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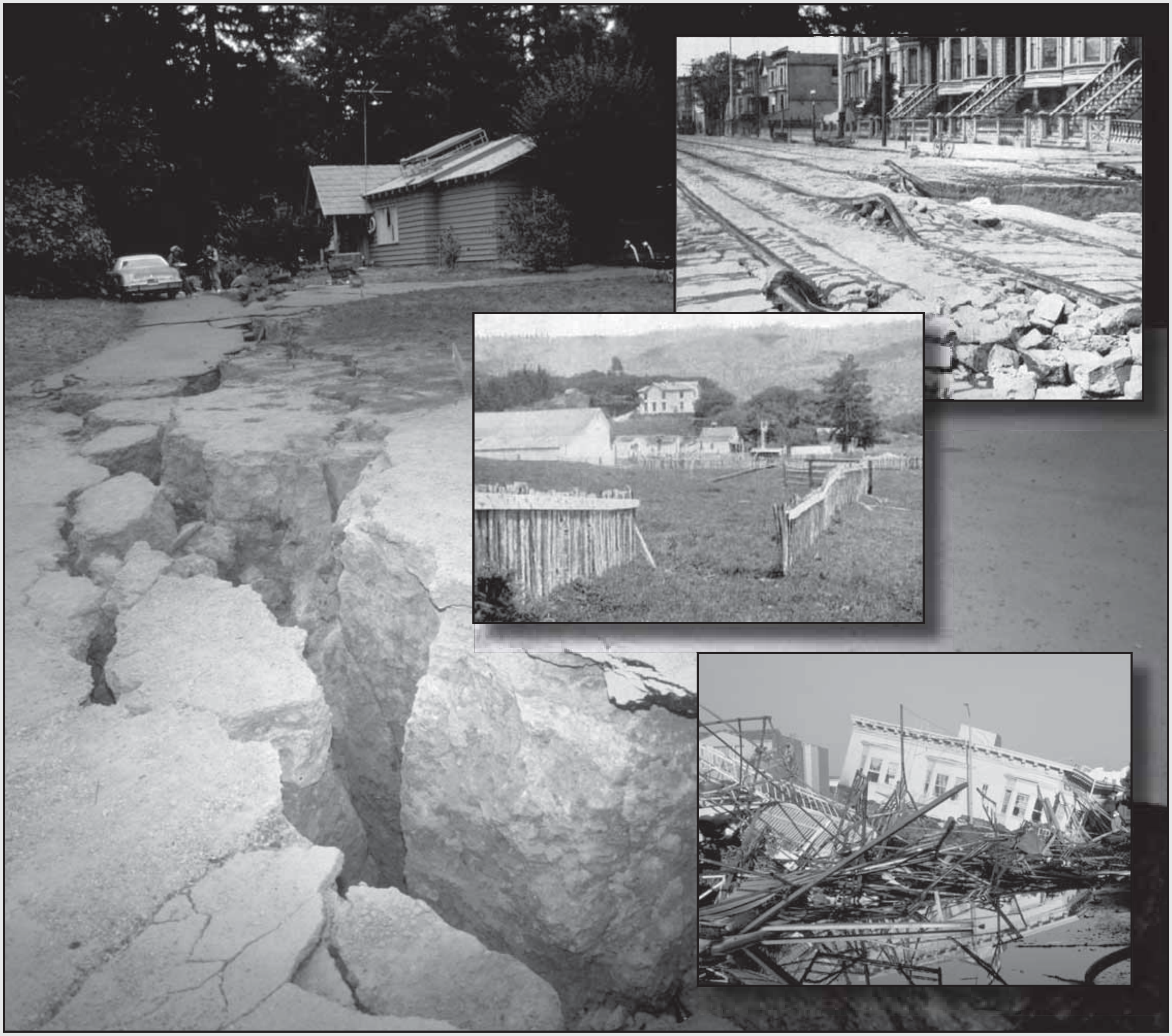
# Earthquake Science Explained

