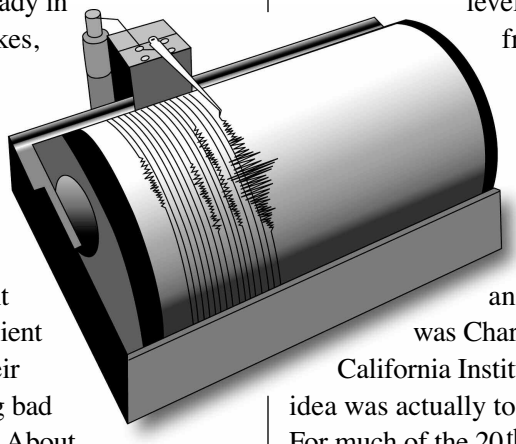
What's Happening IN THE USA?

BY LAWRENCE GABLE VOL 18, NO 8 APRIL 2011

"How Big Was It?"

In 2010 earthquakes killed about a quarter million people worldwide. The one that struck Haiti killed the most people, but there were 16 other earthquakes that were more powerful. Already in 2011 there have been six such quakes, and the one in Japan in March has caused terrible problems. Whenever there is news of a new earthquake, the first question is, "How big was it?" Seismologists provide the answer.



People always have sought explanations for earthquakes. Ancient civilizations often believed that their gods were angry, or that something bad was happening in the underworld. About 2,000 years ago the Chinese developed the first instruments to detect movement in the ground.

The science of seismology developed in the 18th century. An American, John Winthrop, attempted to find scientific explanations for earthquakes, not religious ones. For that reason many people refer to him as the founder of seismology. Soon it became common for people to write down basic information about quakes. That included when they struck, how long they shook, and descriptions of the shaking.

By the late 1800s seismologists had developed two instruments to help their studies. One was the seismometer, which detects seismic impulses and records what time they occur. The other was the seismograph. It records the intensity, direction and duration of seismic impulses onto a piece of paper. When the earthquake struck San Francisco in 1906, for example, seismographs were in place to record valuable information for scientists to study.

In 1931 two American seismologists improved a scale for measuring the intensity of earthquakes. Intensity does not refer to the energy that an earthquake releases. It refers only to the effect it has on people, structures and the landscape in specific areas. The scale, called the Mercalli Intensity Scale, assigns values in Roman numerals. Level I is the lowest, and it means that very few people felt the quake at all. Level XII is the highest, and it means that the area suffered total damage.

The Mercalli Scale does not use instruments to measure a quake. Instead it depends completely on eyewitnesses in certain places. Even though the Mercalli level for the same earthquake changes from place to place, city planners and engineers still use the Mercalli scale. It gives them a valuable record of where earthquake damage tends to be worst.

In 1935 another American developed a scale that measures an earthquake's magnitude. He was Charles Richter, a seismologist at the California Institute of Technology in Pasadena. His idea was actually to measure the amount of shaking. For much of the 20th century his scale was the standard measurement of an earthquake's power.

Richter's scale used readings from seismographs. Although seismographs are now digital, older ones used to have an arm with a needle that drew a line along paper. As the waves from an earthquake shook the arm, the needle drew jagged lines along the paper. When an earthquake moved the arm one-thousandth of a millimeter, Richter called that magnitude "1.0." When it moved one-hundredth of a millimeter, Richter's scale called its magnitude "2.0," but that represented ten times more movement. A difference of two whole numbers represented 100 times more movement.

By the 1970s seismologists knew that they needed a better scale for measuring large quakes. Some years later they began using a scale called "moment magnitude." This considers more things about the Earth's plates that moved and caused the shaking. Its calculations include the length of the plates that slipped, the distance one plate moved compared to the other, and how rigid the rock in the area is. Moment magnitude measures the total energy that the earthquake released, not just the energy and movement at the surface.

Modern seismographs can detect strong earthquakes from anywhere in the world. They allow seismologists to offer a lot of detailed information quickly. Now when people ask how strong a quake was, the answer they get is better than ever.

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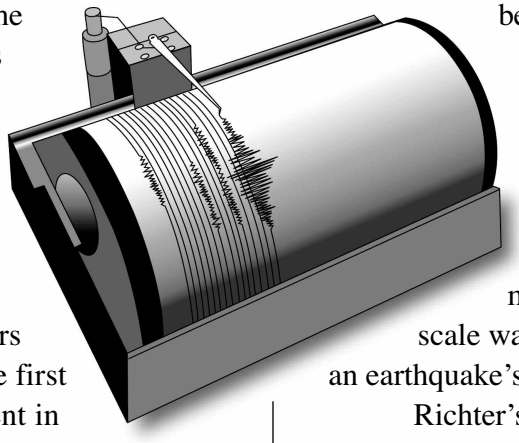

People always have tried to understand earthquakes. Ancient civilizations often believed that their gods were angry. About 2,000 years ago the Chinese developed the first instruments to detect movement in the ground.

The science of seismology developed in the 18th century. An American, John Winthrop, was the founder of seismology. He tried to find scientific causes for earthquakes, not religious ones. Soon it became common for people to write down information about quakes. That included when they struck, how long they shook, and descriptions of the shaking.

