

## *Using the AmaSeis seismogram viewer and downloading seismograms from the Internet - A Tutorial <sup>1</sup>*

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**1. Introduction:** This tutorial is designed to provide instructions on the use of the AmaSeis software for collecting and analyzing seismograph data from an AS-1 seismometer (or with downloaded sample data if an AS-1 seismometer is not attached) and for accessing seismographic data for use with AmaSeis. The software makes it possible to easily view, process and analyze real earthquake seismograms, perform standard seismology calculations such as estimating the distance from an earthquake epicenter to the recording station and determining a magnitude of the earthquake, and explore seismic wave characteristics. Additional information about the AS-1 seismometer and educational activities for the AS-1 seismometer can be found at <http://web.ics.purdue.edu/~braile/>, select AS-1 Seismograph Information and at the IRIS Education and Outreach website at <http://www.iris.edu/about/ENO/>. An installation manual for setting up the AQS-1 seismometer can be found at <http://www.scieds.com/spinet/> and <http://www.iris.edu/about/ENO/AS1AmaSeis.pdf>. Further information on accessing earthquake information can be found at <http://web.ics.purdue.edu/~braile/edumod/eqdata/eqdata.htm>. Additional technical assistance and a tutorial for the AmaSeis software can be found under the **Help** menu in AmaSeis. Teaching lessons that use AS-1 seismograms and AmaSeis can be found at <http://web.ics.purdue.edu/~braile/edumod/as1lessons/>.



<sup>1</sup>

Last modified May 20, 2006

The web page for this document is:

<http://web.ics.purdue.edu/~braile/edumod/as1lessons/UsingAmaSeis/UsingAmaSeis.htm>.

Funding for this development provided by IRIS and the National Science Foundation.

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This tutorial is available for viewing with a browser (html file) and for downloading as an MS Word document or PDF file at the following locations:

<http://web.ics.purdue.edu/~braile/edumod/as1lessons/UsingAmaSeis/UsingAmaSeis.htm>

<http://web.ics.purdue.edu/~braile/edumod/as1lessons/UsingAmaSeis/UsingAmaSeis.doc>

<http://web.ics.purdue.edu/~braile/edumod/as1lessons/UsingAmaSeis/UsingAmaSeis.pdf>

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**2. Downloading the AmaSeis software:** To download the AmaSeis software and install it on your Windows computer, go to <http://www.geol.binghamton.edu/faculty/jones/> (Alan Jones' website, SUNY, Binghamton) and click on **AmaSeis** under Contents/Computer Programs. On the resulting

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screen (Figure 1), click on **AmaSeis**. The AmaSeis program screen will appear (Figure 2). Click on **AmaSeisSetup.exe**.

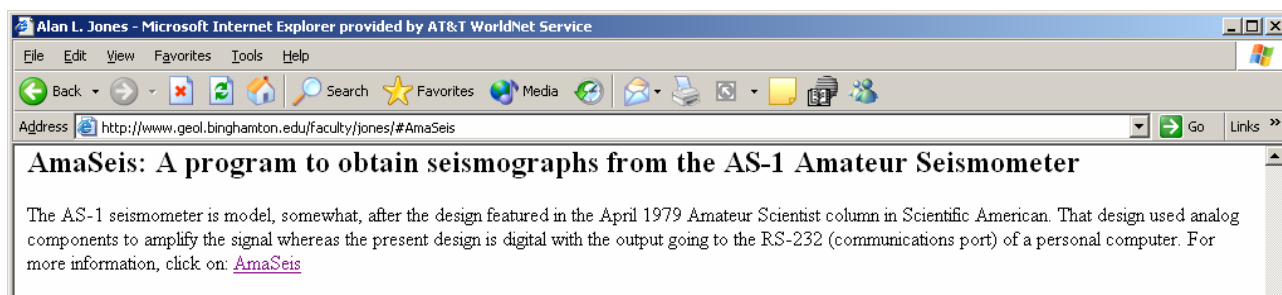


Figure 1. Part of the screen image describing the AmaSeis software from Alan Jones' website.

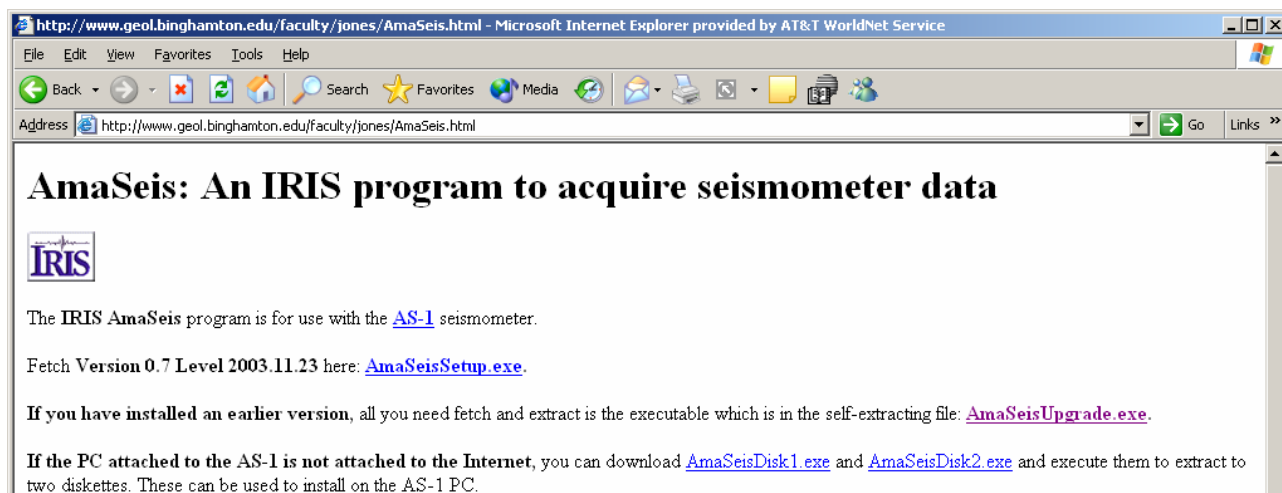


Figure 2. Part of the screen image describing the AmaSeis software from Alan Jones' website.

Selecting **AmaSeisSetup.exe** will open a **File Download** dialog box (Figure 3); click on **Save**. It is convenient to have a folder named **Downloads** on your desktop for downloading programs and other files. Saving the install files in this folder makes them available for transfer to another computer or reinstallation (without additional downloading) if the originally installed software is corrupted or deleted. If you have previously downloaded files to your **Downloads** folder, the **Save As** dialog box (Figure 4) will appear after clicking on **Save**. If you've just created a **Downloads** folder, you can navigate to the download folder using the down arrow symbol to the right of the "Save in:" line of the dialog box (Figure 4) or using the up arrow icon to the right of the "Save in:" line. In the **Save As** dialog box (Figure 4), click on **Save** to download AmaSeisSetup.exe. After a short time (depending on the speed of your Internet connection), the **Download Complete** dialog box (Figure 5) will appear. Click on **Close**.

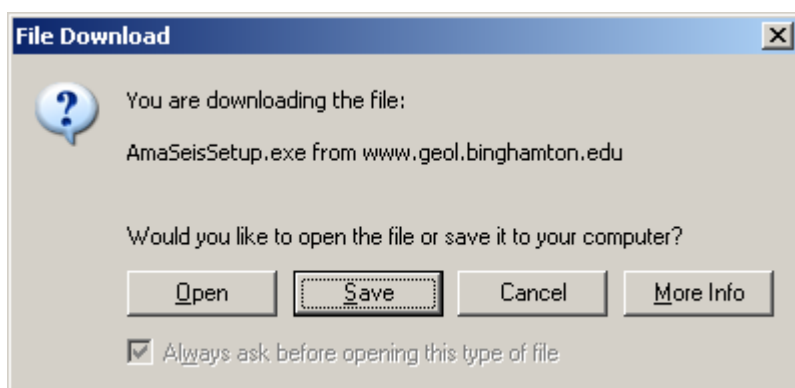


Figure 3. **File Download** dialog box that opens during download of AmaSeis software.

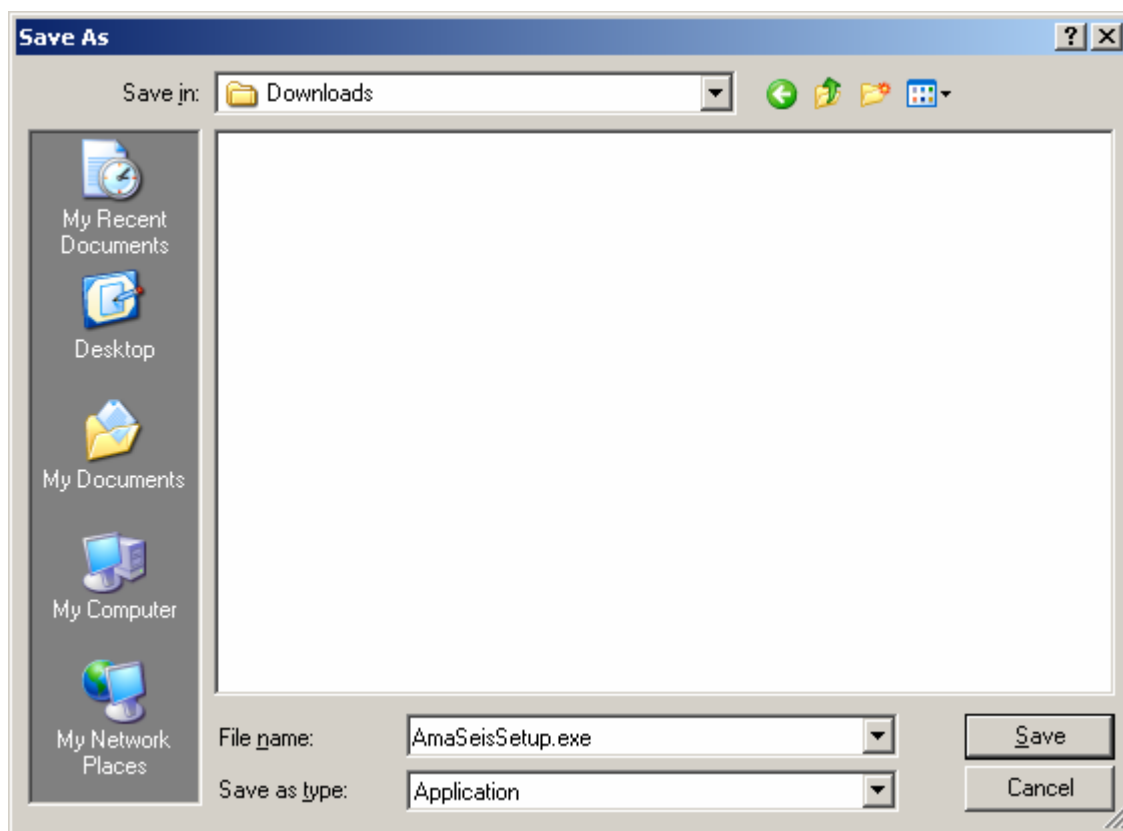


Figure 4. Screen image of the **Save As** dialog box during download of the AmaSeisSetup.exe install file.

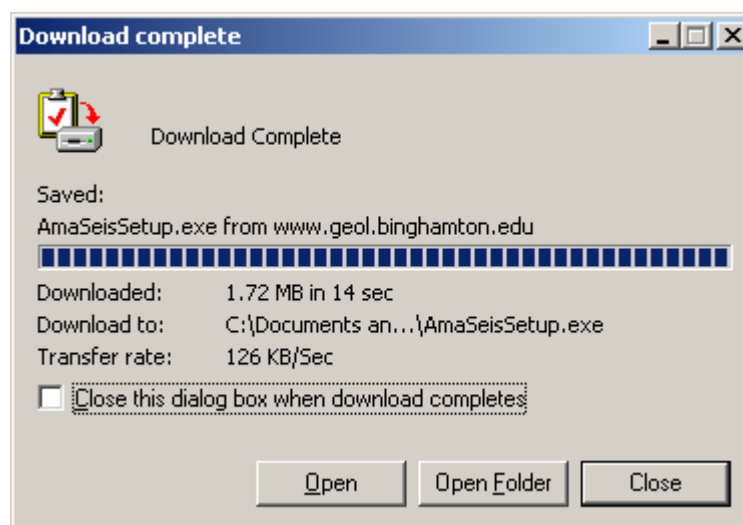


Figure 5. The **Download Complete** dialog box after downloading the **AmaSeisSetup.exe** install program.



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**2.1 Installing AmaSeis:** To install the AmaSeis software on your computer, double-click on the **AmaSeisSetup.exe** icon (Figure 6) and the AmaSeisSetup.exe program will install AmaSeis on the C: drive of your computer. Follow the instructions given during the install procedure. Installation of AmaSeis is now complete. For easy and rapid access to AmaSeis, go to the AmaSeis folder (Figure 7) and right click on the **as1.exe** icon and select **Create Shortcut**. A shortcut icon, **Shortcut to as1.exe**, will be created (Figure 7). Drag (or copy and paste) this icon to the desktop. To start AmaSeis, double click on the AmaSeis shortcut on your desktop and the program will open. If your computer is attached to an AS-1 seismometer, the program will open an information screen, determine the sample interval and open the **helicorder** (multiple line display similar to the traditional drum recorder paper of an older analog seismograph; usually 1 line per hour with 24 lines) display for viewing seismic data (ground motion sensed by the seismometer). If your computer is not attached to an AS-1 seismometer, the program will open the information screen and set the sample rate to 6 samples per second (click **OK** in the dialog box that appears). You are now ready to use the AmaSeis software to view, analyze and interpret seismograms. Further instructions on the use of AmaSeis are provided in the next section of this tutorial (also see the program option descriptions and tutorial in the **Help** menu in AmaSeis).

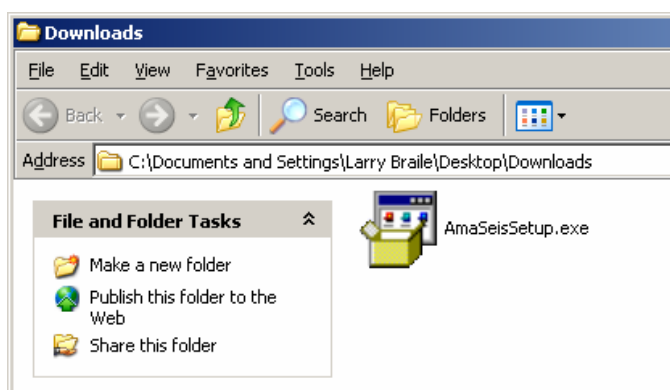


Figure 6. Part of the screen image showing the *AmaSeisSetup.exe* install file in the **Downloads** folder.

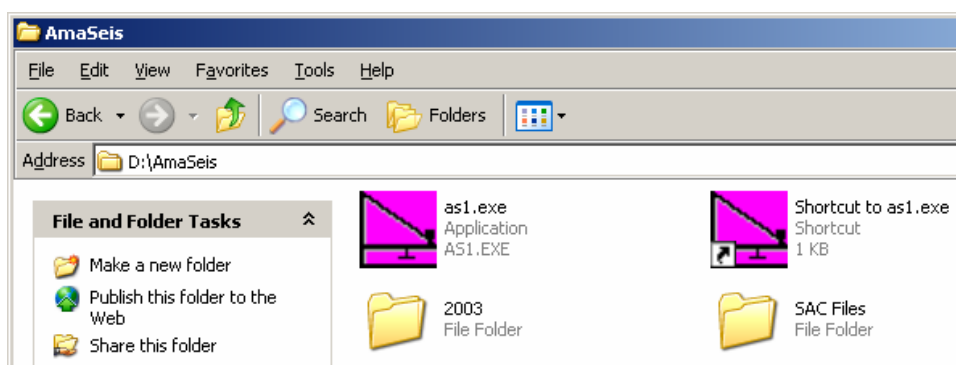


Figure 7. Part of a screen image showing the **AmaSeis** folder and the *as1.exe* (AmaSeis) program icon and created shortcut to AmaSeis. After running AmaSeis with the computer connected to an AS-1 seismometer, a folder (2004) containing archived data will be created in the **AmaSeis** folder. Also shown is a folder (SAC Files) that is used to save and organize seismogram files (in SAC format) that have been saved by the AmaSeis program or downloaded from another source.



**2.2 Moving the install program to another computer:** **AmaSeisSetup.exe** is an install program, 1.72 MB in size, and can be copied onto a Zip disk, thumb or flash drive or CD and moved to another computer or emailed as an attachment to another machine for installation on other computers. Because the file is too large to fit on a single floppy disk, there is also the option [**AmaSeisDisk1.exe** and **AmaSeisDisk2.exe**] to copy the install file (from Alan Jones' website, see Figure 2) onto two floppy disks to move it to another computer.

**2.3 Updating AmaSeis:** If you already have installed **AmaSeis** on a computer and wish to update the software with the latest release of the program (new releases sometimes have additional features not included in the version that was initially installed on your computer), download the **AmaSeisUpgrade.exe** file (see Figure 2), place it in your **AmaSeis** folder, and double-click on the **AmaSeisUpgrade.exe** icon. This program will automatically update your **AmaSeis** software.)



**3. Using AmaSeis:** 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.

**3.1 Setting up AmaSeis for a computer connected to an AS-1 seismometer:** Instructions for setting up an AS-1 seismometer and connecting to a computer running the AmaSeis software are available in the AS-1 and AmaSeis Manual at:

[http://www.scieds.com/spinet/AS1AmaSeis\\_v2.pdf](http://www.scieds.com/spinet/AS1AmaSeis_v2.pdf)

(or at: <http://www.iris.edu/about/ENO/AS1AmaSeis.pdf>) and in the online instructions at:

<http://web.ics.purdue.edu/~braile/edumod/as1mag/as1mag1.htm>. Both resources also contain descriptions of the AmaSeis software similar to the instructions provided here. If your computer is connected to an AS-1 seismometer, the set-up information should be similar to that shown in Figures 8 and 9.

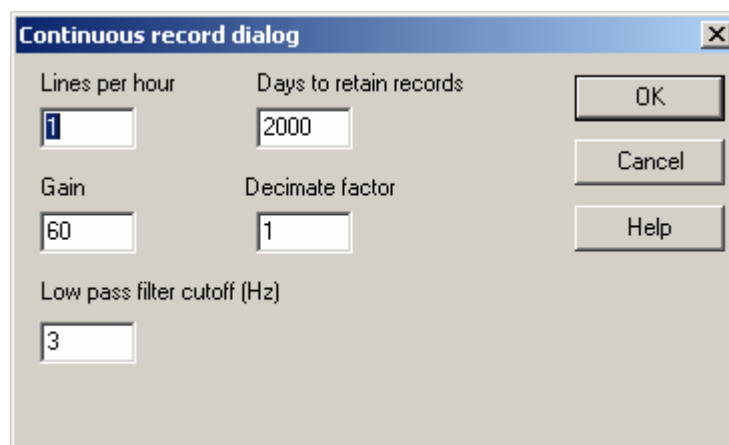


Figure 8. *Continuous record* dialog box from the *Helicorder* selection under the *Settings* menu in AmaSeis.

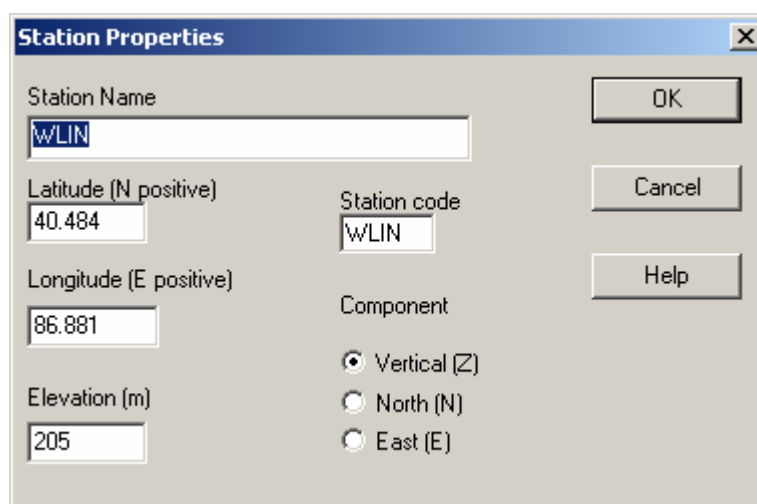


Figure 9. *Station Properties* dialog box from the *Station* selection under the *Settings* menu in AmaSeis.





**3.2 Setting up AmaSeis whether or not your computer is connected to an AS-1 seismometer:** Instructions for setting up an AS-1 seismometer and connecting to a computer running the AmaSeis software are available in the AS-1 and AmaSeis Manual at: <http://www.iris.edu/about/ENO/AS1AmaSeis.pdf> and in the online instructions at: <http://web.ics.purdue.edu/~braile/edumod/as1mag/as1mag1.htm>. Both resources also contain descriptions of the AmaSeis software similar to the instructions provided here. The AmaSeis software also includes a **Help** menu with descriptions of the main features of the software and a brief tutorial. If your computer is connected to an AS-1 seismometer, the set-up information should be similar to that shown in Figures 8 and 9.

If your computer is not connected to an AS-1 seismometer you can download some [sample data](#) (click here to download; ~15MB file, file must be unzipped; instructions are also contained in section [8](#) below) and use it for selecting seismograms and other AmaSeis operations. The sample data are contained in a folder called **2003**. The sample data were recorded at AS-1 station WLIN in West Lafayette, Indiana during the month of September, 2003. After downloading the folder, place it in your **AmaSeis folder**. (If you have recorded data from an AS-1 on your computer during 2003, be sure to not copy the WLIN 2003 data file over your 2003 folder. You can download the WLIN 2003 folder and preserve your 2003 folder by temporarily moving your 2003 folder to another folder.) Starting AmaSeis will then allow you to view the WLIN September, 2003 data as if it had been recorded on your computer. Enter the **Helicorder** and **Station** properties as shown in Figures 8 and 9. To view the data on the 24-hour (one line per hour) display, scroll back in time using the **scroll bar** at the right hand side of the screen (Figure 10) or select the **Go To Date-Time** selection under the **Settings** menu to go to a specific position in the data archive (such as 9/22/03, 14 hours – the data and time refer to the bottom line of the screen – for the display shown in Figure 10). Information on the earthquakes producing significant signals on the seismograph recorded by the WLIN station during September, 2003 is contained in the station catalog shown in Figure 11. Additionally, higher than normal noise levels (Figure 12) are recorded at WLIN on September 18-19, 2003 due to microseisms (caused by high ocean waves hitting the east coast of the U.S.; hurricane Isabel had maximum winds of about 260 km/hr and hit the coastline in North Carolina on September 18-19) due to hurricane Isabel. Additional data for 2004 and 2005 are also available (see section [8](#) below).

When a seismic signal from an unknown earthquake appears on the AmaSeis screen (such as shown in Figure 10), it is necessary to associate the seismogram with a particular event. In general, unless the earthquake is very close to your station, the record will have been created by a moderate to large earthquake. To determine which earthquake has been recorded and the location, origin time and magnitude for the event, one can find information about earthquakes that have occurred around the world by accessing USGS or IRIS websites. Information on recent earthquakes is easily found at the USGS earthquake page, <http://earthquake.usgs.gov/>, or the IRIS Seismic Monitor, <http://www.iris.edu/seismon/>. For older events, instructions for searching earthquake catalogs for events of interest are provided at: <http://web.ics.purdue.edu/~braile/edumod/eqdata/eqdata.htm>. Also, see the instructions in section [3.12](#) of this document.



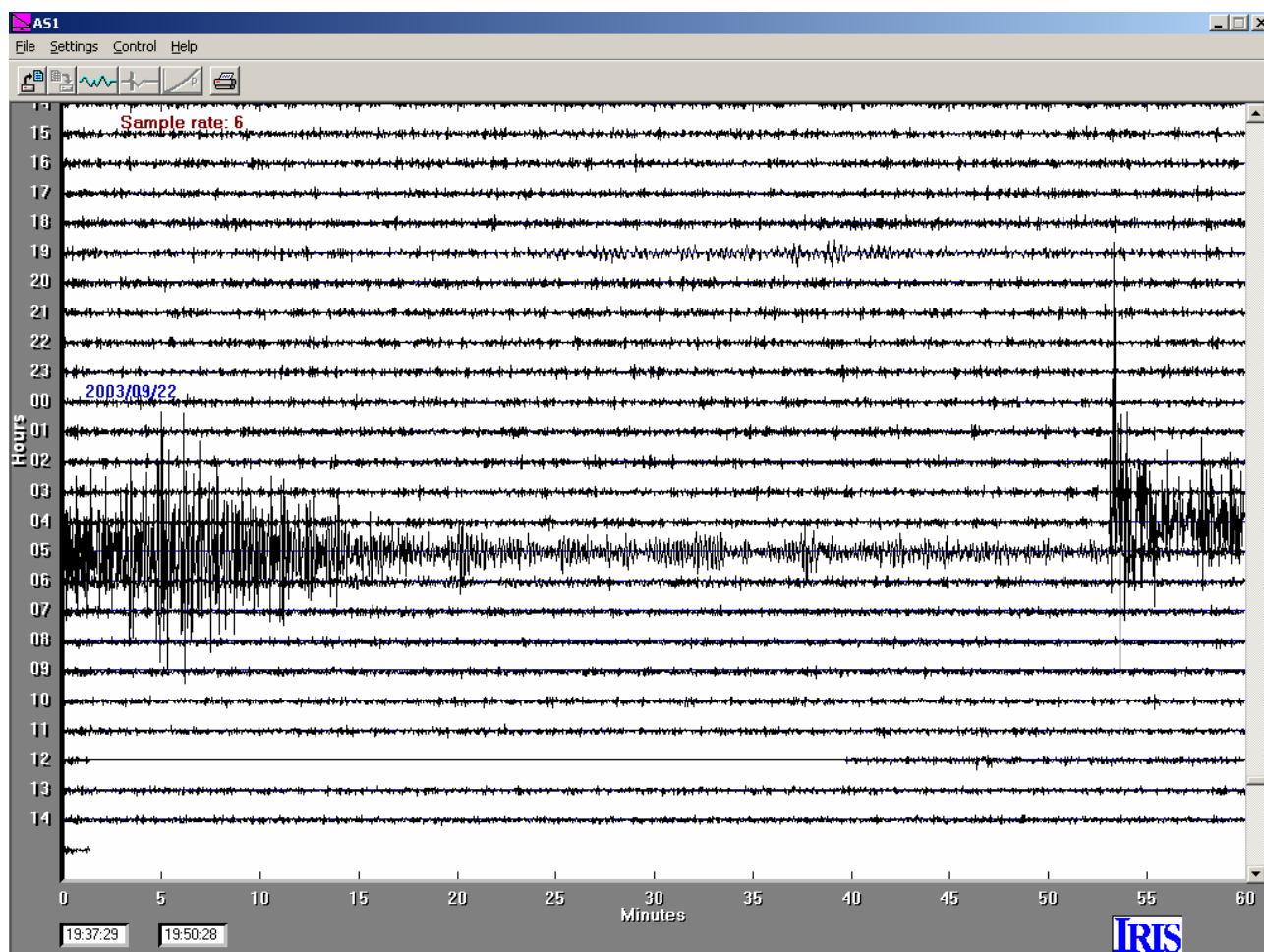


Figure 10. Sample AmaSeis 24-hour screen display (data recorded by AS-1 station WLIN in West Lafayette, IN during September, 2003). The event visible in the middle of the screen is the 9/22/03 M6.5 Dominican Republic earthquake.

Earthquake List -- Events recorded by AS-1 Seismograph, West Lafayette (40.484N, 86.881W) Indiana (L. Braille)															
2	DATE	TIME(GMT)	LAT	LON	DEP.	USGS	USGS	USGS	USGS	AS-1	AS-1	AS-1	Calc. Dist	AS-1 Dist	Location
3	MM/DD/YY	HR:MN:SS	Deg.	Deg.	(km)	mb	MS	Mw	mbLg	mb	MS	mbLg	Deg.	Deg.	
4	09/02/03	18:28:00	-15.263	-173.221	10	6.0	6.6	6.4			6.6		97.020		Tonga
5	09/08/03	6:26:33	-8.432	110.194	51	5.5	5.4	5.9					144.640		Java, Indonesia
6	09/13/03	15:22:41	36.831	-104.907	5				3.8			4.2	14.550		NE New Mexico
7	09/22/03	4:45:36	19.675	-70.666	10	6.1	6.5	6.5		6.3			24.960	25.5	Dominican Republic
8	09/25/03	19:50:07	41.827	143.830	33	6.9	8.1	8.3		6.5	7.8		86.070		Off co. Hokkaido, Japan
9	09/27/03	11:33:26	49.980	87.903	18	6.4	7.5	7.3		6.4	7.1		89.710		Russia-Kazakhstan bdr.
10	09/27/03	18:52:48	50.077	87.786	15	6.0	6.6	6.3		6.0	6.6		89.700		SW Siberia
11	09/29/03	2:36:53	42.450	144.380	25	6.1	6.3	6.4		6.0			85.320		Hokkaido, Japan
12	09/30/03	14:08:38	-30.437	-177.398	10	5.8	6.5	6.4			6.7		109.380		Kermadec Is.

Figure 11. A portion of the station catalog for WLIN showing information on the earthquakes recorded during September, 2003. Also, seismic signals from hurricane Isabelle are included for September 18-19, 2003 (Figure 12).

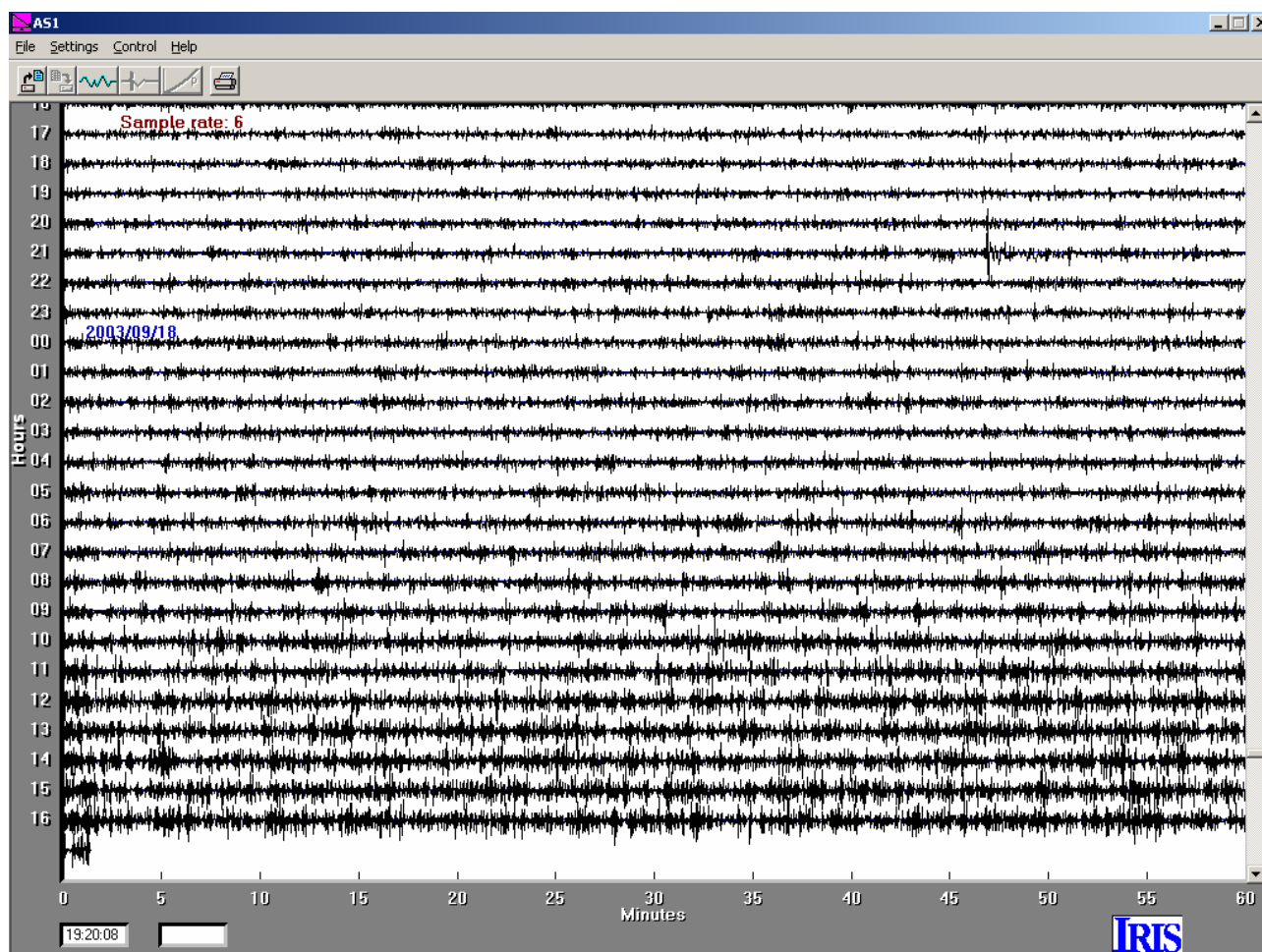


Figure 12. Screen image of AmaSeis 24-hour display for AS-1 station WLIN for September 17-18, 2003. The increased noise level beginning at about 10 hours (UTC), 9/18/03 (and continuing into 9/19/03, not shown here) is due to microseisms from hurricane Isabel.



