Pasta Quake—The San Francisco Treat

Demonstration to learn the concept of magnitude & log scale.

Activity is used with permission from Paul Doherty http://www.exo.net/~pauld/index.html. Worksheets by Roger Groom.

Google the title of this activity for the full 5-page activity including worksheets.

The original was modified by Randy Bechtel, NC Geological Survey for the High School E/En Share-a-thon at 2017 NCSTA-PDI.

Time: 5-10 Minutes
Target Grade Level: 4th grade and up
Content Objective: Students will learn the earthquake magnitude scale by breaking different amounts of spaghetti. Visual scale of the pasta emphasizes the relative differences between magnitudes; each whole step in magnitude

Background

The severity of an earthquake can be expressed in terms of both intensity and magnitude. However, the two terms are quite different, and they are often confused.

Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region depending on the location of the observer with respect to the earthquake epicenter.

Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments which have a common calibration. The magnitude of an earthquake is thus represented by a single, instrumentally determined value.

To Do and Notice

Hold up one piece of spaghetti. Bend the piece between your hands until it breaks. Notice the work it takes to break the spaghetti. Call this a **5** on the Pasta Magnitude scale.
Hold up a bundle of 30 pieces of spaghetti. Bend the bundle until it breaks. Notice the work it takes to break the bundle. If the pasta magnitude scale were like the earthquake magnitude scale this would be a Pasta Magnitude **6** break.
Hold up 900 pieces of pasta, the remainder of the package. Bend the bundle until it breaks. Notice the work it takes to break the bundle. This is a Pasta Magnitude **7** break.

What's Going On?

The magnitude scales for earthquakes are logarithmic scales. In particular, for the Richter scale, each increase of 1 unit on the scale, say from 6 to 7, represented an increase of one order of magnitude, i.e. times 10, in the amount of motion recorded on a particular type of seismograph.
The now-common *Moment Magnitude* scale was defined because the Richter scale does not adequately differentiate between the largest earthquakes. The new "moment magnitude" scale is a new technique of using the Richter scale.

Materials

1 – 1 lb. package of thin spaghetti ***OR***
1- 2 lb. package of regular spaghetti.

Fig. 1. Mag. 5=1 piece, Mag. 6=30 pieces, Mag. 7=900 pieces.

In the moment-magnitude scale a magnitude increase of one unit corresponds to a factor of 30 increase in the energy released by the breaking of the fault in an earthquake. That's why we increased the number of spaghetti noodles from 1 to 30 to 900 (900 =30 x 30).

So What? In order to release the energy of one M 7 earthquake you would have to have 30 M 6 quakes or 900 magnitude 5's. Notice also all the little "quakes" before and after the big-quake break.
In this model, *what does the spaghetti represent?* (The earth, rocks, tectonic plates) What do your hands represent? (Forces, stress, another plate) What does the breaking spaghetti represent? (An earthquake)

Discussion

Describe the energy transfers and transformations—what kind of energy does the spaghetti have when it is bent but not yet broken? (Potential) What kind of energy does the spaghetti have when it is breaking? (Sound, kinetic, heat) Is this an energy transfer or transformation? Explain your choice. (Transformation because the type of energy is changing) If energy cannot be created or destroyed, what happens to the energy released during an earthquake? (It transfers to move buildings, the ground, and the air, and transforms to sound, heat etc)
Are the forces in this investigation balanced or unbalanced? (Unbalanced) How do you know? (The spaghetti bends which is a change in direction (acceleration) and when the spaghetti breaks, it changes speed (acceleration).

What is the North Carolina connection to the Pasta Quake Activity?

Connection

Use the Pasta Quake activity to compare the amount of energy released from historical or current earthquakes to the largest earthquake recorded within the borders of North Carolina, a Magnitude 5.2 (Table 1) (Assume a 5.0 as in the Pasta Quake). For information and education about large recent earthquakes (within hours of the event) see IRIS Teachable Moments www.iris.edu/hq/retm/ .