## A Series of Ten Short Articles for Students, Teachers, and Families



General Interest Product 21

**U.S. Department of the Interior**
**U.S. Geological Survey**

# Earthquake Science Explained

## A Series of Ten Short Articles for Students, Teachers, and Families

Compiled by Matthew A. d'Alessio

The features in this booklet originally appeared in the San Francisco Chronicle from September 12 to November 14, 2005, as part of that newspaper's Chronicle in Education program—a program to distribute newspapers free to classroom teachers and encourage their use as a curriculum resource. For information go to:

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SAN FRANCISCO CHRONICLE
IN EDUCATION

General Interest Product 21

U.S. Department of the Interior
U.S. Geological Survey

**U.S. Department of the Interior**
Gale A. Norton, Secretary

**U.S. Geological Survey**
P. Patrick Leahy, Acting Director

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# A Message from the Director, U.S. Geological Survey

Recent images of massive earthquake-induced waves washing away entire towns or buildings reduced to rubble by the violent shaking of Earth's crustal plates have underlined, all too painfully, the importance of understanding our dynamic and ever-changing Earth. These natural earthquake hazards will always be with us, but the consequences are not inevitable—if we prepare for them. An essential part of that preparation is education. Education is the key to ensuring that people take appropriate actions when living in earthquake-prone areas and for supporting policies and decisions that will save lives and property.

Director Leahy with instruments at USGS headquarters that record seismic waves from earthquakes around the globe.

Earthquake Science Explained is a series of short articles for students, teachers, and parents originally published as weekly features in The San Francisco Chronicle. This U.S. Geological Survey General Information Product presents some of the new understanding gained and scientific advances made in the century since the Great 1906 San Francisco Earthquake. Concepts introduced in each feature are designed to address State and national science-education standards. Written by our scientists, the articles go beyond traditional textbook information to discuss state-of-the-art thinking and technology that we use today.

I encourage you to explore this informative publication as well as the U.S. Geological Survey's science education Web site at http://education.usgs.gov/, and I further invite you to become our long-term partners exploring the full range of our science for a changing world.

P. Patrick Leahy

# Contents

[The articles in the series correlate with the State of California Science Content Standards, as noted in brackets]

## Articles*

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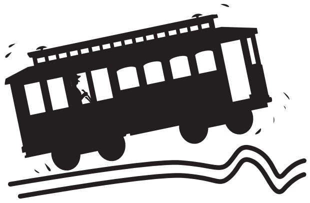
*All articles are written by scientists and focus on the evidence we collect during our work. They therefore directly address the important "Investigation and Experiment" California State Science Content Standard for all grade levels: Grade 4, Sc. 6, Grade 5, Sc. 6, Grade 6, Sc. 7, Grade 7, Sc. 7, Grade 8, Sc. 9, Grades 9 – 12, Science Investigation:

> Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.



*Earthquake Science—Feature 1 of 10*

# The Earthquake Machine:

## What 1906 taught us about how earthquakes work

**On April 18, 1906, the earth moved.** Not only did the ground shake on the day of the Great San Francisco earthquake, but land on both sides of the San Andreas fault permanently shifted. Precise measurements of the amount of motion led scientists to discover why earthquakes happen.

Fences across the San Andreas fault ripped apart, and it was no longer clear who owned the land nearby. Surveyors went to mountain peaks to relocate the property boundaries. While the fences showed that ground had moved near the fault, the surveyors also discovered that much of northern California had moved and distorted during the earthquake. The movement followed a pattern with most of the motion near the fault and less motion far away.

Fence after 1906 earthquake.

At the time, nobody knew what caused earthquakes. The survey measurements led a scientist named H. F. Reid to propose one possible explanation. He hypothesized that strain built up in the earth's crust like the stretching of a rubber band. At some point, the earth would have to snap in an earthquake. The problem was that Reid didn't know what caused the strain to build up.

Scientists continued to survey after the earthquake and saw that motion continued throughout California, providing an important piece of evidence that the Earth's tectonic plates are in constant motion. This plate motion is Reid's missing cause of strain.