By the late 1800s seismologists had made two instruments to help their studies. One was the seismometer, which feels movements and records when they occur. The other was the seismograph. It records the intensity and duration of movements onto a piece of paper. When the earthquake struck San Francisco in 1906, seismographs recorded information from it.

In 1931 two American seismologists improved a scale for measuring the intensity of earthquakes. Intensity refers to the effect they have on people, buildings and the landscape. The scale, called the Mercalli Intensity Scale, assigns values in Roman numerals. Level I means that very few people felt the quake at all. Level XII means that the area suffered total damage.

The Mercalli Scale depends completely on eyewitnesses. As a result, the Mercalli level for the same earthquake changes from place to place. Even so, city planners still use Mercalli levels because they tell where earthquake damage is worst.

In 1935 another American, Charles Richter, developed another scale. His idea was actually to measure the amount of shaking. For much of the 20th century his scale was the standard measurement of an earthquake's power.

Richter's scale used readings from seismographs. Seismographs are now digital, but older ones had an arm with a needle that drew a line on paper. As the waves from an earthquake shook the arm, the needle drew jagged lines along the paper. When an earthquake moved the arm .001 of a millimeter, Richter called that magnitude "1.0." When it moved .01 of a millimeter, he called it "2.0." One whole number on the scale represented ten times more movement.

By the late 1970s seismologists had a better scale for measuring large quakes. They call it "moment magnitude." This considers more things about the Earth's plates that moved and caused the shaking. Its calculations include the length of the plates that slipped, the distance one plate moved compared to the other, and how rigid the rock in the area is. Moment magnitude measures the total energy that the earthquake released, not just the energy and movement at the surface.

Modern seismographs can detect strong earthquakes from anywhere in the world. Seismologists can offer a lot of detailed information quickly. Now when people ask how strong a quake was, the answer they get is better than ever.

Background Information

Seismology comes from the Greek word *seismos* ("earthquake").

Seismometers also pick up seismic impulses from things like volcanic eruptions, landslides, explosions and traffic.

Earthquakes happen when the plates that form Earth's surface move. Seismologists describe their motion as "divergent" (when plates move apart from one another), "convergent" (when plates push toward each other, forcing one plate to slide beneath the other), or "transformational" (when plates rub their sides in opposite directions along each other).

There are two major types of seismic waves. Body waves travel directly through the Earth, and they are short, sharp motions that usually cause little damage away from the epicenter. Surface waves travel along Earth's surface and cause the most destruction.

Giuseppe Mercalli was an Italian scientist who lived from 1850 to 1914. In 1902 another Italian expanded his scale from ten degrees to twelve. Seismologists in the U.S. currently use the Modified Mercalli Intensity Scale, which the American seismologists Harry Wood and Frank Neumann developed in 1931.

Richter's seismographs picked up seismic waves clearly only from nearby, shallow earthquakes. They did not detect seismic waves from quakes that were more than 20 miles below Earth's surface.

An increase of one whole number on the Richter Scale represents 32 times more energy. Two whole numbers represent 1,024 times more energy (32 x 32).

The numbers for moment magnitude correspond closely to Richter's numbers for earthquakes up to magnitude 7.0, but the moment magnitude scale is more accurate for larger earthquakes. For example, the largest earthquake ever recorded was in 1960 along the coast of Chile. Although it registered on the Richter Scale at 8.5, the moment magnitude scale puts it at 9.5.

Calculating moment magnitude takes about two hours.

In the parts of Japan that were hit hardest on March 11, the Mercalli level is IX.

Earthquake researchers in the U.S. founded the Seismological Society of America in 1910 as a response to the San Francisco earthquake of 1906.

Topics for Discussion and Writing

Pre-reading:

- How do scientists measure how big an earthquake was?

Comprehension:

- Compare the purpose of the Mercalli Scale's readings with the purpose of the Richter Scale or moment magnitude.

Beyond the Text:

- Why do non-scientists prefer the Mercalli Scale's measurements to more scientific measurements?
- Make a list of things that you think the Mercalli Scale might mention regarding effect on, or damage to, an area. Then check it against the scale itself at **http://quake.abag.ca.gov/shaking/mmi/**
- Describe one image from Japan's earthquake and tsunami that sticks in your mind.

Vocabulary (*advanced article only)

Article-specific: seismologist; underworld*; eyewitness; magnitude; standard; jagged;

High-use: to seek; civilization; to detect; impulse*; intensity; duration; to release; structure*; specific*; to tend*; rigid

Sources

World Book Science Year August 1, 2009

The Economist April 22, January 21, 1995

U.S. Geological Survey **www.earthquake.usgs.gov**

CA Curricular Standards (4–12)

English-Language Arts

Reading 1.0 Vocabulary Development
2.0 Comprehension (Informational Materials)

Writing 1.0 Writing Strategies
2.0 Writing Applications

ELD—*Intermediate and Advanced*

Reading Vocabulary Development/Comprehension
Writing Strategies and Applications
Listening and Speaking

Science

4.5; 6.1; 6.2; 7.4
Physics (waves); Earth Sciences (CA geology)