-edge at the end of the boom. **CAUTION:** The knife-edge is sharp, be careful not to cut your hand or damage the knife-edge. One end of the spring should be already connected to the upright support post. Attach the other end of the spring to the boom. Put a drop of damping container oil (see step 7) on the knife edge to reduce friction. Position the boom's knife-edge into the slot on the support post. The boom will be positioned at an angle. This is to be expected and will not damage the boom (Figure 2).

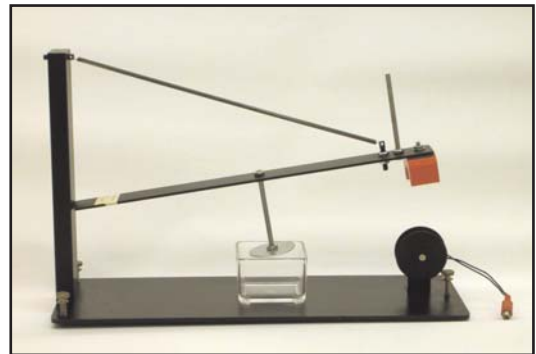


Figure 2

5. The upright bolt on the boom arm requires a stack of one to sixteen washers (depending on the tightness of the spring) approximately 2.5 cm (1 inch) from the top. Secure the stack between hex nuts (Figure 3).

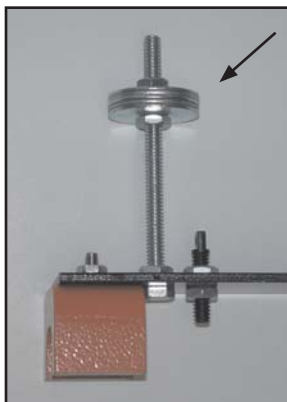


Figure 3

With the added weight of the washer stack the boom arm should now be suspended over the coil. Center the magnet over the coil (Figure 4) by sliding the knife edge at the support post (Figure 5). The boom arm should move freely up and down and the magnet should not touch the coil. This may require additional bending of the coil.

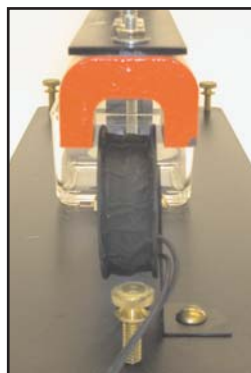


Figure 4

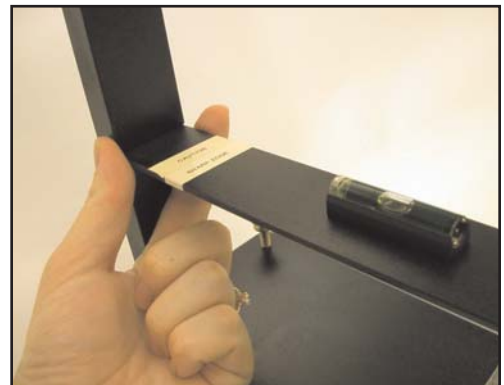


Figure 5



6. Carefully swing the boom up until it is possible to position the damping fluid container under the damping vane. Do not fill the container before it is positioned correctly.

**CAUTION:** Do not release the boom arm abruptly and allow the magnet to hit the coil. The equipment is sensitive; handle and adjust the parts carefully and gently.

7. Add fluid to the damping fluid container. The fluid level should be 1 cm (3/8 inch) below the top of the container. For proper damping, the fluid should be:

- 1/2 STP oil treatment and 1/2 10w40 synthetic motor oil for the thick spring units (spring diameter of 8 mm)
- 1/3 STP oil treatment and 2/3 10w40 synthetic motor oil for the thin spring units (spring diameter of 4 mm)

8. The boom arm must be level to accurately record vertical motion. Begin by positioning the bubble level on the boom, as shown in Figure 6. If needed, add one or two washer(s) along the boom until the boom is level. The positioning of the washers and the bubble level will vary. The bubble level and the balance washer(s) stay on the boom arm to keep it level.

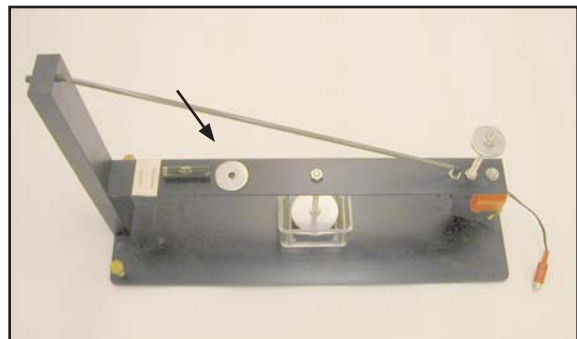


Figure 6

9. Rotate the bubble level 90 degrees on the boom. Adjust the base leveling screws until the bubble is again centered. Rotate the bubble level 90 degrees back to its starting position.

10. Check that the magnet is still centered above the coil. The boom can be horizontally adjusted by pushing the boom at the support post (Figure 7). The boom arm should move freely up and down and the magnet should not touch the coil.



Figure 7

11. Attach the paired shielded coaxial cable to the interface box. To attach a wire to a post the wire must pass through the hole on the post (Figure 8) then tighten the plastic knob. The center conductor of the signal cable (uninsulated wire) should be connected to the ground terminal (black post) on the interface box. The remaining two insulated wires should be connected to the two red posts (Figure 9).

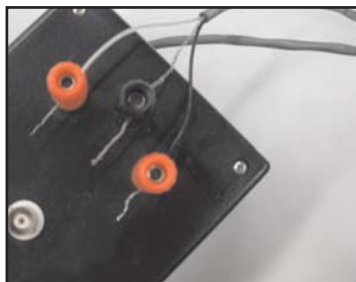


Figure 9

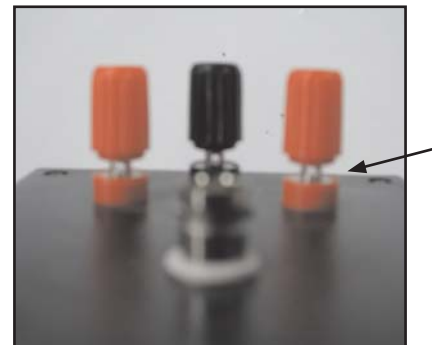
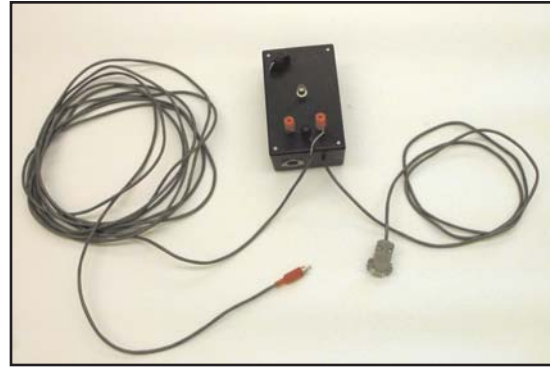