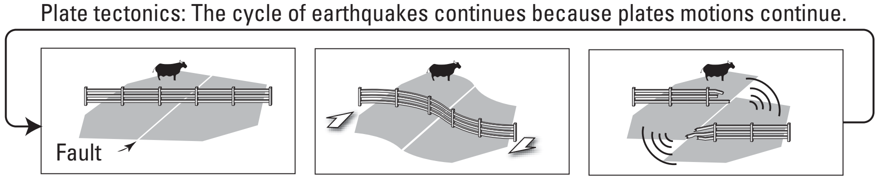
Two plates can get stuck together where they meet (at faults), but forces deep within the earth drag and pull the plates in different directions. Faults remain stuck together for many years as the nearby crust deforms and stretches, but eventually the strain is too much and the two plates shift suddenly in an earthquake.

Today, scientists monitor the buildup of strain near locked faults using satellite observations, and the pattern is much like Reid hypothesized 100 years ago.

By Dr. Matthew d'Alessio

U.S. Geological Survey
Earthquake Hazards Team

Plate tectonics: The cycle of earthquakes continues because plates motions continue.




A new fence is built straight across the fault at the boundary between two plates.

Over many years, plate motions cause strain to build up and deform the earth (and fence).

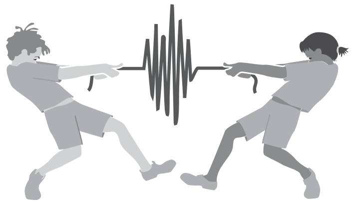
An earthquake is a sudden burst of motion that relieves the strain and causes shaking.

**Resources:** Demonstrate the earthquake cycle in your classroom (animations & "The Earthquake Machine"): http://quake.usgs.gov/research/deformation/modeling/teaching/

Putting Down Roots in Earthquake Country, a special insert in The Sunday Chronicle, Sept. 18, 2005, contains information about making your family safer in the next quake. Also online at: http://pubs.usgs.gov/gip/2005/15/

SAN FRANCISCO CHRONICLE IN EDUCATION

**Newspaper Activity**: Land features can change naturally over time, or more rapidly during an event such as an earthquake. Read and summarize an article in today's Chronicle that discusses natural or man-made changes in the land.



*Earthquake Science—Feature 2 of 10*

# Seismograms: Earthquake Fingerprints

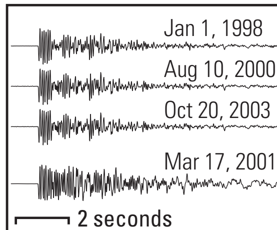
**When a fault slips suddenly in an earthquake, it releases energy in the form of seismic waves.** Captured by sensitive instruments, a seismogram is a recording of the shakes and jolts of these passing seismic waves. Seismograms are like the fingerprints of earthquakes with patterns that can be matched and decoded to learn about how earthquakes affect our world.

We know the earthquake's magnitude from the height of the waves, and we can figure out when and where the earthquake happened from the times the waves arrive at different places. The exact pattern of the wiggles is shaped by the individual earthquake: how deep it was, which direction the fault moved, and what kinds of rocks the waves passed through.

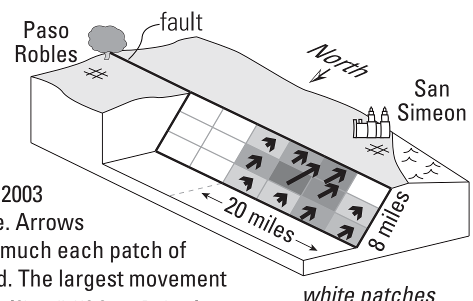
Most earthquakes have unique seismograms, like people have unique fingerprints. Some groups of small earthquakes have almost identical seismograms, which means that these earthquakes are repeats of exactly the same motion in exactly the same direction in exactly the same place.

