

Downloading and Using PEPP Data from IRIS

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Introduction:

The Princeton Earth Physics Program (PEPP) began in 1994 at Princeton University in New Jersey. It was expanded to regional sites in 1996, including Indiana University and Purdue University in Indiana. At this time, more than 20 schools in Indiana are either operating or soon will be operating seismic stations, collecting high-quality seismic data for research and also for use by students in schools. The data is recorded by sensitive seismometers in digital form. Much of this data is being forwarded electronically to IU, which in turn sends it to the Incorporated Research Institutions for Seismology (IRIS). In turn, IRIS makes this data available for download from a tool known as WILBER II. One of the goals of PEPP is to disseminate this data to schools throughout the United States. The intent of this lesson is to introduce teachers and students to the data and to demonstrate the relative ease with which it can be acquired and be used in the classroom. Both students and teachers are encouraged to examine the IU PEPP website, <http://www.indiana.edu/~pepp/index.html> , for more information about the total program.

Objectives:

1. Teachers will be able to locate, download, and prepare data sets for student use from the IRIS/WILBER II website.
2. Students will be able to study and manipulate this data to locate and print maps of earthquake epicenters with a software program called WinQuake.
3. Students will be able to demonstrate an understanding of the significance of P-wave and S-wave arrival times in locating epicenters.

Materials Needed:

Computer with Internet access via Internet Explorer. These computers should also be installed with Microsoft Word and WinQuake. A printer is desirable, but results could be saved electronically.

Target Audience:

This activity, with modifications, is appropriate for grades 8-12.

Science Standards Addressed:

With so much emphasis in education today to meet standards, it is good to know that this type of activity either directly or indirectly meets the following Indiana State Science standards:

Indiana Earth-Space Standards Met

ES.1.23 Explain motions, transformations, and locations of materials in the Earth's lithosphere and interior. For example, describe the movement of the plates that make up the crust of the earth and the resulting formation of earthquakes, volcanoes, trenches, and mountains.

S.1.24 Understand and discuss continental drift, sea-floor spreading, and plate tectonics. Include evidence that supports the movement of the plates such as magnetic stripes on the ocean floor, fossil evidence on separate continents, and the continuity of geological features.

ES.1.29 Recognize and explain that in geologic change, the present arises from the materials of the past in ways that can be explained according to the same physical and chemical laws.

ES.2.6 Describe that early in the 20th century the German scientist, Alfred Wegener, reintroduced the idea of moving continents, adding such evidence as the underwater shapes of the continents, the similarity of life forms and land forms in corresponding parts of Africa and South America, and the increasing separation of Greenland and Europe. Also know that very few contemporary scientists adopted his theory because Wegener was unable to propose a plausible mechanism for motion.

ES.2.7 Explain that the theory of plate tectonics was finally accepted by the scientific community in the 1960s when further evidence had accumulated in support of it. Understand that the theory was seen to provide an explanation for a diverse array of seemingly unrelated phenomena, and there was a scientifically sound physical explanation of how such movement could occur.

Indiana 8th Grade Science Standards Met

8.2.1 Estimate distances and travel times from maps and the actual size of objects from scale drawings.

8.2.4 Use technological devices, such as calculators and computers, to perform calculations.

8.3.2 Explain that the slow movement of material within the Earth results from heat flowing out of the deep interior and the action of gravitational forces on regions of different density.

8.3.3 Explain that the solid crust of the Earth, including both the continents and the ocean basins, consists of separate plates that ride on a denser, hot, gradually deformable layer of earth. Understand that the crust sections move very slowly, pressing against one another in some places, pulling apart in other places. Further understand that ocean-floor plates may slide under continental plates, sinking deep into the Earth, and that the surface layers of these plates may fold, forming mountain ranges.

8.3.4 Explain that earthquakes often occur along the boundaries between colliding plates, and molten rock from below creates pressure that is released by volcanic eruptions, helping to build up mountains. Understand that under the ocean basins, molten rock may well up between separating plates to create new ocean floor. Further understand that volcanic activity along the ocean floor may form undersea mountains, which can thrust above the ocean's surface to become islands

- 8.7.3 Use technology to assist in graphing and with simulations that compute and display results of changing factors in models.
- 8.7.4 Explain that as the complexity of any system increases, gaining an understanding of it depends on summaries, such as averages and ranges*, and on descriptions of typical examples of that system.

