Quake

Students use newspaper reports to map

When the term "earthquake" is mentioned, why do students immediately think of the San Andreas Fault? One reason may be that California tends to receive a large amount of media attention, but most likely many students feel that earthquakes are a far-removed phenomenon that poses no threat to their lives. We decided to design an activity that makes the topic of earthquakes more relevant to all students.

While it is true that episodic earthquakes are generally associated with plate boundaries such as the San Andreas Fault, the midwestern and eastern United States have experienced their share of seismic events. Indeed, *Geotimes* (Snider, 1990) predicted that an earthquake with a magnitude of 6.0 or greater will occur somewhere in the eastern United States by the year 2010. The following activity not only provides a relevant experience for students living in a variety of geographical locations but also introduces them to the type of authentic research that geologists perform while investigating historic earthquakes. This research project was conducted by a junior-senior level environmental Earth science class.

CONTACTING SOURCES

Because earthquakes are usually associated with plate boundaries, the study of plate tectonics provides an opportunity to initiate the study of earthquakes. The initial phase of such a research project takes a considerable amount of time and should begin before the topic of earthquakes is formally discussed. We posed to our students the following scenario (based on fact): In response to the increase in nuclear waste and the necessity of finding safe disposal sites, the Nuclear Regulatory Commission (NRC) has funded studies to investigate the probability of earthquakes in the eastern United States.

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Students investigated a particular earthquake that occurred on May 31, 1897, and was felt in our county and throughout West Virginia. Students had to make a summary of the impact of the quake statewide, a determination of the earthquake's epicenter, and a geological explanation for the event.

Research teams, consisting of three students each, began by generating a list of resources to contact. Typically, students generated short lists of sources on the first day—the Internet, the county courthouse, and the state university. As homework, students thought about additional sources and presented them to the class the following day. After some reflection and discussion, students considered using newspapers from other towns and the state geological survey. The names of organizations from their final list were dropped into a hat, and each research team drew their contacts. Some teams were able to visit their contacts directly, while others relied on mail service. If e-mail addresses were unavailable, teams were instructed to draft a letter to their organizations requesting any information pertaining to the earthquake on May 31, 1897, or events in the days that followed. The e-mail and letter drafts were edited, and teams used word processors to generate business letters on high school stationery. These letters, along with self-addressed, stamped envelopes, were mailed to the potential contacts.

Because not all libraries are willing or able to cooperate with students, a backup plan for obtaining newspaper citations is critical for project completion. Checking with the state's geological survey, the U.S. Geological Survey (*www.usgs.gov*), or with seismic repositories such as the Virginia Tech Seismological Observatory may provide general information on earthquake

Search

the intensity of historical earthquakes

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION/NATIONAL GEOPHYSICAL DATA CENTER

OCTOBER 31, 1935, HELENA, MONTANA

Location: almost directly beneath Helena; Affected area: 363 000 km^2; Damage: $4 million

A series of earthquakes beginning on October 3, 1935, shook the area. The strongest of the shocks was on October 18. Several shocks of lesser intensity were followed by a second strong earthquake on October 31, destroying many buildings that had been previously damaged. The shocks continued with additional strong shocks on November 21 and November 28, 1935.

The photo shows the west wing of Helena High School that collapsed in the October 31 earthquake. The collapsed part of the school had reinforced concrete frame, floors, and roof, and the tile floors were faced with brick. The greatest amount of damage to a single structure was incurred by this school. Construction on the building had been completed only two months prior to the earthquake.

dates and locations of epicenters. Newspaper articles, however, are the crux of the research project. Thanks to the efforts of the National Endowment for the Humanities, all states are currently participating in the U.S. Newspaper Program, which has facilitated the archiving of each state's local newspapers in one location such as a university library. To find the location of a particular state archive, teachers can write to the National Endowment for the Humanities (1100 Pennsylvania Ave., NW, Washington, DC 20506) or visit its website (*www.neh.fed.us*). Once teachers have found the articles, arrangements can be made with the geological survey to send the articles as students request them in subsequent years.

NEWSPAPER ACCOUNTS

As responses from sources began to arrive, we made copies for later use and gave the originals to the respective research teams. Team members sent thank you notes to their contacts. The replies continued to come in as we covered plate tectonics and mountain building in preparation for the unit on earthquakes.