We can find out even more about big earthquakes by breaking them down into smaller parts. For example, a magnitude 6.5 earthquake that hit Paso Robles in December 2003 released built-up strain over a fault area 20 miles long and 8 miles from top to bottom. You can think of this area as being like a quilt divided into individual patches. The movement of each patch has its own unique fingerprint. The seismogram of a large earthquake is then the combined fingerprints of all the patches. We use a computer to match patterns in the large earthquake's seismogram to figure out which patches of the fault moved and by how much.

Some patches of the fault did not slip much, so we can expect future earthquakes sooner there. Patches that slipped a lot already won't move again until plate tectonics causes the strain to build back up.




Seismograms from magnitude 2 earthquakes on the San Andreas fault. The same patch of fault slipped 3 separate times, producing nearly identical seismograms (top 3). A different patch slipped and has a different fingerprint (bottom). [R. Nadeau, UC Berkeley]




View into the Earth along the fault of the December 2003 earthquake. Arrows show how much each patch of fault moved. The largest movement was 9 feet. [Chen Ji, UC Santa Barbara]

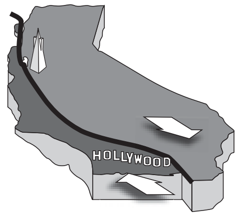
By Dr. Jeanne Hardebeck

U.S. Geological Survey
Earthquake Hazards Team

**Resources:** Recent earthquake locations: http://quake.usgs.gov/recenteqs/latest.htm • Listening to Seismic Waves (activity to introduce seismic waves): http://quake.usgs.gov/info/listen/ • Virtual Earthquake (online activity to locate earthquakes using seismic waves): http://cdl-flylab.sonoma.edu/eec/Earthquake/

SAN FRANCISCO CHRONICLE
IN EDUCATION

**Newspaper Activity**: Advances in technology have helped scientists better understand earthquakes. Read today's Chronicle to find an article about other advances in technology. How could these advances change your life?




*Earthquake Science—Feature 3 of 10*

# Find the Fault:

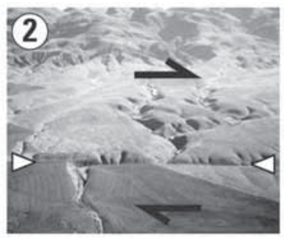
## Recognizing Active Faults

**Faults are where large blocks of the Earth's crust move past each other.** At plate boundaries, they are most often stuck tight, but at times they lurch several feet in a great earthquake. Living near faults is a fact of life for many Californians, but how do you recognize an active fault?

Some faults, called creeping faults, move very slowly all the time. Structures like bridges, sidewalks, and buildings built astride these faults will be offset as the faults slowly move (up to a half inch each year). You can find these faults by looking for bent or offset curbs and sidewalks (Photo 1). Not every offset curb is a fault, but if you find several features that all line up, you may have found a fault.


This curb is offset by about one foot due to creep on the Calaveras Fault. The white triangles point along the fault.

However, most faults don't creep, so geologists look for effects faults have on the landscape. Natural features like streams, valleys, and ridges can be offset from repeated earthquakes if they cross the fault (Photo 2).




The stream in this photo is offset by movement along the San Andreas Fault. As the fault continues to move, the two parts of the stream will get farther apart. Also, a straight ridge, or "scarp" runs along the fault.

Active faults also make their own landscape features. If one side of the fault moves up or down, it creates a long, straight ridge called a "scarp." As faults move along in repeated earthquakes, the rock along the fault is broken and ground down. This shattered zone is more easily eroded than the surrounding rocks, so long valleys can form along the fault (Photo 3). So faults can cause both ridges and valleys to form. Faults also can disrupt the movement of underground water, forcing it to the surface to form springs and ponds.


Crystal Springs Reservoir lies within the long, straight valley broken up by the San Andreas Fault.

A lot of these features are easiest to spot from the air. Our newest tool to find faults is Laser Imaging Detection And Ranging (LIDAR), which uses laser light from an airplane to make a detailed image of the ground surface that can even see through trees in a forest. Being able to read the landscape allows us to pinpoint the exact location of dangerous faults.