Figure 8

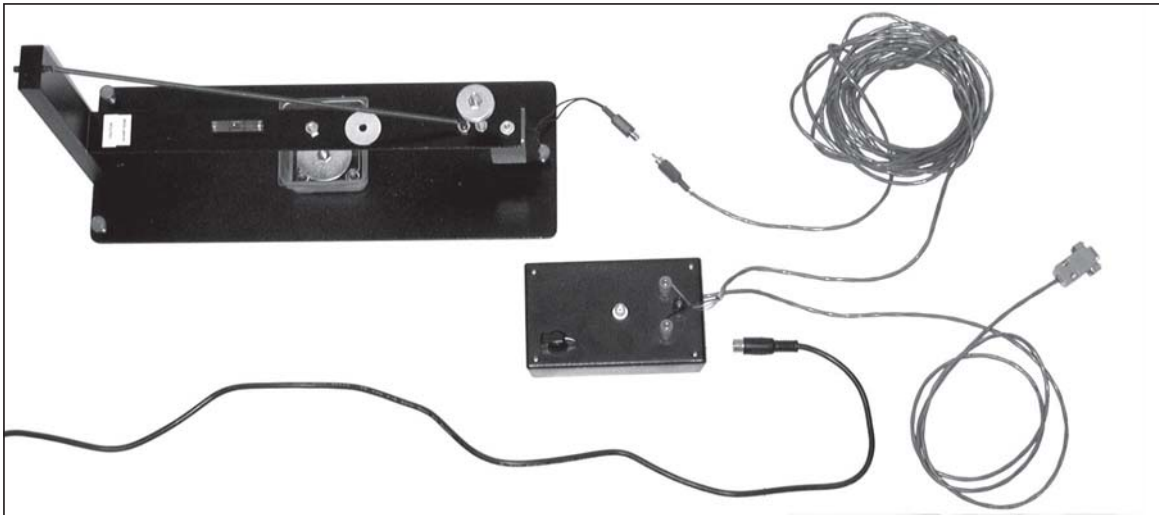
**12.** There are 2 cables leaving the interface box (Figure 10). The paired shielded coaxial cable (attached to the interface box in Step 10) has a plug connector on the end. The other cable has a gray 9-pin connector. Install the 9-pin connector from the interface box to the serial port on your personal computer. If your serial card has a 25-pin connector, you will need to purchase a 9- to 25- pin adapter. If your computer does not have a serial port, you can install the AS-1 through a USB port, a USB- to serial adapter is needed (both available from Radio Shack or similar store).



**Figure 10**

**13.** Plug the connector end of the paired shielded coaxial cable attached to the interface box to the matching connector on the seismometer base.

**14.** Plug in the 5-pin cable from the power supply box to the 5-pin slot on the interface box. Plug in the power cord from the power supply to an outlet (Figure 11).



**Figure 11**

**15.** Cover the seismometer with the plexiglass display box. This will minimize motion of the boom due to air currents.

**CAUTION:** Before moving the seismometer, disconnect the boom to prevent damage to the knife edge.

# 3

## Software Installation and Configuration

### Software Installation

#### a) Installing AmaSeis from CD

- Exit all windows programs before inserting the CD.
- Insert the disk in your CD drive. The setup program will automatically be launched.
- Install using the default settings

#### b) Downloading AmaSeis

- Go to: <http://www.geol.binghamton.edu/faculty/jones/AmaSeis.html>
- Click on the link labeled **AmaSeisSetup.exe**
- Click on Open or Run. This will launch the setup program

#### c) Installing AmaSeis without an Internet Connection

- The file is too large to fit on a single floppy disk, there is the option to create two installation disks to transfer the installation program
- From any computer connected to the Internet go to:  
<http://www.geol.binghamton.edu/faculty/jones/AmaSeis.html>
- Click on the link labeled **AmaSeisDisk1.exe**
- Click on Open or Run. This will save the needed files to a diskette.
- Click on the link labeled **AmaSeisDisk2.exe**
- Click on Open or Run. This will save the needed files to a second diskette.

The standard installation will put files in **My Computer > System C > AmaSeis**

It will also put an icon under the Start menu **Start > Programs > Seismology > AmaSeis**. To create a shortcut link on the computer desktop, right click AmaSeis and select **Send To > Desktop** (create shortcut).

## Installing a New Version of AmaSeis

To upgrade AmaSeis go to: <http://www.geol.binghamton.edu/faculty/jones/AmaSeis.html>

- Click on the link labeled **AmaSeisUpgrade.exe**
- Click on Open or Run. This will launch the upgrade program

## AmaSeis File Structure

AmaSeis stores data in a set of nested folders. A year's worth of data will take up about 350 megabytes. This can be searched for events at any time. Be aware of the amount of space the data will take so that you don't fill your disk. To erase old data, use the Windows Explorer. Remember, once it is deleted, you can not recover it.

The path to the AmaSeis directory (if you used a standard install) is **My Computer > System (C:) > AmaSeis**. The AmaSeis directory contains data folders, files, and the program.

- AmaSeis creates a series of nested folders to store data. The top level folders are divided by years. In each year folder, there will be 12 month folders which contain subfolders for each day. The actual data files are saved with the naming convention hour.z.

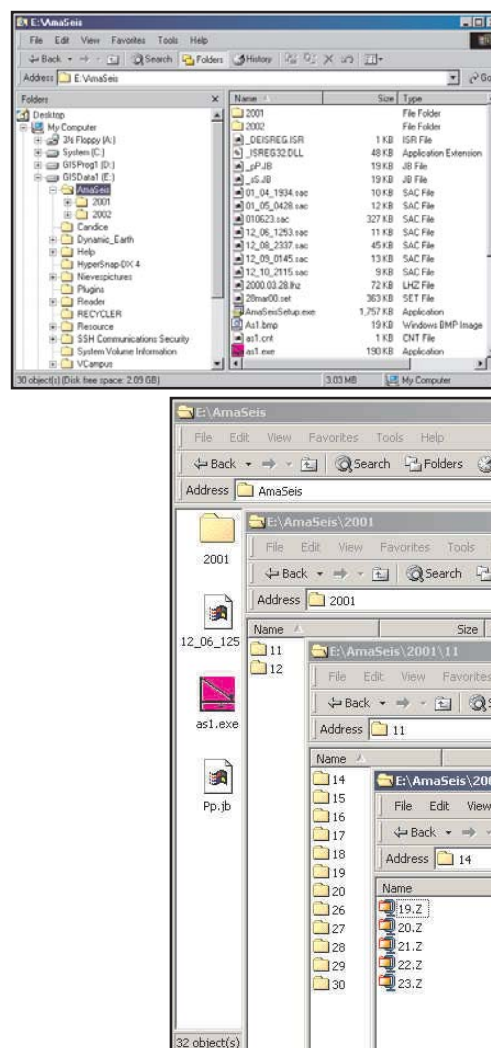
- AmaSeis references time in Coordinated Universal Time (UTC), the international time standard. It is the current term for what was commonly referred to as Greenwich Meridian Time (GMT). Zero (0) hours UTC is midnight in Greenwich England, which lies on the zero longitudinal meridian. Universal time is based on a 24 hour clock, therefore, afternoon hours such as 4 pm UTC are expressed as 16:00 UTC (sixteen hours, zero minutes).

Conversions of UTC:

Mountain Standard (Tucson) + 7 hours

Eastern Standard (Washington DC) + 5 hours

**CAUTION:** Keep your computer set to local time, AmaSeis makes the necessary adjustment based on your time zone setting.