Not all information requests were successful. Some groups received replies indicating the information they requested was not available, and others did not receive any reply at all. Students found, to their surprise, that many newspapers claimed not to have the information on hand. Not surprisingly, some libraries did not have the personnel to search for the specific earthquake citations necessary to complete the study. Our fail-safe source for information was the West Virginia Geological and Economic Survey (WVGES). The education specialist for WVGES agreed to send the appropriate newspaper citations for any complete article collections that were available. Regardless of the sources of data, the students were responsible for acquiring the information and writing appropriate business letters.

> Because plate tectonics had previously been covered, students could apply their knowledge about the Appalachian Mountains to draw conclusions about why the quake occurred.

During the unit on earthquakes we talked about seismographs and the Richter scale. Students were then asked about historical quakes such as the one they were researching. How was the severity of an earthquake determined prior to the invention of the seismograph? After some discussion, students mentioned how much damage was reported to have occurred during the quake. Eureka! Students recognized the need for the scale that geologists used prior to the seismograph.

The Modified Mercalli Intensity Scale, as it is known, is based on what was felt by the residents, the reaction of observers, and the damage reported for historical quakes. Using this constructivist technique, students were able to understand the scales used to rate earthquake intensities and took an active interest in understanding their design. The research teams were armed with enough background to begin interpreting their own earthquake data.

MAPPING WITH MERCALLI

Each research team was given copies of all the newspaper accounts received and a copy of an unabridged Modified Mercalli Intensity Scale. Students read the newspaper excerpts and used the Mercalli descriptions to assign an intensity to each location documented in the articles. For example, the earthquake mentioned in the following passage might be designated as an intensity of III: "Monday afternoon at 2:10 o'clock a distinct shock of earthquake was felt in the entire surrounding country, the tremor lasting according to the estimate of various people, from five to ten seconds. Although the shock was very slight here, in many places throughout pictures, dishes, and the like were tumbled to the floor. This was the first shock publicly noticed since 1885, and produced a great deal of excitement in many localities. The vibration passed from north to south" (Preston County Journal, 1897).

Immediately, students realized the difficulty of assigning intensities based on historic accounts. They observed that the intensity is not always obvious since the articles are often sketchy, and two newspapers may report conflicting accounts for the same location. Research team members were required to agree on the assigned intensity for each location based on evidence and reason.

During their research, students discovered that the epicenter of the earthquake was not actually in West Virginia but just over the state line near Pearisburg, Virginia. Once the accounts of the earthquake were assigned appropriate Roman numeral intensities, students used a West Virginia road map to locate each town identified in the articles and record the intensities felt by the people in the towns. Some teams found references to towns that no longer exist and had to do additional research in order to map all of the data.

Once the intensities were plotted, teams connected the intensities to form intensity contours (Figure 1), which can be highlighted using color pencils. For each team, the end result was an isoseismal map of intensities for the Giles County, Virginia, earthquake as it was felt in the state of West Virginia. Once these maps were completed, the task of providing possible explanations for the quake remained. Because the topic of plate tectonics had previously been covered, students could apply existing knowledge about the Appalachian Mountains to draw conclusions.