By Dr. John Solum and
Dr. Russell Graymer

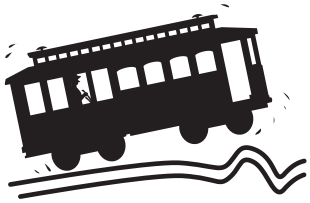
U.S. Geological Survey
Earthquake Hazards Team

**Resources:** Visit the San Andreas Fault: A Geology Fieldtrip Guidebook To Selected Stops On Public Lands, http://pubs.usgs.gov/of/2005/1127/

SAN FRANCISCO CHRONICLE
IN EDUCATION

**Newspaper Activity**: Using the Bay Area map on today's Weather Page, look for features that could indicate a fault. Which cities are closest to these features? Which bodies of water?

Want to know more? Visit http://education.usgs.gov



*Earthquake Science—Feature 4 of 10*

# Looking into the Past With Earthquake Trenches

**Do earthquakes tend to repeat at regular intervals?** If so, that may tell us when to expect the next one. Many earthquakes happened long before recorded history; how can we discover what happened so long ago?

Geologists look for evidence in the ground below us. Layers of earth get added, one on top of the other, over time. Like the pages of a history book, each layer records what was happening at that time. A layer of round rocks can indicate an ancient river, while a layer of mud can be from an ancient flood. Layers also record earthquakes. The ground can shift several feet or more during an earthquake, disrupting the layers (and "tearing" the pages of Earth's history book). In the years after an earthquake, new layers of rock and soil may blanket the area and bury the broken layers below.

Scientists dig trenches across active faults to look for evidence of ancient earthquakes.

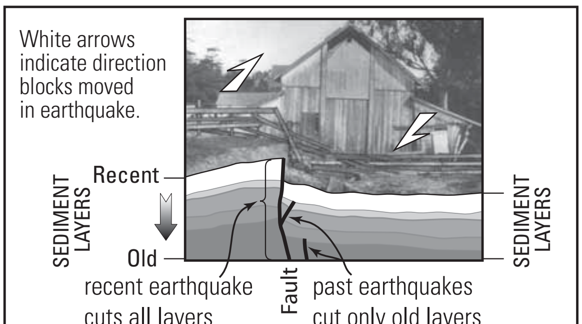
To go back in time, geologists dig trenches up to 20 feet deep and 10 feet wide and then walk in to observe the layers. If there has been a large quake, the sediment will be disrupted at the fault. Any layers that are not disturbed and that rest on top of the faulted layers were laid down after the earthquake.

Then, if we can figure out when the layers formed, we can figure out when the earthquake hit. Geologists look for plant or animal remains, like sticks or bones, in the buried layers and date them using the same tools used by archeologists.

With the information gathered in the trenches, geologists can tell how often earthquakes occur and even how large past quakes were. The more scientists know about a fault's past, the better they are able to suggest what may happen in the future.

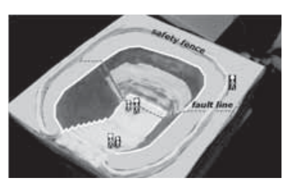
By Heidi Stenner

U.S. Geological Survey
Earthquake Hazards Team



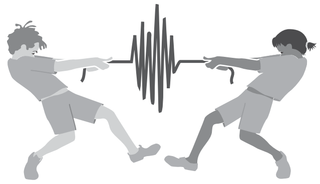

**Newspaper Activity**: Look through today's newspaper for pictures of items that you think should be included in an earthquake preparedness kit. Write a paragraph describing how you made your choices. What is the total price of the items?

In April 2006, visitors will walk below ground level to experience an active fault in downtown Fremont. They'll see evidence of an earthquake in 1868 — known as "The Great San Francisco Earthquake" until the even larger and more damaging 1906 quake.
http://quake.usgs.gov/research/geology/paleoseis/




SAN FRANCISCO CHRONICLE IN EDUCATION

Classroom Activity about trenching:
http://www.data.scec.org/Module/s1act09.html



*Earthquake Science—Feature 5 of 10*

# When will the next big one hit? How do we know?

**Plate tectonics causes stress to build up in the Bay Area, which will eventually be released by an earthquake.** By measuring the rate of stress buildup and the largest stress that the Earth can sustain, we can predict how many earthquakes will occur during a decade. If we could predict exactly when one will occur, people could be better prepared for the disaster. But does the earth give any warning signs that an earthquake is coming? If it does, we could record those signals on scientific instruments.