Time Allotment:

For a teacher it takes about 10 –15 minutes per event to use WILBER II, and 5-10 more minutes to make and save a quake file the first time you try it. As you become more comfortable, the time can be cut in half.

The time frame for “Using WinQuake” with students will vary according to how adept students already are with computers. A possible time frame for younger students might be:

- Opening WinQuake and Importing Seismograms – 30 minutes
- Researching Seismograms – 40 minutes
- Selecting P and S waves – 30 minutes
- Triangulation and Finishing Document – 30 minutes

If older students are familiar with computers and are on a longer (block) class period schedule, the time could be reduced quite a bit.

I would adjust the “Reflection” activity (or delete it) for younger students. This activity, however is consistent with the movement to encourage writing across the curriculum.

Evaluation:

Since this is a multiple-day activity and requires computer, reading, and reasoning skills, it should have a significant value. I have included a five-category rubric for the “Using WinQuake” activity proper, and a four-category rubric for the “Reflection” activity. The reason for different rubrics is because my school is adopting the 6+1 Trait Writing Model for evaluation of all of our cross-curricular writing assignments.

Lab Report: **Using WinQuake**

Teacher name: Mr. David Burch

Student Name _____

CATEGORY	Excellent	Good	Satisfactory	Needs Improvement
Participation	Used time well in activity and focused attention on the process.	Used time pretty well. Stayed focused on the activity most of the time.	Did the activity but did not appear very interested. Focus was lost on several occasions.	Participation was minimal OR student was hostile about participating.
Data	Professional looking and accurate representation of the data Seismograms and Maps are labeled and titled.	Accurate representation of the data Seismograms and Maps are labeled and titled.	Accurate representation of the data in written form	Data are not shown OR are inaccurate.
Drawings/Diagrams	Clear, accurate diagrams are included and make the document easier to understand. Diagrams are labeled neatly and accurately.	Diagrams are included and are labeled neatly and accurately.	Diagrams are included and are labeled.	Needed diagrams are missing OR are missing important labels.
Scientific Concepts	Report illustrates an accurate and thorough understanding of scientific concepts underlying the activity.	Report illustrates an accurate understanding of most scientific concepts underlying the activity.	Report illustrates a limited understanding of scientific concepts underlying the activity.	Report illustrates inaccurate understanding of scientific concepts underlying the activity.
Appearance/Organization	Lab report is typed and uses headings and subheadings to visually organize the material.	Lab report is neatly handwritten and uses headings and subheadings to visually organize the material.	Lab report is neatly written or typed, but formatting does not help visually organize the material.	Lab report is handwritten and looks sloppy with cross-outs, multiple erasures and/or tears and creases.

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6+1 Trait Writing Model: **Using WinQuake Reflection**

Teacher name: Mr. David Burch

Student Name _____

CATEGORY	Excellent	Good	Satisfactory	Needs Improvement
Sentence Length (Sentence Fluency)	Every paragraph has sentences that vary in length.	Almost all paragraphs have sentences that vary in length.	Some sentences vary in length.	Sentences rarely vary in length.
Grammar & Spelling (Conventions)	Writer makes no errors in grammar or spelling that distract the reader from the content.	Writer makes 1-2 errors in grammar or spelling that distract the reader from the content.	Writer makes 3-4 errors in grammar or spelling that distract the reader from the content.	Writer makes more than 4 errors in grammar or spelling that distract the reader from the content.
Focus on Topic (Content)	There is one clear, well-focused topic. Main idea stands out and is supported by detailed information.	Main idea is clear but the supporting information is general.	Main idea is somewhat clear but there is a need for more supporting information.	The main idea is not clear. There is a seemingly random collection of information.
Introduction (Organization)	The introduction is inviting, states the main topic and previews the structure of the paper.	The introduction clearly states the main topic and previews the structure of the paper, but is not particularly inviting to the reader.	The introduction states the main topic, but does not adequately preview the structure of the paper nor is it particularly inviting to the reader.	There is no clear introduction of the main topic or structure of the paper.