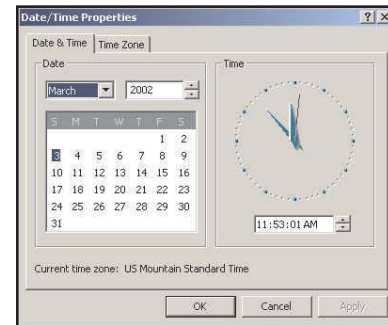


## Setting the Date and Time

Set the date and time on your computer before you launch **AmaSeis**. The software will record data based on these settings, and it is crucial that the time is as accurate as possible.

- Select **Start Menu > Settings > Date/Time**
- The current time is available from <http://www.time.gov>

**CAUTION:** It is highly recommended that the time setting be checked on a monthly basis. Some systems lose accuracy as time passes, and even a discrepancy of a minute or two makes it very difficult to work with data.



## Automatic Time Synchronization

If the AmaSeis computer is attached to the Internet, it is highly recommended that a time synchronization program be run to reset the PC clock every hour. There are free programs available that will go out over the Internet to periodically synchronize a computer's clock to accurate UTC time.

- <http://www.boulder.nist.gov/timefreq/service/its.htm>
- <http://www.arachnoid.com/abouttime/>

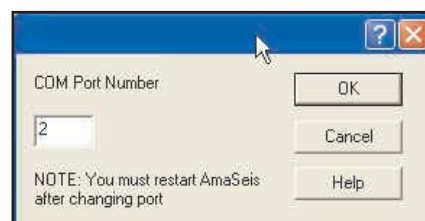
## Initial Program Launch

- To launch the software Double Click on the program icon
- The software assumes the AS-1 seismometer is attached to the communication port COM 1. If you receive a 'no data' error message, your computer is not receiving data from the seismometer. This will occur if the AS-1 is attached to a different port. To fix this error change the port setting.



## Changing the Port Setting

- Select **Settings > COM port**
- Edit setting. Experiment with different COM ports (1-4).
- Quit and relaunch **AmaSeis**
- This is a trial and error process.



**NOTE:** If two copies of **AmaSeis** are launched an error will appear. Make sure to close all open programs, then launch the software by double clicking on the program icon. More than one copy of AmaSeis can be run, but they must be located in different directories and use different COM ports.



## Launching the Program (cont.)



- To launch the software double click on the program icon
- An introductory screen will display for approximately 5 seconds. After that time, the helicorder screen will appear. On the first launch of the software, the station parameters need to be set.

## Setting Station Parameters

- From the Menu Bar choose **Settings > This Station**
- Edit the station properties

### - Station Name

### - Latitude

Enter in decimal degrees

### - Longitude

Enter in decimal degrees

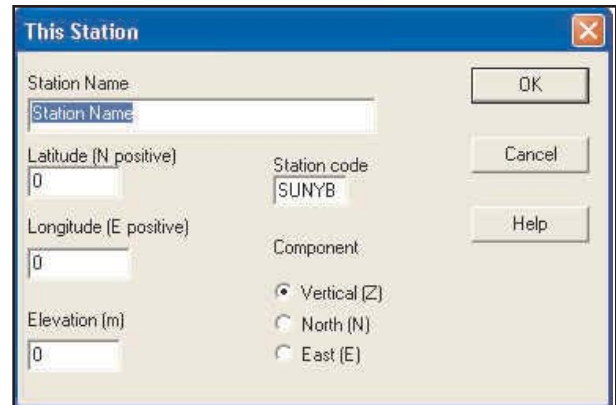
### - Elevation

### - Station Code

A 4 letter code, the first two letters represent your school or organization, the last two letters are a state abbreviation. If you select this code, please check to not duplicate an existing station code at [www.scieds.com/spinet/spinet\\_stations.php](http://www.scieds.com/spinet/spinet_stations.php). If you have any questions or concerns, contact the network administrator at [spinet@scieds.com](mailto:spinet@scieds.com) to be assigned a code.

### - Component

The AS-1 is a vertical component instrument



- To determine the latitude and longitude of your school consult a topographic map or use a handheld GPS receiver. If these options are not available, maps are available online. Go to <http://www.maptech.com/> and select **Online Maps > Maptech MapServer**. Enter the zip code in the dialog box and select **Go**. Make sure to switch to decimal degrees.
- Once the station properties have been entered, this information is stored and does not need to be entered again.



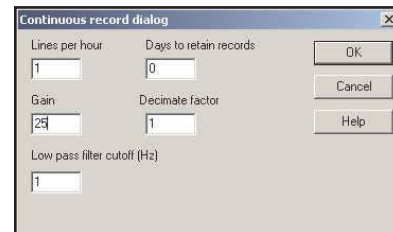
### Registering the Station

- Register the new station online at <http://www.scieds.com/spinet>
- Select **Join the Network**
- SpiNet provides a site for teachers to share their AS-1 data with each other online. Additionally there are links to activities and other resources for teachers using seismic data in the classroom.

### Instrument Settings

All settings in this section only affect the way the data is displayed on the computer screen. They do not effect the data values that are stored on disk.

- From the File Menu choose **Settings > Helicorder**



- **Lines Per Hour** The display can show anywhere from 24 minutes to 24 hours of data on the screen. This value defaults to 1, which means that the width of the screen represents one hour. The data for one day is contained on one screen, this can be useful in searching for earthquakes. If you change the lines per hour setting to 3, one hour of recording will take up three lines and 8 hours of recording will be seen on one screen rather than 24 hours. The value can be increased up to 60 to show details of the waveforms. This can be useful for in-class testing and demonstrations. Select a number that divides into 24 unless you are using a number greater than 24 such as 30 or 60 (one line a minute).
- **Gain** This setting adjusts the amplification of the signal and varies with the location of the seismometer. Choose a gain setting such that the background noise is just visible. For example, there is always a little bit of up and down movement of the trace. A value between 25-50 is ideal. If the trace is too noisy, adjust the gain to a lower value. Any adjustment to the gain may require slight adjustments to the set zero level.
- **Low pass filter cutoff** Set to 1 Hz. This setting filters out local noise from the school building and makes it easier to see distant earthquakes.
- **Days to retain records** This setting controls how many days are available to scroll back through when looking for events. All data will be stored by the system until it is deleted by the user, this setting just controls how much is available to display.

- **Decimate Factor** This setting controls the number of plotted points when the trace is redrawn, but does not affect the quality of the recording. Select 10 for this setting. If scrolling is very slow, adjust this setting higher to speed up scrolling.

### Selecting a Gain

The Gain setting adjusts the amplification of the signal and an appropriate value for this setting varies with the location of the seismometer. The goal is to minimize noise while highlighting any earthquakes that the AS-1 records. Often the best strategy is to watch carefully for the first earthquake, if the event is barely or not visible adjust the gain to a higher value. If the event seems to take over the screen, adjust the gain to a lower value. Since this setting only affects how data is displayed on the screen and does not effect the data values that are stored on disk, try multiple values to compare the earthquake signal with background noise. Selecting an appropriate gain maximizes the instructional value of the instrument. A few examples are listed below to help select a starting value.