**3.3 Extracting (selecting seismograms) and saving signals from the AmaSeis helicorder (normal screen) display:** To select a portion of the screen for “close-up” viewing or to save a selected signal, use the mouse (click and drag over desired lines of data) to highlight a specific area of the screen (Figure 13); then click on the Extract Earthquake icon (Figure 14). For example, the selected event shown in Figure 13 (the 9/22/03 magnitude 6.5 Dominican Republic earthquake) results in the seismogram (Event view) shown in Figure 15 (after clicking on the Extract Earthquake icon). Notice that only the selected signal is shown and that the signal is magnified to approximately fill the screen. Any length signal can be selected and shown as an extracted seismogram in order to better observe the characteristics of the signal. Note that the horizontal scale shows the time in minutes. The Time Expansion arrows in the lower left hand corner of the Event view can be used to decrease the time range of the data that are viewed. The vertical scale shows signal amplitude in digital units. The time and amplitude of any point on the signal can be measured by placing the tip of the mouse on that point. The amplitude will be displayed in the small window at the lower right hand corner of the screen. The time

corresponding to the mouse cursor location will be displayed in the small window to the left of the amplitude window.

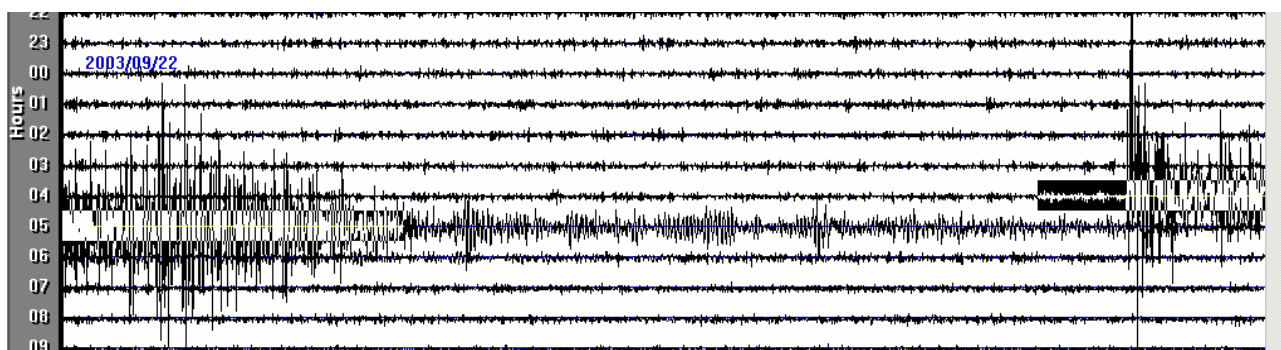


Figure 13. A portion of the AmaSeis helicorder display showing a selected signal (seismogram).

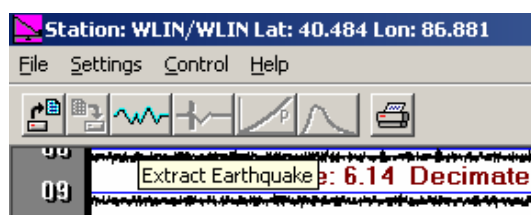


Figure 14. Portion of the AmaSeis helicorder display showing the *Extract Earthquake* icon (wiggly line).

To save the seismogram, select the **Save As** option from the **File** menu in the **Event** view (as in Figure 15) and a **Save As** dialog box (Figure 16) will appear. Enter a file name for the seismogram (also be sure that the file is saved in .sac format by using the down arrow key to the right of the **Save as type** selection at the bottom of the screen to select the SAC format) and click on the **Save** button. Any file name can be used but the naming convention used for uploading data to the SpiNet website is convenient. In this naming convention, the first two digits are the year, the next two digits are the month, the next two digits are the day, the next two digits are the hour (24-hour system, UTC or GMT), and the next four characters are the AS-1 station code. For example, for the seismogram shown in Figure 15, the name would be 03092204WLIN.sac (Figure 16). The .sac extension indicates that the format of the seismogram file is SAC – corresponding to the Seismic Analysis Code format. This is simply a binary file format that has become a standard for seismic files in general and AS-1 seismograph files in particular. AmaSeis writes and reads SAC files and SAC files can be uploaded to and downloaded from the SpiNet website. It is convenient to create a folder called **SAC Files** within the AmaSeis folder for storing your saved or downloaded SAC format seismograms. Of course you can also use sub-folders within the **SAC Files** folder to further organize the seismograms according to events, year, source or station, etc. You can download the WLIN AS-1 seismogram shown in Figure 16 by clicking [here](#) (or from the SpiNet website). Use the back button (or close the window) to return to the helicorder display.

To open a seismogram that is stored in your **SAC Files** folder, use the **Open** selection under the **File** menu in AmaSeis. A dialog box similar to that shown in Figure 17 will appear. If the opened folder is not the **SAC Files** folder, navigate to that location, select the seismogram to open and then click **Open**. For example, for the file shown in the **Open** dialog box in Figure 17, the seismogram shown in Figure 15 will be opened in the AmaSeis **Event** screen.

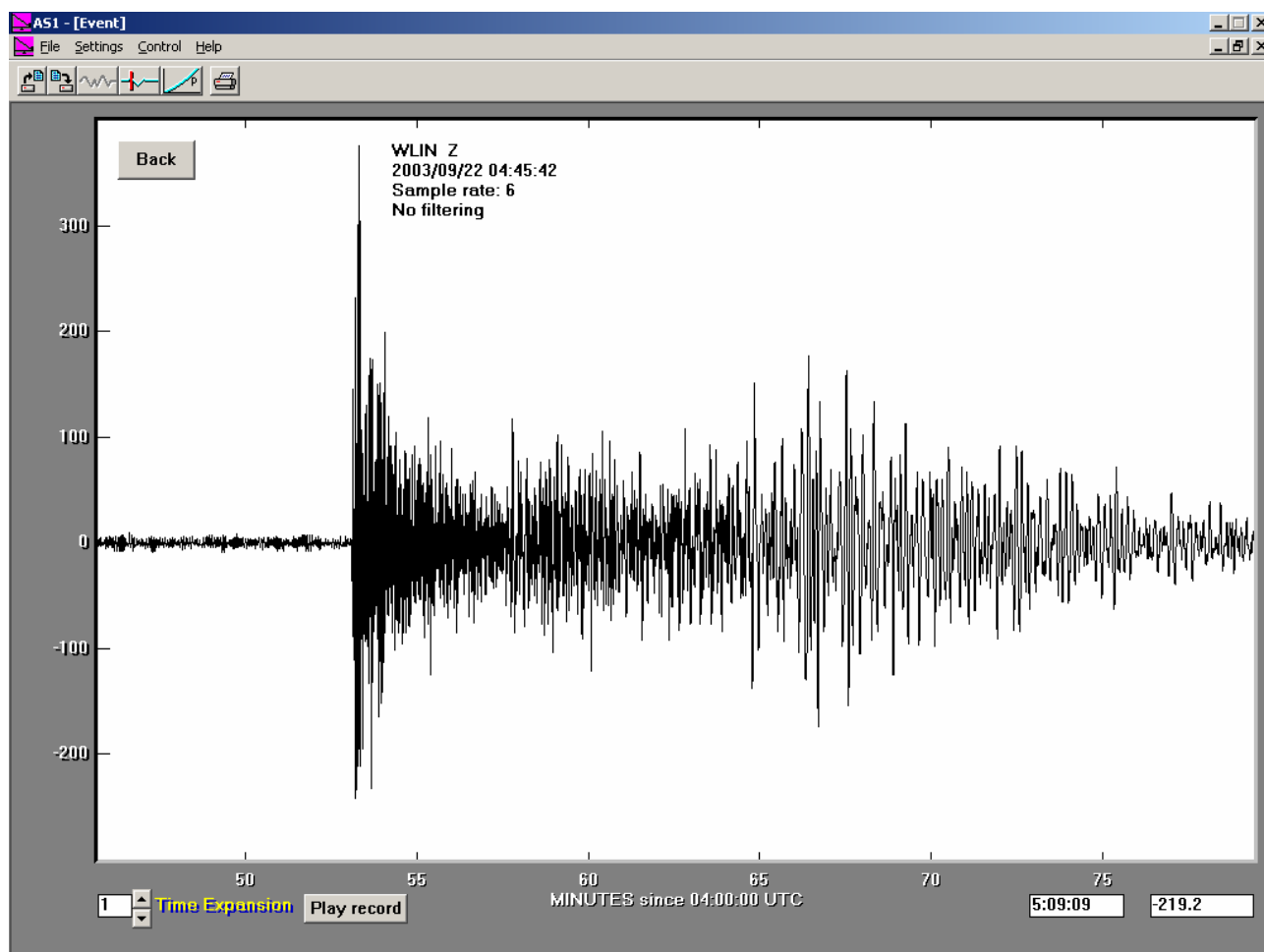


Figure 15. Extracted signal (seismogram shown in Event view) from the selection shown in Figure 13.

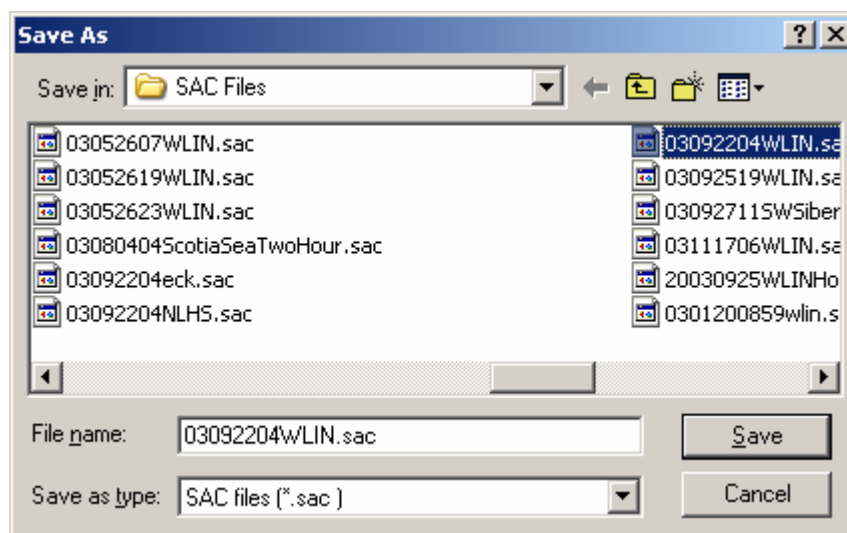


Figure 16. **Save As** dialog box (open from the AmaSeis **File** menu) used to enter a file name and file type (SAC) for the selected seismogram to save (for example, the seismogram selected as shown in Figure 13 and displayed in Figure 15).

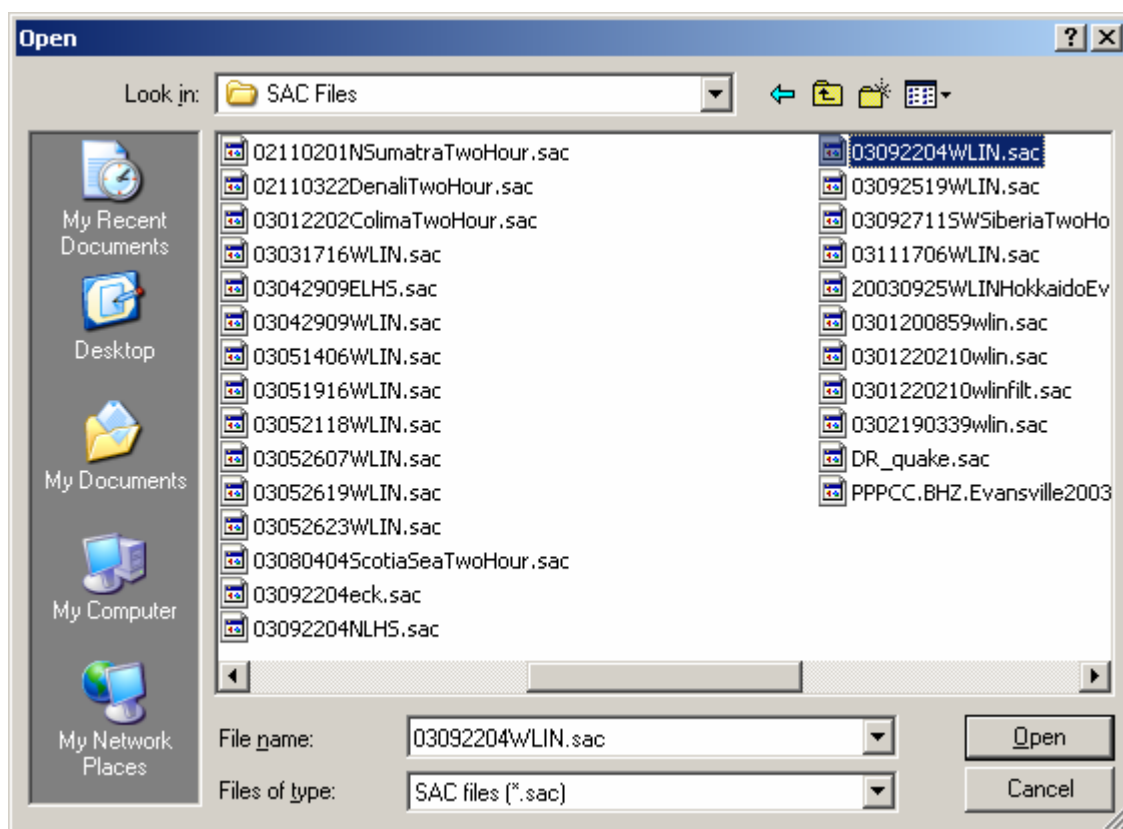


Figure 17. **Open** dialog box (open from the AmaSeis **File** menu) used to open a seismogram file.



**3.4 Zooming in on seismogram in the Event screen:** To further zoom in on a seismogram, use the mouse cursor to select (click and drag over a time range) an area of the seismogram in the **Event** screen as shown in Figure 18. Clicking on the **Extract Earthquake** icon (Figure 14) opens the **Event** screen with the “zoomed in” seismogram (Figure 19). This new seismogram can also be saved as a SAC file as described in section [3.2](#). This zooming option is very useful for selecting specific parts of the seismogram (“phases” or “arrivals”) used to estimate the magnitude of an earthquake and for adjusting the length of a seismogram, particularly one that has been downloaded and may be of longer time duration than desired.

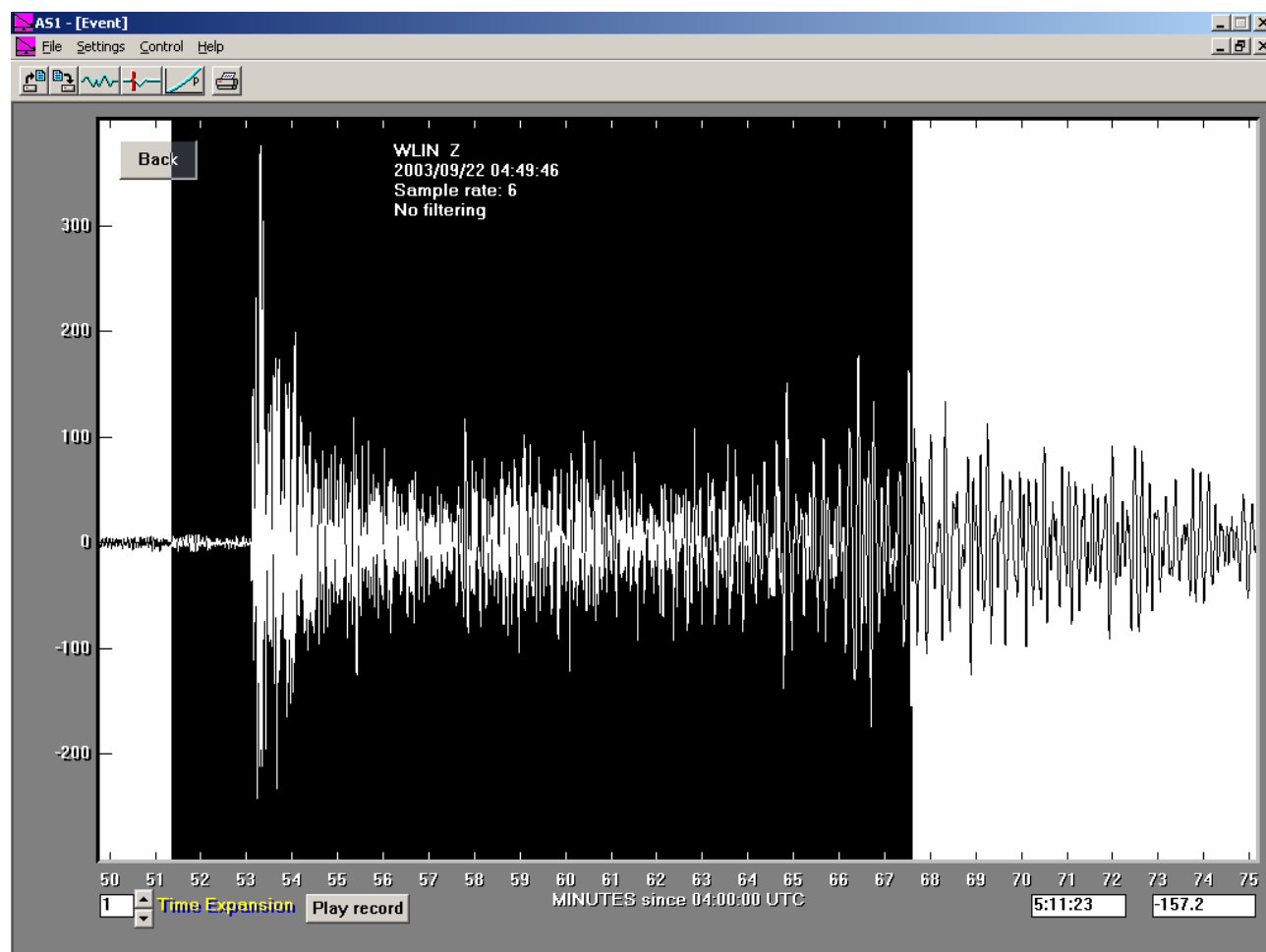


Figure 18. Selected time range (using mouse cursor) for zooming in on a seismogram.

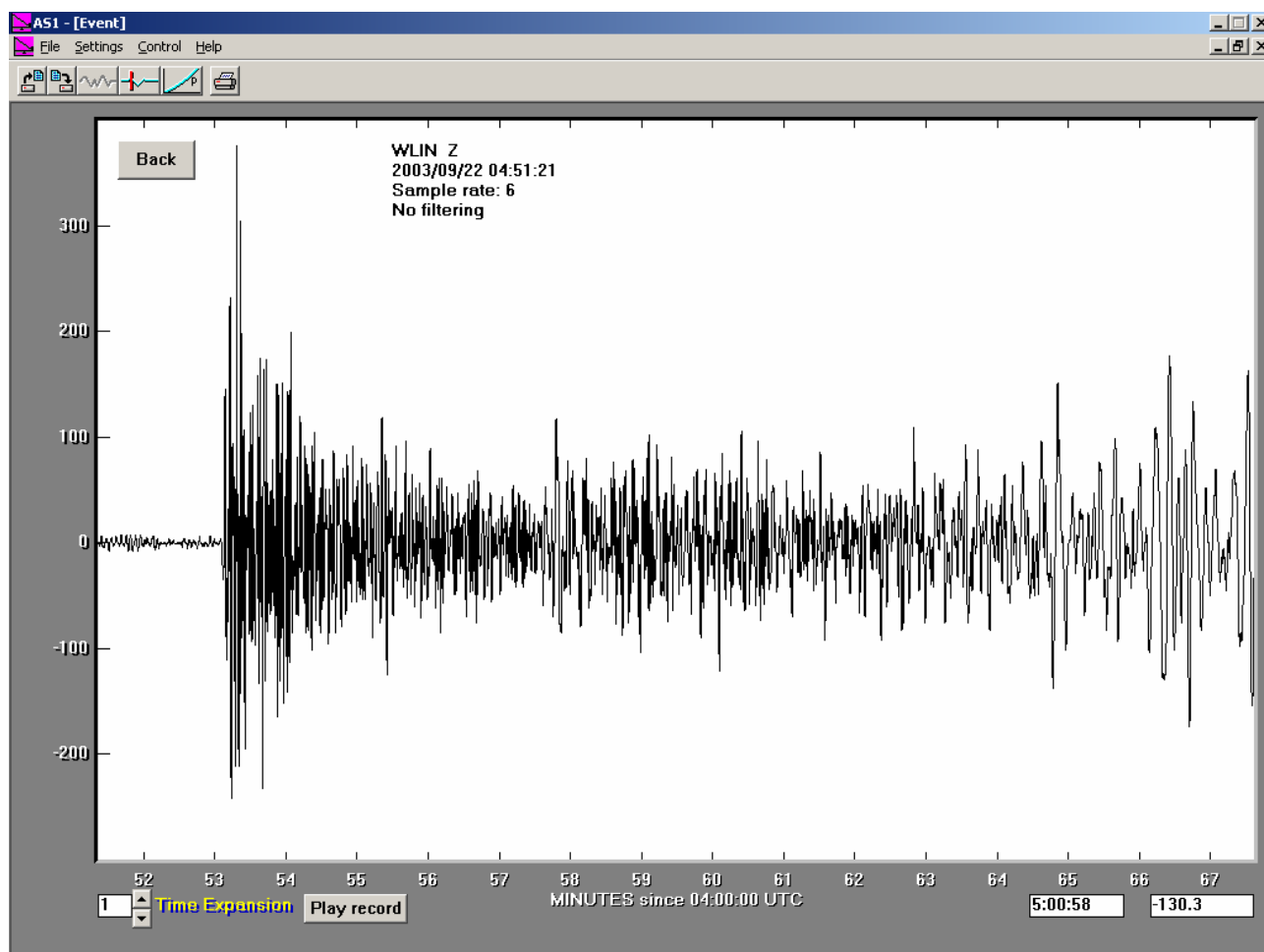


Figure 19. Extracted seismogram from the selection shown in Figure 18.



**3.5 Filtering seismograms with AmaSeis:** Filtering is a digital signal processing operation that is designed to enhance features of the seismogram that have certain frequency content. Commonly, certain arrivals (P-waves, S-waves, surface waves, etc.) have more or less distinct frequency characteristics and can be enhanced (or reduced) by filtering. Further, some types of noise on seismograms are characterized by specific frequencies that can be reduced with appropriate filtering. One of the most useful applications of filtering of seismograms is to enhance the S-wave to better identify this arrival on the seismogram. To apply filtering, select the **Filter** option from the **Control** menu in AmaSeis. A dialog box (**Filter Dialog**, Figure 20) will appear. The filter settings shown in the dialog box in Figure 20 have been found to be useful for enhancing the S-wave arrival. For example, for the Dominican Republic seismogram shown in Figure 19, the filter cutoffs shown in Figure 20 were applied (enter the filter cutoff frequencies and click on **OK**) resulting in the filtered seismogram shown in Figure 21. Note that the S-wave (at about 04:58 time, UTC) is much more distinct in the filtered seismogram. The S-wave is identified on the seismogram in Figure 21 by both strong relative amplitude and a change in frequency (to a somewhat lower frequency, visible by the greater time between up and down motions).



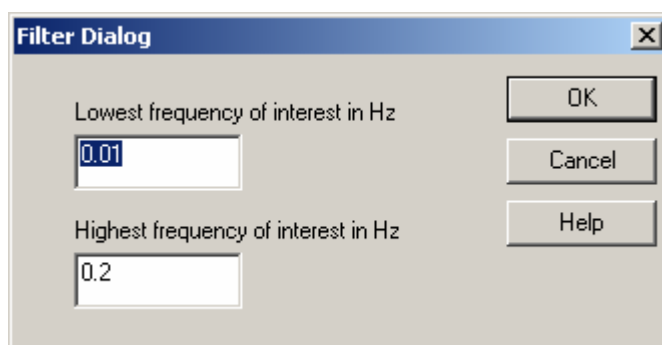


Figure 20. **Filter Dialog** box showing filter cutoff settings appropriate to enhancing the S-waves (and the surface waves) on AS-1 seismograms. Due to the sampling interval of AS-1 seismic data, the Highest frequency cutoff should be set no higher than 3 Hz (cycles per second).

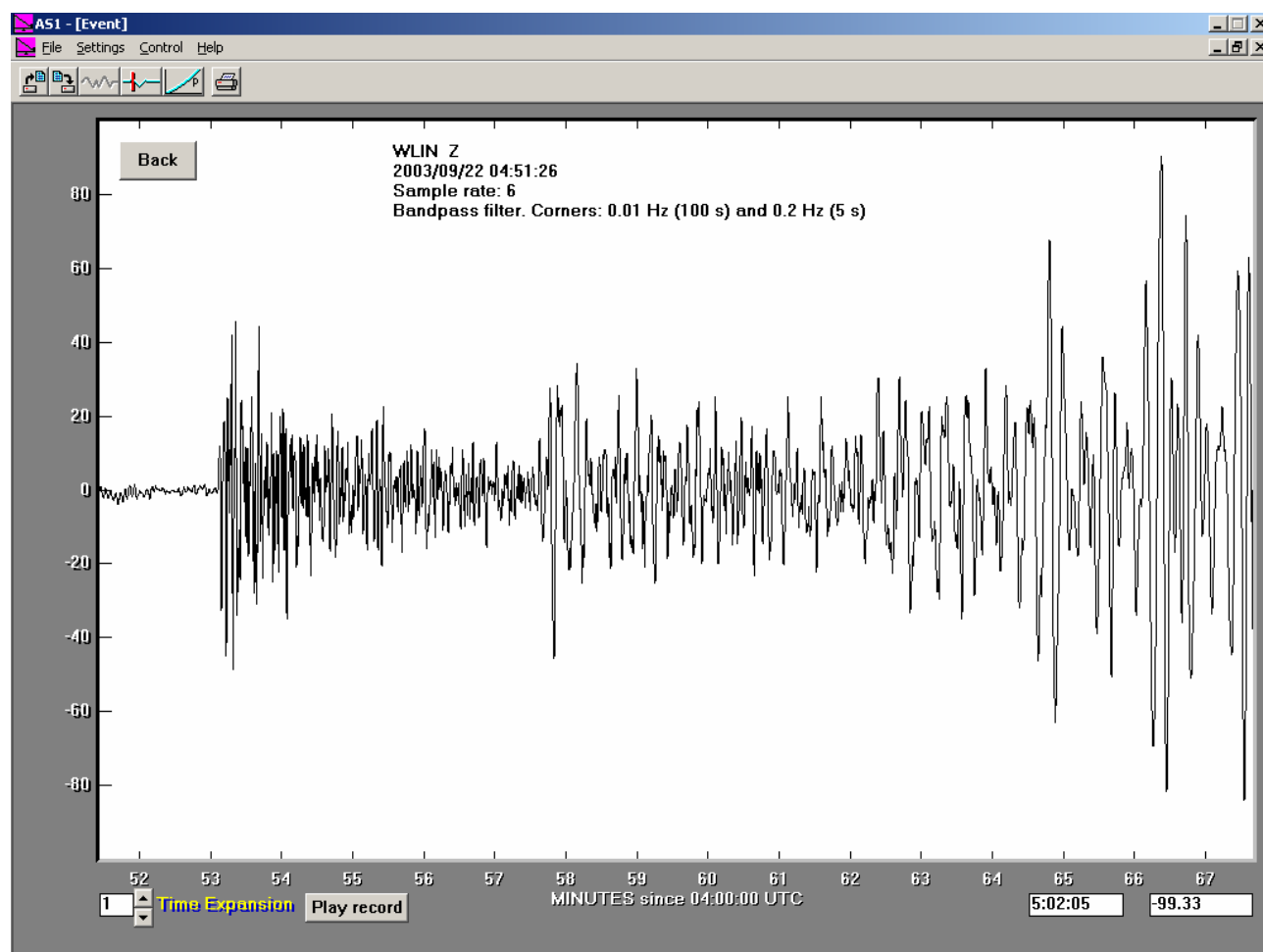


Figure 21. Filtered Dominican Republic earthquake seismogram showing enhanced S-wave arrival. Compare with the seismogram shown in Figure 19.



**3.6 Picking travel times and using the travel time curve tool in AmaSeis:** Picking arrival times of seismic phases is easily accomplished with the AmaSeis software. Select the Pick arrivals icon (Figure 22) and then position the mouse cursor on the seismogram at the

interpreted location of an arrival. The time window in the lower right hand corner of the AmaSeis screen will display the arrival time. Clicking on the seismogram will mark the location of the arrival time with a red vertical line. More than one arrival time can be picked. An example is shown in Figure 23.



Figure 22. The **Pick arrivals** icon (seismogram with vertical line) in the AmaSeis **Event** screen display.

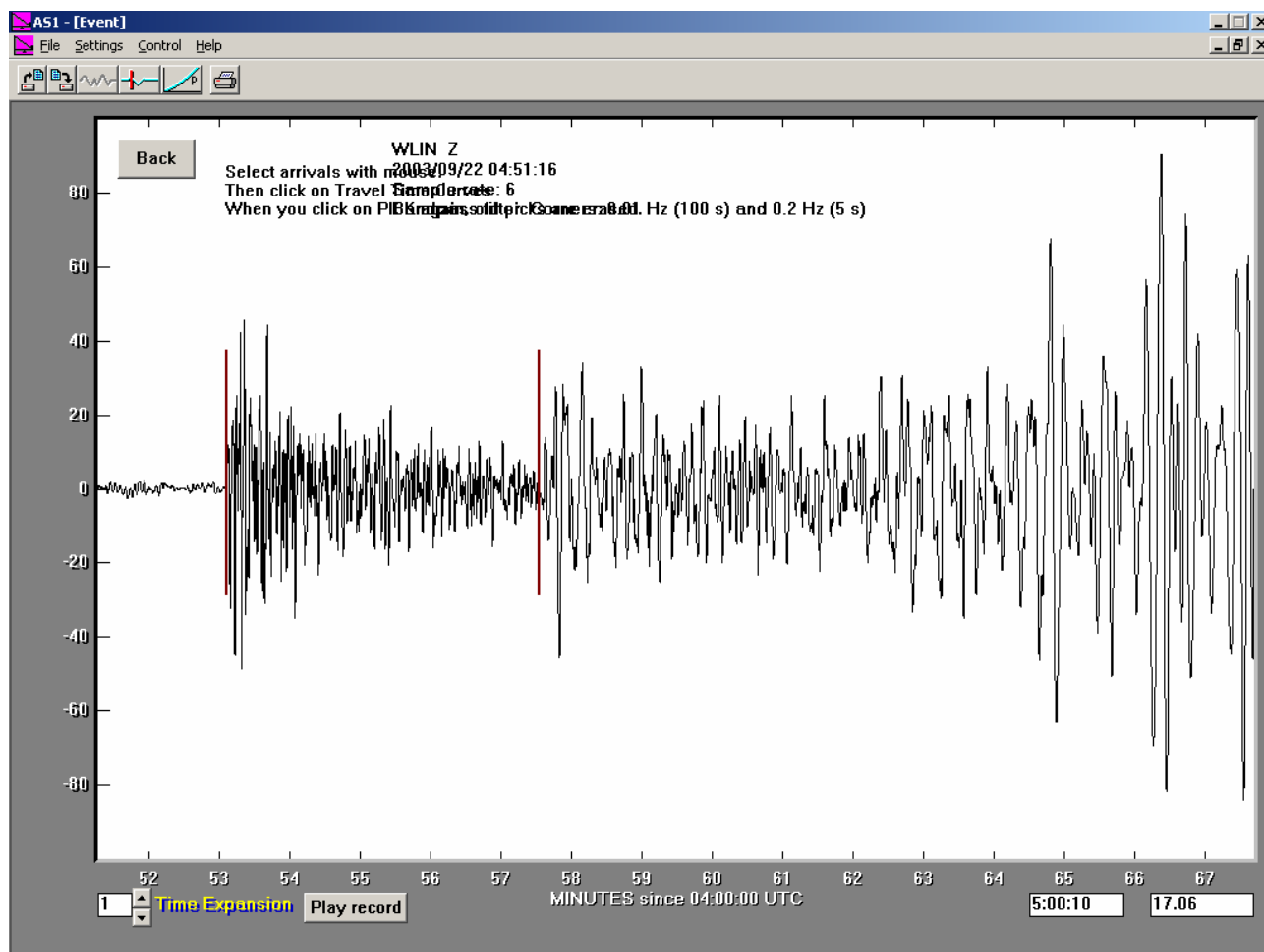


Figure 23. Seismogram after picking arrival times (by clicking with the mouse cursor) at the interpreted P-wave arrival (at about 04:53:05) and S-wave arrival (at about 04:57:30).