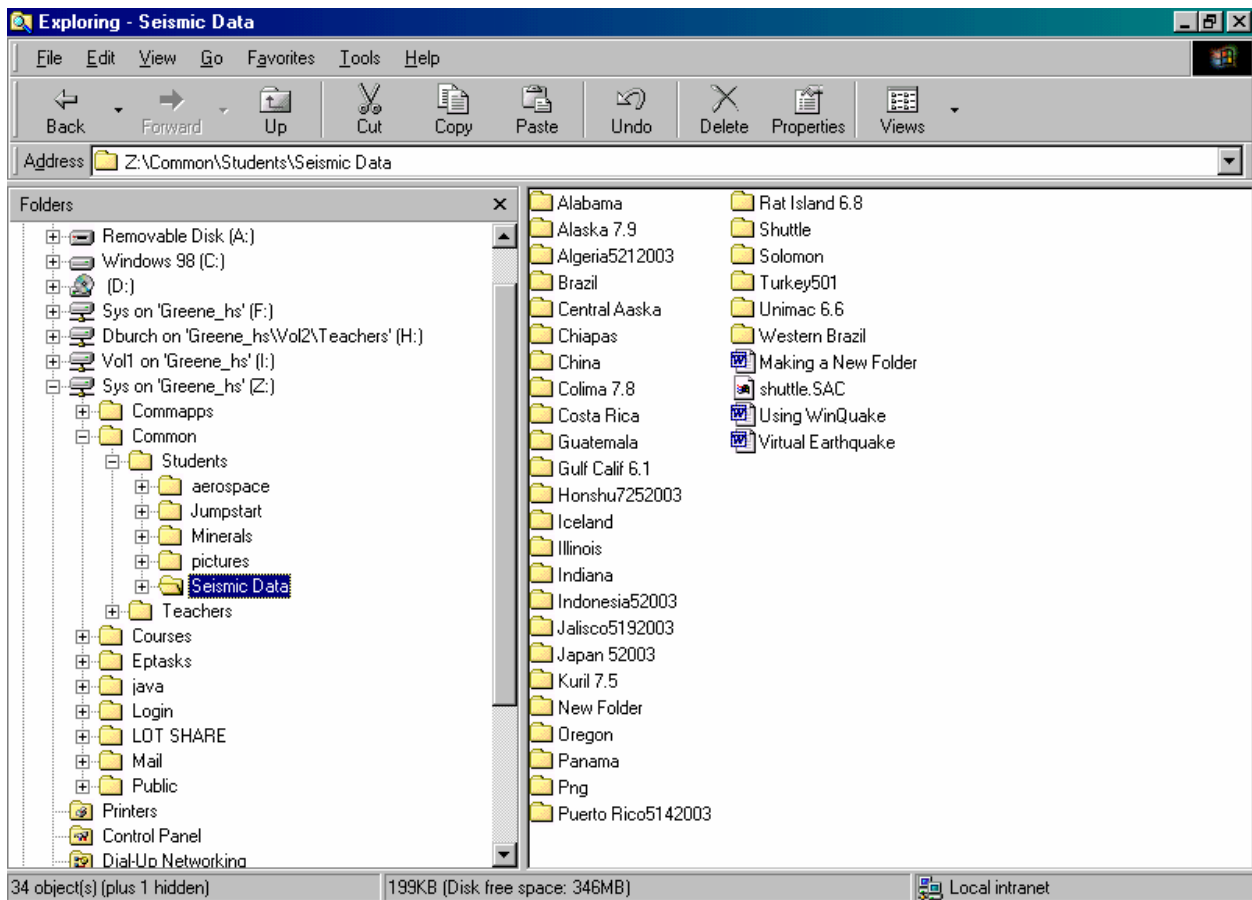
Teacher Notes and Information:

“[Downloading Seismograms from WILBER II](#)”. This page is intended mainly for teachers, but advanced students could easily perform this task. Access to this page can be accomplished simply clicking on the link if this lesson is in electronic form. If you have to type the URL, you might have to stop after the “edu” and then get to WILBER from the main IRIS site. Another alternative is to use the link from the IU PEPP website, www.indiana.edu/~pepp and then click on “Earthquakes”. On this page, scroll down to the link to WILBER.

Even though the files in WILBER go back several years, the school-recorded PEPP data only goes back into 2002. You can still get data for historical quakes and examine them in WinQuake. If you want data from older quakes from the PEPP network, you might try the Princeton PEPP site, <http://lasker.princeton.edu/index.shtml>. This download uses a somewhat different process, but is fairly logical.

Only download a few (5 or so at most, but at least three) seismograms for each quake. If an older, more advanced student is doing a major project, he/she might want more data per quake. Too many seismograms tend to overwhelm the average or below-average student.