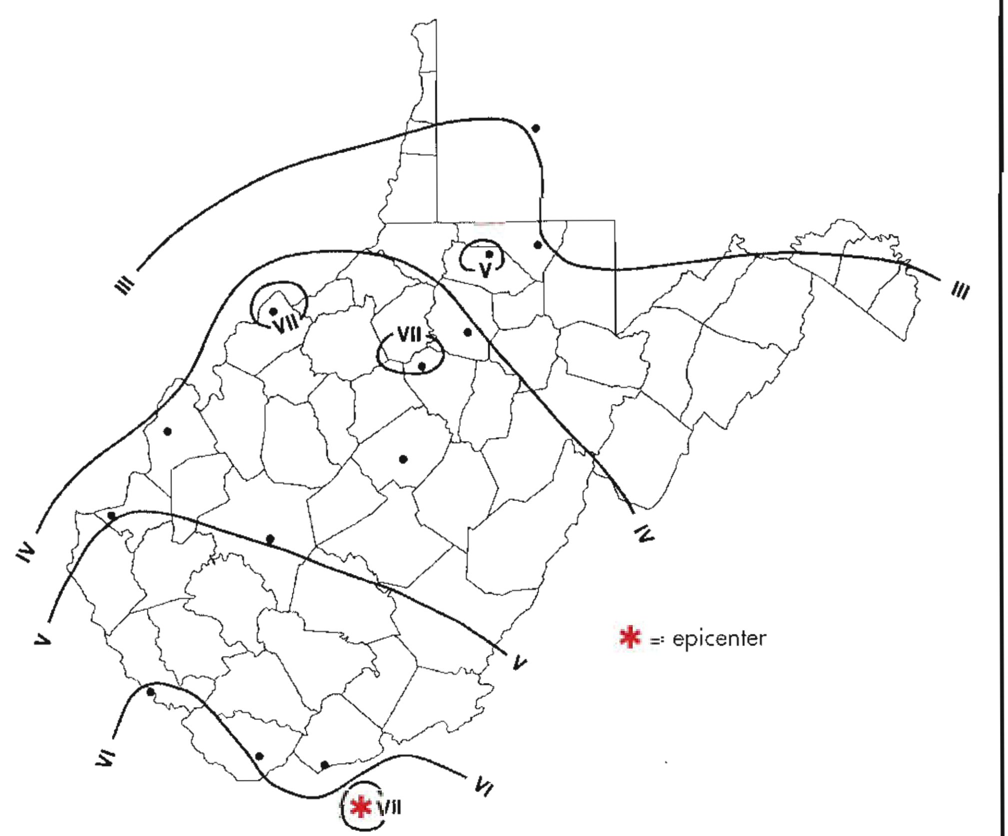
DISCUSSION AND PRESENTATION

The research teams posted their maps in the classroom, and each group briefly discussed their results and conclusions. Students first discussed the difficulty of assigning intensities for each location on the map. They mentioned the subjective nature of assigning objective numbers to each location depending on individual interpretation of the newspaper accounts, many of which lacked detail. Some articles were brief, consisting of a line or two, and others were vague in description.

Students observed that various articles contradicted each other about the events in a specific area, leading to a discussion of possible explanations for these discrepancies. It occurred to students that some newspapers may have exaggerated the damage or not gotten all the facts. Although high school students are prone to believe that anything in print must be true, this activity made students realize that they should be more skeptical about what is printed in a newspaper.

FIGURE 1.

Student isoseismal map of the Giles County, Virginia, earthquake of 1897, generated from newspaper accounts.



Students went on to observe that even if the intensities they labeled for each town were consistent, their interpretation of the location of the contour lines differed. Some students pointed out that the contours could not be closed because there was no data for the surrounding states. This led to a debate on whether isoseismal mapping should follow the same rules as contour mapping. An intensity of VII may be mapped in an area surrounded by a IV intensity interval, a situation never seen on a contour map. The question of who is correct resulted in the resounding answer,"We all are!" We placed the stipulation that students base their interpretations on sound logic and support them with data.

Discussion stemming from these maps can be as geologically in-depth as desired. For example, our students generally assumed that the further from the epicenter of an earthquake residents are, the less intense the quake will feel. But some students noticed in the case of this earthquake that the intensity was felt more severely in some areas to the north, further away from the epicenter, than was felt by people in closer locations to the east. Consulting a geologic map of West Virginia revealed the presence of glacial lake clays in this region, which are more unstable during quakes than bedrock. The students' observations extended their knowledge well beyond what might be covered in a typical lesson on earthquakes, with connections made to their prior geology lessons including mapping, plate tectonics, and historical geology.

To finish our discussion, we showed a map of the Giles County earthquake that geologists had generated and asked students to compare their maps to that of the geologists. The geologists' map was much different than the student maps—most of West Virginia is labeled as an intensity of III by geologists. After their initial panic, students realized that the geologists' map was less detailed than their own. Further, they recognized that they had more data points and information about the state of West Virginia than the geologists who drew the map, making the student maps more accurate! They had become scientists in the true sense of the word.