One use of the arrival time picking tool is using the P and S arrival times to estimate the distance of the event from the seismograph station. Because P- and S- waves in the Earth travel similar paths to the same station but travel at different speeds, the difference between the S and the P times (called the S minus P time) is directly related to the epicenter-to-station distance. To use the S minus P time to determine this distance (for events less than about 120 degrees away – two-thirds of the way to the opposite side of the Earth or less than about 13343 km), pick the P

and S times (on seismograms that have identifiable S arrivals) as shown in Figure 23 and then click on the Travel Time Curves icon (Figure 24). A Depth Dialog box (Figure 25) will appear. If the depth of focus of the earthquake is known, enter that depth (in km). If the depth isn't known, a common selection is to use 33 km as the depth, particularly if the seismogram displays prominent surface waves indicating that it is of relatively shallow focus.



Figure 24. **Travel Time Curves** selection icon (curved line with the letter “P” next to it) in the AmaSeis **Event** screen display.



Figure 25. **Depth Dialog** box. Input a depth for the earthquake (in this case 10 km for the Dominican Republic event). If the depth is unknown, use a “standard” depth (33 km) if the earthquake appears to be shallow (surface waves are prominent in the seismogram).

Next, click OK and the seismogram will be displayed in red overlaying the standard travel time curves for the Earth calculated for the selected depth of focus. The travel time curves show the typical travel times (arrival times minus origin time – the time of the initiation of the earthquake) for P, S, and other arrivals. More information about travel time curves can be found in Bolt (1993) or Shearer (1999). (Travel time curves are most often displayed with the distance on the horizontal axis and time on the vertical axis. The curves are displayed with the opposite convention in AmaSeis so that the seismograms will be viewed with time increasing to the right.) The seismogram on the screen can be moved by clicking and dragging with the mouse. By positioning the seismogram so that the P wave (the first arrival) time overlays the P wave travel time curve and the S wave time overlays the S wave travel time curve (Figure 26). The epicenter-to-station distance is determined (assuming that the P and S arrival times have been accurately identified and that the depth of focus is approximately correct; note that the absolute times arrival times are not required, on the difference between the S and the P times) by the S minus P times (the S and the P times on the seismogram will only match the travel time curves at one location on the screen corresponding to the epicenter-to-station distance that is displayed (in degrees geocentric angle; one degree is 111.19 km along the surface) to the left of the seismogram. This S minus P method distance tool can be used to locate an earthquake's epicenter by triangulation using the distances from 3 separate stations recording the same event. More information on using AmaSeis in the S minus P location method can be found at:

<http://web.ics.purdue.edu/~braile/edumod/as1mag/as1mag2.htm>. To compare the distance estimated by the S minus P times for an earthquake with the actual distance, you can calculate the distance from the epicenter to your station using the online distance calculation tool provided by the USGS ([http://neic.usgs.gov/neis/travel\\_times/](http://neic.usgs.gov/neis/travel_times/)). This online tool is described further in section 3.13. To calculate this distance (in degrees geocentric angle), the station coordinates (latitude and longitude) must be known and the epicenter coordinates must also be

known. If the epicenter location is not known, one can perform a search to obtain information about the earthquake using the online catalogs and tool described in section [3.12](#).

The arrival time for any location on the extracted seismogram screen can be found using AmaSeis by placing the cursor at the desired location on the trace. The time corresponding to that position will be displayed in the second window from the lower right hand corner of the screen as shown in Figure 23 (the displayed time reads 5 hours, 0 minutes and ten seconds). An additional example is shown in Figure 27 in which the cursor location (at the peak of an arrival) is shown. For this example, the location of the cursor is at 4:53:09 (UTC) and amplitude 146 (digital units) as indicated in the time and amplitude windows shown in the lower right hand corner of the extracted seismogram screen. The time displayed should be UTC (or GMT) time and will be accurate if the computer clock for the computer that recorded the seismic data using AmaSeis was synchronized to UTC time. A convenient way to synchronize the computer clock if your computer is connected to the Internet is to use the software tool AboutTime (<http://www.arachnoid.com/>) or similar tools. More information about time synchronization for the AS-1 seismograph and the AmaSeis software is provided at: <http://web.ics.purdue.edu/~braile/edumod/as1mag/as1mag1.htm>.

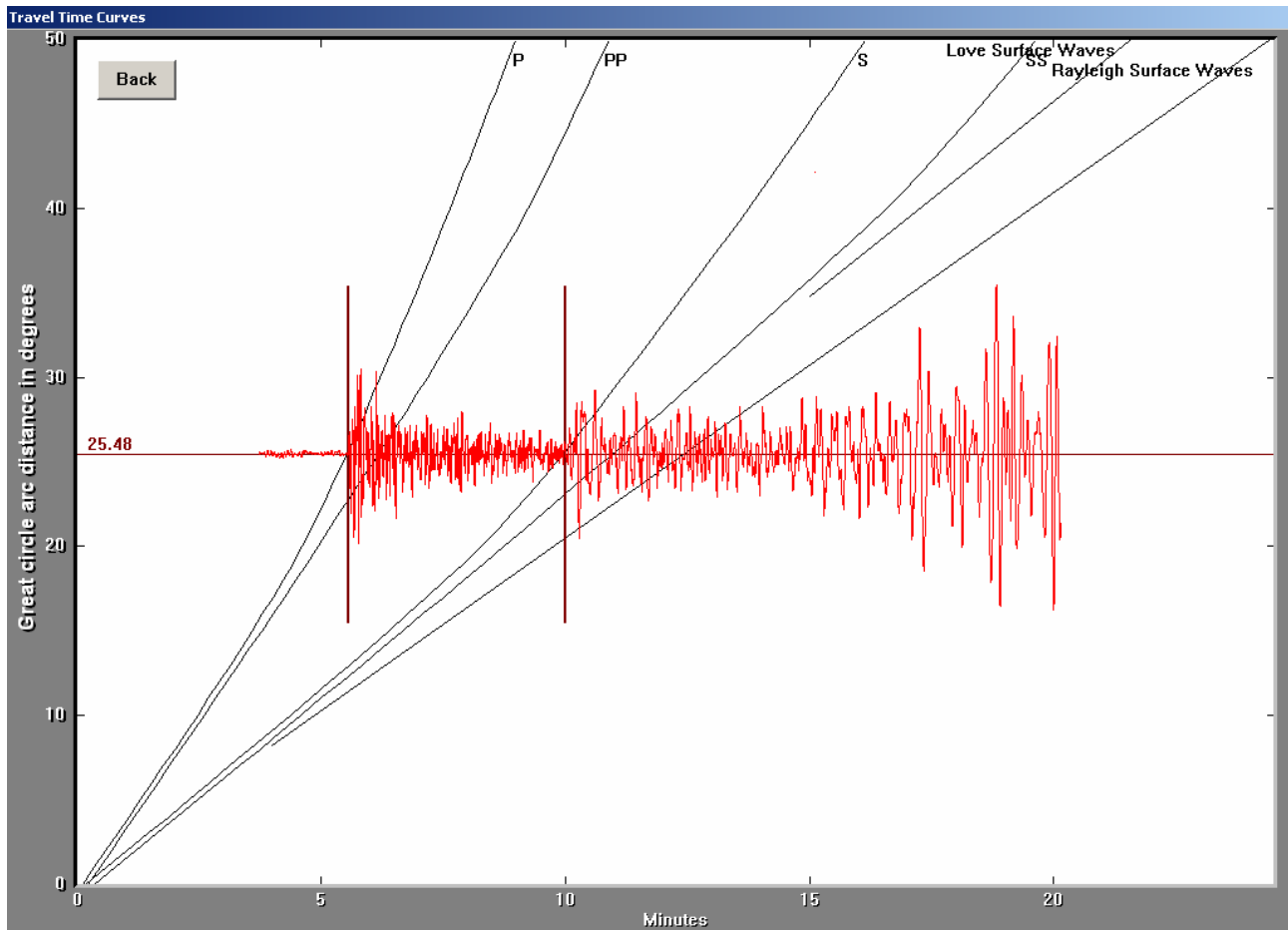


Figure 26. Seismogram with arrival time picks (vertical lines) on the travel time curves (Travel Time Curves display in AmaSeis). The seismogram can be moved with the mouse cursor (click and drag) to position it so that the P- and S-arrival times are aligned with the P- and S-travel time curves. The inferred epicenter-to-station distance (in degrees geocentric angle; one degree =

111.19 km distance along the Earth's surface) is then given to the left of the seismogram (from the distance scale). The horizontal scale is time in minutes after the earthquake.



**3.7 Measuring amplitudes in AmaSeis and calculating magnitude:** The amplitude of arrivals on extracted seismograms can be measured using the mouse cursor and the AmaSeis software. Positioning the mouse on the peak of an arrival displays the amplitude in a window in the lower right hand corner of the screen as illustrated in Figure 27. If the amplitude of the “zero line” (the seismogram amplitude prior to the first arrival) is approximately zero amplitude, then the amplitude displayed is the amplitude of the arrival. If the “zero line” is not near zero amplitude, the difference between the arrival (peak) amplitude and the zero line amplitude is the amplitude of the arrival. Amplitudes can be measured at any location on the seismogram. However, to calculate the magnitude of an earthquake, the amplitudes of the P-wave arrival, the 20-second surface wave arrival, or the amplitude of the mbLg wave arrival can be measured and used to calculate magnitude estimates. Magnitudes can be calculated using the online AS-1 magnitude tool MagCalc at:

<http://web.ics.purdue.edu/~braile/edumod/MagCalc/MagCalc.htm>.

For the example seismogram shown in Figure 27, the MagCalc AS-1 magnitude tool calculated a body wave magnitude of 6.3 from the measured amplitude of the AS-1 seismogram. The official body wave magnitude (mb) reported by the US Geological Survey was 6.1. More information, including additional examples, about measuring amplitudes and calculating magnitudes using AmaSeis and the MagCalc tool can be found at the MagCalc link, at: <http://web.ics.purdue.edu/~braile/edumod/as1mag/as1mag3.htm>, and at: <http://web.ics.purdue.edu/~braile/edumod/MagCalc/AS1Results.htm>.

Magnitude information (as well as location, origin time and other information about an earthquake) can be found on the Internet as described in section [3.12](#). The epicenter to station distance is also required to calculate the magnitude. This distance can be determined using the online tools described in section [3.13](#) or estimated from the S minus P arrival times (for seismograms with distinct S arrivals) as described in section [3.6](#).

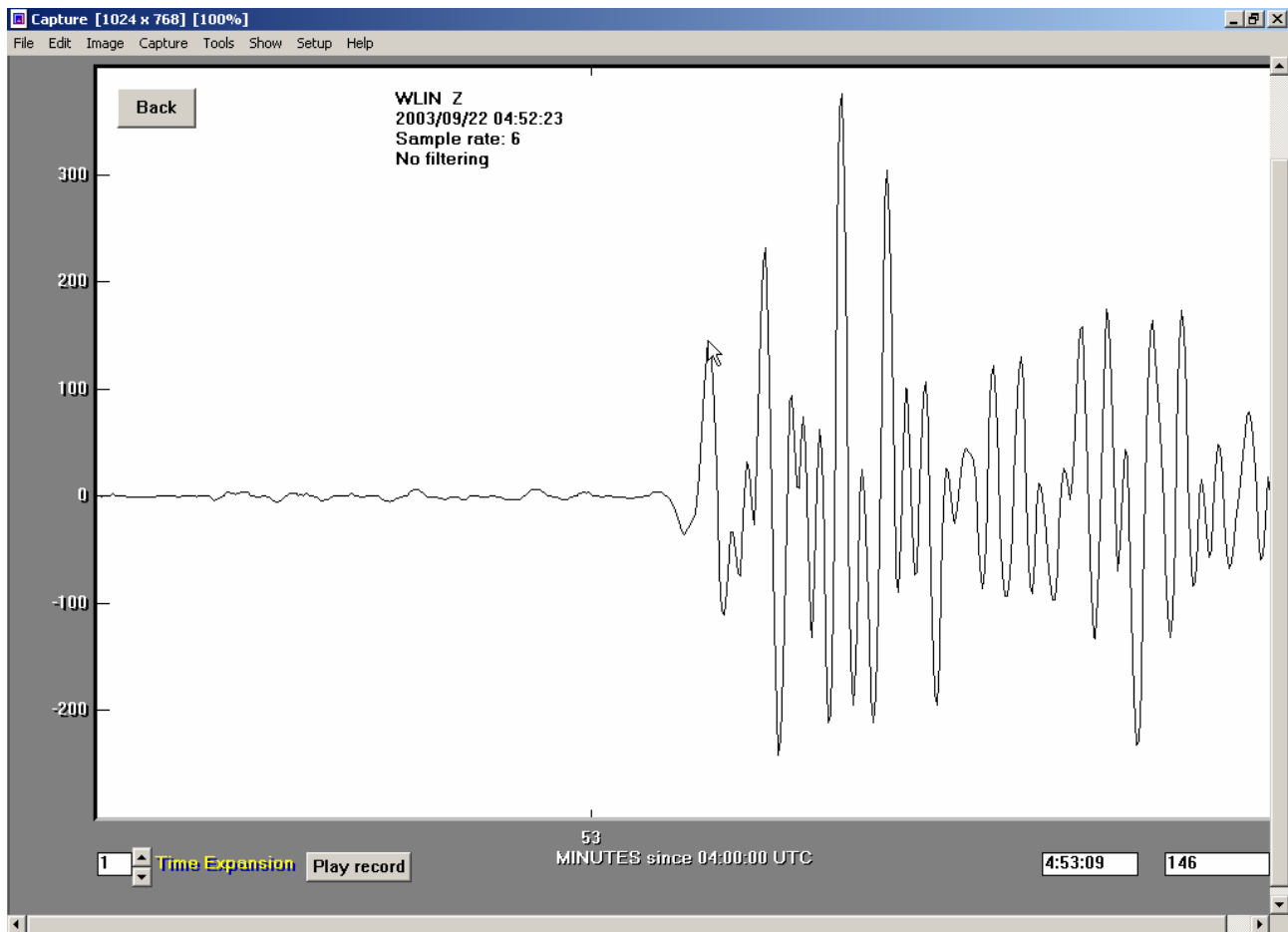


Figure 27. AmaSeis screen image showing seismogram (“zoomed in” on the P arrival using extraction tool) and the use of the amplitude measuring capability of the software. The amplitude (146 digital units) of the mouse location is displayed in the window in the lower right hand corner of the screen. The seismogram is from the September 22, 2003 Dominican Republic earthquake.



**3.8 Real time playback of seismograms using AmaSeis:** Extracted or saved seismograms can be played back in real time (or speeded up time) by clicking on the “Play Record” button at the bottom of the AmaSeis extracted seismogram screen. This capability is useful to illustrate the ground shaking during an earthquake, particularly for seismograms recorded very near to the epicenter of a strong earthquake. By watching the screen as the ground motion appears in real time and displays the amplitude, frequency content and duration of the shaking, one can get a sense of the actual shaking that occurred at that location. An example seismogram that is useful for real time playback is shown in Figure 28. This seismogram is called an accelerogram because it is a record of acceleration of the ground in a particular direction, in this case horizontal. The accelerogram shown is only 28 seconds long and show that ground motions in this location reached peak accelerations of about 40% of the acceleration of gravity (enough to be very strongly felt and cause significant damage) and that the strong shaking lasted for about 6 seconds. Also notice that the ground motion begins with relatively low-amplitude and high-frequency shaking (corresponding primarily to P-wave arrivals) and then becomes much larger and of lower frequency as S- and surface-waves arrive at the station. This seismogram can be

downloaded to your computer for display and play back using AmaSeis by selecting:  
<http://web.ics.purdue.edu/~braile/edumod/as1lessons/UsingAmaSeis/northridge76.sac>

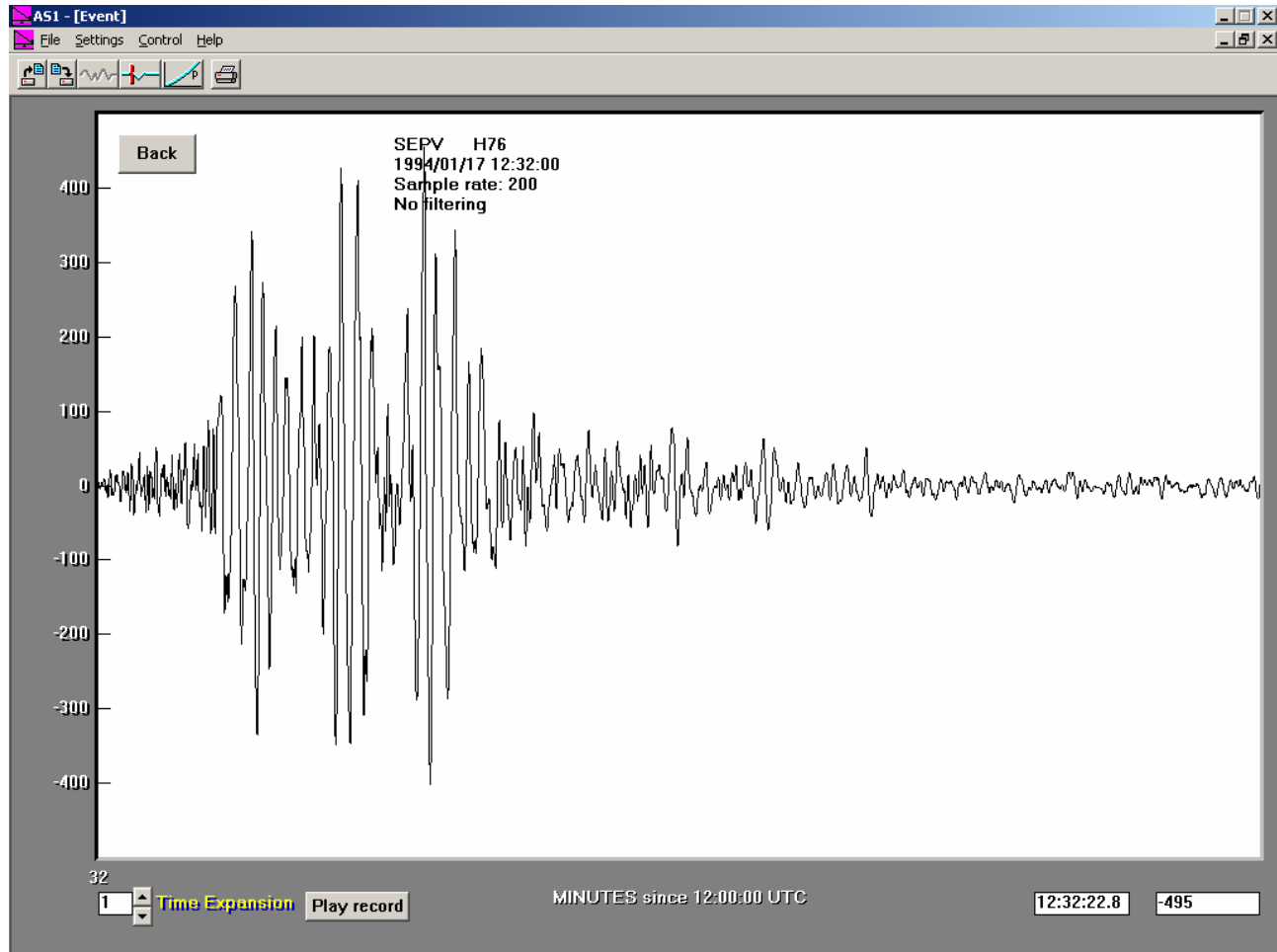


Figure 28. Accelerogram (seismogram approximately recording ground acceleration) from a 1994 Northridge earthquake aftershock recorded at station SEPV. The ground motion recorded is the horizontal component in the direction N76°E. The seismogram begins at 12:32:00 UTC and ends at 12:32:28, a length of 28 seconds. The vertical time scale is acceleration (in the N76°E horizontal direction) in  $\text{m/s}^2$ . The maximum amplitude ( $\sim 400 \text{ m/s}^2$ ) corresponds to about 40% of the acceleration of gravity ( $g$ ).



**3.9 Analyzing the frequency content of seismograms – the Fourier Transform Tool:** The Fourier transform is a mathematical technique for analyzing the frequency content of a signal. Basically, the Fourier transform finds the relative amplitudes (and phases or alignments) of fundamental sinusoids that could be added together to very closely approximate the analyzed signal. The frequency content (relative amplitudes of various frequencies contained in the signal) are displayed by plotting the amplitudes of these sinusoids versus frequency (or period, the reciprocal of frequency). For example, if a seismogram (or selected segment of a seismogram) is made up primarily of 0.5 Hz (Hertz or cycles per second) energy, the Fourier transform will show a peak at about 0.5 Hz. The Fourier transform display is called a spectrum.



The spectrum displays the relative amplitudes versus frequency. To calculate the spectrum of a seismogram or selected part of a seismogram, use the **Extract Earthquake** tool to select the signal of interest (see section [3.3](#) above) and then click on the **Fourier transform tool** icon (Figure 29).



Figure 29. **Fourier transform tool** selection icon (graphed line showing a “peak”) in the AmaSeis **Event** screen display.

Examples of the use of the Fourier transform are shown in Figures 30-35. A relatively complete seismogram for the October 19, 2004 Vancouver Island earthquake is shown in Figure 30. We might be interested in the frequency content of the P-wave energy arriving early in the seismogram. Selecting the first couple of minutes of the seismogram and extracting results in the signal shown in Figure 31. Calculating the Fourier transform generates the spectrum shown in Figure 32. The resulting spectrum shows that this signal (mostly P waves) contains energy with frequencies from about 0.2 to 0.8 Hz with peaks at about 0.6 Hz. Note also that this signal contains little energy for frequencies below 0.2 Hz or above 0.6 Hz (because the sampling rate of the AS-1 seismograph is about 6 samples per second, the digitizing electronics filters out energy above about 1 Hz so the absence of high frequencies in our selected signal is partly caused by removing these frequencies by filtering).

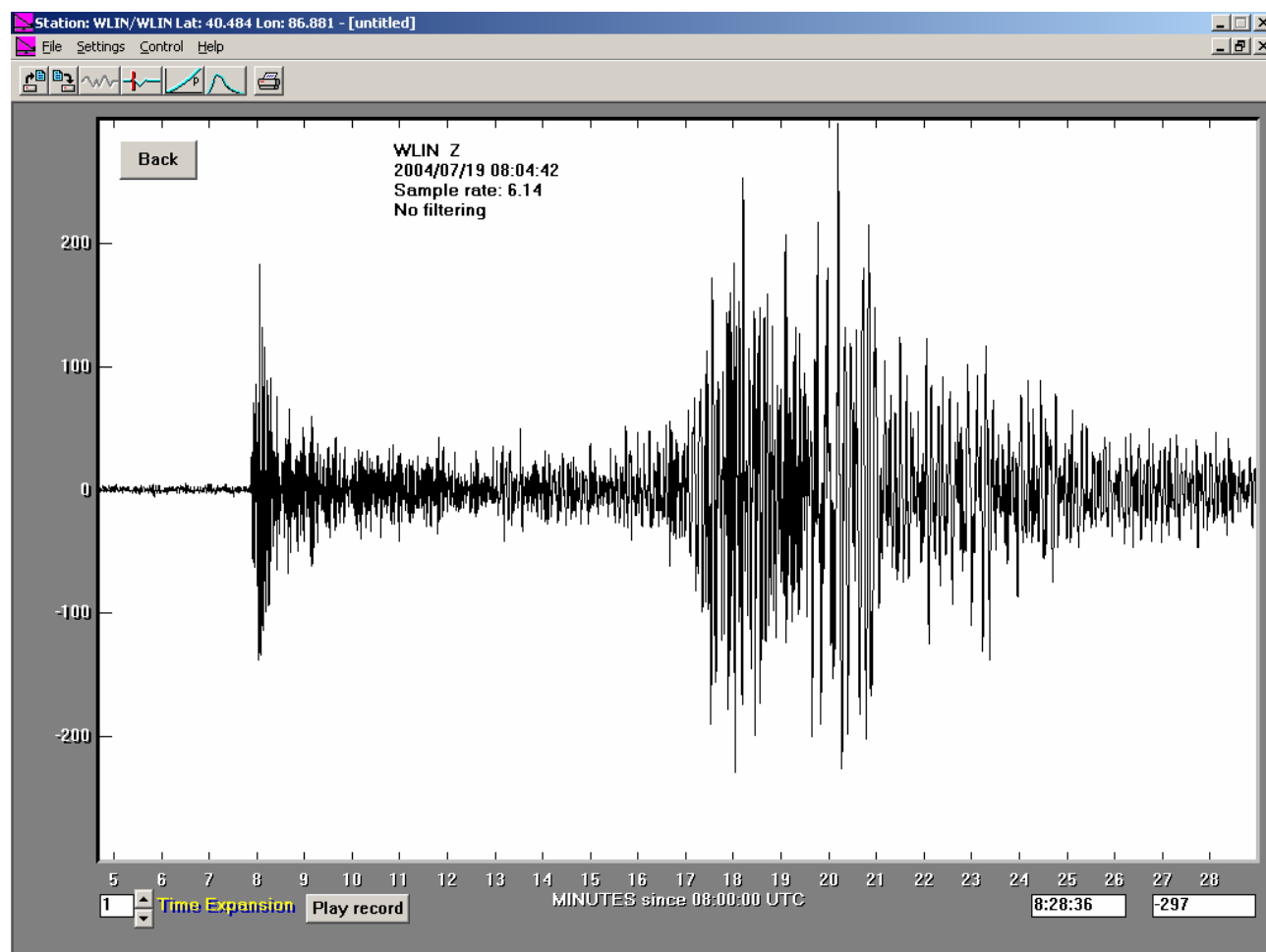


Figure 30. Seismogram for the M6.4 July 19, 2004 Vancouver Island earthquake.

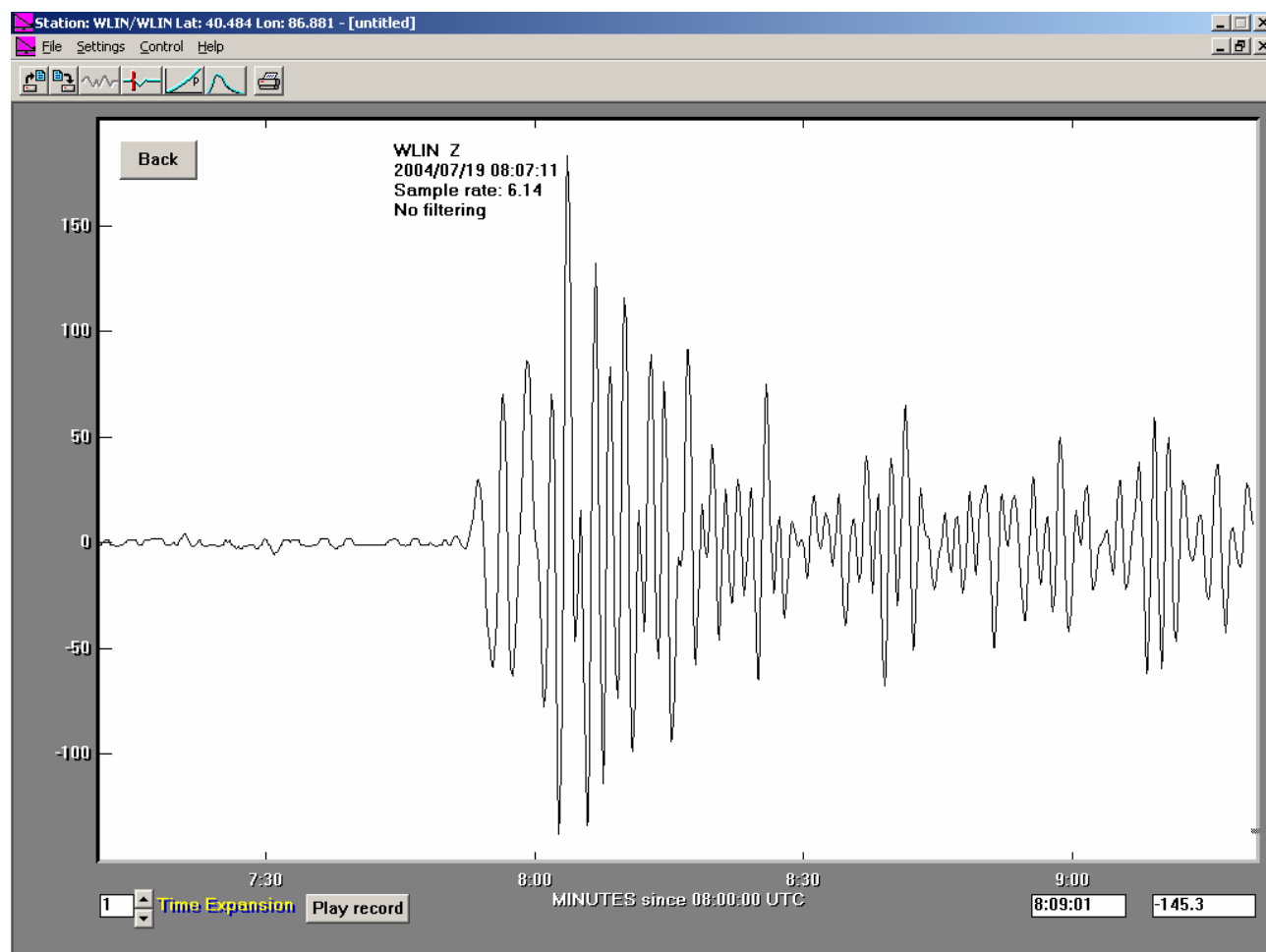


Figure 31. Extracted (selected) segment of the Vancouver Island seismogram (Figure 30) that includes primarily the P wave arrivals.

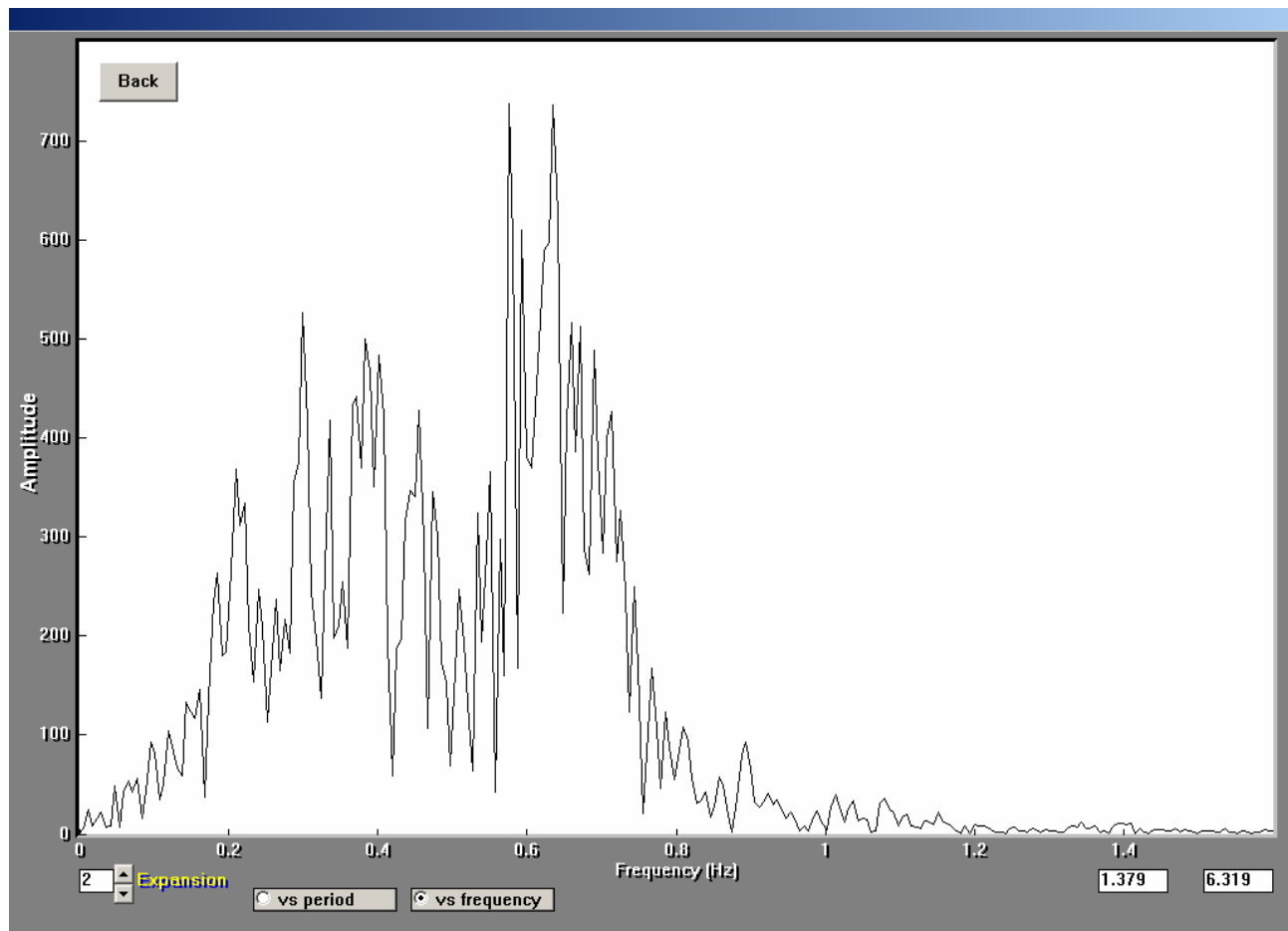


Figure 32. The Fourier transform of the seismogram segment shown in Figure 31. Note that for this display, the spectrum is plotted versus frequency (the **vs frequency** button at the bottom of the screen is selected) and the frequency scale has been expanded (by a factor of 2) using the arrow keys in the lower left hand corner of the screen.