The saving of data sets is not as difficult as it sounds. A big part of this is how much access you might have to your school server. If it is readily available, there is probably somewhere on it where you can make a “Seismic” file to store the data. Here is an example:



Notice that the files are not stored in the teacher's folder, but in a "Common" folder where students can access but not alter the data. This is also where the student worksheets and instructions for the seismogram activity are stored. A less-desirable alternative is to use a CD or Floppy. It would be relatively easy to make multiple copies of data sets this way. Floppies tend to get corrupted and damaged fairly easily, so make sure you always keep a master copy away from student access.

"Using WinQuake". WinQuake is a powerful program and works fairly well, but there are a few quirks that can be confusing for students.

- 1) The process of locating files can be a stumbling block. The program does not show the files in the selected folder until the operator clicks onto the "Open File" command button.
- 2) Another big problem is saving files to a disk or folder. If all the student does is print seismograms and maps, this does not become an issue. Students who have used WinQuake several times can go through the entire "Using WinQuake" activity in less than thirty minutes. However, if the class period is ready to end and the student is not done with the entire task, work must be saved, or they will have to start all over again at the next session. If files are not saved properly, the student will have to repeat all of the typing of data in the "Display/Modify" window. **Here are the steps to save files so data will not be lost:**

1. Click on "Save" button on the upper toolbar.
2. Make sure the "Save Format" in the lower left of the save window is on "SAC Binary"(the format used to download the original data)
3. Select "Browse" and use the pull-down triangle in the new window to choose the proper place to save to (floppy, My Documents, Student Folder, etc.). If a different location is not chosen, it will be saved in the WinQuake program on that particular computer.
4. Name the file (probably the station name or student name)
5. Click "Save"
6. This procedure must be done for **every individual seismogram** open in WinQuake at the time or the work to that point will be lost!! WinQuake will not save all seismograms at the same time.
7. When done properly, the files can be opened at the next session without loss of any work done on them previously.

In the section titled "Researching Seismograms", the URL for the website will have to be typed in if you are not using this document in electronic form. If you have to type the URL, you might have to stop after the "edu" and then get to WILBER from the main IRIS site. Another alternative is to use the link from the IU PEPP website, www.indiana.edu/~pepp and then click on "Earthquakes". On this page, scroll down to the link to WILBER.

In the section titled “Selecting P and S Waves”, it might take some practice in double-clicking and dragging to expand the first part of the seismogram. Luckily, the student can always go back by using the “RST” button. Also, do not be surprised if the WinQuake program does not pick the P and S arrivals exactly where they may appear to be. It picks theoretical times based on the tables built in to the program. This may also cause the “Triangulation” paths to not cross exactly on the epicenter location, but they should be pretty close to correct. Some students may also overdo the “Zoom” before they copy the map to paste into their Word document. They can always zoom out as well as zoom in.

When students are picking P and S locations is a good time to call their attention to the Header information at the top of each seismogram. They can see how the P and S selections can change the calculated distance to the quake and the origin time. Another item to discuss at this time is the time scale at the bottom of the seismogram (try to determine duration of the quake recording); also the relative count scale on the left side of the seismogram (its order of magnitude – 10’s, 100’s, 1000’s, etc.).

The “Finishing Up the Document” section is mainly cosmetic. Some may want to save it for an electronic school portfolio, or to display on a class bulletin board.

The electronic form of this document includes three sample data sets – a local earthquake set, a regional earthquake set, and a teleseismic earthquake set.

Downloading Seismograms from WILBER II

(Teacher or Advanced Student Activity)