Scientists have made hypotheses about several ways faults might signal that they are about to rupture. For example, faults might start moving very slowly before they lurch violently in a big earthquake – a lot like a car starting up at a stoplight. This slow start could take place over a whole year or a fraction of a second. So far, it looks like the earth starts slipping too quickly to give us any warning, but it's possible that our instruments aren't sensitive enough to detect this motion.

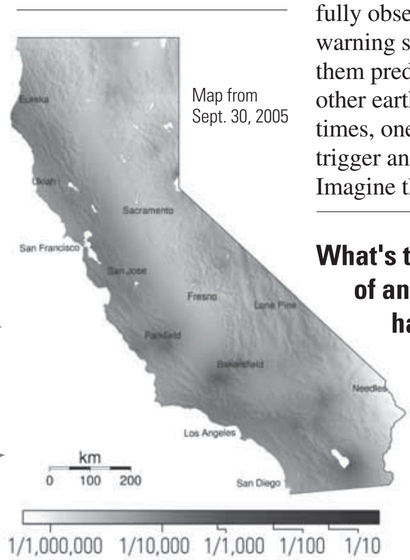
Scientists have successfully observed one type of warning sign that helps them predict earthquakes – other earthquakes. Sometimes, one earthquake can trigger another one. Imagine that an earthquake is like having one leg of a table break – if the objects on the table are too heavy for the remaining three legs to support, another leg will eventually snap under the stress. This is why aftershocks occur after a large earthquake. Scientists have detected patterns in aftershocks and can now predict how many large aftershocks there will be. This information helped San Francisco decide how many firefighters to keep on duty during the days after the 1989 earthquake.

Sometimes an aftershock can even be bigger than the first earthquake. When a small earthquake occurs, scientists predict the odds that the earthquake is a warning sign that a larger earthquake will hit soon. These odds are based on the earthquake's magnitude and the seismic history of the fault on which it occurred. If the chance is large enough, the government issues a warning.

There are lots of unanswered questions, and we are always looking for new, creative ways to measure what the Earth is doing.

By Dr. Matthew d'Alessio

U.S. Geological Survey
Earthquake Hazards Team




Probability of Exceeding MMI VI Shaking

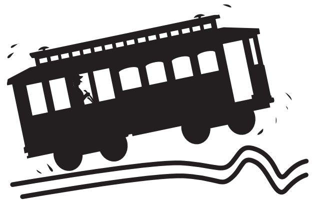
### What's the probability of an earthquake happening today?

An earthquake is more likely to happen in the dark areas.

*See today's map at*: http://pasadena.wr.usgs.gov/step

SAN FRANCISCO CHRONICLE IN EDUCATION

**Newspaper Activity**: Earthquake scientists have tried to use Earth's clues to predict earthquakes. Using today's Chronicle, read the headlines of a few articles to try to predict what the articles are about. Were your predictions correct?



*Earthquake Science—Feature 6 of 10*

# Liquefaction— When the ground *flows*

***After the 1989 Loma Prieta earthquake, a fireman on Treasure Island (in the middle of San Francisco Bay) told me his earthquake experience. He saw water spurting out of the ground from many places, and his greatest fear during the earthquake was that he might drown.***

As I listened, I was thinking how ironic this was. Only a few miles away in San Francisco, the same natural phenomenon that triggered the spurting water in the 1989 earthquake contributed to the fire that burned about 500 city blocks in San Francisco after the 1906 earthquake.