Another seismogram (for the September 25, 2003 M8.3 Hokkaido, Japan earthquake) is shown in Figure 33. This seismogram shows prominent, relatively low frequency, surface waves (Rayleigh waves) arriving beginning about 37 minutes after the first arrival. To analyze the frequency content of these signals, we select and extract a section of the surface wave energy (Figure 34) and then calculate the Fourier transform. The resulting spectrum is shown in Figure 35. This spectrum shows that most of the surface wave energy in the selected part of the seismogram has periods (the reciprocal of frequency) of about 20-25 seconds.

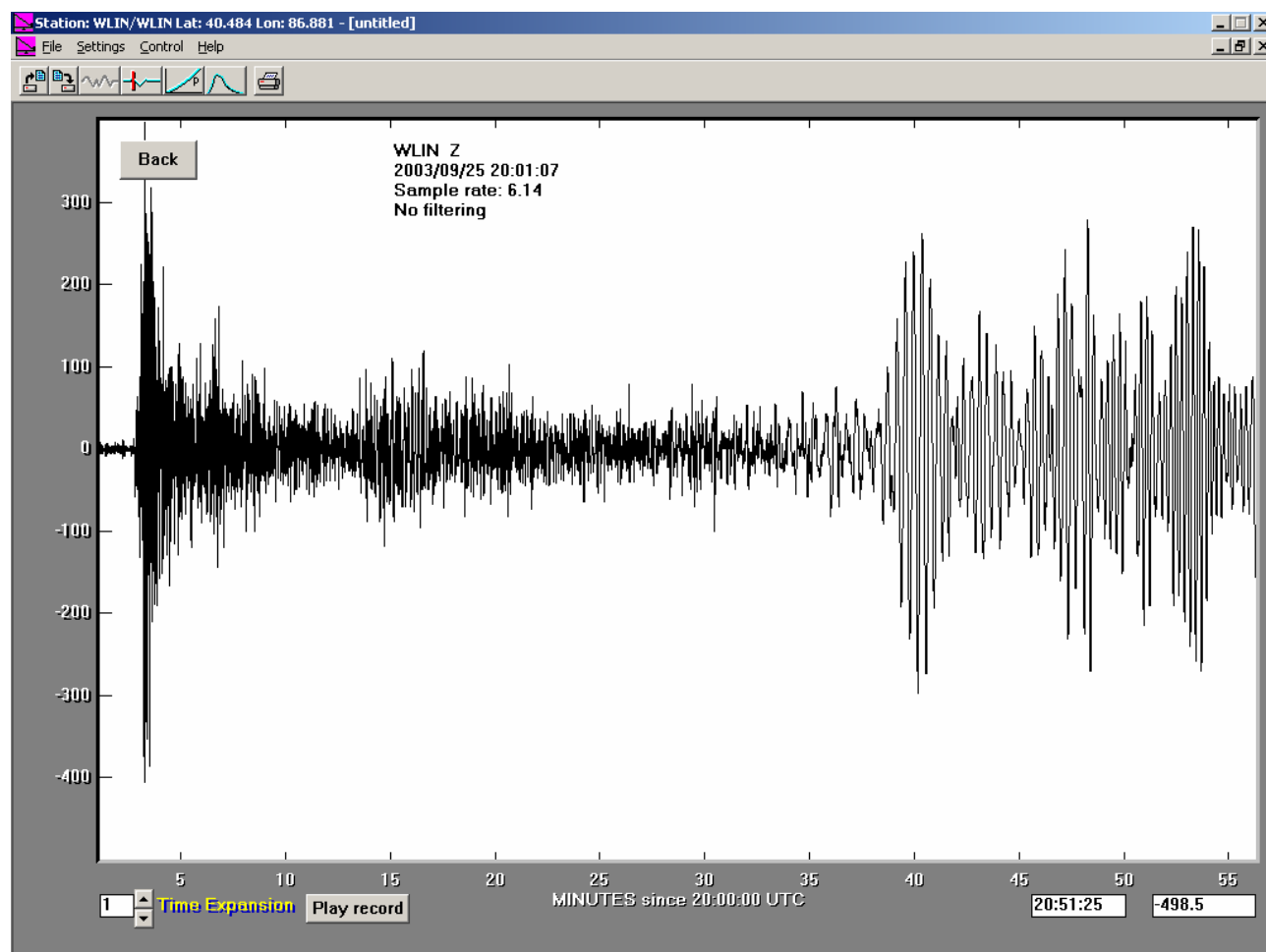


Figure 33. Seismogram for the M8.3 September 25, 2003 Hokkaido, Japan earthquake.

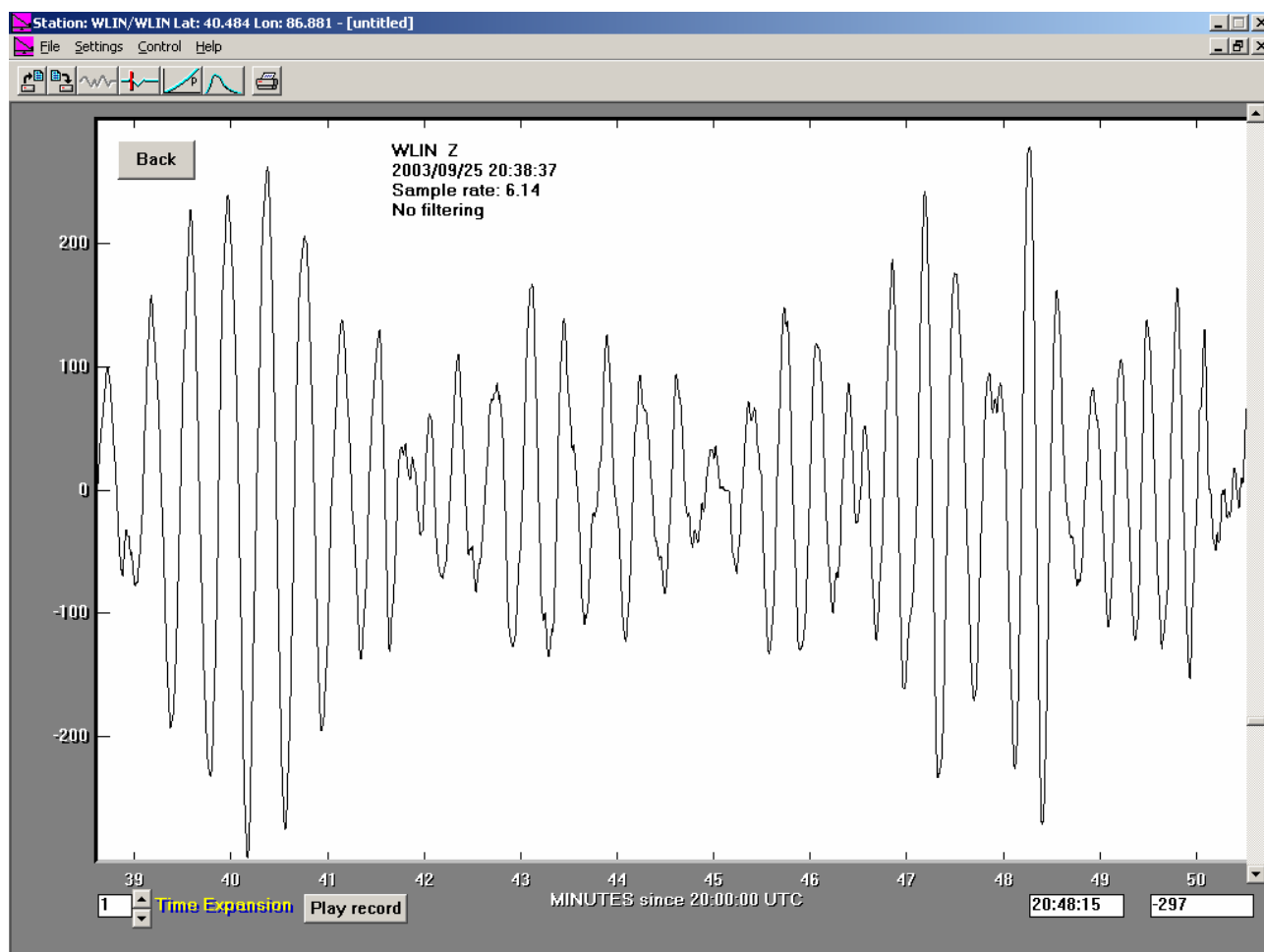


Figure 34. Extracted (selected) segment of the Vancouver Island seismogram (Figure 33) that includes primarily the Surface wave arrivals (because this is a vertical component seismogram, the surface wave energy is almost exclusively Rayleigh waves).

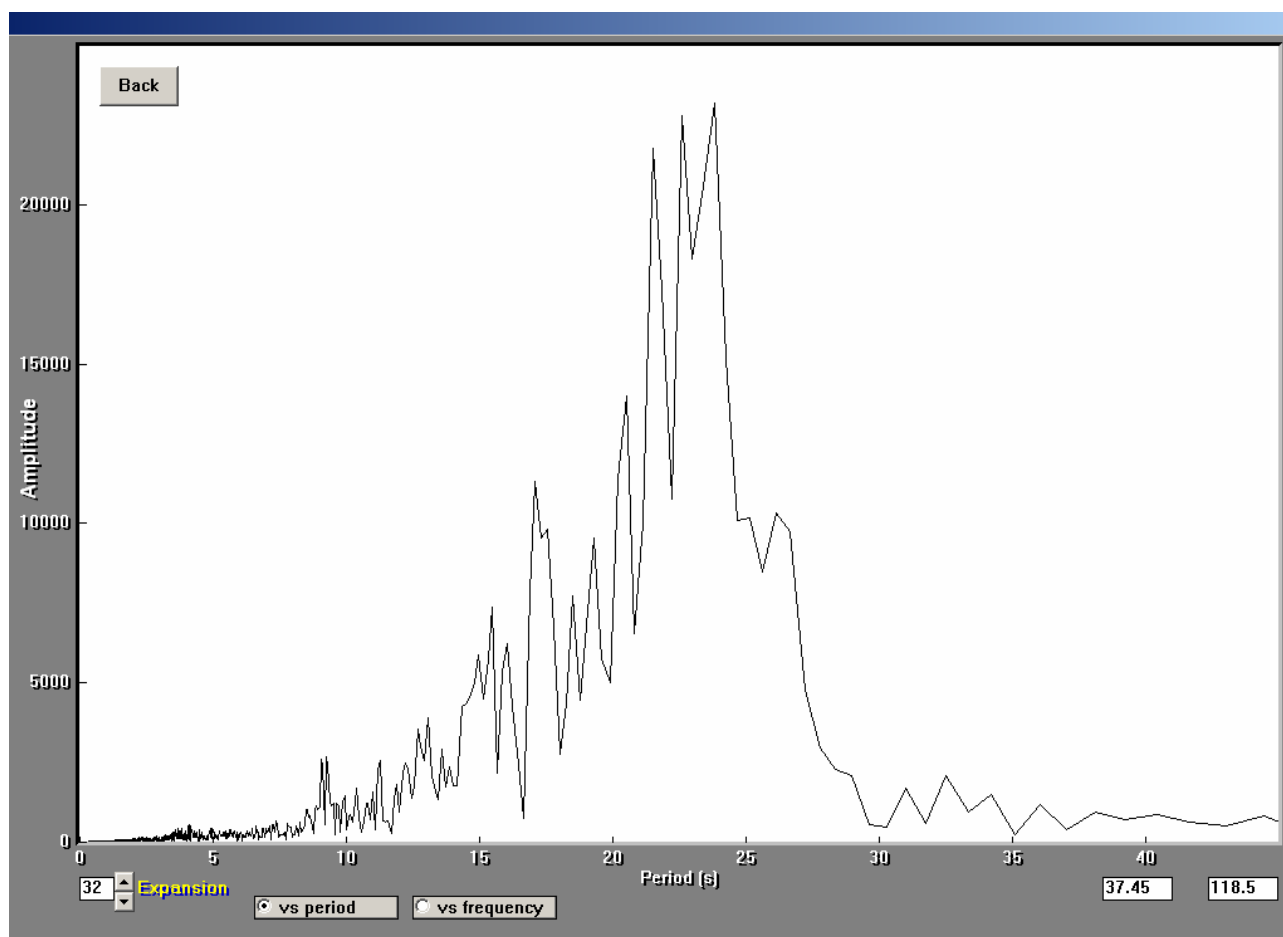


Figure 35. The Fourier transform of the seismogram segment shown in Figure 34. Note that for this display, the spectrum is plotted versus period (the **vs period** button at the bottom of the screen is selected) and the period scale has been expanded (by a factor of 32) using the arrow keys in the lower left hand corner of the screen.



**3.10 Printing from AmaSeis screens:** The simplest and most effective method of printing AmaSeis screen displays is to use the Windows Print Screen key (**Prt Sc**) on your computer keyboard. With an AmaSeis 24-hour screen display visible (such as shown in Figure 10), push the Print Screen key (this will copy a bitmap image of the screen to the clipboard), then open MS Word or another word processing program or a photo or image processing program and paste the image into the open page of the application. The image can then be scaled, cropped or labeled and then printed from the opened application. Modifying the image (cropping; change brightness or contrast, etc.) in MS Word is easily performed using the **Picture Toolbar** (select **Toolbars, Picture** from the **View** menu at the top of the screen). The screen images shown in this document were all obtained using this method. AmaSeis screen images for 24-hour records (such as Figure 10), extracted seismograms (such as Figure 15), “zoomed” seismograms (such as Figure 27), time picked seismograms (such as Figure 23), seismograms overlain on travel time curves (such as Figure 26), and Fourier transforms of seismograms (such as Figure 32) can all be copied and pasted and then printed using this method.





**3.11 Manually setting the AmaSeis sample rate:** The analog to digital circuit (digitizer) in the AS-1 seismometer does not have a fixed sample interval. It normally samples at about 6 samples per second and that is the default sample rate set by the AmaSeis software when AmaSeis is opened to view or analyze seismic data and an AS-1 is not connected to your computer. Because this default value (6 samples per second) is not always the actual sample rate, it is possible to manually set the sample rate to be closer to the rate that was used in actually recording the data. For example, for the WLIN AS-1 data (either the continuous, 24-hour records such as in the 2003 folder or the SAC format files of individual seismograms), the rate is close to 6.14 samples per second. To manually set the sample rate, use MS Word to open the file **AS1.ini** from the **AmaSeis** folder. This is a text file that stores information about your AS-1 and AmaSeis set up. The text file will be similar to the following:

```
[MRU]
Count=4
[AS1]
Latitude=40.484
Longitude=86.881
Elevation=205
BAUD=2400
COM=1
Gain=60
Component=Z
StationName=WLIN
StationCode=WLIN
FileExtension=LPZ
LinesPerHour=1
DecimateFactor=1
DaysToRetainRecords=2000
LowPassCutoff=3
ZeroLevel=2048
InitSampleSeconds=5
SampleRate=6
BandPassLowCutoff=0.01
BandPassHighCutoff=0.2
Device=AS1
```

Notice that the sample rate in this file (fourth line from the bottom) is the default value of 6. To manually set the sample rate, change this number to the appropriate value (such as 6.14) and save it (using the file name **AS1.ini**) as a **plain text** file in the AmaSeis folder. The **Save As** dialog box in MS Word should look like that shown in Figure 36. Note that the file name is **AS1.ini** and the file type is **Plain Text** (near the bottom of the dialog box). When this updated file is saved, a dialog box will appear (Figure 37) that requests information about text encoding; click on the **MS-DOS** selection as shown in Figure 37 and then click **OK** to complete the save of the **AS1.ini** file with the updated sample rate information.

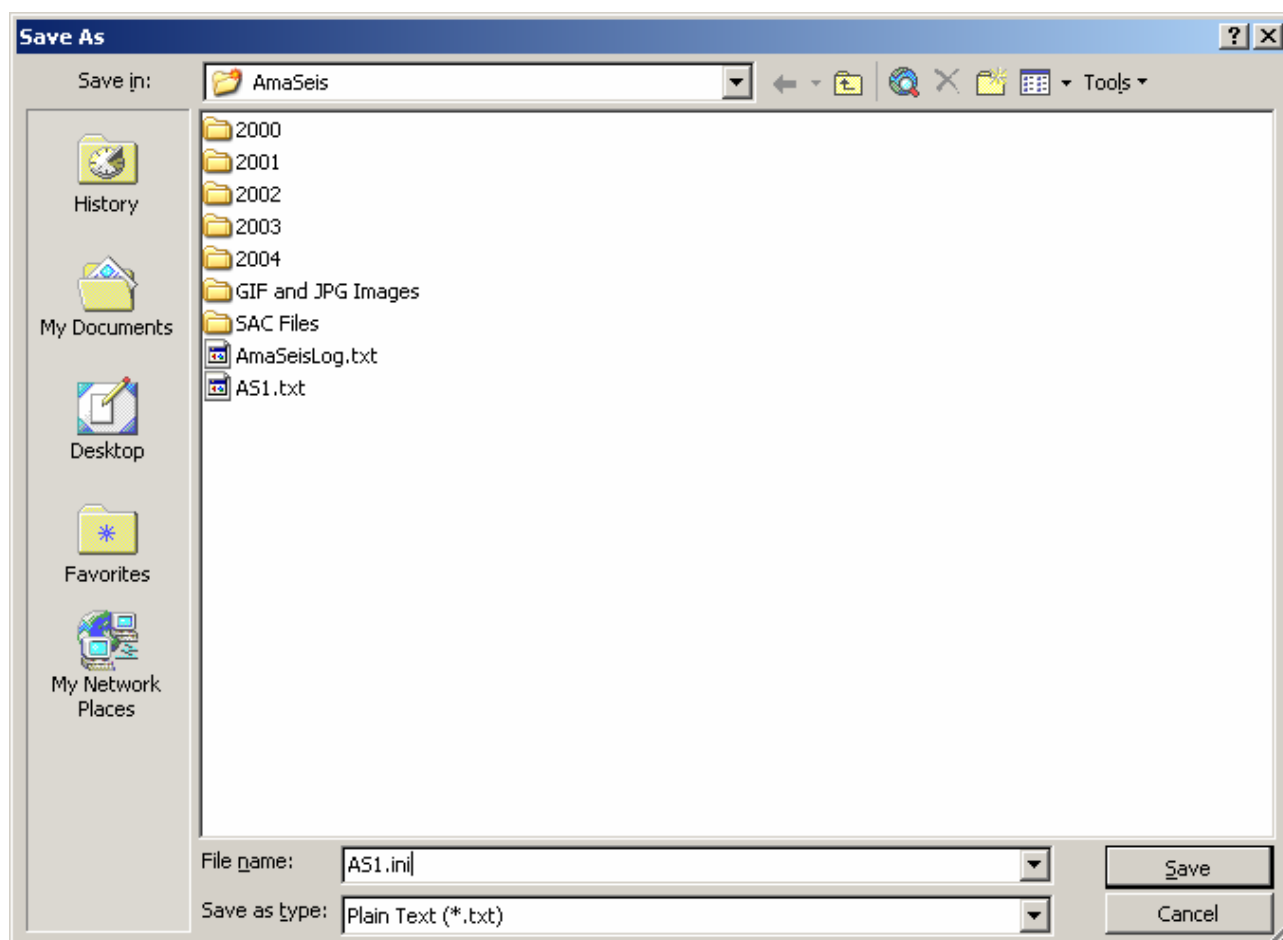


Figure 36. Dialog box from MS Word that appears while saving the AS1.ini file.

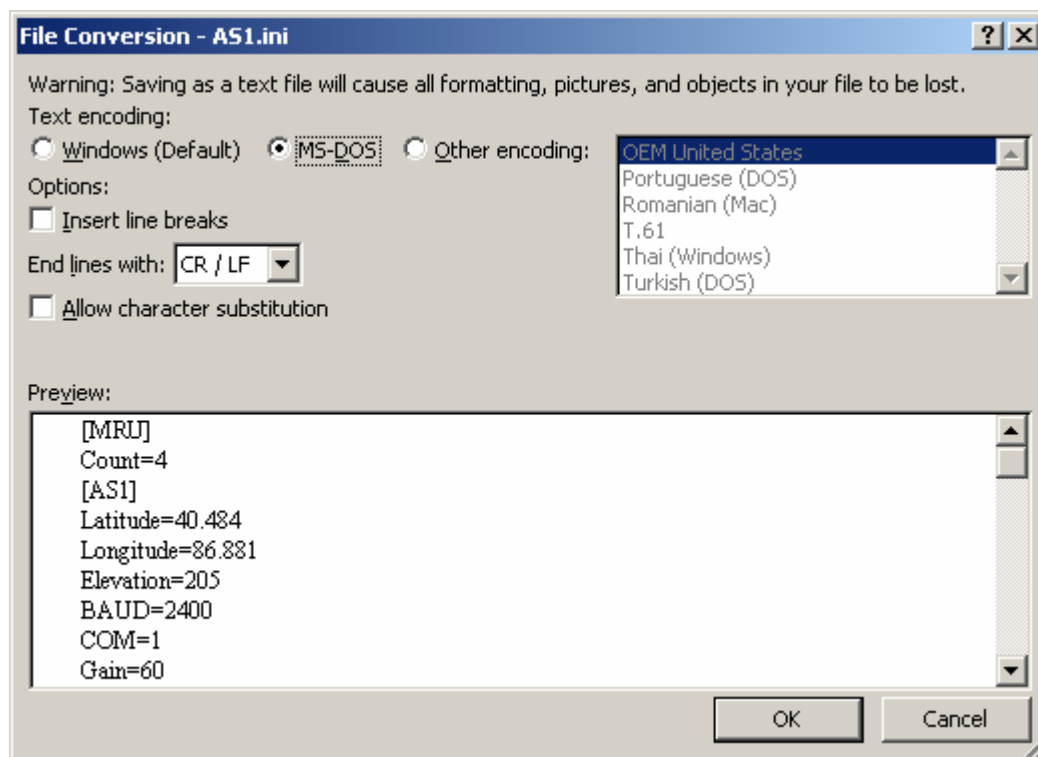


Figure 37. **File Conversion** dialog box from MS Word that appears while saving the AS1.ini file. The MS-DOS button has been selected to control text encoding.



**3.12 Accessing earthquake hypocenter data from the Internet:** You can find information about earthquakes that have occurred around the world by accessing USGS or IRIS websites. Information on recent earthquakes is easily found at the USGS earthquake page, <http://earthquake.usgs.gov/>, or the IRIS Seismic Monitor, <http://www.iris.edu/seismon/>. For older events, instructions for searching earthquake catalogs for events of interest are provided at: <http://web.ics.purdue.edu/~braile/edumod/eqdata/eqdata.htm>. Locations, origin times and official magnitude determinations (moment magnitude or M) for recent events can be found at the USGS earthquake website by selecting **Latest Earthquakes** (at the top left hand corner of the page), and then select **NEIC Current Earthquake Information** (on the left side of the screen). The resulting list provides information on earthquakes that have occurred during the last 7 days. To access data for 8-30 days ago, select this list from near the bottom of the page. For more information, including maps for many events, select the earthquake of interest from the list. The **Magnitude** link (heading on the data table in the earthquake catalog) provides a useful link to a large amount of additional information on earthquake magnitudes. To access older data, see the instructions below or the instruction in: [Accessing Earthquake Data](#).

To obtain detailed magnitude data from the USGS catalog for recent events (for determining the magnitude comparison with AS-1 determined magnitudes), go to <http://earthquake.usgs.gov/>; click on “*Latest Quakes*”, then “*NEIC Current Earthquake Information*” for a list of recent events (you can also access the last 30 days of activity, maps and other data lists). To find detailed magnitude data for a specific event, click on the event in the list of earthquakes, then scroll down the page and select **Phase Data**. Magnitude (and other event) information for the selected earthquake will be displayed.



**3.13 Calculating distance from an epicenter to your station:** The USGS online distance calculator ([http://neic.usgs.gov/neis/travel\\_times/](http://neic.usgs.gov/neis/travel_times/)) is an easy to use tool for calculating distance between an epicenter and your station (or any two points on Earth). To use the distance calculator, the coordinates (latitude and longitude) of the epicenter and station must be known.

To find the coordinates of permanent seismograph stations, go to the IRIS GSN station page <http://www.iris.edu/stations/stations.htm>, select **Global Seismic Network (GSN)**, and then select **stations**, or go to the list directly at: [http://www.iris.edu/SeismiQuery/bin/gsn\\_sta\\_s.pl](http://www.iris.edu/SeismiQuery/bin/gsn_sta_s.pl). The IRIS GSN station page also has a link to a list of over 11,000 station names that exist or have existed in the past. Detailed station information for many of the GSN stations can be obtained from the IRIS [Seismic Monitor](#); click on the map in the area of interest and a close-up view of that area will appear; then select a station (triangles on the map) and a page listing detailed station information will appear (if available).

To find the coordinates of an AS-1 station, go to [SpiNet](#); select **Current Network Stations** and then select the station of interest to list the station information. If you need to determine the

coordinates of your AS-1 station, there is an online tool that is convenient (you could also use a handheld GPS receiver if available).

To determine your seismograph station coordinates from online maps, go to <http://www.maptech.com/> and select **Online Maps** from the links at the top of the page, and then **Maptech MapServer**. Enter desired city and state information (or zip code) in the dialog boxes and select **Go**. If a list of possible locations or maps appears, select the desired location or map. A topographic map of the area will appear on the screen. You can navigate on the map using the arrows at the map edges to move the view to an adjacent location. When you have your station location in view, select the **DD.DD** (specifies that coordinates are to be displayed in degrees and decimal degrees which is the most common usage) setting in the coordinates dialog box to the left of the map. Next, place the cursor on the map at the location of your station and read the latitude and longitude of the cursor position in the windows to the left of the map.

To find the epicenter (location) of an earthquake from online catalogs, use the methods described in section [3.12](#) (above). For more information on the online tools for searching earthquake catalogs, see [Accessing Earthquake Data](#).

When you have determined your station and epicenter coordinates, go to the USGS online [Distance Calculator](#), select **Specify Earthquake**, and enter the coordinates into the appropriate dialog boxes. Use degrees and decimal degrees format to the coordinates. Also, use negative numbers for *South* latitude and *West* longitude. Click on **Compute** at the bottom of the page to determine the epicenter to station distance (Delta) given in degrees geocentric angle. (For a quick estimate of epicenter to station distance, you can sometimes use the distance determined from the S minus P arrival times as described in section [3.6](#).) To determine the corresponding distance in kilometers along the surface, multiply this number by 111.19 km/degree. The distance calculator also provides calculated travel times to your station of several seismic phases (arrivals) and, if the earthquake magnitude is entered, the estimated ground motion at your site from this earthquake. When calculating travel times to your station, or ground motion estimates at your station, be sure to enter the correct depth of focus for the earthquake. It is also convenient to save your station coordinates so that they will not have to be entered every time that you use the distance calculator. From the main distance calculator page, you can also access a plot of standard travel time curves and a table of travel times.



**3.14 Adding event information to extracted seismograms:** After extracting a seismogram (see section [3.3](#), above), the earthquake hypocenter information, can be entered and saved in your SAC-format file using the **Event** option in the **Settings** menu. After entering the appropriate information, click on **OK** to save the seismogram. More information on the **Event** option can be found in section [7](#), below.



**3.15 Adding calibration information and calculating magnitudes in AmaSeis:** Under construction.



**4. SpiNet:** SpiNet is a website that supports educational seismology through providing educational products and serving as a data archive for AS-1 and other seismograms. You can download seismograms (mostly AS-1 seismograms in SAC format) that can be viewed and analyzed using the AmaSeis software. You can also upload seismograms recorded by your AS-1 seismograph to the SpiNet site so that other interested persons can use them. If you are operating an AS-1 seismograph, we encourage you to register your seismograph station with the SpiNet network. There are instructions for downloading and uploading on the SpiNet website and illustrated instructions are also provided below.

**4.1 Downloading seismograms from SpiNet:** To download seismograms from SpiNet, click on the icon below to go to the SpiNet website (<http://www.scieds.com/spinet/>).

# SPINET

At the top of the SpiNet home page you will see several links (shown below); click on the **Seismicity** link and then on **Download Sac Files**. On the resulting screen (Figure 38), you can navigate to the time period of interest and select a seismogram to download.

# SPINET

PROMOTING K-16 EDUCATIONAL SEISMOLOGY

► SEISMICITY ► EDUCATION ► NETWORK ► INSTRUMENT ► LINKS

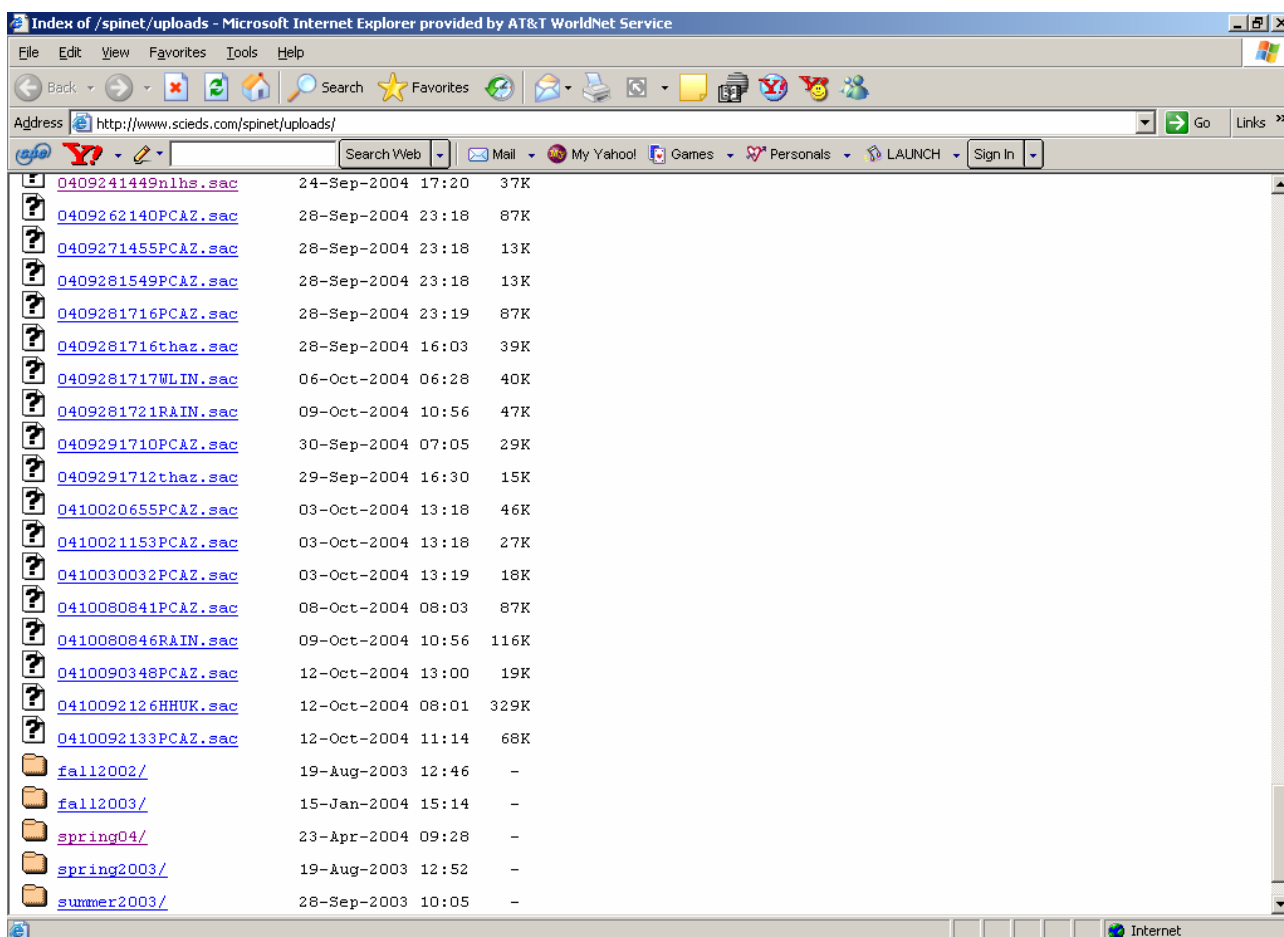


Figure 38. Seismograms available for download from the SpiNet website. The most recent seismograms are listed by event date included in the file name (see file naming convention). The date of upload is also shown to the right of the file name. Seismograms for previous time periods are contained in folders shown at the bottom of the list. To access data from these time periods, click on the appropriate folder name to see the list of seismograms during that time period.