1. Open the home page for WILBER II: http://www.iris.washington.edu/cgi-bin/wilberII_page1.pl
This page has a worldview map with dots indicating earthquakes recorded during the present quarter of the year. It also has a scroll-down menu to pick previous quarters from the past. You may click onto a location on the map to start data retrieval or click on the link above the map titled [list all events](#). For recent quakes, the “list all events” link works well. The most recent quakes are at the bottom of the list.
2. Choose an event from this list by clicking onto the date given. This will open a page listing all the networks that have recorded that event. There may be several hundred stations of potential data. Since we are working mainly with PEPP data, find the Network labeled PN with a box in front of it. Click in the box; a check mark will appear indicating you have selected the Indiana PEPP Network. To continue, click the “PROCEED” button at the bottom of the page.
3. A new page has been opened, containing just the Indiana PEPP stations recording this event. The stations can be sorted by distance from the event, or alphabetically by using the scroll down menu above the station names. The station names and locations can be identified by referring to the IU PEPP site at:
4. <http://www.indiana.edu/~pepp/schooltable2.htm> .
5. The seismograms from these stations can be previewed by clicking on the name of the station. A smaller window will open, and the seismogram will be displayed. If you would like to download data from that site, click in the box by the name of the station. You can select data from all stations if you want, but you will have relatively large files as a result. Pick at least three or four stations after previewing their seismograms.
6. In the section of the page labeled “Available Channels”, select the box by the letters **BHZ**.
7. In the section labeled “Available Data Formats”, select **SAC BINARY Individual files**.
8. In the “Time Window Data”, you can select the duration of your files. For a small local or regional quake, you probably only need 30 minutes or less of data. For a teleseismic event, you may want to request 60 minutes.
9. The first time you use WILBER, you will need to designate a USER NAME, usually your email name. For “REQUEST LABEL” just name your quake; perhaps use the location followed by a date such as: Scotia20030804. This will help when you retrieve the data later. Fill in your email address, click in the button to “Notify me through email when complete”, then click the PROCESS REQUEST button.
10. If everything has been filled out properly, a new page will appear telling you your request has been processed. Depending on how many other requests have been made, it may be available for download in a very short time period. You should get an email something like this:

Subject: WILBER II: Product Ready

-----Request Completed!-----

ID Number: 22586

User Name:

Request Label: Scotia20030804

Data Format: SAC

File Size: 70548 bytes

Download the data file from the directory:

<ftp://ftp.iris.washington.edu/pub/userdata/dburch/Scotia20030804>

Thank you for making use of WILBER II!

11. Click onto the ftp link in the email message; this will take you directly to the IRIS site for download. You can download to a floppy, a CD, or to your computer. Make a file folder and give it the name of your quake before you start the download. In addition to the seismograms, you will see files labeled “my processing log” and “my request”. There is no need to download these files. Left-click and drag to highlight the files you want. Place the cursor on the highlighted files and right-click. From the dialog box select “COPY TO FOLDER” and select the proper folder to copy to. The files should now be copied and ready to open in WinQuake.
12. There are several ways to save data sets. The most efficient way is to use a school server if it is available. It will have a common folder on a drive that allows teachers to put folders of data in it that can be accessed, but not altered, by students. This is how most computer labs in schools operate. It is very easy to add data sets this way. Seismogram sets could also be put on separate floppy disks available for student use.

Using WinQuake

(Student Activity)
Importing Seismograms

1. Open WinQuake by double clicking on the icon on the desktop or using the “Start/Programs” button .
2. Select “Change Directories”.
3. The instructor will tell you where to locate the seismogram files. Double click on that location.
4. Each folder should contain at least 3 seismograms of earthquakes which have occurred in the past. Select a folder by double-clicking on it.
5. Seismogram names will appear on the screen. Hold down the “Shift” key and select all the files by highlighting them.
6. Select “Open File”. The seismograms should appear on the screen. In order to see one at a time, click on the “Maximize” square in the upper right corner of one of the seismograms. To view the others in full screen, click onto the “Window” button on the upper toolbar and select which seismogram to view. If the seismogram seems to be a very thin line, use the scroll bar on the right side of the screen to adjust the vertical scale.

Researching Seismograms

1. Find the date of your seismogram in the upper left part of the “Header” above the seismogram. Write it down. Minimize WinQuake.
2. Open a new Microsoft Word document; this is where you will save all of your documentation. Type your name and today’s date on the first line of the document; double space.
3. Open “Internet Explorer” by double clicking on the icon on the computer desktop or using the “Start/Programs” button .
4. Click on to this website: http://www.iris.washington.edu/cgi-bin/wilberII_page1.pl
5. If it is a recent EQ, choose “list all events”. If an older EQ, select the correct date range in the window on the left side of the page.
6. Copy and paste the quake information, including **magnitude, latitude, longitude, date, depth, and exact origin time, including date** to your new Microsoft Word document below your name and date. For Example,

Event: 2003/01/22 02:06:35.8

Catalog: NEICALRT Mag: 7.3 Type: MO Contributor: NEIC

Lat: 18.81 Lon: -103.89 Depth: 33.00

Description: NEAR COAST OF MICHOACAN, MEXICO Source: SPYDER®

7. Restore WinQuake.
8. Select the “Display/Modify” button on the upper toolbar. Click on to “Event Information”. If the blanks are empty, you must type in the correct information for that EQ. The information must include the following: **magnitude, latitude, longitude, date, depth and exact origin time, including date**. Make sure you enter the date in the proper format, and put a space between the year and the time.