Background Information

Scientists use various scales to determine the strength of an earthquake. Two of those scales are the Magnitude Scale and the Modified Mercalli Intensity Scale. The Magnitude Scale is an attempt to measure how much energy was released by the earthquake and is the number that most people associate with an earthquake, for example "magnitude 3." The Modified Mercalli Intensity Scale describes how earthquakes "feel" and how much destruction the earthquake causes. This scale has twelve levels designated by Roman numerals I – XII (one through twelve), to symbolize the amount of damage felt by the earthquake. Many factors determine the intensity of an earthquake at the surface of the earth, such as the depth where the earthquake originates and what kinds of rock and soil are at the surface.

Table 1. Damaging Earthquakes in North Carolina from 1598 - 1989. United States Geological Survey Professional Paper 1527.

Year	Epicenter	Magnitude	Intensity (Mod. Mercalli)
1861	Near Wilkesboro, Wilkes County	5.0	VI
1916	Near Skyland, Buncombe County	5.2	VII
1926	Southern Mitchell County	5-6 estimated	VII
1957	Near Woodlawn, McDowell County	4.0	VI
1957	Buncombe County	3.7	VI
1957	Northwest Jackson County	3.9	VI
1981	Near Hendersonville, Henderson County	3.5	VI

North Carolina has its share of earthquakes, but large, damaging seismic events are infrequent in our state. As you can see from the earthquake map, these seismic events originate in our state and surrounding states (fig. 2). Circles and squares represent earthquake epicenters and bigger symbols represent larger magnitude earthquakes. The effects of an earthquake cover a much larger area than the location of the dot or epicenter.

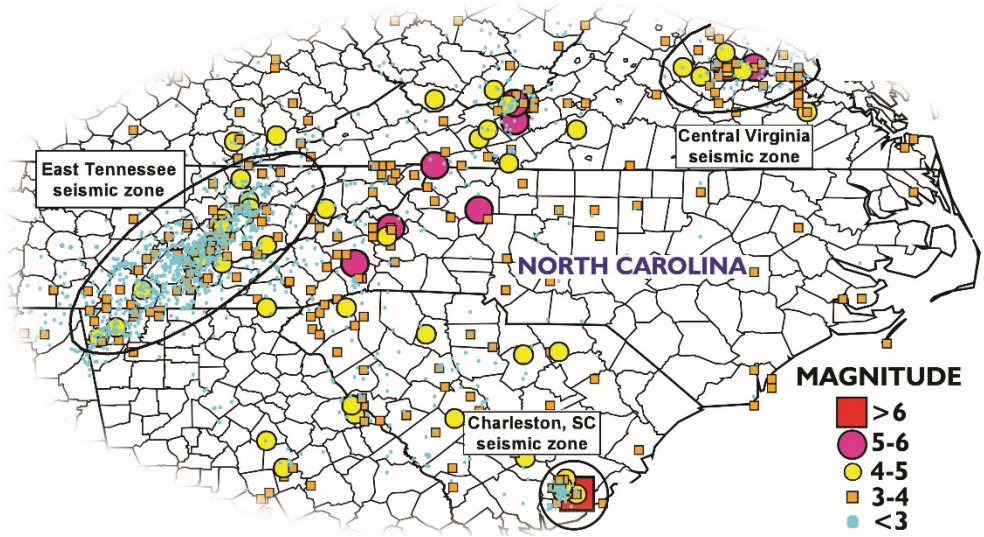

Fig. 2. Earthquake epicenters from 1968-2002 in and around North Carolina.

More seismic information and activities:

For a great video of this activity, including an extension "spaghetti building resonance", go to www.iris.edu/hq/inclass/animation/235 .

For more earthquake activities, videos/animations and information can be found through: www.iris.edu/hq/inclass/animation/235 , www.iris.edu/hq/retm/ and www.iris.edu/hq/ .

References for North Carolina information: Bechtel, R., 2005, When the Ground Moves!: A Citizen's Guide to Geologic Hazards in North Carolina: NCGS Information Circular 32

2014 N.C. Earthquake Education Workshops - Download activities and information for free : A) google "NC earthquake workshops" or B) https://deq.nc.gov/about/divisions/energy-mineral-land-resources/north-carolina-geological-survey/geoscience-education/earthquake-workshop-downloads

For N. C. related information contact Dr. Kenneth Taylor kenneth.b.taylor.taylor@ncdenr.gov or randy.bechtel@ncdenr.gov of the N.C. Geological Survey.