The seismograms are identified by the file naming convention described below.

### File Naming Convention

All files adhere to the following naming convention

(two digit year, two digit month, two digit day, two digit hour, **two digit minute**, station code)

Some examples:

Tempe High School (thaz) recorded an event at 19:30 on June 23, 2001-

**File Name:** '0106231930thaz.sac'

or...

RAIN (Indiana) recorded an event at 07:09 on July 30, 2003-

**File Name:** '0307300709rain.sac'

Footnote: Under the old naming convention (prior to 7/29/2004) files are named as follows (two digit year, two digit month, two digit day, two digit hour, station code)

The above THAZ and RAIN examples would have the following names:

'01062319thaz.sac'

'03073007rain.sac'

To download the seismogram, click on the seismogram file name in the SpiNet window. The dialog boxes shown in Figures 39-40 will appear. When the Download Complete dialog box appears, click on **Close**.

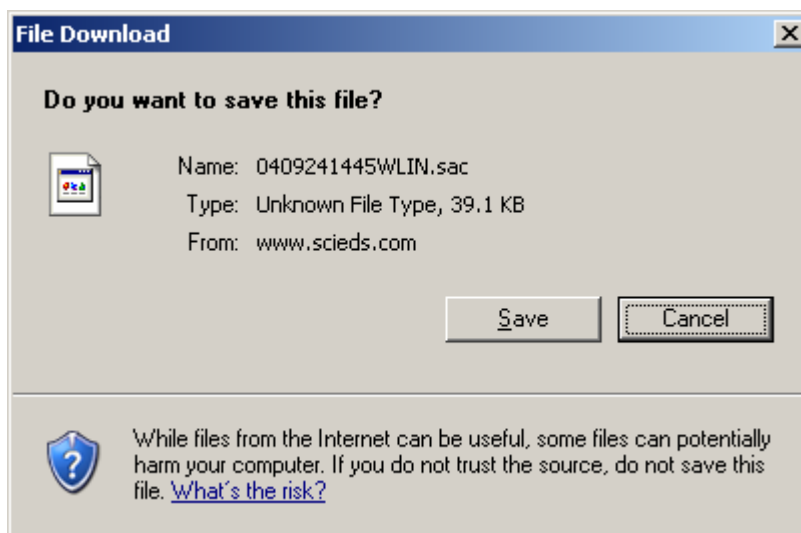


Figure 39. Dialog box that appears during the download of seismograms from the SpiNet website. To complete the download, click **Save**.

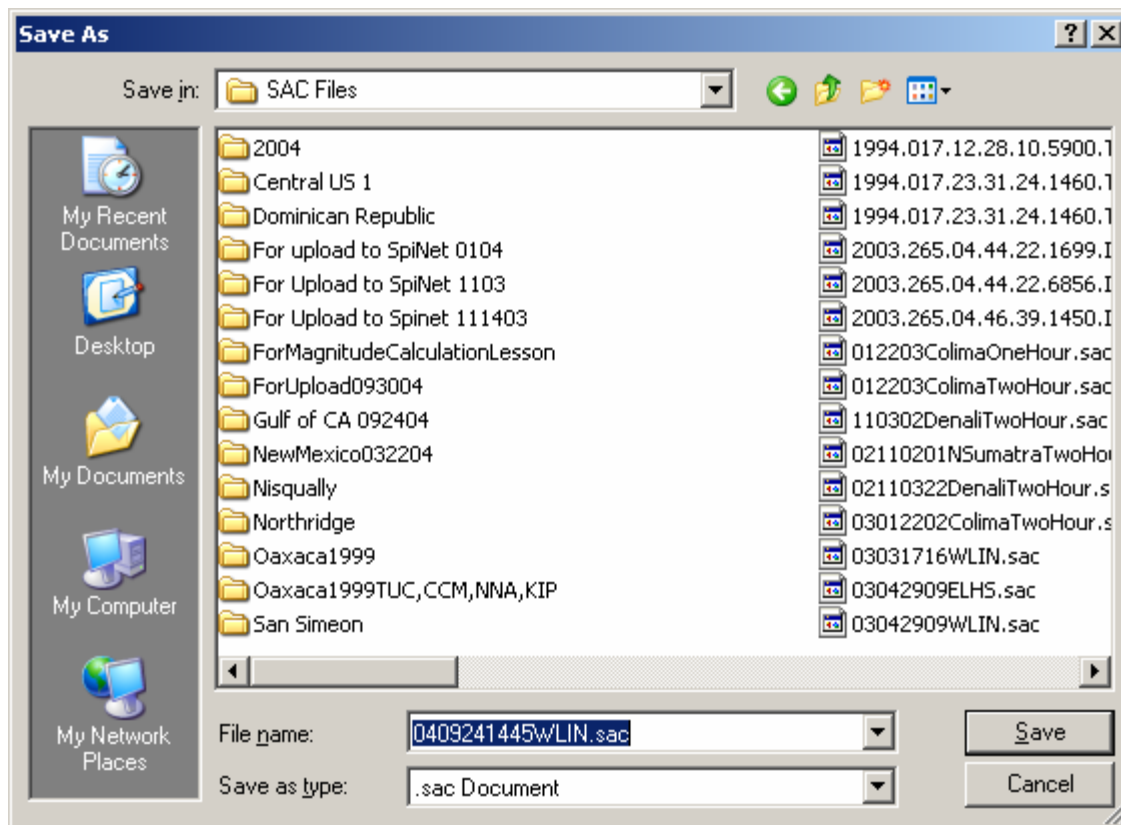




Figure 40. Dialog box that appears during the download of seismograms from the SpiNet website. If the selected folder location is not where you want to store the seismogram, navigate to the desired folder and then click on **Save**.

To view the downloaded seismogram, start AmaSeis, click on **Open** from the **File** menu. If the correct folder doesn't automatically open, use the arrow keys (to the right of the folder name at the top of the dialog box) to navigate to the folder that contains your SAC files. It is convenient to establish one or more folders for storing your own SAC files of seismograms and downloaded seismograms. Once the correct file is found, select the file name and click on **Open** (Figure 41). For the example shown here, the file 0409241445WLIN.sac (corresponding to the M5.9 September 24, 2004 Gulf of California earthquake recorded by the WLIN AS-1 station in West Lafayette, IN) appears (Figure 42). This seismogram can be filtered, segments selected ("zoomed"), arrival times picked, and to estimate distance from the S minus P times, and determine magnitude using AmaSeis as described in section 3 of this tutorial.

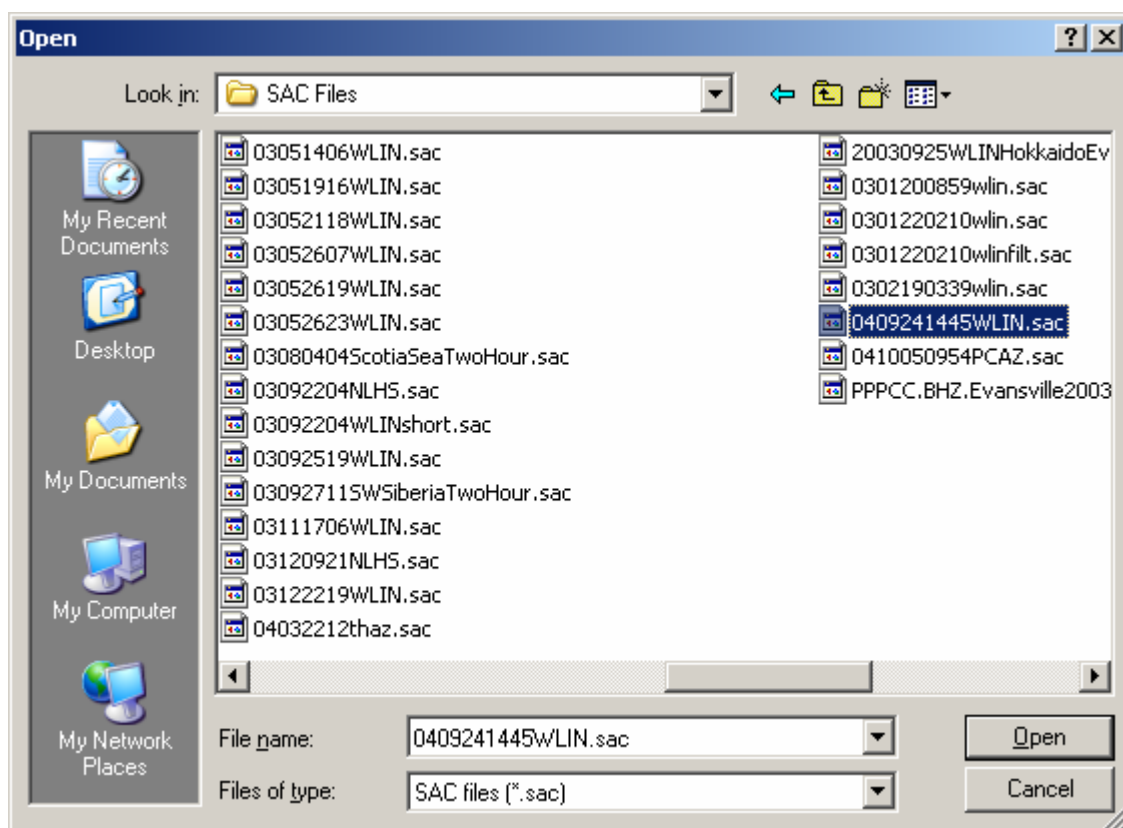


Figure 41. Dialog box that appears when opening a SAC file seismogram from within AmaSeis.

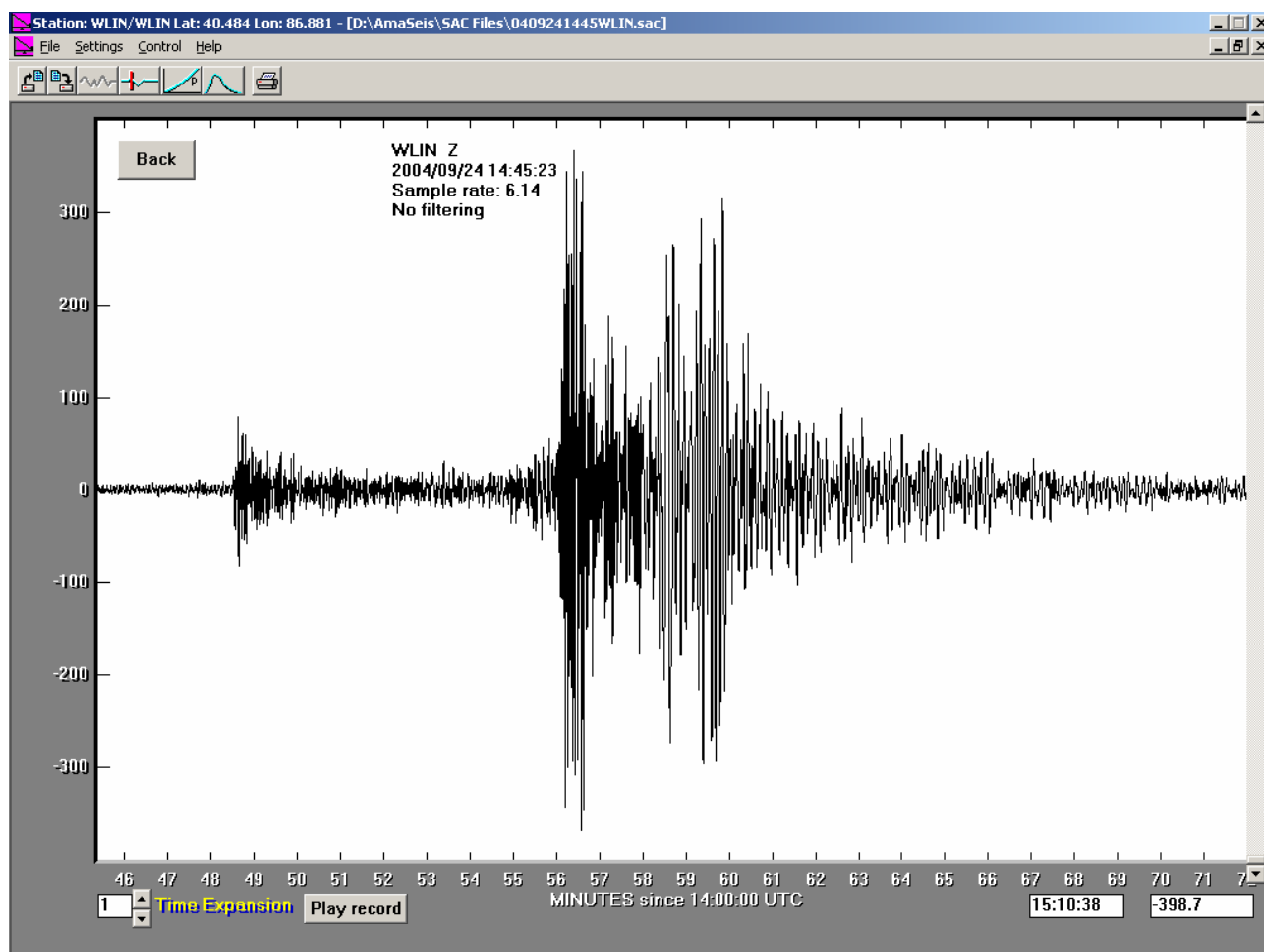


Figure 42. WLIN AS-1 seismogram for the Gulf of California earthquake.

For recent events, the easiest way to find seismograms for download from SpiNet is to open the **Recent Events** page (Figure 43; select **Seismicity** and then **Recent Events** from the SpiNet home page). From this page, you can select and download seismogram files for specific earthquakes by station name (listed to the right of the event information on the screen shown in Figure 43).

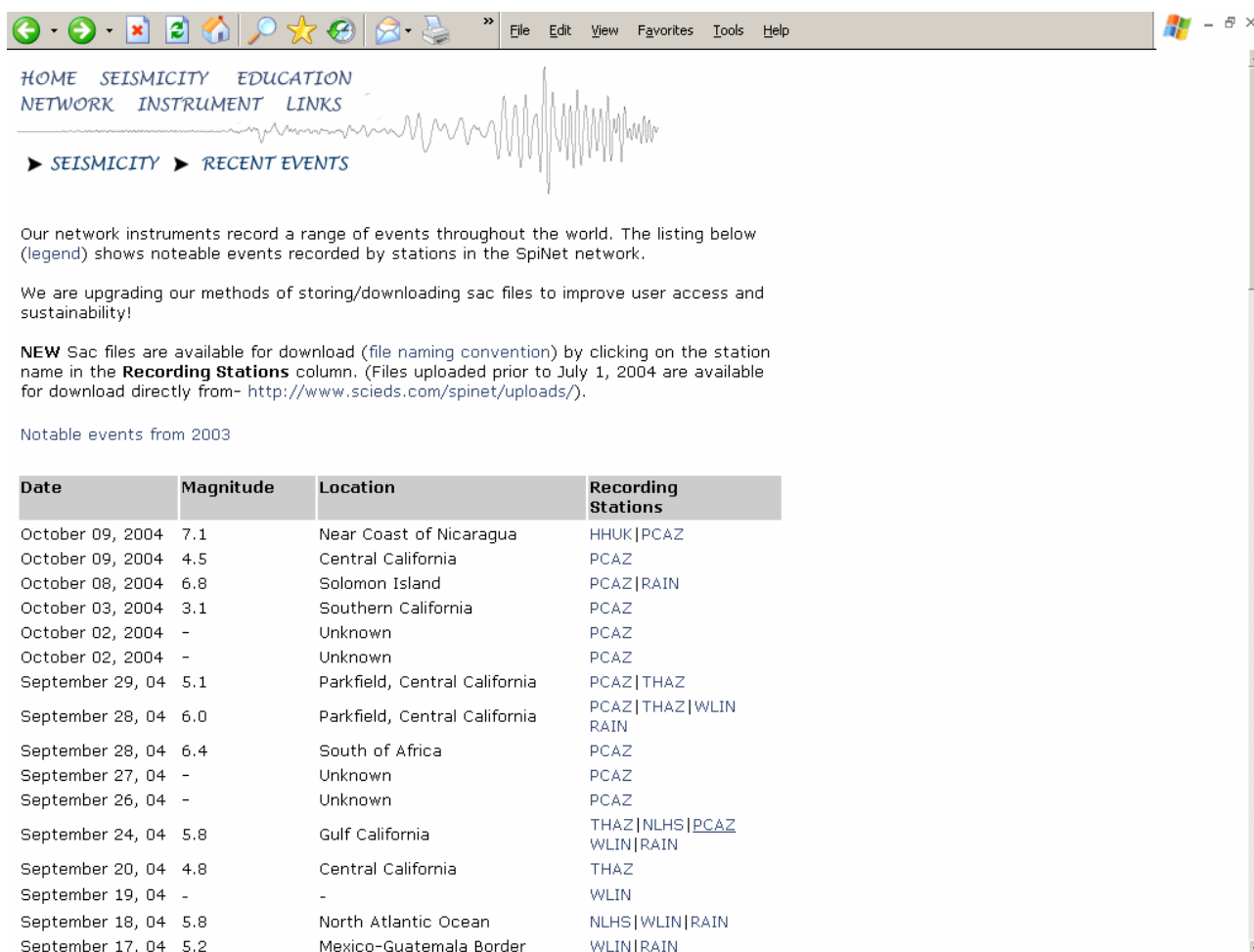


Figure 43. Example of SpiNet **Recent Events** page showing stations (four letter codes to the right of events) for which seismograms are available in the SpiNet archive for the listed event. For example, selecting **WLIN** from the list for the September 24, 2004 Gulf of California earthquake will download the **WLIN** SAC format seismogram (shown in Figure 42) to your computer for viewing with AmaSeis .



**4.2 Uploading seismograms to SpiNet:** To upload a seismogram (SAC format file) from your computer to SpiNet, open the [SpiNet](#) website, and select **Seismicity** from the links at the top of the page; then select **Upload a SAC file**. Follow the instructions at the bottom of the page to upload your seismogram. Be sure that you have saved your SAC format seismogram using a file name consistent with the SpiNet file naming convention (see section [4.1](#) above) before beginning the upload process. Your uploaded file is checked and then placed in the SpiNet archive and will be displayed for others to download with a day or so (on pages similar to those shown in Figures 38 and 43).



**5. Downloading seismograms from the IRIS Data Management Center (DMC) using WILBER II:** This section provides instructions for finding and downloading seismograms from the Incorporated Research Institutions for Seismology (IRIS) Data Management Center's (DMC) archive using the online tool WILBER II. The seismograms in the DMC archive include data from many earthquakes since 1990 recorded by standard seismograph stations (including the IRIS/USGS Global Seismograph Network [GSN] stations) around the world. Seismograms from significant earthquakes are often available within 30 minutes to an hour after the event. The instructions below illustrate how to download data from the DMC to your computer to display and analyze using the AmaSeis software. A help page for using WILBER II is also available from the IRIS DMC at: [http://www.iris.edu/wilberII\\_dir/html/help.html](http://www.iris.edu/wilberII_dir/html/help.html). More information on data in the IRIS DMC data archive, seismogram formats and data access tools can be found at: <http://www.iris.edu/manuals/DATutorial.htm>.

**5.1 Opening WILBER II:** To connect to WILBER II directly, click on the icon below (then skip to section [5.3](#) of these instructions):



[http://www.iris.edu/cgi-bin/wilberII\\_page1.pl](http://www.iris.edu/cgi-bin/wilberII_page1.pl)

**5.2 Opening WILBER II from the IRIS website (www.iris.edu):** To connect to WILBER II from the IRIS website, click on the icon below (<http://www.iris.edu>):



The screen shown below (Figure 44) will appear. You can use this screen to link to all of the programs and other information related to IRIS. To access recent earthquake epicenter information, click on the **Seismic Monitor** icon. To access data using **WILBER II**, click on **data**. The IRIS DMC Data screen (Figure 45) will appear. To open WILBER II, click on the **WILBER II** icon (oval) located near the lower right hand corner of the screen (highlighted by a red arrow in Figure 45). The opening WILBER II screen (Figure 46) will appear.

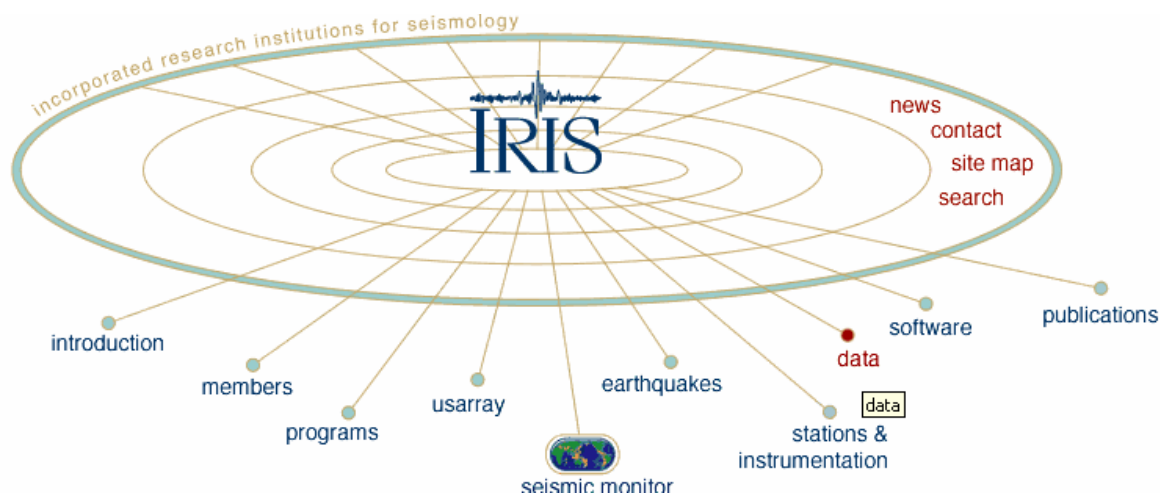


Figure 44. IRIS home page.

**Data**

What data does IRIS have?

[Types of data](#) available from IRIS

IRIS data sources for [Waveforms](#) and [Event Catalogs](#)

[World and US Broadband Data Centers](#)

[Data Distribution Statistics](#)

Requesting data from IRIS

[How to get data](#) from the large IRIS archive

Check on archived data availability using [SeismiQuery](#)

Check on real-time data holdings using [BUD](#)

How to check on status of a data request

View customized

View

View [status of assembled data requests](#)

How to check on data problems

**request tools shortcuts - click on me**

FISSURES Data Handling Interface (DHI) Request Tools

IRIS DMC Data Organization Repositories

Traditional Request Tools

LEGEND

- Quality Controlled Continuous Data
- Limited QC Continuous Data
- Metadata
- QC'd Event Windward Data
- Limited QC Event Windward Data
- DHI tools

Figure 45. IRIS DMC Data screen. To access WILBER II, click on the WILBER II oval located near the lower right hand corner of the screen (see red arrow above).



**5.3 WILBER II first screen:** The WILBER II opening screen is shown in Figure 46. From this screen, one can access digital earthquake data (seismograms) in the IRIS DMC archive. The data are organized by time and event and accessed using the time period (in quarters of a year) scroll bar and the interactive map of (selected) events during that time period.

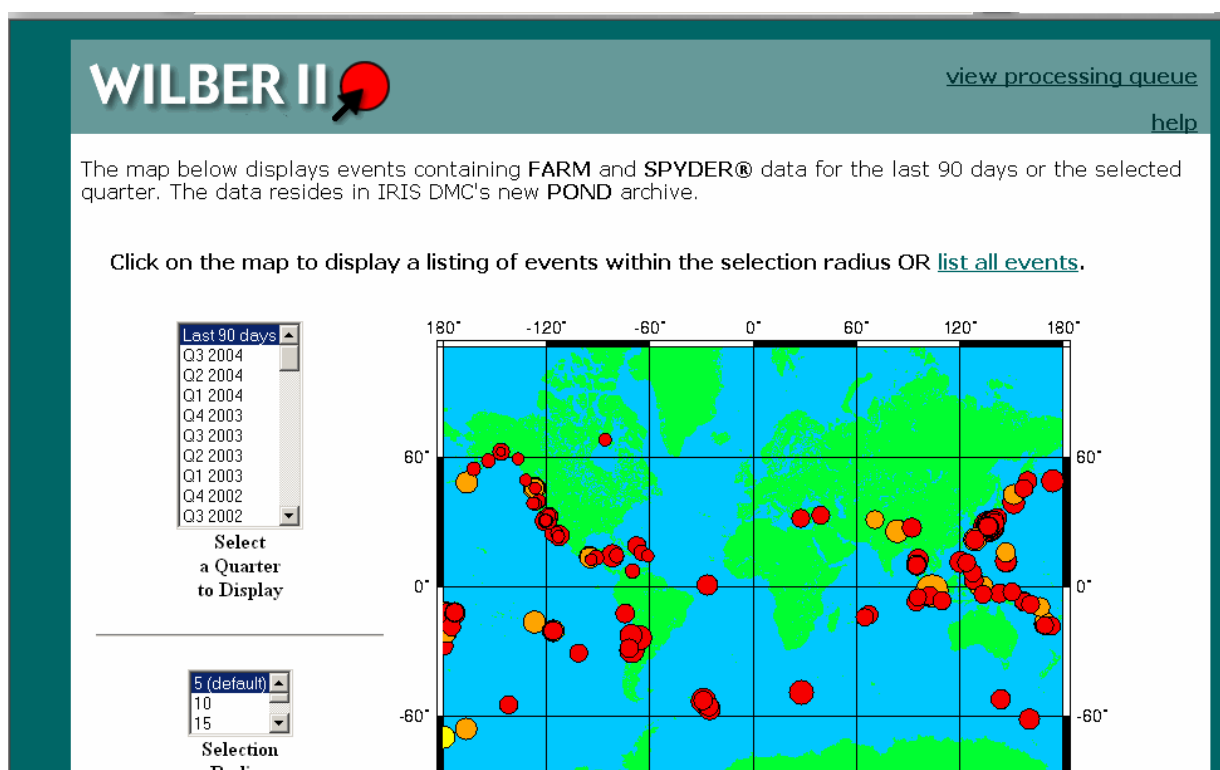
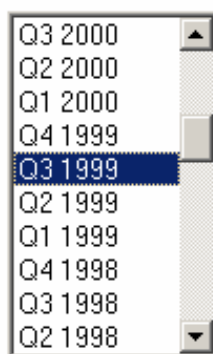


Figure 46. WILBER II opening screen. The map shows earthquakes occurring in the last 90 days that have been selected for preparing individual seismograms.

On the WILBER II opening screen (Figure 46), we select the period of interest from the scroll window to the left of the map. In this case we choose Q3 of 1999 (Figure 47). A new map (Figure 48) showing the events for which seismograms are available for that quarter appears. Click on the large dot located on the west coast of southern Mexico (as shown in Figure 48) to select the Oaxaca earthquake of September 30, 1999. (You can find information about earthquakes that have occurred around the world by accessing USGS or IRIS websites. Information on recent earthquakes is easily found at the USGS earthquake page, <http://earthquake.usgs.gov/>, or the IRIS Seismic Monitor, <http://www.iris.edu/seismon/>. For older events, instructions for searching earthquake catalogs for events of interest are provided at: <http://web.ics.purdue.edu/~braile/edumod/eqdata/eqdata.htm> as described in section 3.12 of this document). A screen with information about that event (Figure 49) will appear. Select the event from the list (in this case there is only one event in the list) and a Responding Networks page (Figure 50) will appear.



Select  
a Quarter  
to Display

Figure 47. Selection of date (by quarters of a year) on the WILBER II opening page. In this case we select Quarter 3 (Q3) of 1999 because the event of interest occurred on September 30, 1999.

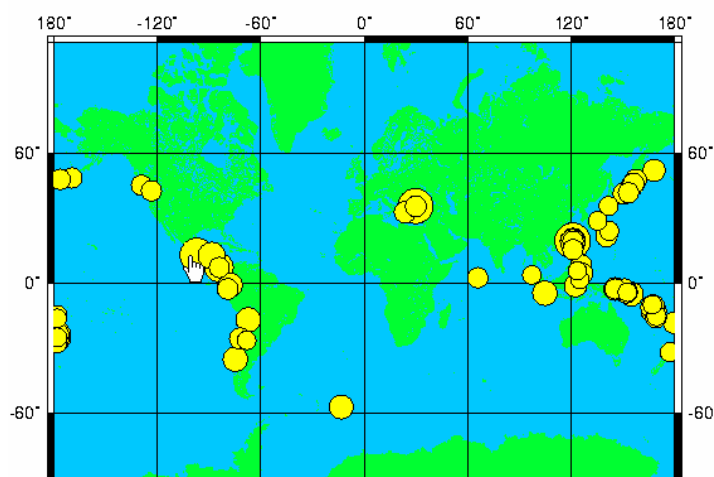


Figure 48. Map of events in quarter 3 of 1999. The desired event is selected by moving the hand cursor to the large dot on the west coast of southern Mexico and clicking the mouse.

[back to map](#)
WILBER II 
[help](#)

Events within 5° distance of selected Lat: 17.32° Lon: -98.24° for Q3 1999

DATE	TIME	SOURCE	MAG	LAT	LON	DEPTH	DESCRIPTION
1999/09/30	16:31:15.6	FARM	7.5	16.06	-96.93	60.60	OAXACA MEXICO

Total of 1 distinct events

Please select an event in the list to:

- view detailed information
- generate requests for data from that event.

Figure 49. Event information for the event selected in the map shown in Figure 48.



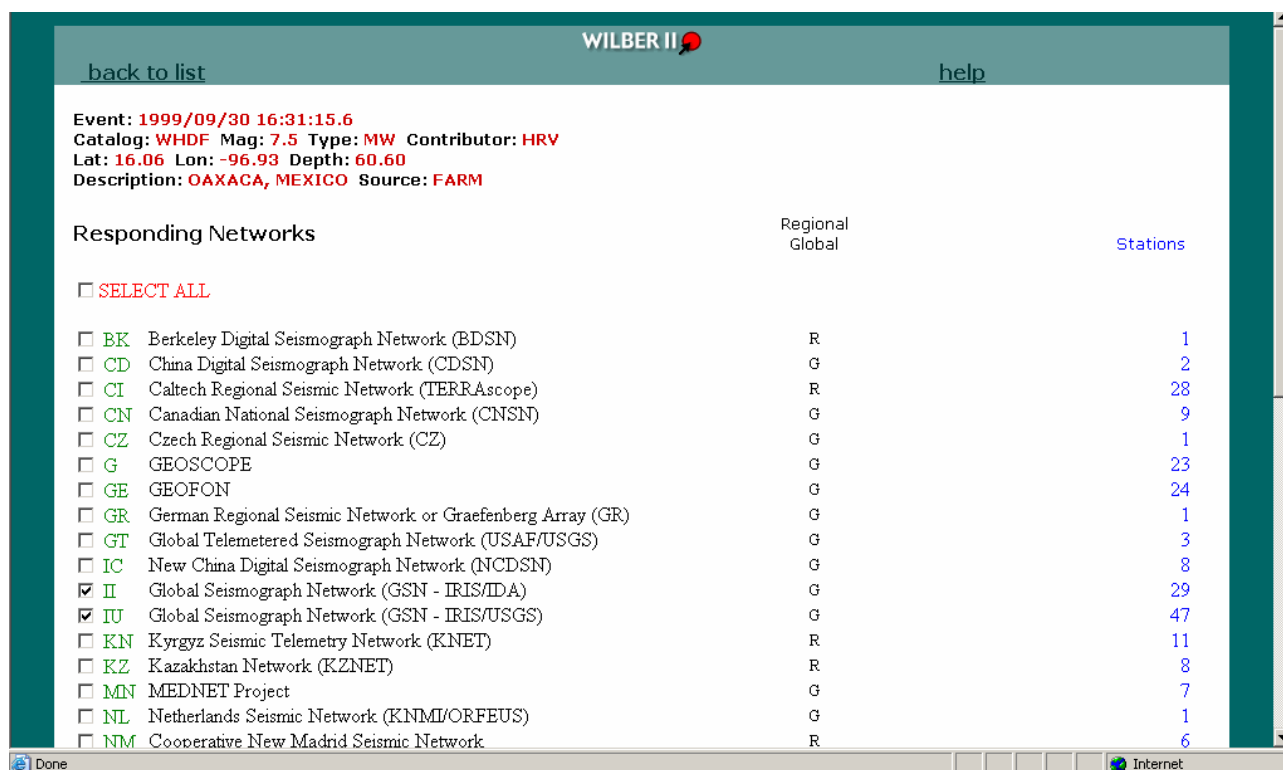


Figure 50. Data corresponding to many different seismograph networks can be selected. For most requests, select the II and IU GSN networks as shown here then click **Proceed** at the bottom of the page.