- **THAZ** - Gain 35

This instrument is located in a science storeroom in the back of a classroom at Tempe High School in Phoenix, Arizona. It is on the ground floor of a one-story building. This school is in downtown Tempe and the classroom is about 60 meters from a four-lane street.

- **RAIN** - Gain 45

This AS-1 is located in the basement of the six-story Department of Geological Sciences Building at Indiana University. It sits on a concrete pier specially designed for seismic instruments that is cut away from the building's foundation. There is a small one-lane street five meters west of the instrument.

- **WGCO** - Gain 50

This instrument is located on top of a small wooden cabinet which is situated in the back of the entry level conference room of the USGS National Earthquake Information Center in Golden, Colorado. This is a concrete-slab building with three floors above and one below the entry level.

- **PCAZ** - Gain 25

This instrument is located on the floor next to the wall in a classroom of Phoenix Country Day School in Paradise Valley, Arizona. The teacher had a small piece of carpet removed so that the AS-1 sits on concrete. The classroom is on ground floor of a one-story building. There is a small surface street 25 meters north of the instrument. The seismometer registers anyone who walks within three meters of it.



## Finding the Trace

- From the File Menu choose **Settings > Set Zero Level**
- 
- Set the Zero Level at 2048 (This value centers the trace thus preventing clipping of the signal from a large event)
  - From the Menu Bar choose **Settings > Helicorder**
  - **Set the Gain to 1** (Setting the Gain to 1 facilitates the centering process, once the AS-1 is recording close to the current hour line adjust the gain higher and complete the centering procedure)
  - By setting the gain to 1, the trace will now be drawn on the screen, and it may be visible. Or, more commonly, it is recording off the screen and will not be visible. Slowly move the potentiometer (black knob- Figure 12) on the AS-1 interface box until the trace is visible on the screen. Moving the potentiometer one direction will move the position of the trace up on the screen and the opposite direction will move the trace down on the screen. Each line represents one hour, so the trace moves slowly. The current UTC time is always the bottom hour line (in blue). The screen will scroll up through the day, leaving the trace always recording on the bottom hour line.
- 
- Figure 12
- Once the trace is visible on the screen moving it down to the current hour line requires gentle tapping of the potentiometer (use the end of a pencil). This is a difficult and slow process. Be patient and get the trace as close to the current hour line as possible.
  - In addition to just watching the trace on the screen, it can be helpful to use the **Settings > Show Data Values** window when adjusting the potentiometer. The goal is to have the data values bouncing above and below zero.
  - Set the gain to 25 (or value suitable for seismometer location). Adjust the trace to the current hour line by a gentle tapping of the potentiometer (use the end of a pencil).
-

### Centering the Trace

Once the trace is close to the correct hour line, fine tune adjustments can be made using the set zero level. Adjustments made to this value are **RELATIVE** to the starting value.

- From the File Menu choose **Settings > Set Zero Level**
- To shift the trace down to the correct hour line increase or decrease the value in the Set Zero Level pop-up window. Fine tuning the trace position requires a relative change of 5 or 10. This number should remain relatively close to 2048 and **SHOULD NOT** be used to make large adjustments.



### Congratulations!

By reaching this point, your seismometer is accurately recording and will store any events that it is able to detect. The AmaSeis program needs to be running at all times in order to collect data, however the display window can be minimized.

# Using AmaSeis 4

The AmaSeis program is used to record and archive data from the AS-1 Seismometer. Additionally, AmaSeis can be used to view, save, filter, analyze and interpret seismograms. The seismograms may be saved from the AS-1 data (continuous output of the seismometer) or imported from other sources (onto your computer whether or not an AS-1 seismometer is connected). Thus, AmaSeis can be used as a viewer for display analysis and interpretation of earthquake seismograms without an attached AS-1 seismometer.

If data has already been collected on this PC but the AS-1 instrument is not attached at this time, an error message will be displayed but the program will still run and be able to scroll back to previously recorded data or open events that have been saved to disk.



Z files are AmaSeis storage files, there should be one Z file for each hour of each day/month that an instrument is running. After the data is placed in the correct directory structure in the AmaSeis folder it should be visible. From the Helicorder screen select **Settings > Helicorder** and change the Days to Retain Records option to something big enough to “look back” to the time period in question. Often we set this to 365 so you can look back at one years worth of data at any time. Now on the Helicorder screen on the far right side is a scroll bar, drag this up to look back in time at old data. Or to go to a specific date/time click on **Settings > Go to Date-Time** and enter the Year/Month/Day/Hour of interest.

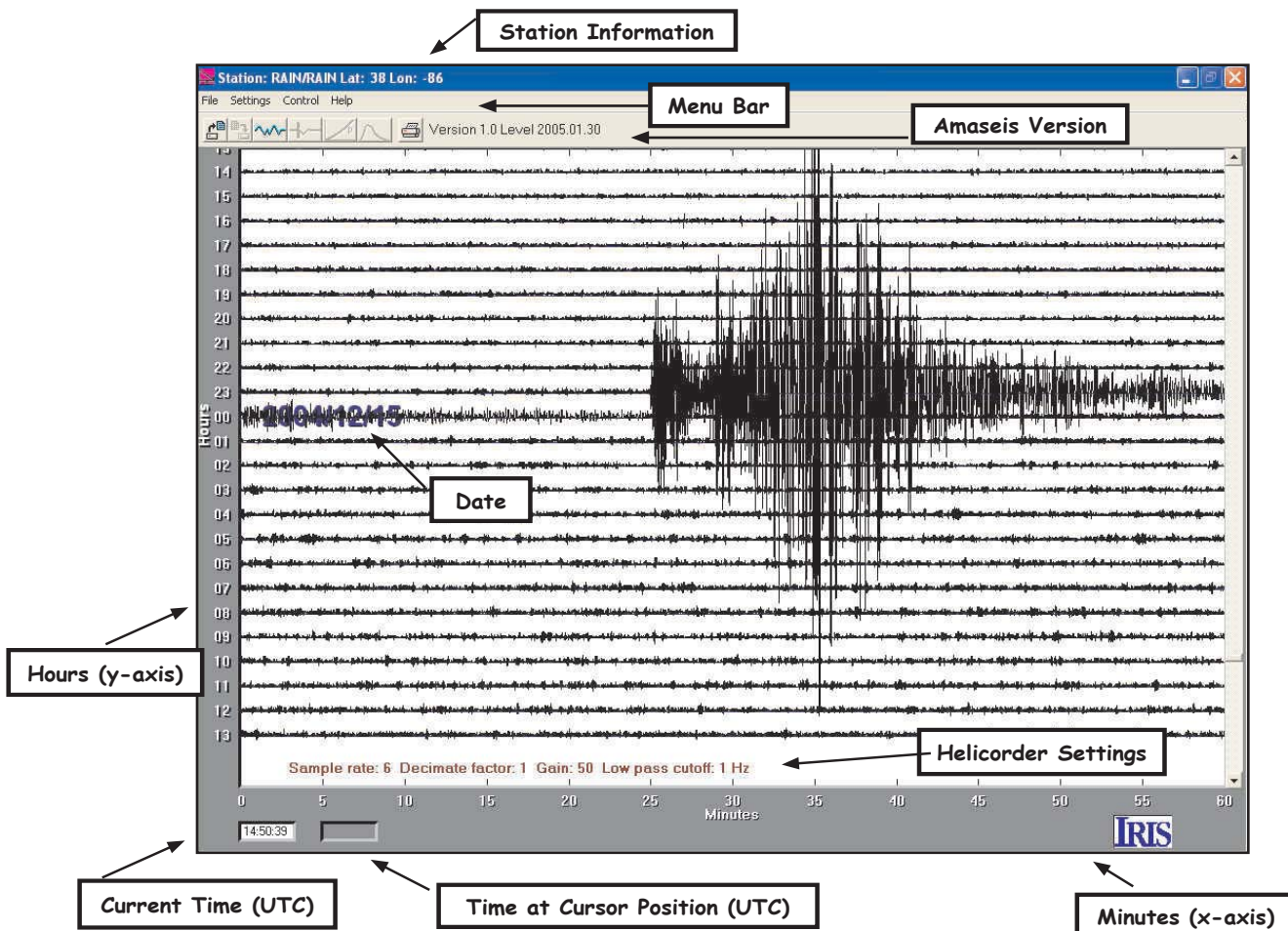
To open a seismogram that is stored as a SAC file, use the **Open** selection under the **File** menu in AmaSeis. This not only allows for sharing of AS-1 data across the SpiNet network, but allows comparison of AS-1 data to data recorded from other types of seismometers.