Once the discussions were exhausted, concept application began. Students synthesized all they had learned from working in their group as well as from other group presentations. Each student was given the individual task of writing a report to the NRC describing the historic Giles County earthquake as it affected our county—the intensity of the quake, the location of its epicenter, the cause of the quake, and the risk of future seismic events in our area. Students based their future

FIGURE 2.

List of some historical earthquakes (Snider, 1990).

The oldest written records of earthquakes in the eastern United States date to the mid–1500s. Since then, hundreds of earthquakes have been recorded. These are among the more significant events.

Cape Ann, Mass., 1755. Magnitude 6.0; felt from Chesapeake Bay to Nova Scotia. In Boston, walls, chimneys, and stone fences were knocked down. Waves like the swelling of the sea were reported on the Earth's surface.

New Madrid, Mo., 1811–12. The three largest earthquakes documented in all of North America with magnitudes 8.6, 8.4, and 8.8. Observers saw the Earth roll in waves a meter high. On the Mississippi River, great waves overwhelmed many boats and washed thousands of trees into the river. Church bells rang in Boston, 1770 kilometers away. The damage to property and loss of life was small, mostly due to the extremely sparse population of that time.

New York, N.Y., 1884. Magnitude 5.0, felt from Vermont to southern New Jersey. Greatest damage in Jamaica and Amityville, N.Y., where large cracks appeared in walls, windows were broken, and chimneys toppled.

Charleston, S.C., 1886. Magnitude 7.7; felt for a radius of 1290 kilometers, strongly shaken to 160 kilometers. Widespread and extensive damage to buildings, railroad lines, and communications.

Charleston, Mo., 1895. Magnitude 6.2; felt in 23 states. Extensive damage to buildings in Charleston and Cairo, Illinois.

Giles County, Va., 1897. Magnitude 5.8; felt from Georgia to Pennsylvania. Old brick houses were cracked, and bricks were thrown from chimney tops.

St. Lawrence River, 1925. Magnitude 7.0; felt in eastern Canada, south to Virginia, and west to the Mississippi River. Damage and loss of life were minimal due to sparse population in epicentral area.

Attica, N.Y., 1929. Magnitude 5.8; felt from Ontario to Ohio, Pennsylvania, Connecticut, Maine, Vermont, and New York. Two hundred and fifty chimneys were knocked down. Walls cracked as far away as Sayre, Pa.

Massena, N.Y., 1944. Magnitude 5.6; felt from Maine to Michigan to Maryland and Pennsylvania. Damage estimated at 2 million dollars (1944 value) in the epicentral area.

Wilkes-Barre, Pa., 1954. Magnitude 5.0. A local shock damaged hundreds of homes. Streets and sidewalks were cracked, and gas and water mains snapped. Damage was assessed in excess of 1 million dollars.

risk assessment on their determination of what caused the fault, how active the fault has been since the Giles County event, and their distance from the epicenter.

We evaluate the groups on their ability to defend their drawing of intensity contours and the plausibility of their maps (contour map mechanics must be employed properly to represent the data). Students are also assessed individually on their reports to the NRC for accuracy (intensity, epicenter, and cause of earthquake) and recommendations as to how a nuclear waste repository would be affected by potential earthquakes in the area. Students are required to make a scientifically sound recommendation based on the evidence for future seismic activity.

This activity can be adapted for use in most areas of the United States. Contacting any state geological survey will provide, at the least, the dates of some local historical earthquakes. The only actual information necessary to get started on this activity is the date of the earthquake. Figure 2 lists some historical quakes that are good starting places.

The benefits of student research include promoting scientific attitudes and habits of mind. Our students knew they were performing authentic scientific research and investigating a historical earthquake just as geologists do. The project also had the benefit of being long-term; students had sustained contact with a topic and data that tied into prior knowledge. They realized that the term "research" does not imply a literature review; rather, it is the collection, manipulation, and interpretation of data.

Students demonstrated scientific habits of mind such as persistence and skepticism as they endeavored to collect their research and were invested in the project because they felt it was student directed. They realized that earthquakes are not necessarily only a concern of West Coast residents but that the faulting that resulted from the formation of the Appalachian Mountains and withdrawal of Africa creates the potential for a sizeable earthquake in the eastern United States. What better way to learn that lesson? ✧

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