In both 1989 and 1906, buildings and streets had lots of damage where they were built on wet sand layers. This sand had been deposited not long ago either by rivers and creeks or by humans making new land by dumping sand into water bodies. Normally such sandy soil provides excellent support for buildings, but earthquake shaking jiggles the sand and squeezes the water trapped between the grains so much that the layer begins to act like a muddy liquid. We call this process liquefaction.

In 1989, the fireman on Treasure Island witnessed one effect of liquefaction, as muddy water spurted from the ground like the violent squeezing of a sponge. In 1906, the liquefied sandy soils flowed down hill slopes and snapped buried water pipes. With so many water pipes broken, firefighters in San Francisco did not have enough water to douse the fire. It raged out of control for three days. Firefighters even blasted buildings with dynamite to try to form fire breaks.

Today, many neighborhoods around San Francisco Bay are built on sandy soils. Geologists are busy mapping soil types to identify areas that might be at risk for liquefaction. They push probes more than 100 feet down into the soil, measuring how the probes slide into the earth. This tells them how much sand is present and how firmly it is packed together. Engineers and planners can use this information to make our community safer for the next time an earthquake shakes the Bay Area.

By Dr. Thomas Holzer

U.S. Geological Survey
Earthquake Hazards Team

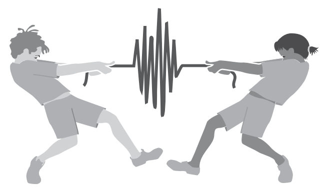
The fire that destroyed 500 city blocks after the 1906 quake raged out of control because **liquefaction** broke water pipes that were needed by firemen to fight the fire.

**Newspaper Activity**: This feature recounts a fireman's observations of liquefaction. Read today's Chronicle to find an article in which a personal experience was used to discuss a fact or theory. Write a summary of the article you chose.

**Liquefaction in your classroom:** Take a large rubber dish pan and fill it about one-quarter full with tap water. Then add sand with the texture of table salt until the sand surface reaches the water level. Stir the sand as you pour it into the water to remove bubbles and level the sand surface. Gently place a brick on the sand so that it stands up on its end like a skyscraper. Tap the side of the pan with a mallet with a series of quick taps. What happens to the brick?

SAN FRANCISCO CHRONICLE
IN EDUCATION

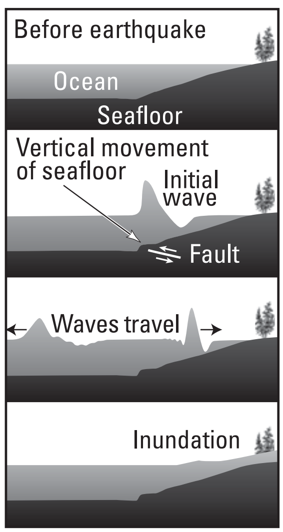
**Related activities**: See Lesson 6 of http://teachingboxes.org/earthquakes for an explanation and liquefaction maps.



*Earthquake Science—Feature 7 of 10*

# Bay Area Tsunamis: Are we at risk?

**The infamous 1906 San Francisco Earthquake** began when a tiny section of the 1300 km-long San Andreas fault began to rupture. That initial break-known as the hypocenter-occurred just offshore of San Francisco. Although most of the movement was strike-slip (with blocks of crust moving horizontally) there was a small amount of vertical movement. When the ocean floor moved down, it created a tsunami.




Tsunamis occur when the ocean floor moves vertically.

Luckily for San Franciscans already suffering the effects of a major earthquake, the 1906 tsunami wasn't a large one. In fact, it measured only 10 centimeters high when it arrived at the San Francisco tide gauge station near Crissy Field.

Does that mean there's no tsunami danger in the Bay Area? Not exactly! Our greatest tsunami danger comes from subduction zones similar to the one that generated the 2004 Indian Ocean tsunami, where one tectonic plate dives beneath another. When an offshore earthquake occurs along a subduction zone, a large section of ocean floor moves vertically, generating a tsunami. Tsunamis from subduction zone earthquakes as far away as Alaska or Japan, for example, can hit Bay Area shores. In 1964, a large earthquake in Alaska caused waves 6 meters high in northern California, killing 11 people. Today, the West Coast/Alaska Tsunami Warning Center would alert authorities in time to evacuate coastal regions. Although San Francisco Bay is sheltered by its narrow entrance at the Golden Gate, tsunamis can still enter the bay and result in strong currents.