In the Responding Stations window (Figure 50), uncheck all of the boxes next to the station names except for the desired stations, in this case, stations TUC, CCM, NNA and KIP. Select the components of interest, in this case, the BHE, BHN, and BHZ components (these components are broadband horizontal components in the east and north directions and the broadband vertical component; hold down the control key while clicking on the components with the cursor to select multiple components). Click on **Proceed** at the bottom of the page. The Responding Stations screen shown in Figure 51 will appear.

If you wish to see a station map that shows the locations of responding seismograph stations for this event, click on **Station Map** (before un-checking stations if you want to see all station locations as shown in Figure 52). Selecting an area of the map (screen shown in Figure 52) by dragging the cursor over the map from the upper left to the lower right of the desired area results in a close-up view in which the station names are visible (Figure 53). For the data request in this example, we are interested in stations TUC, CCM, NNA and KIP. Un-check all of the other stations on the Responding Stations screen (Figure 51) to select only the seismograms of interest. To examine the seismograms for a station before submitting the data request, click on the station name on the Responding Stations screen (Figure 51). An example of selecting a preview of the data is shown for the TUC station in Figure 54. From this page, one can also access detailed station information (including the coordinates of the station) by selecting Station Book for TUC (Figure 55).

After selecting the stations of interest for the request, scroll to the bottom of the Responding Stations page (Figure 51) and complete the request by selecting the data format and time range and entering personal information for tracking your request. An example is shown in Figure 56. Then



click the Process Request button (Figure 56) to submit the data request. Requests for small amounts of data (a few seismograms) are usually processed within a few minutes. While the request is being processed, the screen shown in Figure 57 will appear, followed by a progress report (Figure 58) and a Request Completed! message screen (Figure 59). Connecting to the ftp address (click on the address on screen similar to that shown in Figure 59) on the Request Completed! page (or from the email sent by the IRIS DMC after completion of your request; see Figure 56), a screen similar to that shown in Figure 60 will appear. Selecting each of the SAC format files will cause the file to be downloaded to your computer. Place in a **SAC Files** folder (or a sub-folder) within the AmaSeis folder on your computer.

WILBER II

[back to networks](#) [help](#)

Event: 1999/09/30 16:31:15.6 OAXACA, MEXICO  
 Mag: 7.5 Type: MW Lat: 16.06 Lon: -96.93 Depth: 60.60  
 Catalog: WHDF Contributor: HRV Source: FARM

**FILTER BY:**

**NETWORK**  
☐ ALL  
☐ II  
☐ IU

**CHANNEL**  
☐ ALL  
☐ BHE  
☐ BHN  
☐ BH2  
☐ BH1  
☐ BH2  
☐ BLE  
☐ BLN

**DISTANCE**  
 from 0 to 180 deg

**AZIMUTH**  
 from 0 to 360 deg

**DISTRIBUTE** ☐

**76 Responding Stations**  
 name.net (distance/azimuth)

<input type="checkbox"/>	<a href="#">JTS.II</a>	(12.99°/114°)
<input type="checkbox"/>	<a href="#">HKT.IU</a>	(13.87°/3°)
<input type="checkbox"/>	<a href="#">PAYG.IU</a>	(17.87°/157°)
<input type="checkbox"/>	<a href="#">DWPF.IU</a>	(18.68°/47°)
<input checked="" type="checkbox"/>	<a href="#">TUC.IU</a>	(20.49°/324°)
<input type="checkbox"/>	<a href="#">ANMO.IU</a>	(20.66°/337°)
<input type="checkbox"/>	<a href="#">WVT.IU</a>	(21.57°/20°)
<input checked="" type="checkbox"/>	<a href="#">CCM.IU</a>	(22.48°/11°)
<input type="checkbox"/>	<a href="#">PFO.II</a>	(24.81°/318°)
<input type="checkbox"/>	<a href="#">RSSD.IU</a>	(28.61°/349°)
<input type="checkbox"/>	<a href="#">SJG.IU</a>	(29.48°/81°)
<input type="checkbox"/>	<a href="#">SSPA.IU</a>	(29.54°/30°)
<input checked="" type="checkbox"/>	<a href="#">NNA.II</a>	(34.23°/143°)
<input type="checkbox"/>	<a href="#">FEC.II</a>	(38.78°/355°)
<input type="checkbox"/>	<a href="#">RPN.II</a>	(44.59°/195°)
<input type="checkbox"/>	<a href="#">LCO.IU</a>	(51.48°/150°)
<input checked="" type="checkbox"/>	<a href="#">KIP.IU</a>	(57.79°/285°)
<input type="checkbox"/>	<a href="#">KDAK.II</a>	(58.48°/328°)

**TOOLS:**

**SORT BY**  
 Distance

**STATION MAP**  
 Plot

**RECORD SECTION**  
 Plot

**REQUEST DATA**  
[Below](#)

Figure 51. Station information for the Oaxaca event. Selected stations are checked and desired components are selected.

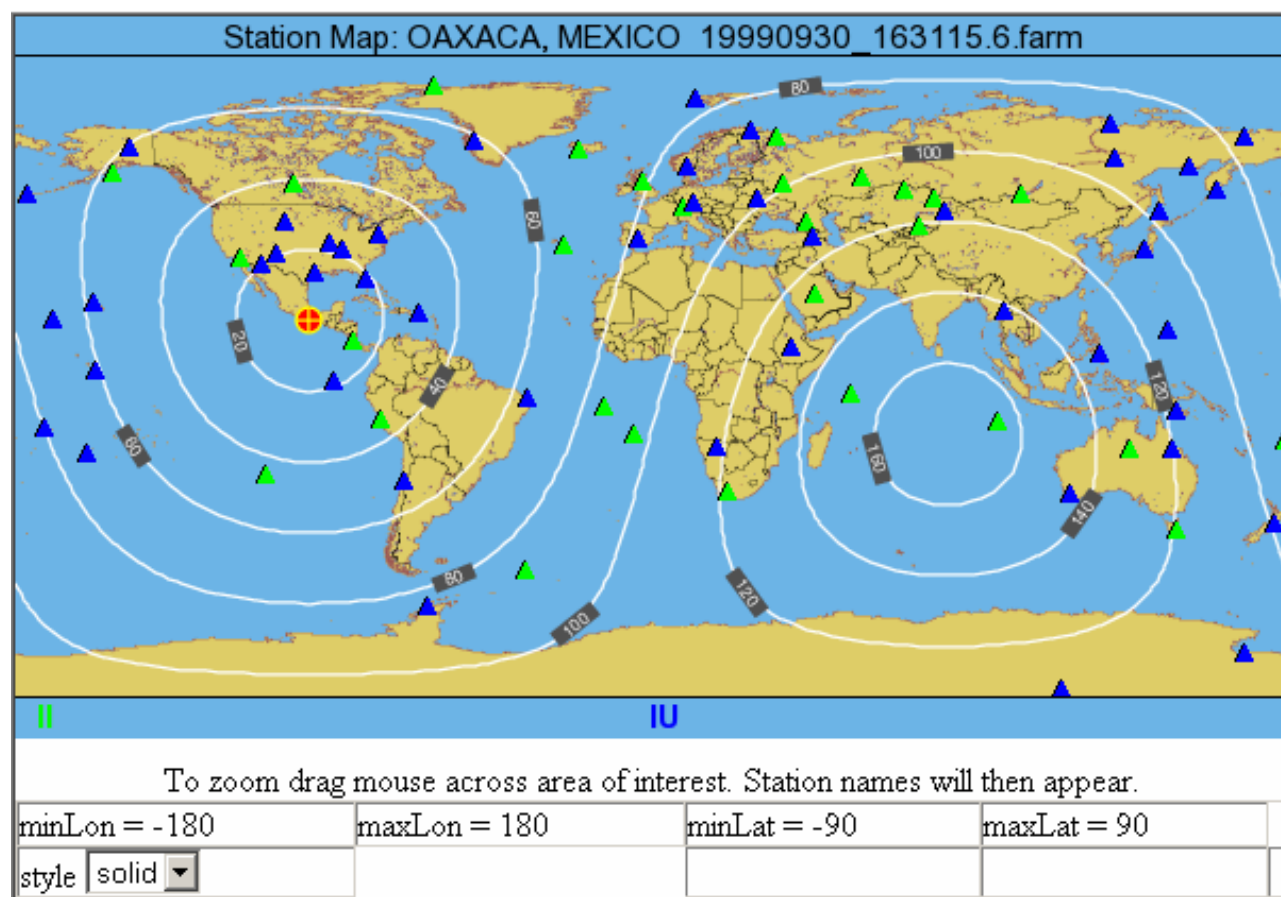


Figure 52. Station map generated by clicking on the **Station Map** box on the screen shown in Figure 51. The station map was generated with all the stations (II and IU networks) shown in screen on Figure 51 selected. The green triangles are II stations; the blue triangles are IU stations. The contours show distances (in degrees) from the Oaxaca earthquake epicenter (red circle).



Figure 53. Zooming in on the station map (screen shown in Figure 52) by dragging the cursor from the upper left to the lower right of the area of interest generate the map shown here. The station names identify GSN seismograph stations within the selected area. The contours show distances (in degrees) from the Oaxaca earthquake epicenter (red circle). The stations of interest for the S minus P location example described here are TUC, CCM, NNA and KIP.

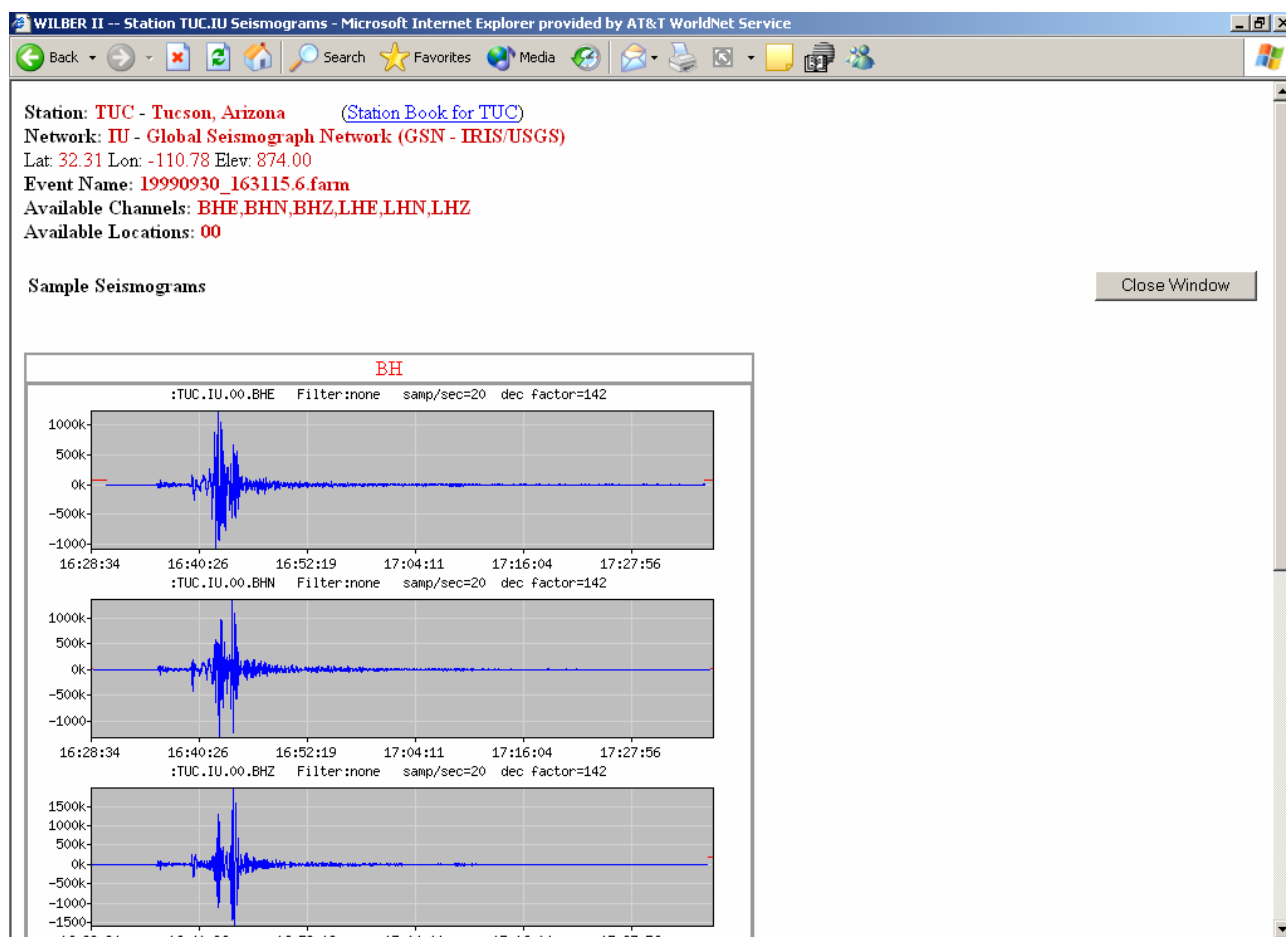


Figure 54. Seismograms (displayed from the station link on the screen illustrated in Figure 51) for the TUC station for the Oaxaca earthquake. Station and event information is provided at the top of the screen. The seismograms are broadband (BH) records for the East-West (E) horizontal component (top), North-South (N) horizontal component (middle), and vertical (Z) component (bottom).

FDSN Station Info - TUC - Microsoft Internet Explorer provided by AT&T WorldNet Service

Back Forward Stop Home Search Favorites Media Mail Print Print Setup

**FDSN Station Book** ? HOME BACK NEXT LOOK

---

## TUC - Tucson, Arizona

**INFORMATION for TUC as of February 1994**

**Station:** Tucson, Arizona (UTC-7)

**Director:** Dr. Terry Wallace      **Network Affiliation:** IRIS/USGS  
- GSN

**Address:**      **Network Contact:**  
University of Arizona      Albuquerque Seismic Laboratory  
Department of Geosciences      Building 10002 Kirtland AFB East  
Gould/Simpson Bldg. #77, Rm 208      Albuquerque, NM 87115  
Tucson, Arizona 85721

**Telephone:** 602 621-4849      **Open Station:** Yes  
Phone #602 621-1733

**Fax:** 602 621-2672      **Parent Organization:**  
University of Arizona

**Email:**

**Coordinates:**  
Latitude: 32.3096N      Elevation to Sensor (M): 874  
Longitude: 110.7846W      Depth to Sensor (M): 0

**Geology:** Seismometers are located in foothills of the Santa Catalina mountains on granite.

**Vault Conditions:** Vault is located in a small building which is well insulated against the summer heat. Piers are isolated from the floor and attached to bedrock. No air conditioners were in use during installation. Temperature variation in the vault is unknown.

**Site Description:** N/A

Figure 55. Station book information for the TUC seismograph station (from the link shown at the top of the screen shown in Figure 54).

1. Select NETWORK(s), CHANNEL(s) and station checkboxes to compose your data request.

Use [Apply Filter](#) button to verify data availability and to select by distance, azimuth and interval ranges.  
Click on the underlined station names to view sample seismograms and station detail.  
Change the sorting order of the list using the SORT BY popup.  
RESPONDING STATIONS map currently shows all stations.  
RECORD SECTION plot operates on the currently selected stations and the selected channel.  
Note that Javascript must be enabled for WILBER to work.

2. Select data format, time window and user identification here:

**Available Data Formats**

- SEED (default)
- miniSEED
- SAC BINARY individual files**
- SAC BINARY tar file
- SAC BINARY gzipped tar file
- SAC BINARY compressed tar file
- SAC ASCII individual files
- SAC ASCII tar file
- SAC ASCII gzipped tar file
- SAC ASCII compressed tar file

Data formats [help](#)

**Time Window Data**

2 (default)

1

3

minutes before P

and

10 (default)

20

30

minutes after P

**Personal Information**

User Name\*

Request Label\*

Email Address

☒ Notify me through email when complete

\* = required fields

3. Click button to process request.

Internet

Figure 56. Illustration of data format and time request for seismograms to download from the IRIS DMC using WILBER II. These dialog boxes are located at the bottom of the station selection screen shown in Figure 51. For use with the AmaSeis viewer, select **the SAC BINARY individual files** format. The time range can also be selected. For the example used here, the beginning time is set at one minute before the P arrival and the end time is set to 20 minutes after the P arrival. The **Personal Information** is entered for tracking the data request and notification of completion of the request. After completing the selections, click on **Process Request** to submit.

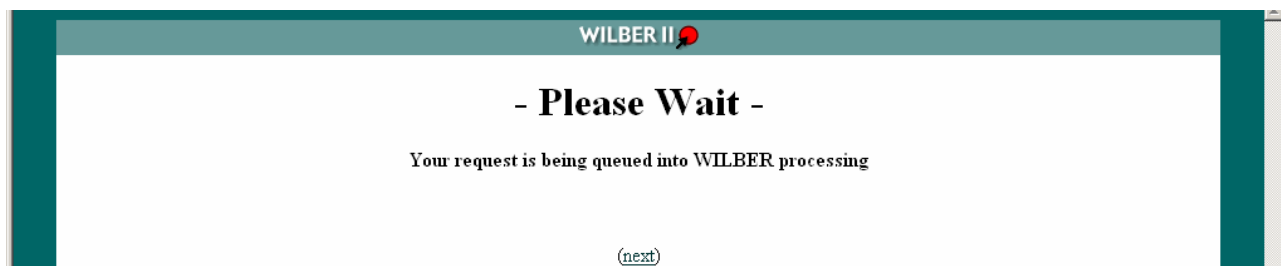


Figure 57. WILBER II screen that appears after data request has been submitted.

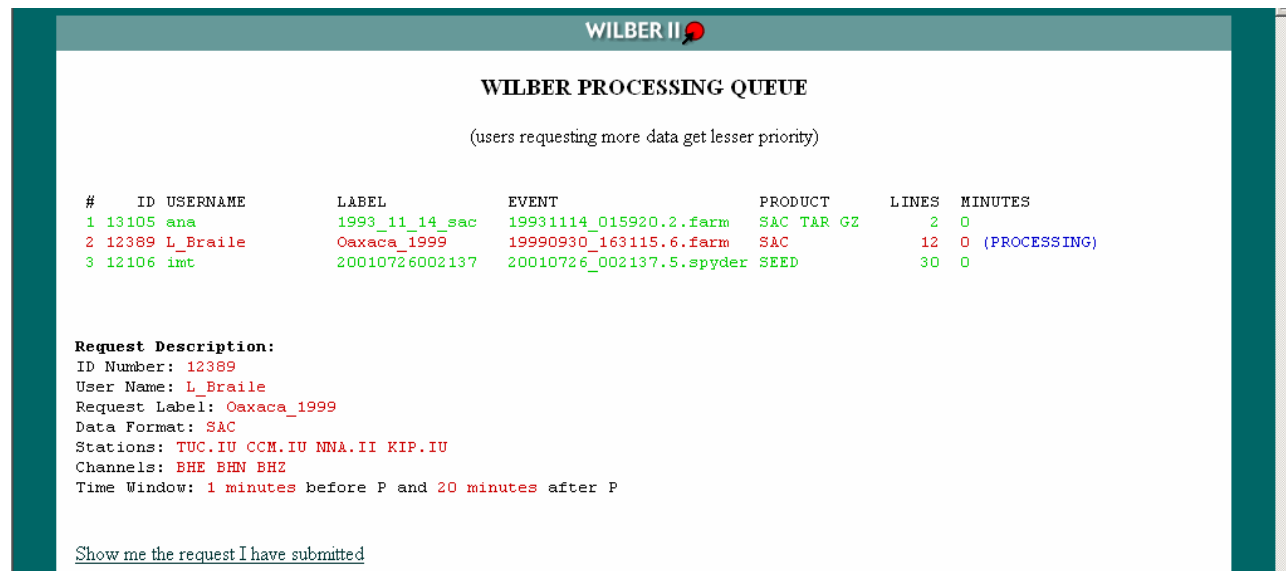


Figure 58. WILBER II screen that indicates data request progress.

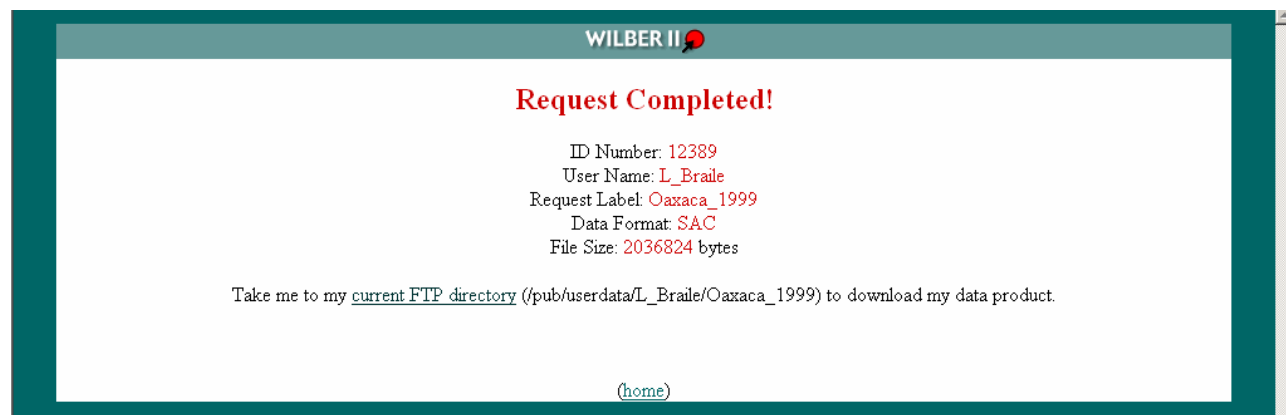


Figure 59. WILBER II screen that indicates that the data request was completed. If requested (Figure 56), and email will also be sent notifying the requestor that the data request has been completed.

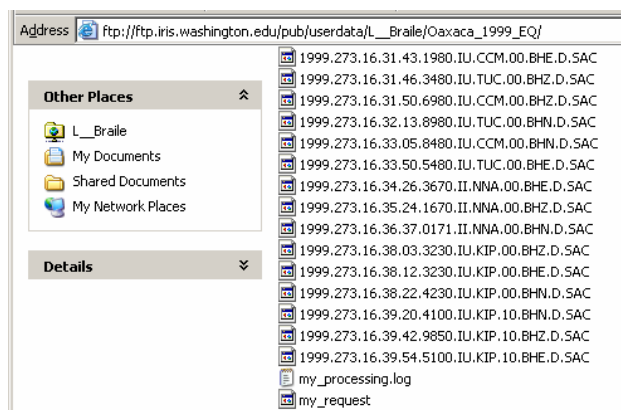


Figure 60. WILBER II ftp screen showing seismograms in the data request, in this case, 3 seismograms (3 components) for each of 4 stations.



**5.4 Viewing the seismograms downloaded from WILBER II using AmaSeis:** To view the seismograms that have been downloaded from WILBER II, start AmaSeis and click on **Open** from the **File** pull-down menu and navigate to the SAC Files folder (or a sub-folder that contains the seismogram files). Select a sac file to view and click on **Open** in the dialog box (similar to that shown in Figure 41). The seismogram will appear in the AmaSeis Event screen just the like extracted seismogram shown in Figure 15 or the seismogram downloaded from SpiNet shown in Figure 42. The seismograms can be viewed individually or, by selecting three seismograms corresponding to the 3 components for a single station, AmaSeis will display the three seismograms on a single screen (Figure 61). To select two or three seismograms for display on the same screen, hold down the **Ctrl** key while making the selections. The multiple seismogram display is useful for viewing the waveforms corresponding to various arrivals such as P, S and surface waves.

The three seismogram display can also be used to display seismograms from three different stations as long as the start times of the seismograms are not too different. For example, Figure 62 shows seismograms for the September 24, 2004 M5.9 Gulf of California earthquake recorded in Arizona (THAZ), Indiana (WLIN) and North Carolina (NLHS). These seismograms are available at the [SpiNet](#) website. Information about the stations can be found at SpiNet. Because of the different distances of the stations from the epicenter, the seismograms look quite different even though they are all from the same event. Note the different amplitude scales on the left hand axis. The differences in amplitude between stations is due to the distance of propagation (energy spreading out as the waves propagate from the source).

The downloaded (WILBER II) seismograms from the Oaxaca earthquake can be viewed and analyzed in AmaSeis. For example, opening the TUC vertical component (Z) seismogram results in the view shown in Figure 63. We can zoom in on the seismogram to better see the characteristics of the P, S and surface wave arrivals (Figure 64 and 65). The P and S arrivals are distinctly visible on the seismogram shown in Figure 65. The P arrival is at about 16:36:23 and the S arrival is at about 16:40:12. These times can be read from the AmaSeis screen using the cursor. The AmaSeis travel time curve tool can also be used to infer the epicenter-to-station distance as shown in Figure 66 as described in section [3.6](#) above. The complete S minus P



location procedure for this event is described in section 2.3 of the Accessing earthquake data document (<http://web.ics.purdue.edu/~braile/edumod/eqdata/eqdata.htm>).

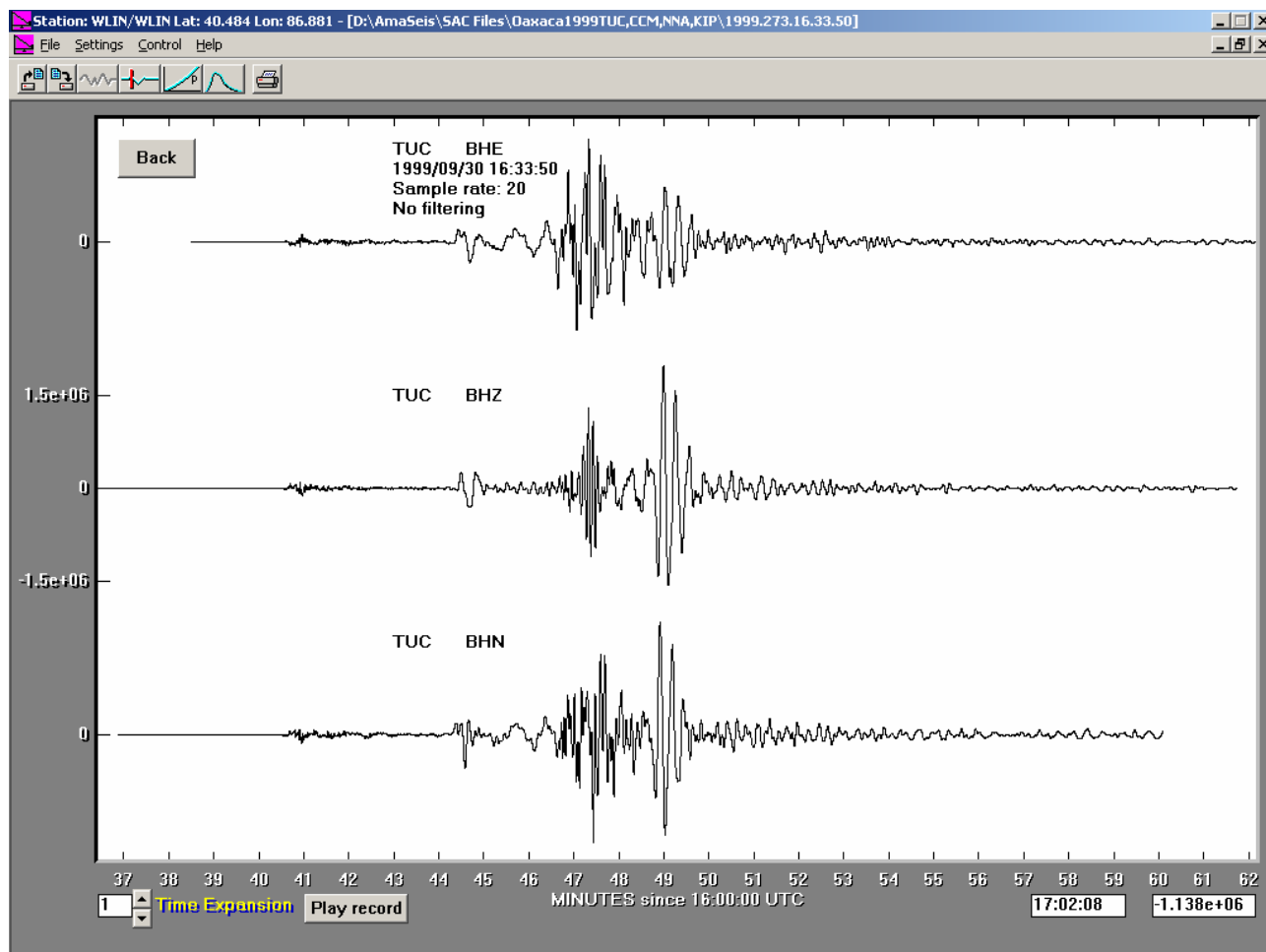


Figure 61. Illustration of three component seismogram (E, Z and N components for the TUC station for the Oaxaca earthquake) display in AmaSeis.



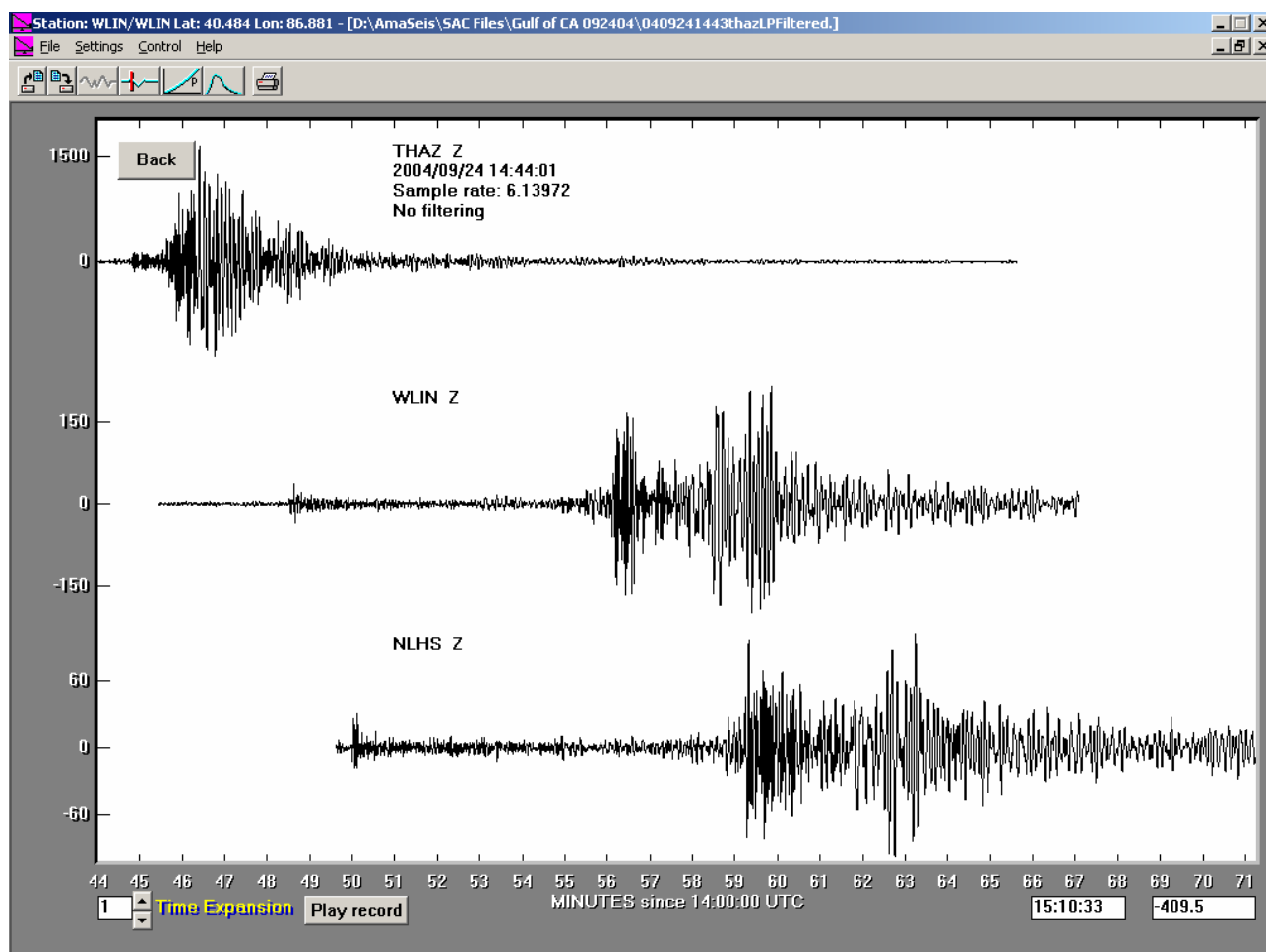


Figure 62. Three seismograms (AS-1 stations NLHS, WLIN, and THAZ downloaded from SpiNet) for the September 24, 2004 M5.9 Gulf of California earthquake. Seismograms are plotted at the correct times. Amplitude scales (in counts) for each seismogram are shown on the vertical axis. Seismograms were low pass filtered (filter cutoffs 0 to 1 Hz).