## Helicorder Screen Overview

The window that appears when the program is launched is called the helicorder screen. The recording emulates what appears on a drum recorder.

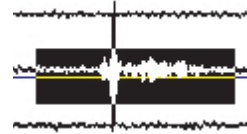


- Using default settings each horizontal line represents an hour. The current time (UTC) is found in the bottom left corner of the screen. The trace should be recording along the bottom hour line.
- The date is posted on the 00 hour line. The scroll bar along the right side of the window can be used to scroll back through the earlier recorded data.
- The sampling rate is the data per second that are sent from the seismometer to the computer. It should be a number between 6.1 and 6.2 samples per second for the AS-1. This rate is determined when the introduction screen is visible, by counting the number of data points that arrive in 5 seconds.



## Saving an Event

- From the helicorder screen **highlight** an event by holding down the left mouse button and dragging over the event



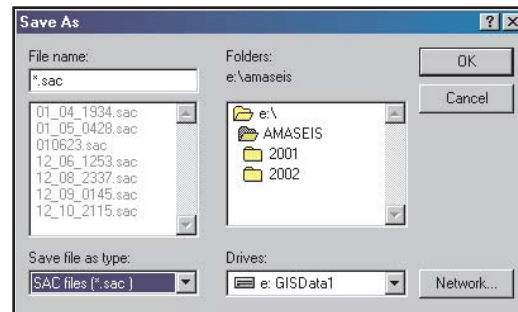
- Click the extract icon below the Menu Bar



This will open the **Extract Event Screen**

- To save the data in a file select **File > Save As**
- In the upper left corner of the **Save As Dialog Box** name the file (change the \* in front of .sac to your filename). Please use the following naming convention: two digit year, two digit month, two digit day, two digit hour, two digit minute (of first arrival), station code (yyymmddhhmmstcode)

**Example:** Tempe High School (thaz)  
recorded an event at 19:30 on June 23, 2001  
**0106231930thaz.sac**

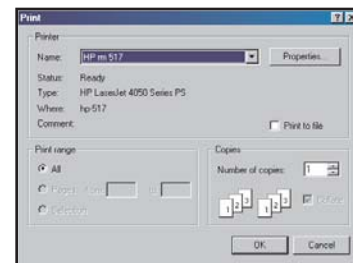


- In the bottom left hand corner, set the **File Type** to **SAC**
- Send us your event!** You can upload the SAC file through your internet browser at <http://www.scieds.com/spinet>

## Printing an Event







- From the Extract Event screen click on the print icon or from the Menu Bar choose **File > Print**
- At the Print Dialog Box click on **Properties**
- Set the Orientation to **Landscape**, Click **OK**
- Click the **OK** button

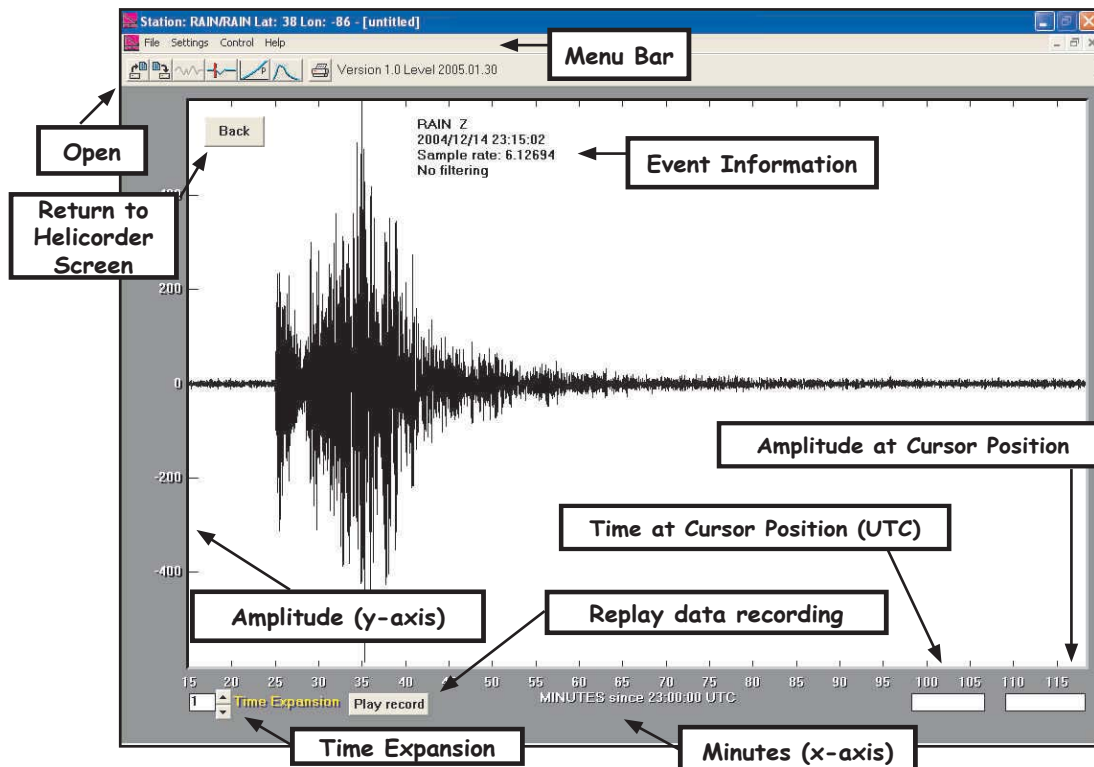


An alternative way to save the screen for incorporation into a Word document is to press the <alt> <print scrn> keys. Nothing will apparently happen, but you can open Word and **Edit > Paste** to insert the image. Be sure to have **View > Toolbars > Drawing** and **Views > Toolbars > Picture** checked. The pasted image can be cropped and resized within Word.