9. For latitude, positive numbers are north, and for longitude, positive numbers are for east. You must be sure to type a minus sign for south or west.
10. When data is entered, click the “Make” button, then click “OK”.
11. For the remaining seismograms, click the “Display/Modify” button on the upper toolbar. Click on to “Event Information” as you did with the first seismogram. But this time, simply press the “Add” button and the information will go into the blanks. Then click “OK”.
12. Click the “Tables” button on the upper toolbar. Type in the correct depth of your earthquake at the lower left of the window, and select either “Regional” or “Teleseismic” in the lower right of the window. A regional quake is generally closer, in North America; farther away quakes are teleseismic.

Selecting P and S Waves

2. After entering the data described above, Maximize one of the seismograms. If the seismogram trace is too small to see clearly, use the scroll bar at the right side of the seismogram to enlarge the trace.
3. If you would like to examine the seismogram more closely, place the cursor near the start of the quake, then double-click and hold down the left mouse button. A vertical line will appear on the screen. Still holding down the left mouse button, drag the line to where you want to stop your examination, then release the mouse button. This will expand the view of the selected section of the seismogram.
4. You may continue to do this over and over, until you can clearly see the first arrival of seismic waves. If you expand too much, you can back up by clicking the “RST” (Restore) button on the upper toolbar to return to the original seismogram.
5. Click on to the upper toolbar button labeled “PS”. This will put a P and S on the seismogram.
6. Click on to the P or S and drag it to where you think that wave may be. To check your choice, click on to the upper toolbar button labeled “LOC”. If you are close, the software should put them in the correct place, based on current knowledge of the earth’s structure.
7. Make sure it shows the correct P and S location before copy and pasting.
8. Click on to the “View” button on the upper toolbar. Scroll down to “Copy” and select “Both”. This will copy the seismogram and its header information to the computer clipboard.
9. Restore your Word document and paste the seismogram below the previously-pasted data from WILBER. Double-space after the seismogram.
10. Repeat this procedure with the remaining seismograms. After you have pasted the remaining seismograms, save the Word document to your seismology folder. Name the document “WinQuake”

Triangulation

1. Go back to WinQuake to your seismograms with the selected P and S waves. Click on to the upper toolbar icon that looks like a gray circle with a large plus sign in it. This is the “Locate Event” button.
2. A map of the world should appear containing the location points of the seismograph stations and the epicenter of the earthquake marked by a square where three circles cross.
3. Using the “Zoom” feature (located in the toolbar), change the size of the map to get the best view of the stations and the epicenter.
4. Click on to the “Copy” button on the upper toolbar. This will copy the map to the computer clipboard. Restore your Word document and paste the map below the seismograms previously copied to the document.
5. Save the document to a folder as directed by your teacher.

Finishing Up the Document

1. Your Word document titled WinQuake should now contain: 1) EQ data pasted from the internet, 2) Several seismograms of the same EQ with the P and S waves correctly located, 3) A map showing the Station locations and the Triangulated epicenter of the EQ. You should also have your name and today’s date typed on the first page.
2. If you click on to an image, a line should appear all around the image. Do this and then click on to the “Centering” icon on the upper toolbar to center the image on the page.
3. Enlarge or reduce each image by dragging a corner of the image to make it larger or smaller, so it will fill the width of a page.
4. Label each seismogram, telling what seismograph station it came from.
5. Make sure your name is typed on each page (for printing purposes).
6. Save the document to a folder as directed by your teacher. It may be saved on disk, on the school server, or on the computer in “my documents” or the desktop.
7. If time allows, print a hard copy to turn in.

Reflection

Write a one-page typed essay describing your experience in seismic analysis. Express any feelings of frustration or achievement you may have felt. Would you want to have a career in this field? Do you have a greater appreciation for scientists involved in research projects now than before this activity?

Resources

<http://www.indiana.edu/~pepp/>

<http://lasker.princeton.edu/index.shtml>

<http://rubistar.4teachers.org/>

http://www.iris.washington.edu/cgi-bin/wilberII_page1.pl

<http://www.indiana.edu/~pepp/schooltable2.htm>

http://ideanet.doe.state.in.us/standards/standards2000_science.html

<http://www.indianastandards.org/grade2.asp?subj=sci>