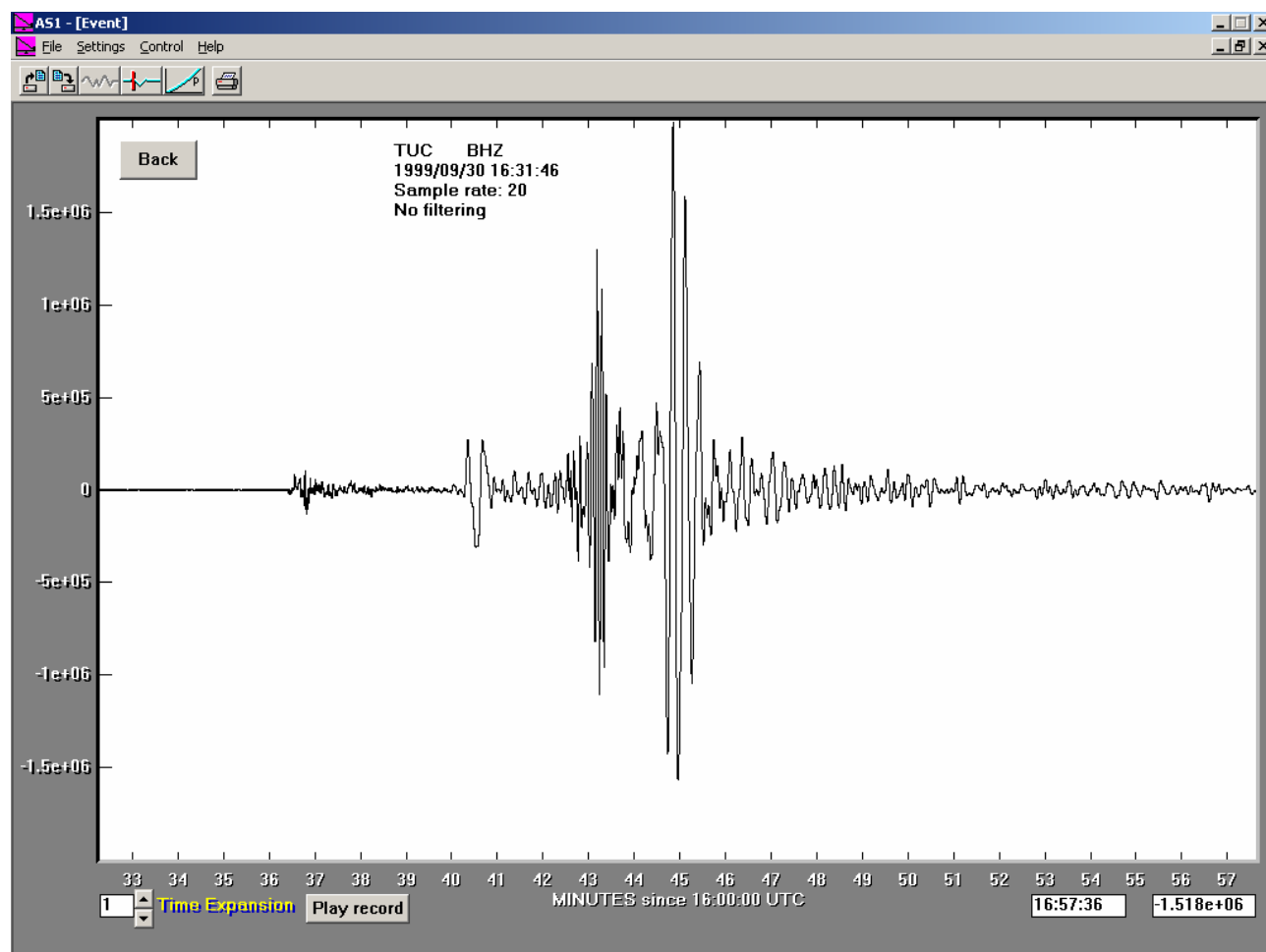


Figure 63. Vertical (Z) component seismogram for the TUC station for the Oaxaca earthquake as viewed in AmaSeis.

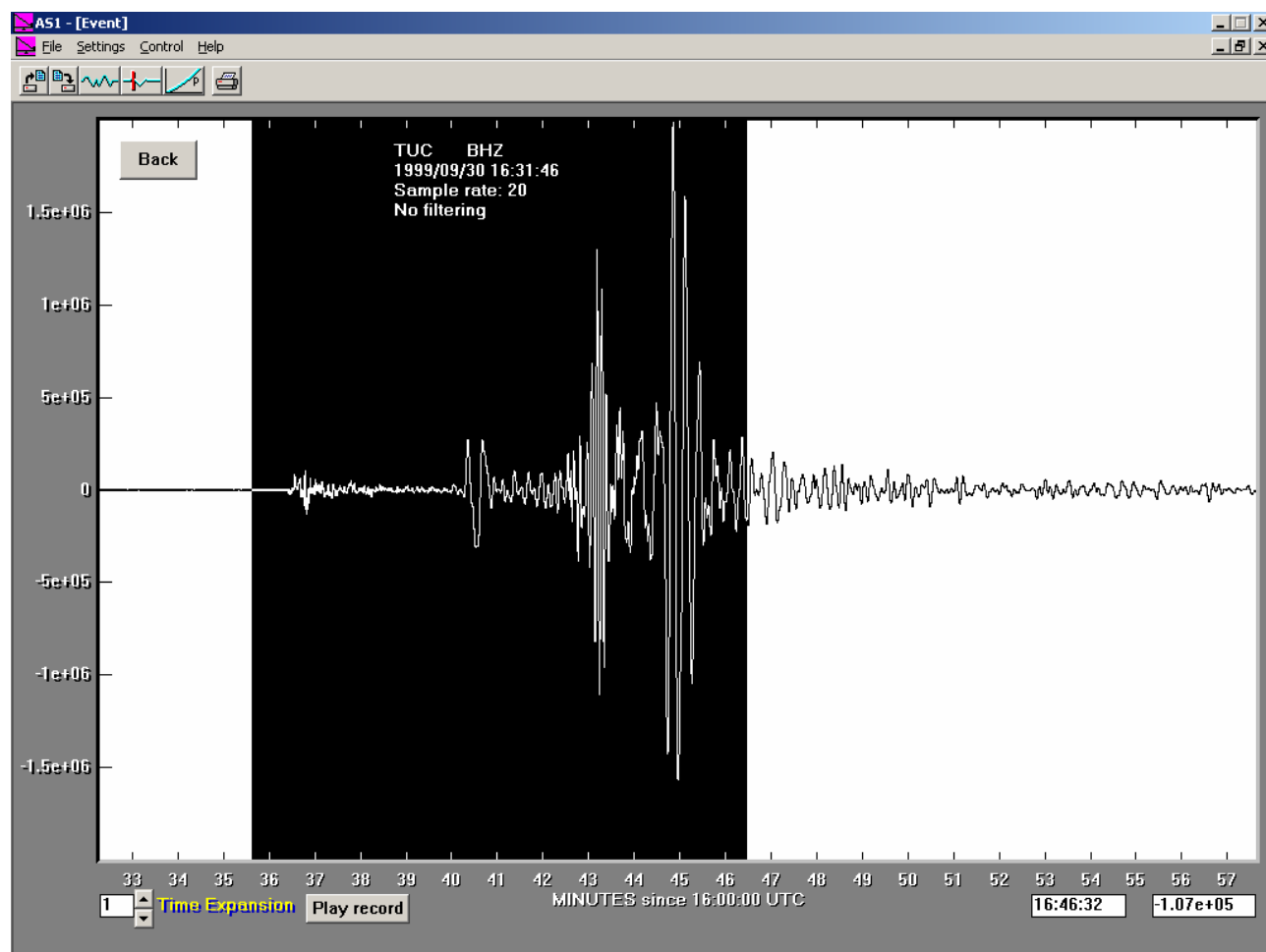


Figure 64. Zooming in on the P, S and surface wave arrivals for the TUC vertical component seismogram

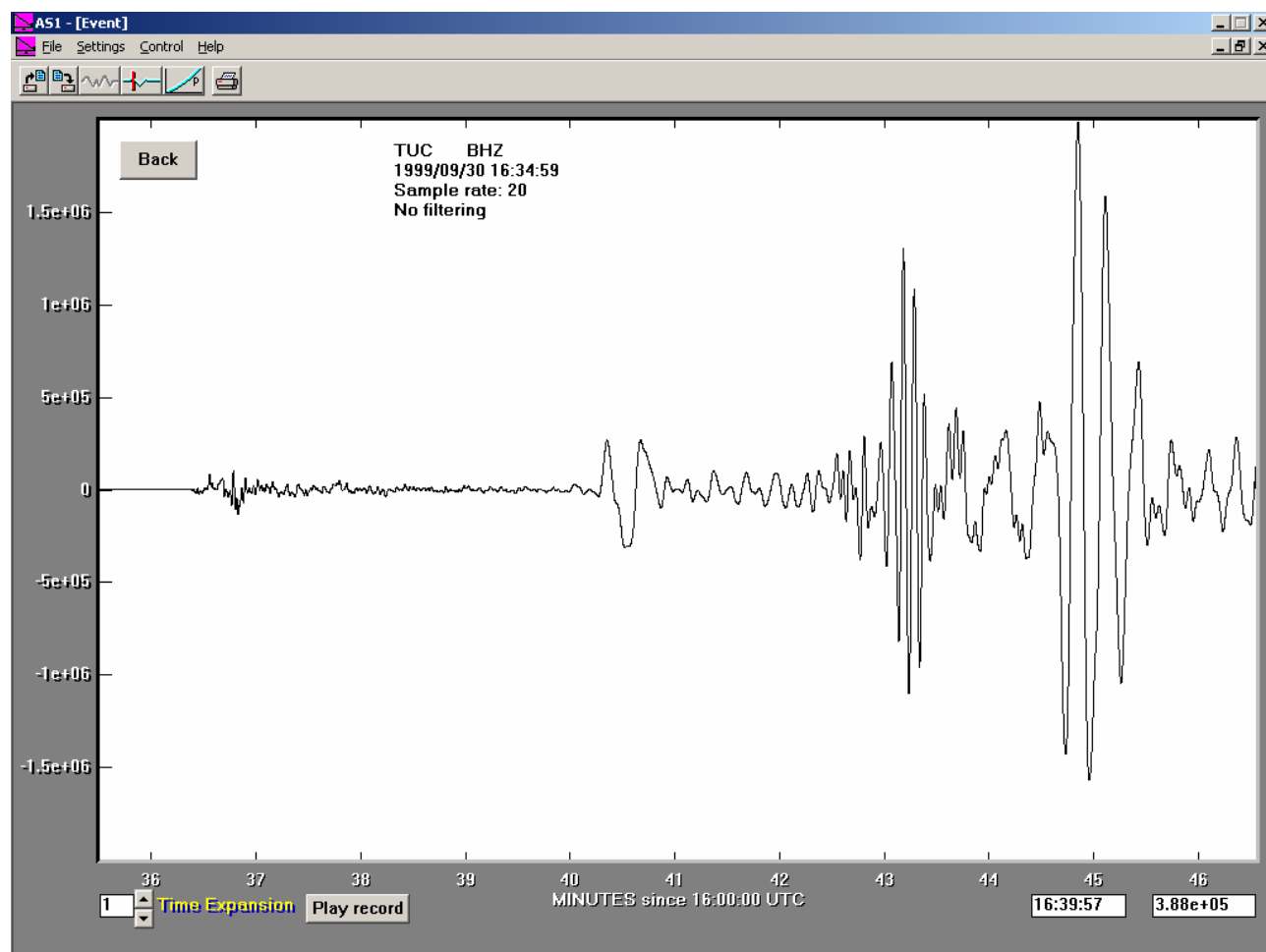


Figure 65. TUC vertical component seismogram after zooming in as shown in Figure 63.

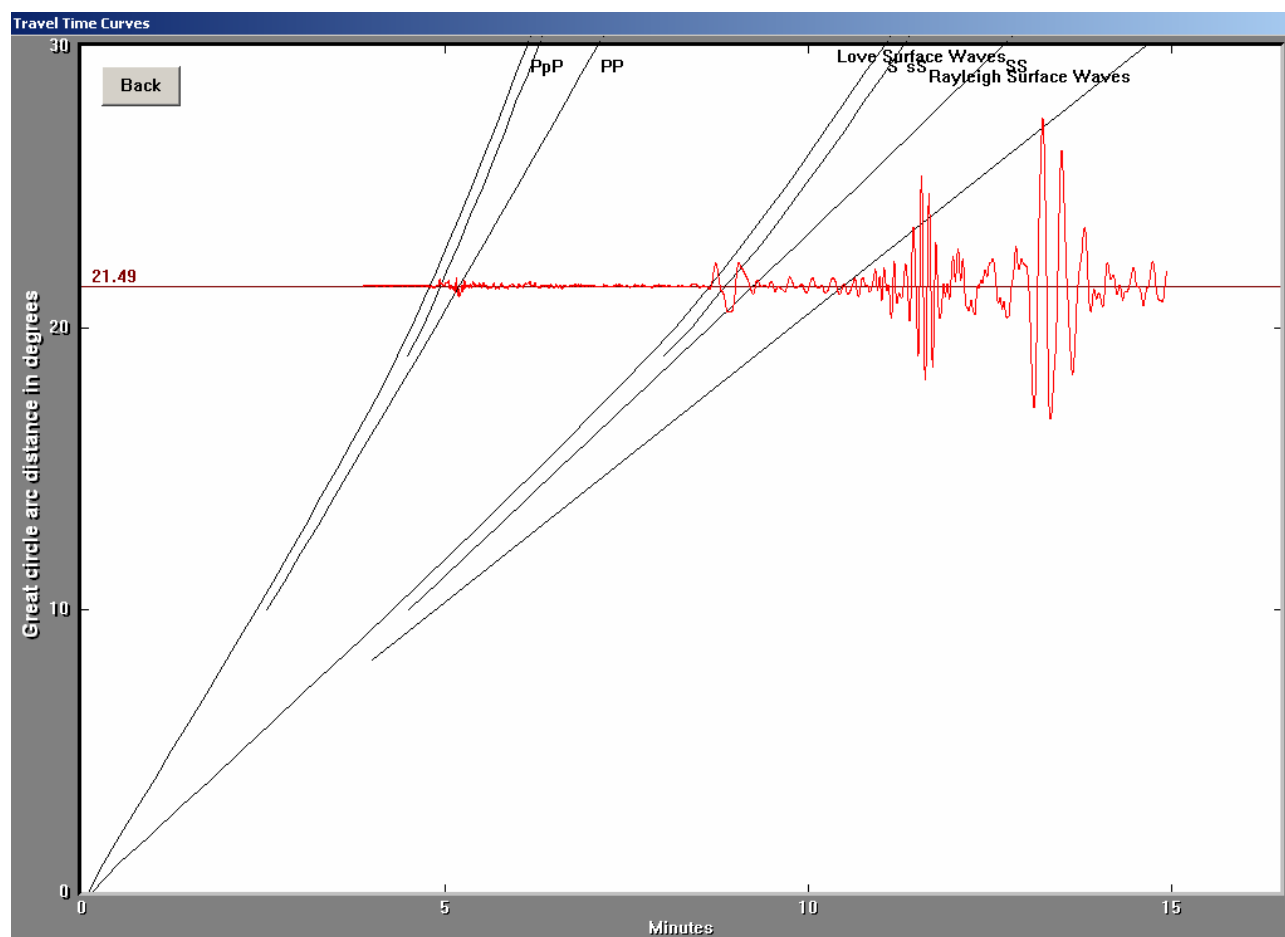


Figure 66. The vertical component TUC seismogram aligned on the standard Earth travel time curves. The seismogram is positioned so that the first P arrival and the first S arrival match the P and S travel times. The inferred epicenter-to-station distance is about 20.5 degrees (2279 km).



**6. Downloading preassembled data sets:** Seismograms for preassembled data sets can be downloaded to your computer (place in the **SAC files** folder in your **AmaSeis** folder) and then opened using AmaSeis (see section 3.3 for information about saving seismograms in SAC format and opening downloaded or saved SAC format seismograms). The pre-assembled data sets can be used for viewing seismograms from different earthquakes at different distances, experimenting with AmaSeis features such as filtering, zooming in, comparing arrivals with the travel time curves to identify phases, and S minus P location. The AS-1 seismograms can also be used to determine magnitudes using the AS-1 Magnitude Calculator ([MagCalc](#)). Earthquake location using the S minus P method can be displayed using the online mapping tool in the IRIS Event Search website. Instructions are available at:

<http://web.ics.purdue.edu/~braile/edumod/eqdata/eqdata.htm> (see section 2).

Additional instructions are included in the IRIS Event Search web pages at:

<http://www.iris.edu/quakes/eventSearchInstructions.htm>.

Some preassembled data sets are provided below:

**6.1 M7.5 September 30, 1999 Oaxaca, Mexico earthquake recorded at GSN stations CCM (Cathedral Caves, MO), TUC (Tucson, AZ), NNA (Nana, Peru), and KIP (Kipapa, HI) – click on the SAC files below to download (useful for S minus P location exercise; see example in: <http://web.ics.purdue.edu/~braile/edumod/eqdata/eqdata.htm>, section 2):**

[CCM.00.BHZ.D.SAC](#), [TUC.00.BHZ.D.SAC](#), [NNA.00.BHZ.D.SAC](#), [KIP.00.BHZ.D.SAC](#)

Station coordinates (degrees latitude, degrees longitude): CCM: 30.056, -91.245; TUC: 32.310, -110.785; NNA: -11.987, -76.842; KIP: 21.423, -158.015.

Earthquake epicenter (degrees latitude, degrees longitude): 16.01, -96.93.

Suggested map area (latitude and longitude range, in degrees; for IRIS Event Search and S minus P location map): -15 to 55, -165 to -65.

**6.2 M6.5 September 22, 2003 Dominican Republic earthquake recorded at GSN station SJG (San Juan, Puerto Rico), and AS-1 stations ECK (Eckard College, FL), WLIN (West Lafayette, IN), and BCMA (Boston College, MA) – click on the SAC files below to download (useful for S minus P location exercise and magnitude calculations using [MagCalc](#) for the AS-1 seismograms):**

[03092204SJG.00.BHZ.R.SAC](#), [03092204eck.sac](#), [03092204WLIN.sac](#), [03092204BCMA.sac](#)

Station coordinates (degrees latitude, degrees longitude): SJG: 18.112, -66.150; ECK: 27.750, -82.670; WLIN: 40.484, -86.881; BCMA: 42.335, -71.171.

Earthquake epicenter (degrees latitude, degrees longitude): 19.675, -70.666.

Suggested map area (latitude and longitude range, in degrees; for IRIS Event Search and S minus P location map): 10 to 50, -100 to -55.

**6.3 M5.0 June 18, 2002 Evansville, IN earthquake recorded at GSN stations CCM (Cathedral Cave, MO) and WCI (Wyandotte Cave, IN), AS-1 station WLIN (West Lafayette, Indiana), and PEPP station PPNVW (Northview High School, Brazil, IN) – click on the SAC files below to download (useful for S minus P location exercise and magnitude calculations (for the mbLg magnitude) using [MagCalc](#) for the AS-1 seismogram):**

[CCM.BHZ.D.SAC](#), [WCI.BHZ.D.SAC](#), [WLIN.AS1.SAC](#), [PPNVW.BHZ.Short.sac](#)

Station coordinates (degrees latitude, degrees longitude): CCM: 30.056, -91.245; WCI: 38.229, -86.294; WLIN: 40.484, -86.881; PPNVW: 39.518, -87.166.

Earthquake epicenter (degrees latitude, degrees longitude): 37.987, -87.778.

Suggested map area (latitude and longitude range, in degrees; for IRIS Event Search and S minus P location map): 34 to 42, -92 to -82.



**7. Exporting seismograms to the Seismic Waves program:** The AmaSeis software can be used to export AS-1 or other SAC-format seismograms to the **Seismic Waves** program (<http://www.geol.binghamton.edu/faculty/jones/>) for viewing the seismic wave arrivals in speeded up time, along with a simulation of seismic wave propagation through the Earth. The display can be

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used with one or more seismograms and is useful for illustrating seismic wave propagation concepts. Because seismograms that were recorded on classroom seismographs can be viewed in the Seismic Waves program, the display is also an interesting method for students and teachers to view “their” data.

**7.1 Exporting seismograms:** Seismograms can be opened and exported to Seismic Waves using AmaSeis. The AmaSeis software creates files with station and event coordinates, origin time and seismogram start times and moves the files and the seismograms to the Seismic Waves folder. We will utilize an example for the November 21, 2004, M6.3 Leeward Islands earthquake and three AS-1 seismograms (recorded at stations NLHS, WLIN and PCAZ) that were downloaded from the SpiNet website. After the seismograms were downloaded from SpiNet using the techniques described in section [4.1](#), above, the seismograms were opened one by one in AmaSeis (Figures 67-69) and the **Event Dialog** box opened from the **Settings** menu. In the Event Dialog box, enter the event name, in this case, Leeward Islands, the earthquake magnitude, origin time and location (latitude longitude and depth). Some information, including the seismogram start time will already be entered into the Event Dialog box from the SAC-format seismogram file. Be sure to check the earthquake origin time entry. If the AS-1 seismogram was recorded on a computer that has a clock that was synchronized to UTC time, no adjustment in the start time will be necessary. In the case of the NLHS and PCAZ seismograms, the start times had to be adjusted (time-corrected). For the NLHS seismogram, 57 seconds was subtracted from the start time that was read from the SAC-format seismogram. For the PCAZ seismogram, 48 seconds was added to the start time that was read from the SAC-format seismogram. These corrections were determined by calculating the theoretical arrival times of the first P arrival at each station (using the USGS online travel time tool, [http://neic.usgs.gov/neis/travel\\_times/](http://neic.usgs.gov/neis/travel_times/)) and comparing with the observed arrival times as measured using the AmaSeis arrival picking tool. This method assumes that the observed arrival time at the two stations should be equal to the theoretical arrival time calculated for a standard Earth velocity model.

After these data entries have been made in the Event Dialog box, enter the location and name of your Seismic Waves folder in the space provided at the bottom of the box. This location and name will usually be **C:\sw** (if the Seismic Waves program was installed on your computer using the default installation options) although in the example shown here, the name and location are **D:\seiswave**. To save a copy of the time corrected seismogram, click **OK** and then save the seismogram as a SAC file (using the **Save As** command as described in section [3.3](#), above). To export the seismogram to the Seismic Waves folder, click on **Create files for Seismic Waves**. Complete this process for one or more seismograms (as shown in Figures 67-69 for the Leeward Island earthquake and the NLHS, WLIN and PCAZ seismograms). Using this procedure, the AmaSeis software creates a folder and an event file in the Seismic Waves folder that are used while running the Seismic Waves program.

The three seismograms (AS-1 seismograms; SAC format) used in this example can be downloaded by clicking on the file names shown below. The seismograms are time corrected so that no time correction is needed in the Event Dialog boxes for exporting the seismograms to the Seismic Waves program. After the seismograms have been exported, the Seismic Waves program can be used to view them in speeded up time and simultaneously with a wave propagation simulation.

**Seismograms for the November 21, 2004 Leeward Islands earthquake:**

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[0411211147NLHS.sac](#), [0411211147WLIN.sac](#), [0411211149PCAZ.sac](#)

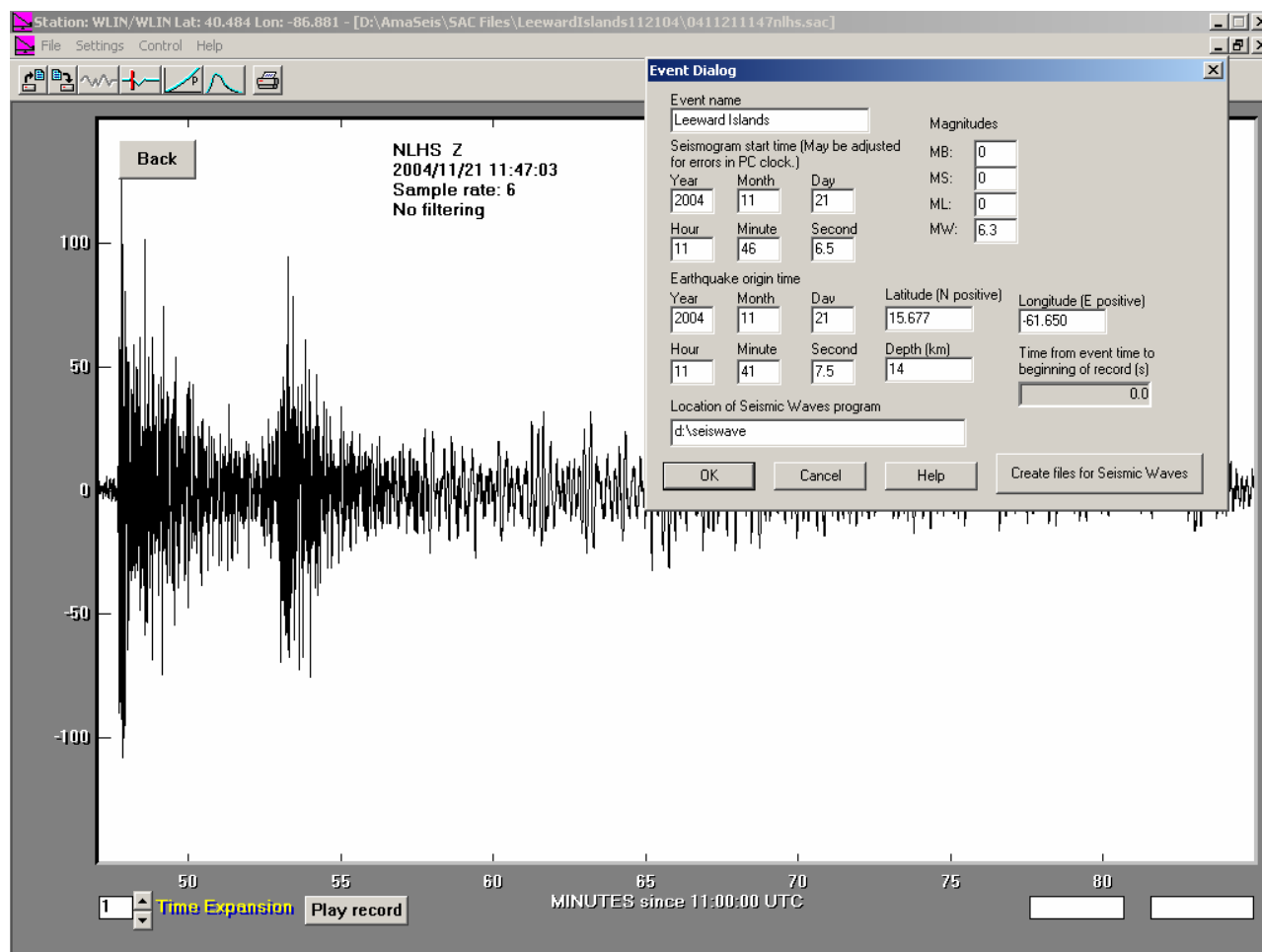


Figure 67. Seismogram for the Leeward Islands earthquake recorded by the AS-1 seismograph at NLHS, and **Event Dialog** box with earthquake and seismogram data.



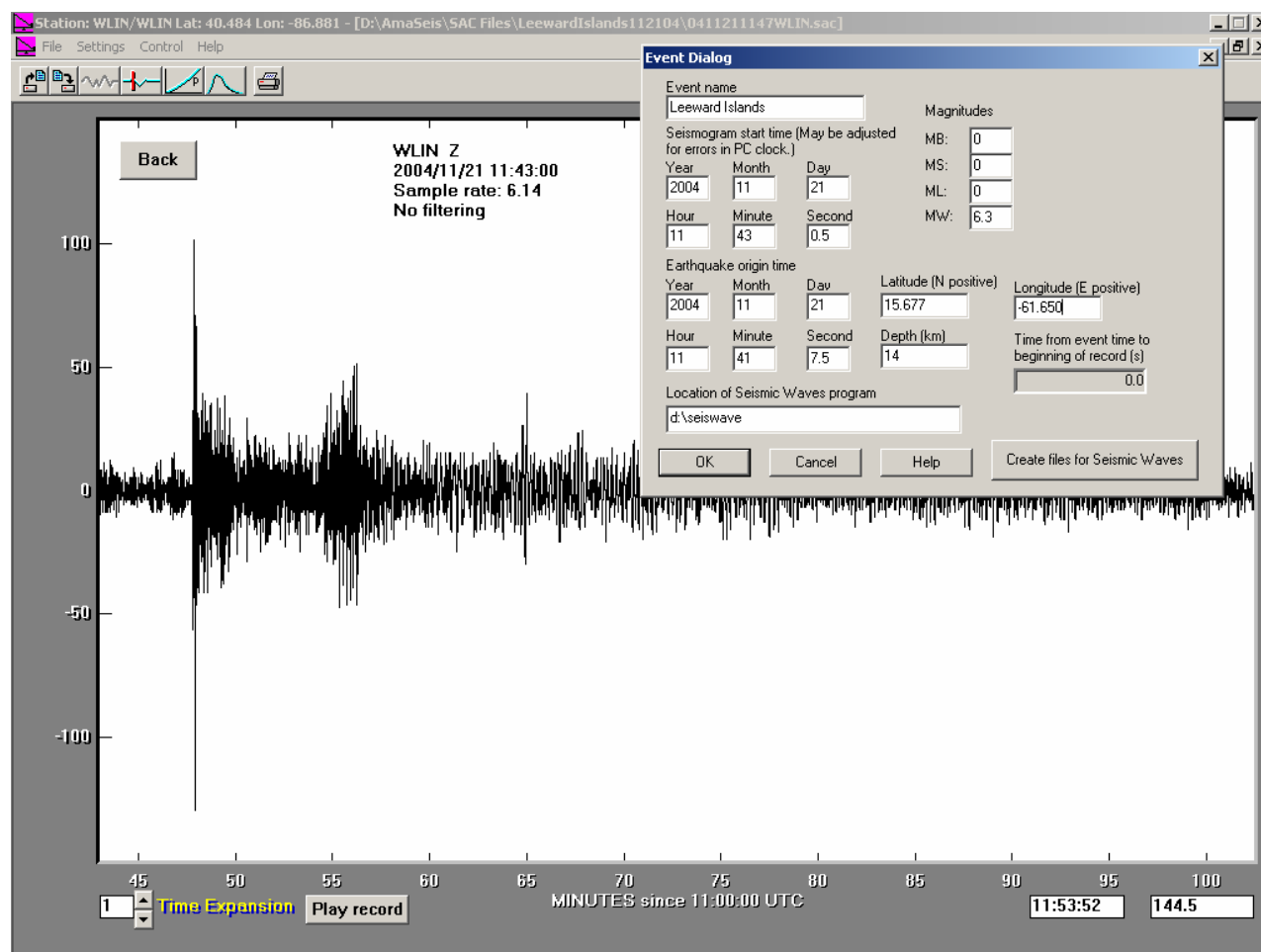


Figure 68. Seismogram for the Leeward Islands earthquake recorded by the AS-1 seismograph at WLIN, and **Event Dialog** box with earthquake and seismogram data.