## Extract Event Screen Overview

The highlighted portion of the trace is displayed in this window. To zoom in again, highlight the record and click the extract icon below the Menu Bar.

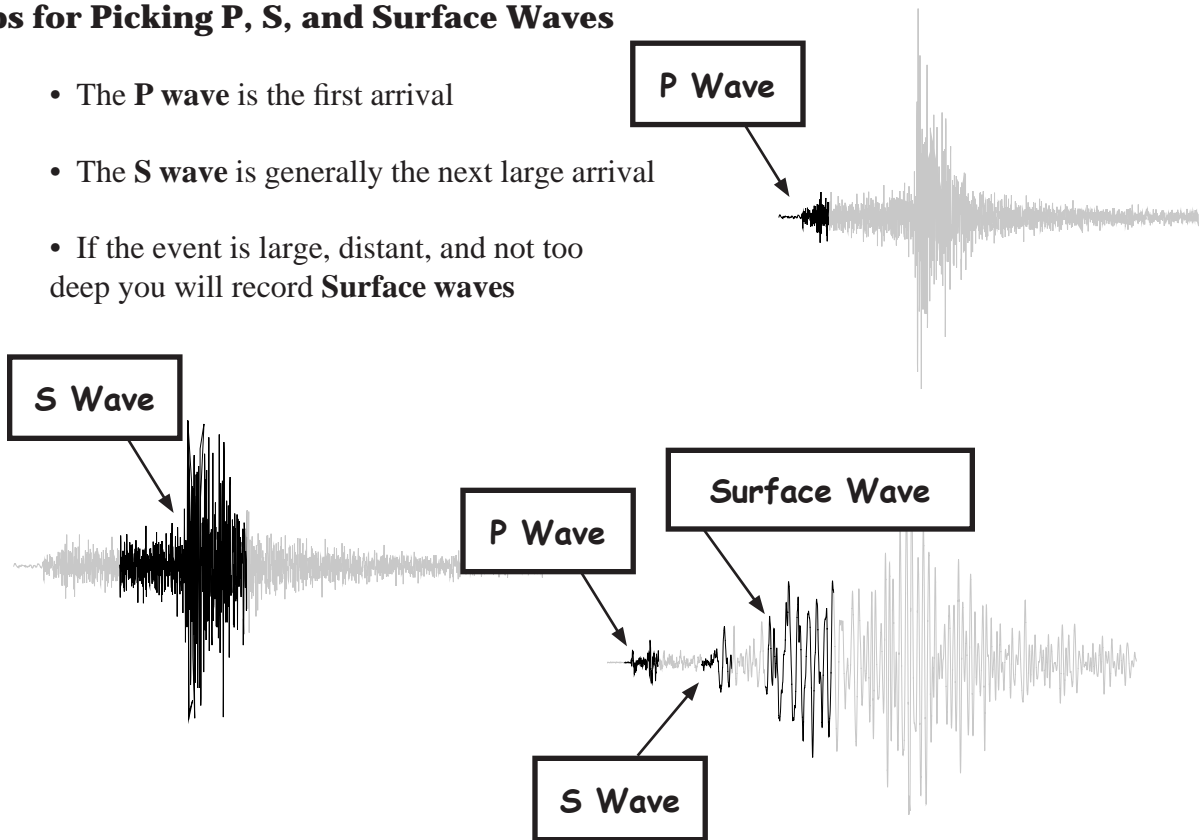
- **Time Expansion** expands the x axis. For example, when the time expansion is 2, the time axis is doubled in length allowing you to zoom in. In this case only the first half of the waveform is displayed. To see more of the waveform use the scroll bar at the bottom of the screen.
- The cursor position is linked to the time on the seismic record and the amplitude which is useful for determining periods and amplitude for magnitude determination.
- **Play Record** replays the data recording. This is useful to point out when arrivals are coming in when reviewing an event with students.
- Load a previously saved event using the **Open Icon**. 
- The **Pick Arrivals Icon** is used to mark wave arrivals. For regional events it is sometimes easier to mark the P wave and Surface wave arrivals. For global events, mark the P and S wave arrivals. 
- The **Travel Time Curves Icon** is used to determine the distance from the event to your station using the time delay between wave arrivals. 
- The **Fourier Transform Icon** is used to analyze the frequency content of the seismogram. 





## Tips for Picking P, S, and Surface Waves

- The **P wave** is the first arrival
- The **S wave** is generally the next large arrival
- If the event is large, distant, and not too deep you will record **Surface waves**



## Picking Arrivals in AmaSeis

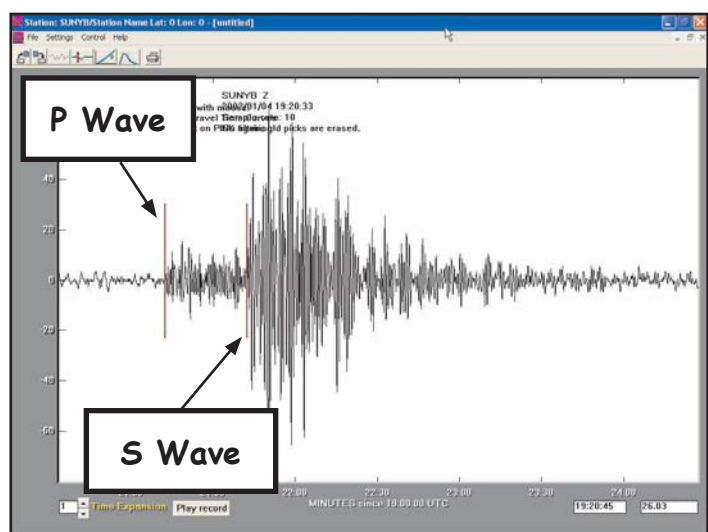
- On the **Extract Event Screen** click on the **Pick Arrivals Icon**.



- Mark the arrival by positioning the mouse on the trace at the arrival and clicking with the **Left Mouse Button**.

- For regional events, mark the P wave and Rayleigh wave arrivals. For global events, mark the P and S wave arrivals.

- Picks will be marked with a vertical brown line. To repick, click on the **Pick Arrival Icon** again.



