Resource from animation found at: <http://www.iris.edu/hq/inclass/search>

**Narration from the animation:**

**Magnitudes: Moment Magnitude Explained**

Earthquakes are now reported as “moment magnitude”.

So what happened to the Richter scale?

Charles Richter & Beno Gutenberg developed the first magnitude scale in the 1930’s to quantify earthquakes by comparing [relating] the size, or amplitude of seismic waves, shown on the right, plotted against distance as calculated from S-P arrival times. Connecting the two gives you the Richter Magnitude.

The scale is logarithmic, so a one-unit increase in magnitude 34 corresponds to ten times larger amplitude.

The limitation was that seismologists measured certain frequencies which meant that the signals from large earthquakes weren't adequately represented, like not being able to hear the bass notes on your laptop speaker.

That meant that the Richter scale underestimated large earthquakes.

Scientists have since developed far-more sensitive seismometers that, with faster computers, have enabled them to record & interpret a broader spectrum of seismic signals, These improvements allowed them to better determine the energy released by large earthquakes,”. .

In 1979 they connected the seismograph recordings with the actual physical displacements. that occur during an earthquake.

The result was the moment magnitude scale. Seismologists no longer look at only the amplitudes of seismic waves but instead use much more information contained in the seismogram to calculate what is called the seismic moment”

The seismic moment, which defines how much force is needed to generate the recorded waves, is defined by this equation: Mo = \* D \* A.

Myu is rock rigidity. It describes the resistance of the rock to bending when force is applied and is a constant for a given rock material."

More elastic energy is stored bending rocks of high rigidity than is stored bending rocks of low rigidity. For example, this brick has a high rigidity and when bent or sheared would yield a strong “earthquake”. The cake has lower myu, and shears easily. Rock rigidity is lower in the crust than it is in the mantle **.**

As mentioned earlier, in most cases distance and area can be determined by mathematical modeling of seismograms.”

D is the distance that the rock slipped along one side of the fault zone relative to the other side. In the 1906 San Francisco Earthquake this fence line was offset .over 3 meters

A is the estimated area of the fault zone along which the rock slipped the distance D.

A is the the area that actually ruptured during the earthquake.

Let’s watch an earthquake happen.

The arrows show forces building on opposing sides of a fault. Growing stress that will be relieved in the earthquake is shown in red.

Here we see Blocks of rock move in opposite directions across a strike-slip fault zone, such as the San Andreas fault in California.

Potential energy, in the form of elastic energy, is stored in Earths crust or mantle building stress as the ground slowly deforms between large earthquakes.

If we could look below the ground, we would see the earthquake rupture that defines the seismic moment and is determined by mathematical modeling of seismograms.”

That equation is then plugged into the Moment Magnitude equation which is used by [seismologists](http://en.wikipedia.org/wiki/Seismologist) to measure the size of earthquakes in terms of the *energy* released, not just the amplitude of the recorded waves.]

The constants in the moment scale are chosen such that at smaller magnitudes the moment mag matches the richter scale.To truly appreciate this, consider the changes in earthquake rupture required to increase the moment magnitude by one unit. Either the area of rupture or the slip distance or both must increase so that the product of slip distance times area increases by a factor of 32*.*

While the amplitude of shaking caused by a magnitude 5 earthquake is ten times larger than for a magnitude 4 earthquake**,** the *energy* released increases by about 32 times for each unit increase in magnitude.

To understand the scaling we’ll look at the effects of the rupture area by using pasta as a model for magnitude.

The cross-sectional area of a strand of spaghetti is about asquare millimeter. When you break the noodle it makes an “earthquake” of, let’s just say magnitude 5 for our model.

Mu is constant for all strands of pasta and for D we’ll use 1 millimeter of displacement across the fault. So here we see the pasta break and move laterally 1 mm.

To increase it to a Moment magnitude of 6 we multiply it times 32. The surface area is 32 times higher, yet the amplitude is just 10 times higher. To reach a magnitude 7, you have to multiply 32 times 32 and you get roughly a 1000 strands, or about a pound of spaghetti noodles.

To get a magnitude 8 you need 32,000 pieces of spaghetti.

A magnitude 8, on the other hand, would require a million pieces of spaghetti.

A magnitude 9 releases 1000 times more energy than a magnitude 7 earthquake.