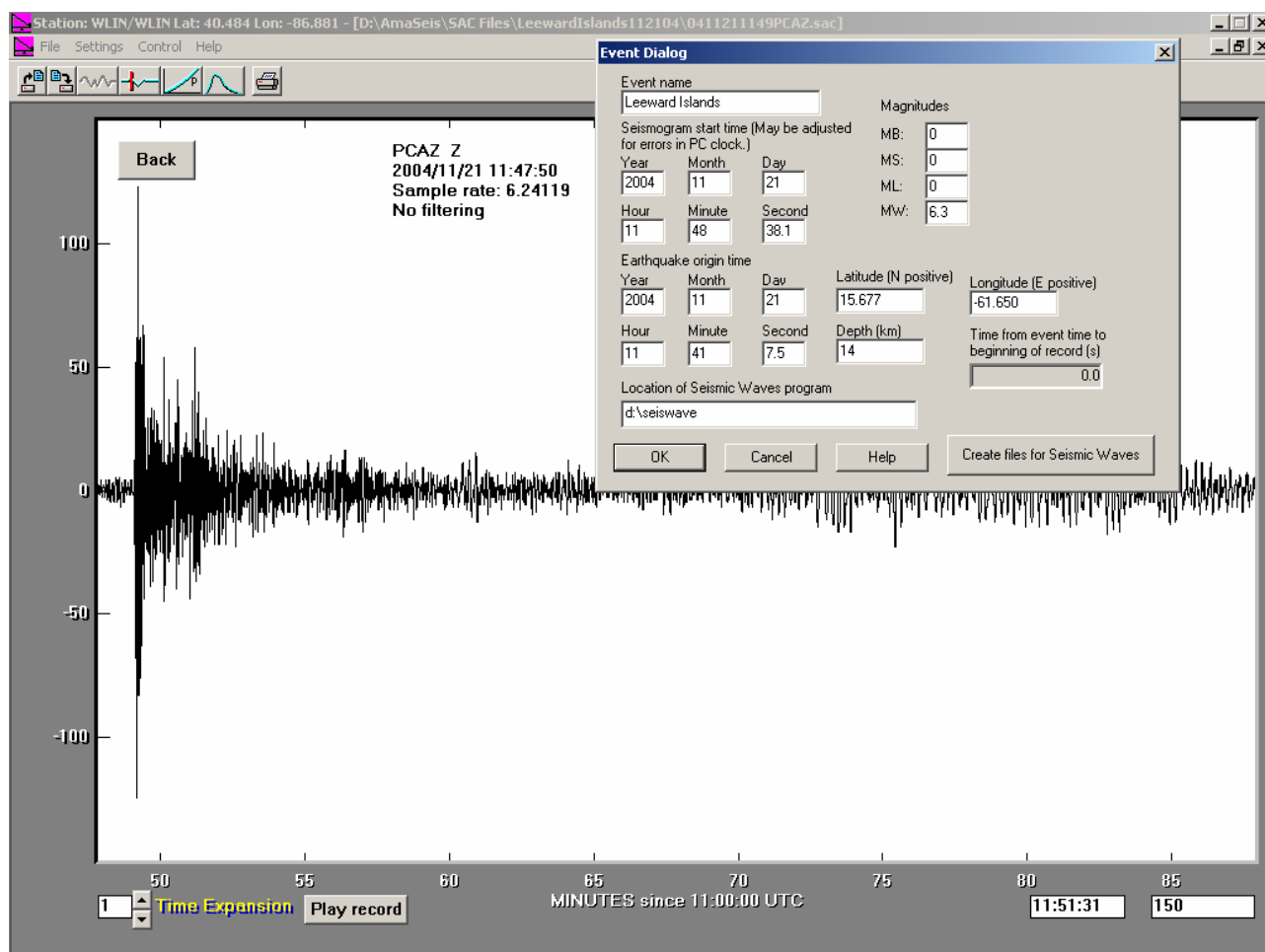


Figure 69. Seismogram for the Leeward Islands earthquake recorded by the AS-1 seismograph at PCAZ, and **Event Dialog** box with earthquake and seismogram data.



**7.2 Displaying the seismograms in Seismic Waves:** After new event information and associated seismograms have been exported to Seismic Waves, opening the Seismic Waves program results in a world map screen similar to that shown in Figure 70. Selecting the Leeward Islands event produces an **Event Information** dialog box as shown in Figure 71. In the **Event Information** dialog box, click on **Select Stations**. The station map shown in Figure 72 will appear. Click on each station (white dot) and the **Station Components** dialog box for that station will appear (Figure 73). Click on the selection box next to the Z (vertical) component then click on **OK**. The white dot on the station map will change to red indicating that the station has been selected. After all stations have been selected, click on the event epicenter on the station map to start the display of the seismograms and the seismic wave propagation simulation (Figures 74 and 75).

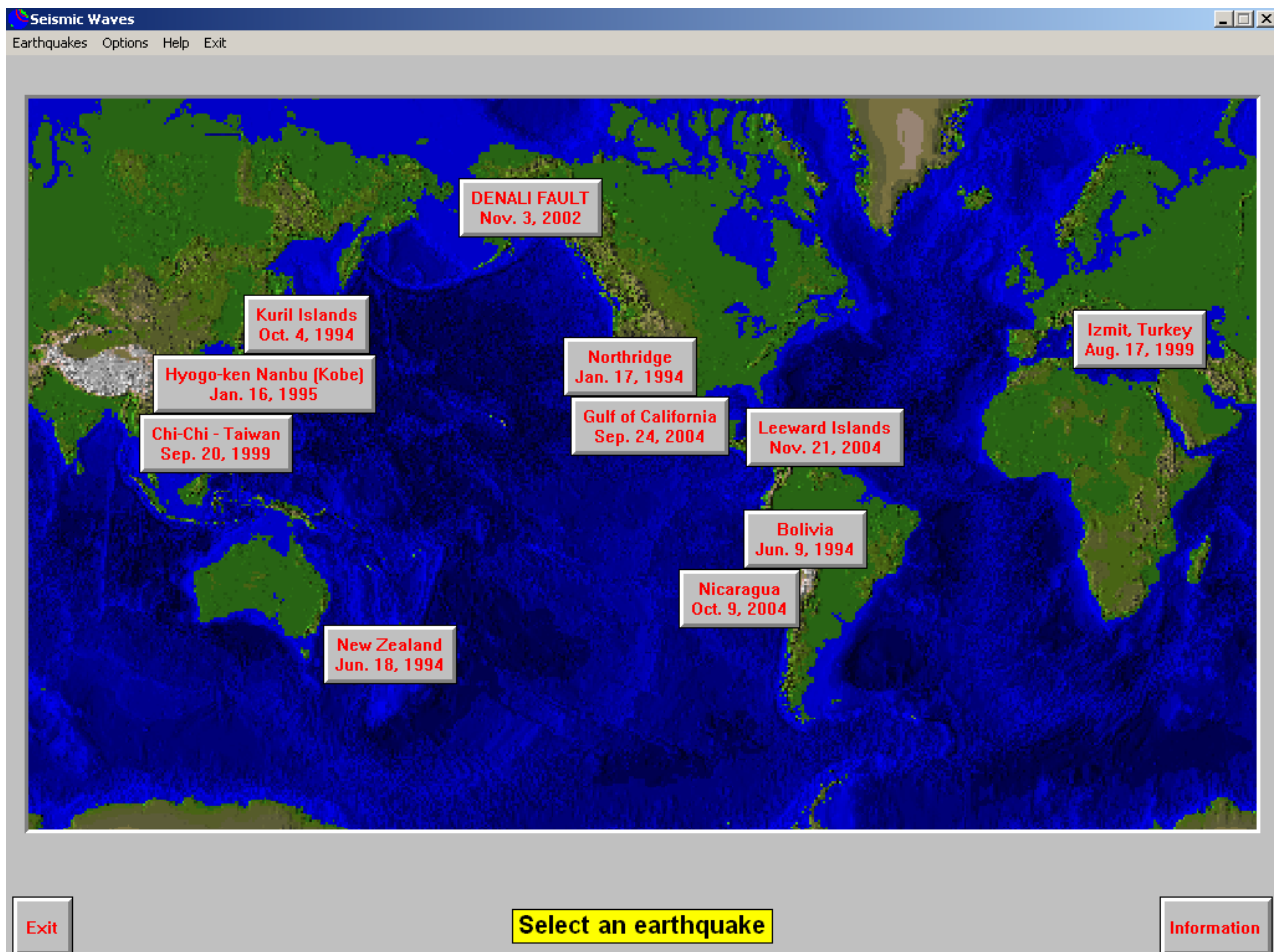


Figure 70. *Seismic Waves* world map display showing the earthquakes for which seismograms are available for viewing. Select an event to view seismograms and wave propagation simulation.

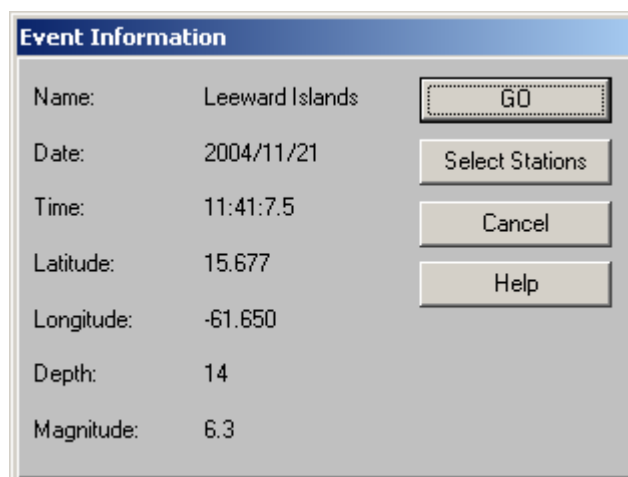


Figure 71. **Event Information** dialog box for the Leeward Islands earthquake. Click on **Select Stations** to display the map shown in Figure 72 and select the seismograms to include in the record section display. On subsequent runs of *Seismic Waves*, just select **GO**.

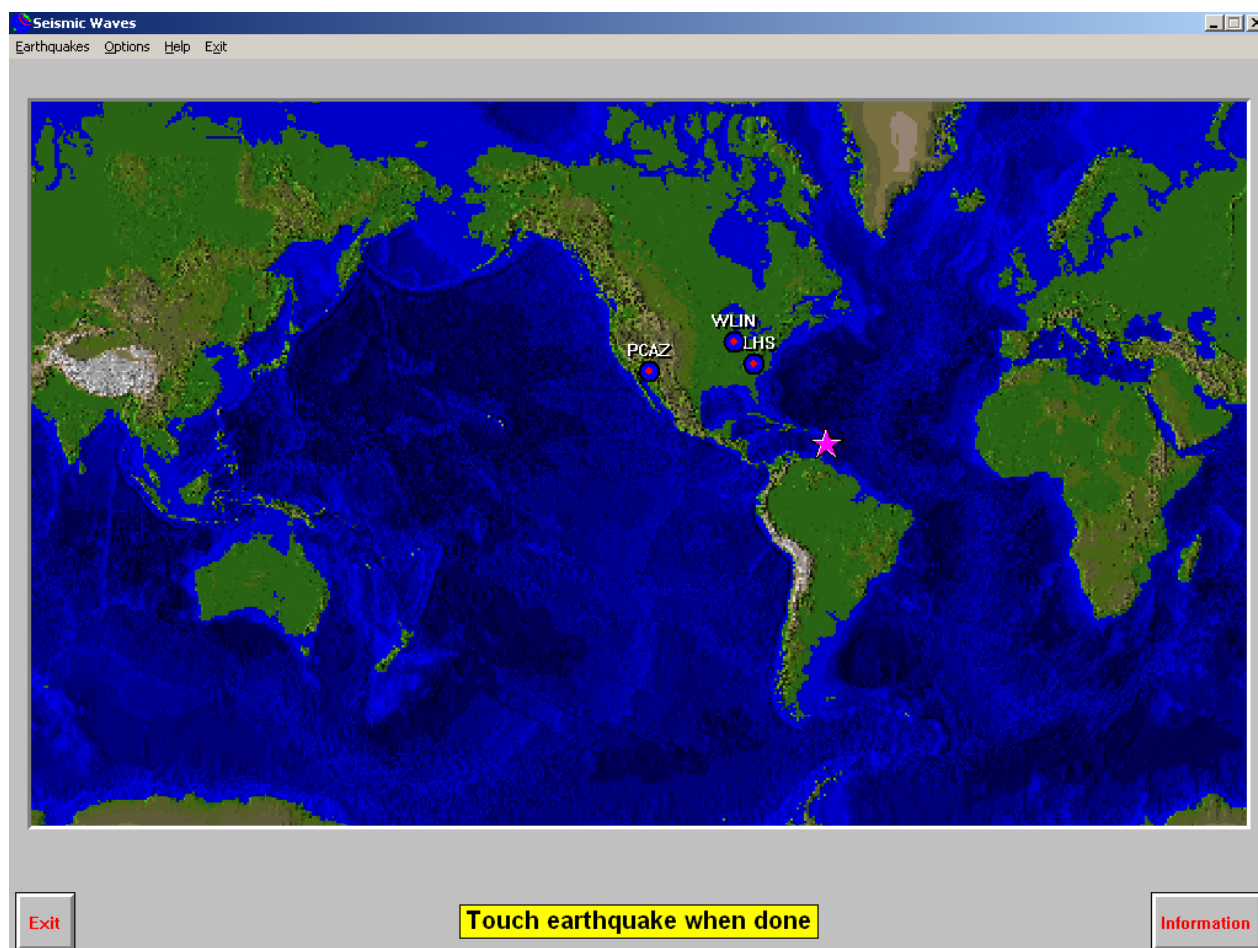


Figure 72. Station map for the Leeward Islands earthquake. Select each station (click on the dot next to the station names) to open the **Station Component** dialog box (Figure 73) and select the seismogram by identifying the component (Z for vertical, N-S for North-South horizontal or E-W for East-West horizontal). Click on the epicenter (star) to start the Seismic Waves display of seismograms and wave propagation simulation.

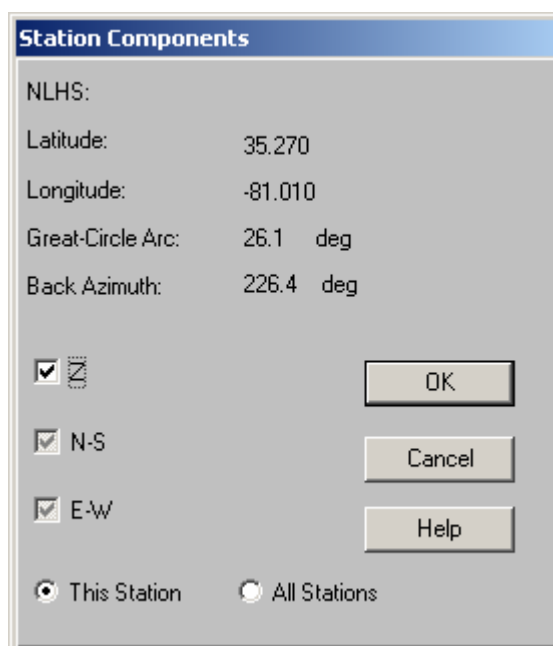


Figure 73. *Station Components* dialog box for the Leeward Islands earthquake and the NLHS station. Select the Z (vertical) component and click on **OK**.

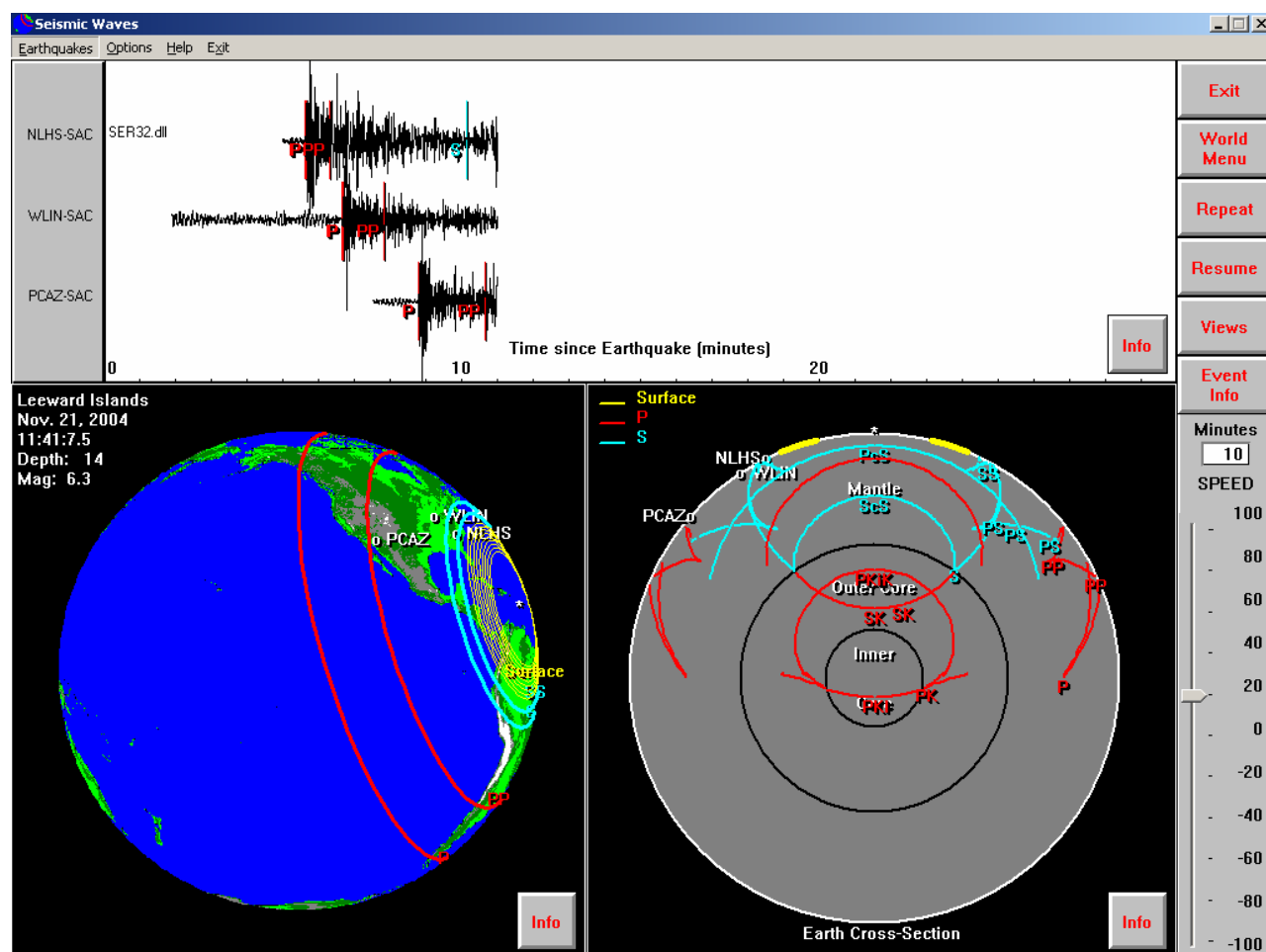


Figure 74. *Seismic Waves* Leeward Islands seismograms display and wave propagation simulations after about 10 minutes of wave propagation time. The speed of the playback can be

controlled using the slider to the right of the cross section display (set at 20 times real time playback speed for this example).

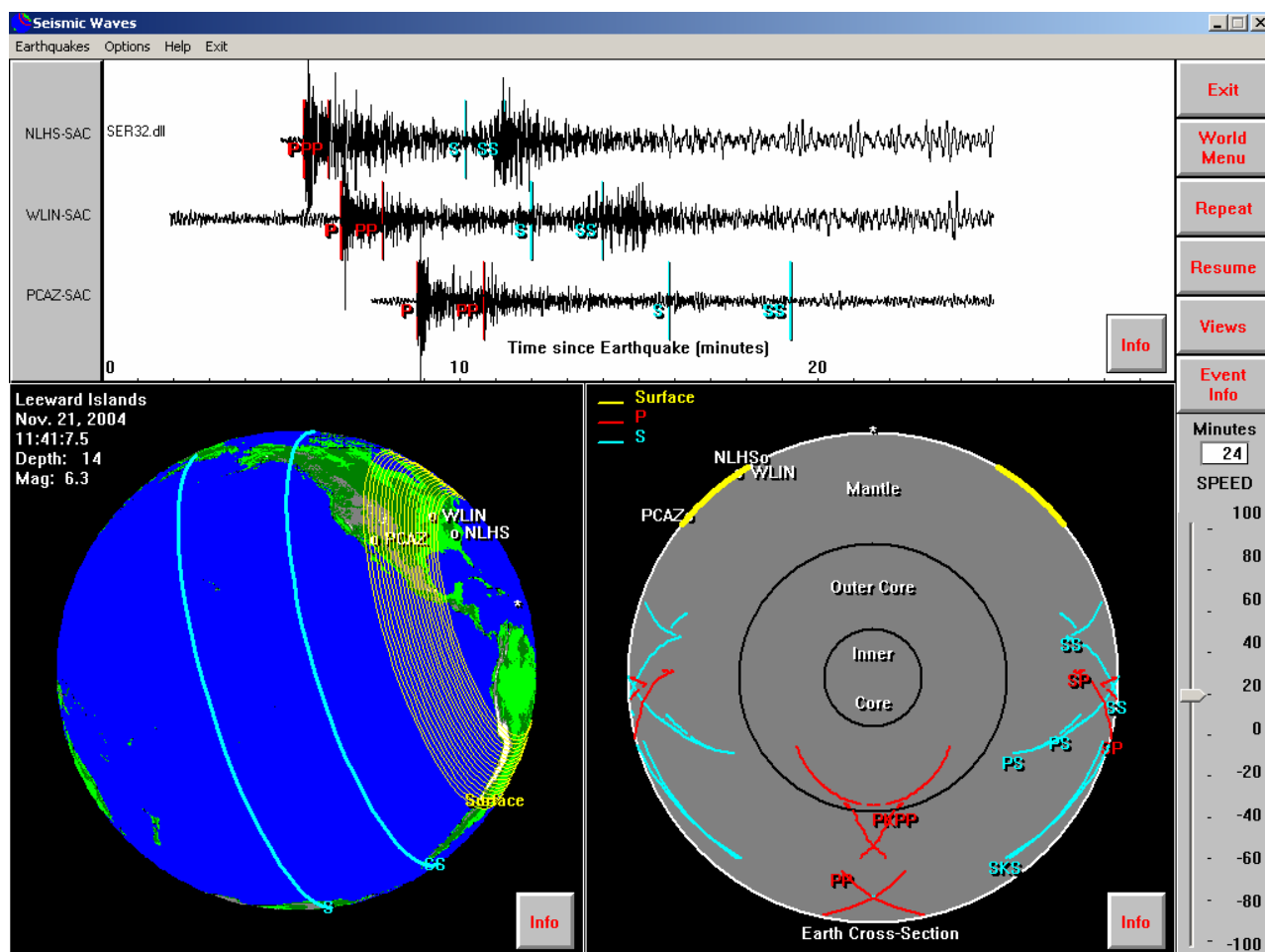


Figure 75. Seismic Waves Leeward Islands seismograms display and wave propagation simulations after about 24 minutes of wave propagation time.



## 8. Downloading the WLIN AS-1 2003.zip seismic data (and 2004 and 2005):

Download the 2003.zip file to provide sample seismic data for AmaSeis (**you do not need to have an AS-1 seismograph to utilize these data, only the AmaSeis software**). The file is zipped (compressed). The 2003 folder contains data recorded at the WLIN AS-1 seismograph station for September, 2003 and is about 15 MB in size (data for the following dates have been deleted to make the file easier to download: September 1, 3, 9-12, 14-17, 20, 23, 24, 26, and 28 – no significant events were recorded on those dates). Data are also available for the WLIN station for selected days in 2004 (November and December, 2004 [including the December 26, 2004 M9.0 Sumatra earthquake], only days with events, ~17MB) and 2005 (March through September, 2005, only days with events, ~46MB). An Excel file (the station catalog for AS-1 station WLIN with information on the earthquakes in the 2003.zip, 2004.zip and 2005.zip data sets) is also available at: <http://web.ics.purdue.edu/~braile/new/EarthquakeList.xls>.



To download the WLIN 2003 (or 2004 or 2005) folder click here: [2003](#) (or [2004](#) or [2005](#)) A **File Download** dialog box will appear. Click on **Save**. A **Save As** dialog box will appear. Save 2003.zip (or 2004.zip or 2005.zip) in the default location or navigate to another folder (it's convenient to place a "Downloads" folder on your desktop for these tasks) using the down arrow or the folder icon. Click on **Save**.

The 2003.zip file is compressed (zipped) using a program called WinZip. WinZip 8.1 (or higher) can be obtained at <http://www.tucows.com> (search for WinZip). It is shareware and you can use an evaluation version. Other zip programs can also be used and may already be on your computer. To unzip the 2003.zip (or 2004.zip or 2005.zip) file after download, double click on the 2003.zip (or 2004.zip or 2005.zip) file. (If you've previously installed the WinZip program, you should be able to simply right click with the mouse on the downloaded file [2003.zip, 2004.zip or 2005.zip] and select "Extract to..." to unzip the file and place it in your AmaSeis folder. This shortcut avoids the more lengthy procedure illustrated below.) The WinZip program will open a dialog box as shown below (Figure 76):

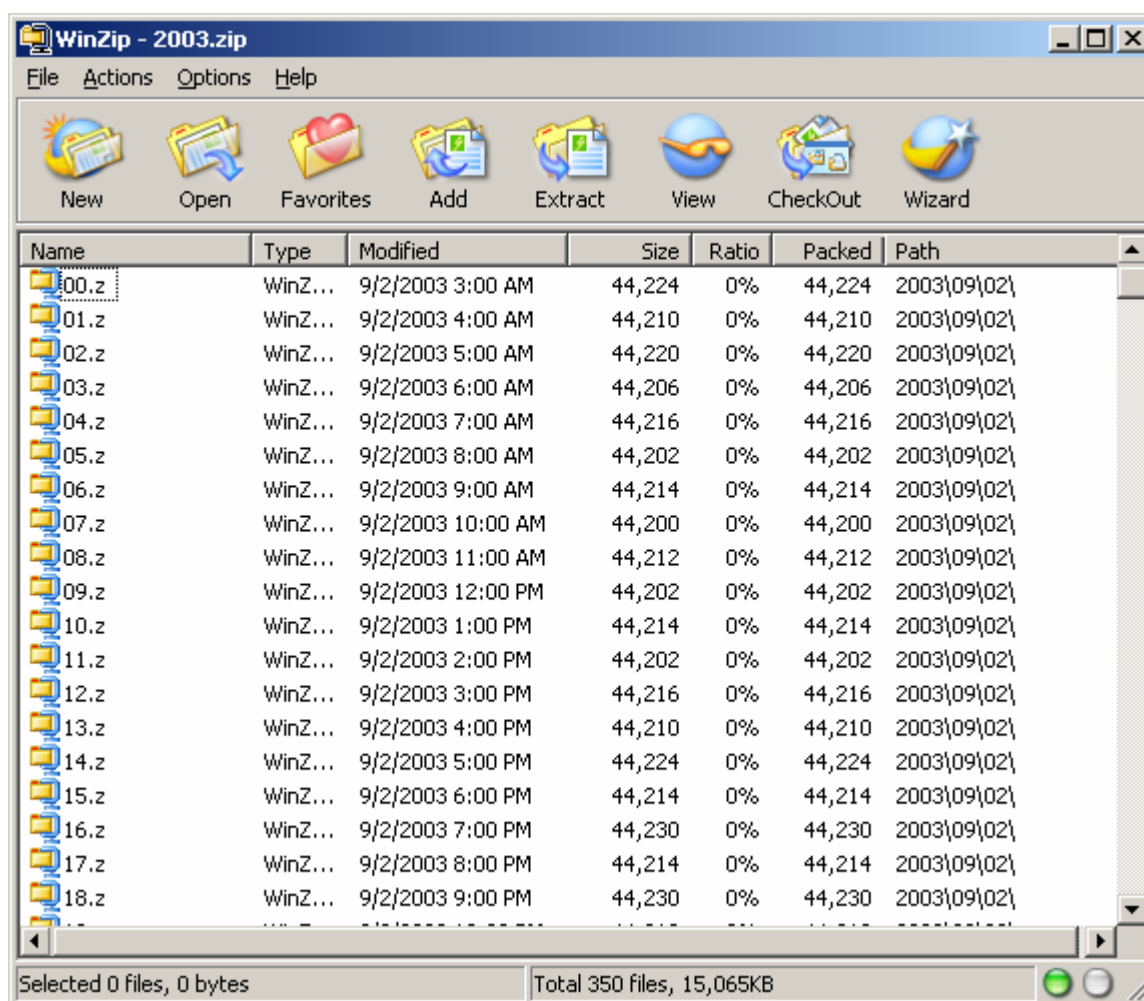


Figure 76. WinZip dialog box when downloading the 2003 folder.

Choose **Select All** from the **Actions** menu and then click on the **Extract** icon. An **Extract** dialog box as shown in Figure 77 will appear. Use the default location to save your unzipped 2003 folder or navigate to another location. Click on **Extract**. A folder called 2003 (or 2004 or 2005, depending on which file has been selected) will be created. Note that the files within the subfolders

within the 2003 (or 2004 or 2005) folder will remain compressed (zip) files. The AmaSeis program uses the files in this form (opening and saving) in order to minimize data storage space on your hard drive.

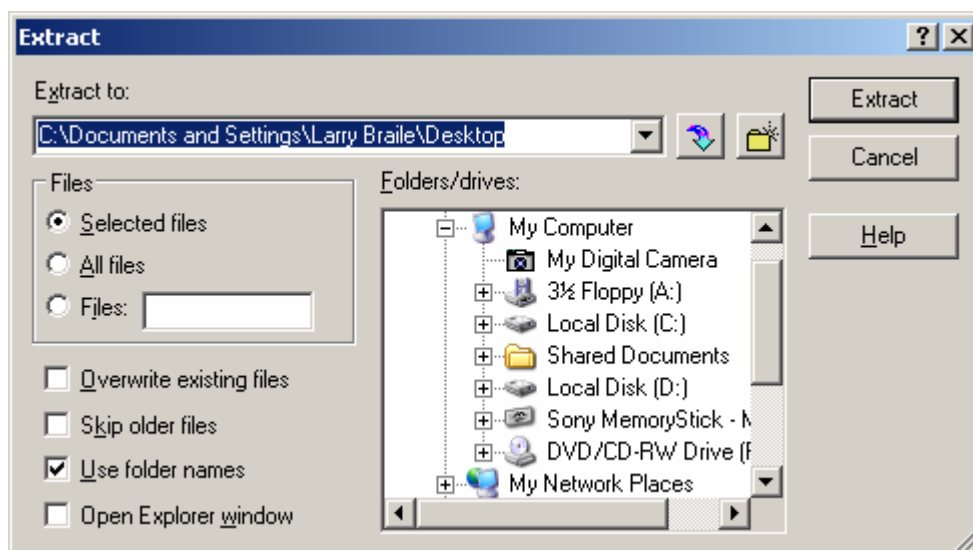


Figure 77. WinZip **Extract** screen that allows one to navigate to the desired location for writing the 2003 folder.

Place the 2003, 2004 or 2005 folder in the AmaSeis folder. **(If you have recorded data from an AS-1 on your computer during 2003, 2004 or 2005, be sure to not copy the WLIN 2003, 2004 or 2005 data file over your 2003, 2004 or 2005 folder. You can download the WLIN 2003 folder and preserve your 2003, 2004 or 2005 folder by temporarily moving your 2003, 2004 or 2005 folder to another folder or by temporarily renaming it.)** You can now run AmaSeis and view the 2003, 2004 or 2005 WLIN data as if these data were originally recorded on your computer.



**9. A note on connections to national education standards:** This tutorial/website is primarily a resource for understanding the use of the AmaSeis software and related data access tools so that seismic data can be used to learn about earthquakes, seismology and related Earth science. This software, the included tools and the data sources will allow the user to perform educational activities related to earthquakes and seismology and to explore real seismological data. Activities and lessons related to earthquake location, wave and energy propagation, natural hazards, data analysis and interpretation, and use of technology can be utilized with these resources. These activities, skills and topics are included in Teaching Standards, Earth science and physical science Content Standards of the *National Science Education Standards* (NSES; NRC, 1996) as listed below.

**Teaching Standards:** inquiry-based (A, B).

**Professional Development Standards:** opportunity for learning new Earth science content (A, C).

**Content Standards:** **Science as Inquiry** – practice inquiry and fundamental science skills (grades 5-8 and 9-12, A); **Physical Science** – properties of matter, motion, transfer of energy (grades 5-8, B), structure of matter, motion, interactions of energy and matter (grades 9-12, B); **Earth and Space Science** – relate to energy in the Earth system (grades 9-12, D).





**10. References:**

Bolt, B.A., *Earthquakes and Geological Discovery*, Scientific American Library, W.H. Freeman, New York, 229 pp., 1993.

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Shearer, P. M., *Introduction to Seismology*, Cambridge University Press, Cambridge, UK, 260pp, 1999.