## Using the Travel Time Curve

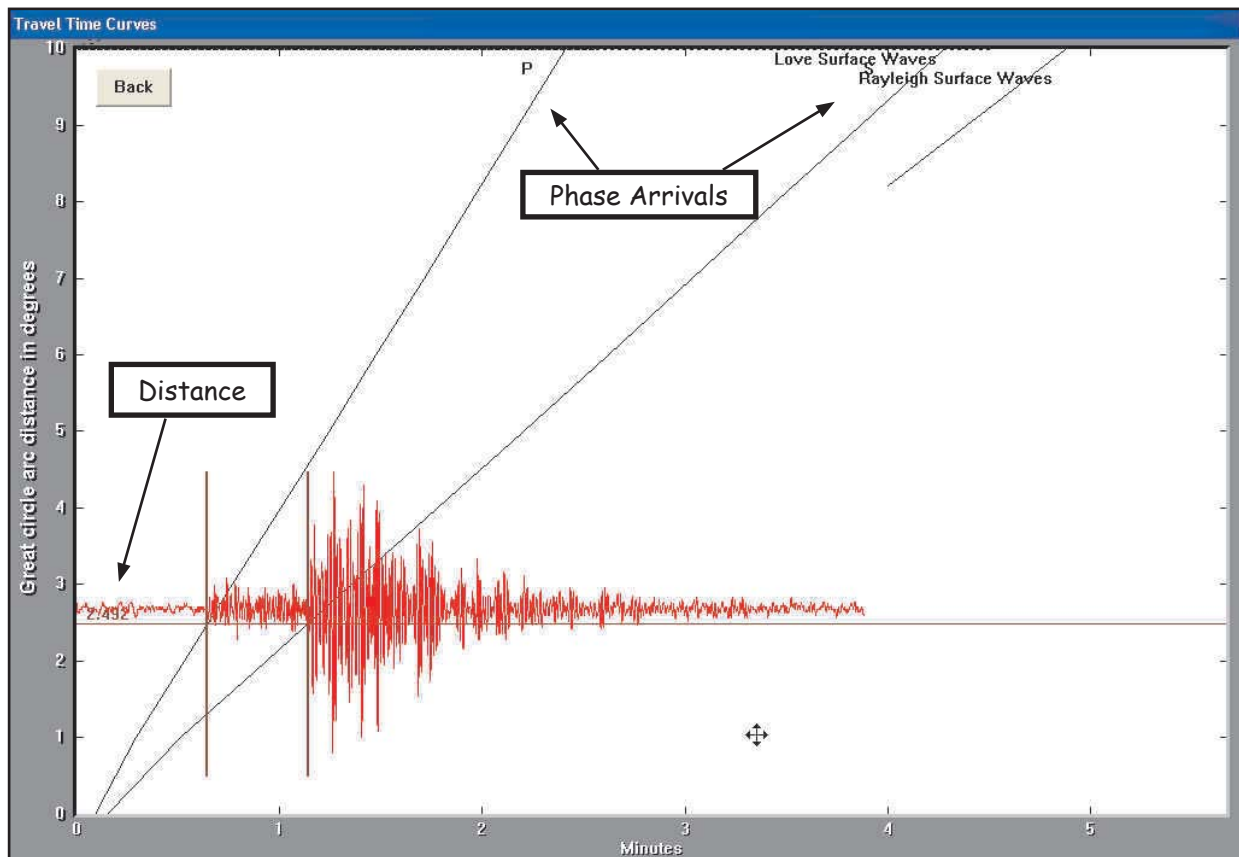
- After picking arrivals in the **Extract Event Screen** click on the **Travel Time Curve Icon**



- If the depth is known for the event, enter it in the **Depth Dialog** box, or leave the default 33 km. The depth is used to determine the correct travel time curve to use.



- Using the Mouse, drag the trace up or down along the vertical axis to align the Arrival Picks with the corresponding Phase Arrival Lines.
- Once the record is aligned with the travel time curve, the distance to the event is reported on the left under the trace.
- The distance is reported in degrees. To convert from degrees to kilometers:  
**1 degree = 111 kilometers**





## Storing Event Information

Once you have identified an event that your AS-1 has recorded, you can store information about it for future instructional use. There are many applications for using real-time seismic data in the classroom.

To store data about an event:

- On the **Extract Event Screen** select **Settings > Event**

- Enter the event information in the **Event Dialog** box.

- The Seismogram Start time will be pre-filled.

- Earthquake Origin Time  
AmaSeis will pre-fill part of this section, use information from an NEIC or IRIS bulletin to input the event parameters of latitude, longitude, origin time, and depth.

**Event Dialog**

Event name:

Seismogram start time (May be adjusted for errors in PC clock.)

Year	Month	Day
2005	3	9
Hour	Minute	Second
1	5	46.0

Magnitudes

MB:	0
MS:	0
ML:	0
MW:	0

Earthquake origin time

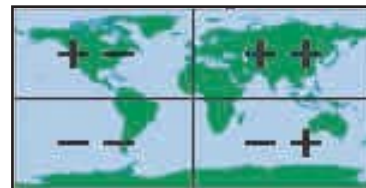
Year	Month	Day	Latitude (N positive)	Longitude (E positive)
2005	3	9	0	0
Hour	Minute	Second	Depth (km)	Time from event time to beginning of record (s)
1	5	46.0	0	0.0

Location of Seismic Waves program:

Buttons: OK, Cancel, Help, Create files for Seismic Waves

**NOTE:** Using internet earthquake databases is described in the next section. Use these databases to gather the above information about the event.

- The latitude and longitude must be entered as signed numbers, negative for west longitude and negative for south latitude.



- Magnitudes

Record any magnitude reported by IRIS, NEIC, or if you calculated your own station magnitude report it here.

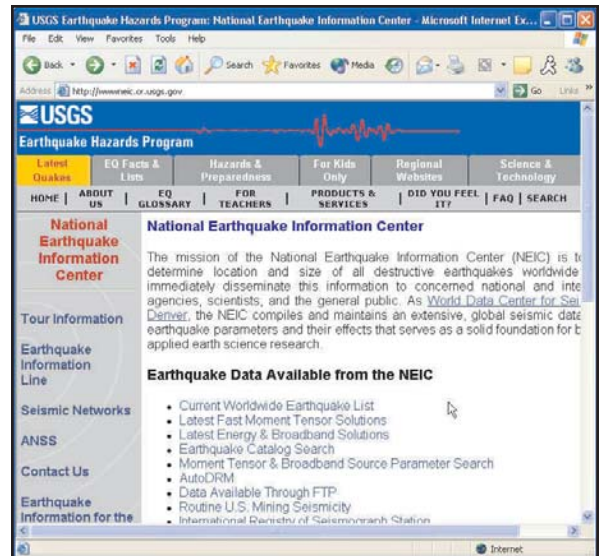
**NOTE:** Data from the AS-1 can be exported for use in Seismic Waves. See the SpiNet website for additional documentation on this feature.

## Searching for Current Events in NEIC (National Earthquake Information Center)

- Select **Current Worldwide Earthquake List**
- Events from the last 7 days will be displayed

- Scroll down and click on **Last 8-30 Days of Earthquake Activity**

- Launch your browser and go to:  
<http://www.neic.cr.usgs.gov>
- Select **Earthquake Catalog Search**.
- Scroll down and select **Global (Worldwide)**.
- Use the default selection for the **Output File Type** and **Database**.
- In the **Optional Search Parameters** fill in a date range to narrow down the records. It is not necessary to fill in all the fields. NOTE: If you enter a minimum magnitude, the site requires a value for the maximum magnitude.
- Click on **Submit Search**



Optional Search Parameters:

Date

Starting Year  Starting Month  Starting Day  
 Ending Year  Ending Month  Ending Day

Magnitude

Minimum Magnitude  Maximum Magnitude

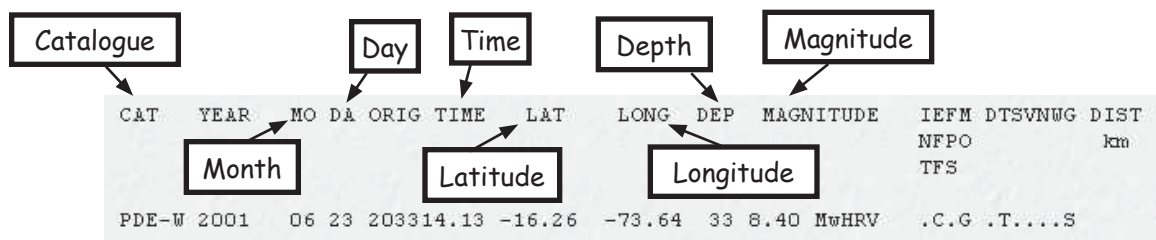
Depth

Minimum Depth  Maximum Depth

Intensity

Minimum Intensity  Maximum Intensity

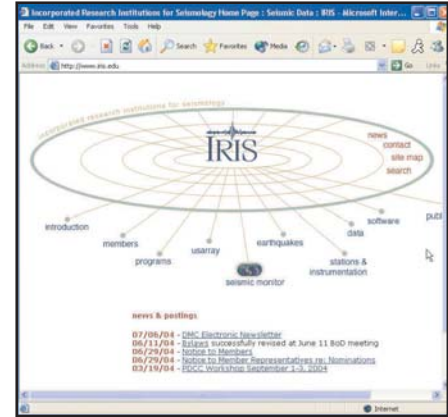
When the search is complete, you will see a table of data in your browser window.



## Searching the IRIS Earthquake Database

The IRIS event search is very similar to the NEIC event search. However, IRIS also provides a geographical location in addition to the latitude and longitude.

- Launch your browser and go to: <http://www.iris.edu>
- Select **Earthquakes**
- Select **Search Event Catalog > Event Search**
- Enter a date range in the search form.
- This site does not require all fields to be filled in.
- Click on **Submit Search**



## Site Output

When the search is complete, you will see a table of data in your browser window.

TIME	LAT	LON	DEP	MAG	TYPE	CATALOG	REGION
2001/01/26 03:16:40.5000	23.419	70.232	16	8.0	MS	MHDF	INDIA

Labels pointing to the table fields:

- Month: 2001
- Day: 01
- Time: 26 03:16:40.5000
- Latitude: 23.419
- Longitude: 70.232
- Depth: 16
- Magnitude: 8.0
- Magnitude Type: MS
- Catalog: MHDF
- Region: INDIA

## Searching for Mining Seismicity

NEIC catalogues routine mining seismicity in the United States.

- Launch your browser and go to: <http://wwwneic.cr.usgs.gov>
- Select **Routine U.S. Mining Seismicity**

[January 2001](#) | [February 2001](#) | [March 2001](#) | [April 2001](#) | [May 2001](#) | [June 2001](#) |  
[July 2001](#) | [August 2001](#) | [September 2001](#) | [October 2001](#) | [November 2001](#) | [December 2001](#) |  
[January 2002](#)

- Scroll down through the catalogues and click on the month of interest.

## Site Output

ORIGIN TIME	UTC	GEOGRAPHIC COORDINATES	DEPTH	MAGNITUDE	SD	GAP	NO. STA USED	F-E REGION, CONTRIBUTED MAGNITUDES AND COMMENTS
DAY HR MN SEC		LAT LONG	mb MS					
01	21 05 29.2*	43.614 N 105.532 W	0 G		0.9	242	10	WYOMING. ML 3.3 (GS). 40 miles ENE of Midwest.
03	21 07 54.8*	43.725 N 105.319 W	0 G		0.6	246	13	WYOMING. ML 3.3 (GS). 40 miles SSE of Gillette.
04	21 21 48.8	36.378 N 110.343 W	0 G		0.6	176	8	EASTERN ARIZONA. ML 2.4 (GS). 25 miles SSW of Kayenta.
04	22 00 16.8*	33.213 N 109.262 W	0 G		0.7	257	8	EASTERN ARIZONA. ML 3.4 (GS). 35 miles NE of Safford.

Labels pointing to the table fields:

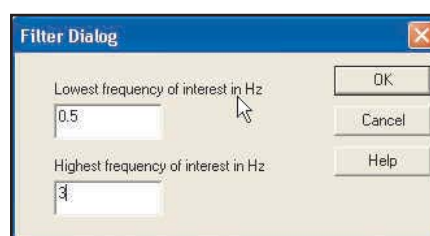
- Date: 01 21 05 29.2\*
- Latitude: 43.614 N
- Longitude: 105.532 W
- Depth: 0 G
- Region: WYOMING
- Magnitude: ML 3.3

## Filtering

Local and regional event (less than 10 degrees distance) earthquake seismograms are usually dominated by short period (near 1 s period) energy. Teleseismic (distant earthquakes, 10 to 180 degrees) recordings usually consist of lower frequency (longer period) energy and often have prominent surface wave arrivals of 12 - 30 s period. The AS-1 seismometer has a natural period of oscillation of about 1 s. To make the seismometer more useful for recording distant earthquakes, the long period (greater than 10 s) response of the instrument is enhanced. Because background noise is always present, filtering of the records is often desirable to enhance the earthquake signals.

### Local and Regional Events

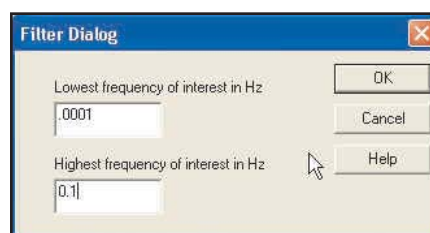
- In the Extract Event Screen, from the File Menu Bar select **Settings > Filter**
- A useful filter is a bandpass filter with frequency cutoffs of 0.5 Hz and 3 Hz (isolating the short period energy: 2 s - .333 s period).
- Enter the two frequencies in the **Filter Dialog Box**.



### Global Events

For teleseismic or distant earthquakes, lower frequency filtering often enhances the seismogram, especially the surface wave arrivals that are prominent for shallow focal depth (0 - 70 km) earthquakes.

- In the Extract Event Screen, from the File Menu Bar select **Settings > Filter**
- Suggested filter cutoffs for lower frequency (longer period) signal enhancement are 0.0001 Hz and 0.1 Hz (isolating the longer period energy: 10,000 s - 10 s period).
- Enter the two frequencies in the **Filter Dialog Box**.



### Default Low Pass Filter

- AmaSeis's default low pass filter is a display filter that removes high frequency noise. We recommend that this be set to 1 Hz.

# 5

## Additional Resources

### Additional Resources and Information

#### AmaSeis Updates

- <http://www.geol.binghamton.edu/faculty/jones/amaseis.html>

#### Identifying Earthquakes or Mining Seismicity

- <http://www.neic.cr.usgs.gov>
- <http://www.iris.edu>

#### Web Sites for Information and Curriculum Resources

- <http://www.scieds.com/spinet/>
- <http://www.eas.purdue.edu/~braile/>

#### Latitude and Longitude

- <http://terraserver.homeadvisor.msn.com>
- <http://www.maptech.com/>

### Time

- <http://www.time.gov>
- <http://www.boulder.nist.gov/timefreq/service/its.htm>
- <http://www.arachnoid.com/abouttime/>

### California Earthquake Information

- <http://www.scec.org/earthquakes/>  
(select **Recent California Earthquakes**)