We have tsunami danger from another source as well: a local earthquake could trigger coastal or underwater landslides, potentially leading to dangerous waves. If you feel shaking, be sure to leave the beach, even if no official alerts you!

What about that 10 centimeter 1906 tsunami? To scientists it was important; that single tide gauge record helped them to decipher how the offshore portion of the San Andreas fault moved during the Great 1906 Earthquake.

Eric Geist and
Anne Rosenthal

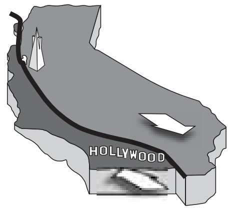
U.S. Geological Survey
Coastal and Marine Geology Program

**Newspaper Activity**: Tsunami is a word of Japanese origin meaning harbor wave. American English has adopted many words of non-English origin. How many non-English words can you find in today's Chronicle?

**Tsunamis in your classroom:** Take a glass baking dish (9" x 13" or larger) or clear rubber tub and fill with enough water to at least cover the bottom. Tip one end up and gently let the dish down to rest on the counter to generate waves. Use a ruler and stop-watch to calculate the speed at which waves move. Add more water and make new waves. How does the speed of the waves vary with the depth of water in the dish? The same is true for tsunamis! Tsunamis travel at different speeds in the deep Pacific Ocean than they do in the shallow San Francisco Bay.

SAN FRANCISCO CHRONICLE IN EDUCATION

**Find out more**: 1906 tsunami simulation: http://walrus.wr.usgs.gov/tsunami/1906.html




*Earthquake Science—Feature 8 of 10*

## An Earthquake Scientist in Action: Jessica Murray

I'm a geophysicist working with the Earthquake Hazards Team at the U.S. Geological Survey in Menlo Park. Although my father is a geologist, I didn't know I wanted to become an earth scientist until I took an introductory geology course in college. I was fascinated with understanding how different types of rocks are formed and change through various processes, especially the tectonic forces that cause earthquakes.

As an earth science major in college I took courses in many different aspects of geology. When I graduated I knew I wanted to pursue a career in the field, but wasn't sure in what to specialize. I did know that my favorite courses had been about "structural geology" which is the way in which rocks are slowly folded to form mountains or broken by faults like the San Andreas. I also knew that I wanted to do scientific investigations that were important for society in general – not just other geologists.

For those reasons I chose to attend graduate school to study a branch of geophysics called "crustal deformation." I learned to make and use measurements that tell us how the Earth's crust is distorted, or deformed, around faults and volcanoes. With this information we can determine where strain is building that may be released in an earthquake, or recognize that a volcano is inflating and may erupt soon.

One of the ways we monitor the slow movement of the Earth's surface is with Global Positioning System (GPS) instruments. These instruments are similar to what people use while camping or boating,

but are specialized for scientific applications. We can tell exactly where a location on Earth is to within about half the diameter of a dime.

A great thing about being an earth scientist is the opportunity to travel all over the world to investigate unique geological features. I get to work in a wide range of environments. Many of us do "field work" at least part of the year. This involves going to different locations, like near a fault or a volcano, and making measurements or taking samples.

For me, the best part is that I know the work I do will help us better understand the earthquake cycle and the hazards from large earthquakes.

Precise measurements using this GPS instrument help Dr. Jessica Murray monitor the motion of active faults.

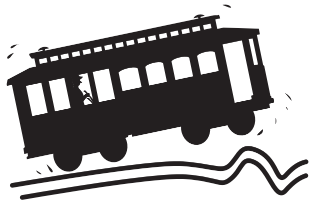
By Dr. Jessica Murray

U.S. Geological Survey
Earthquake Hazards Team

**Newspaper Activity**: Dr. Murray describes why she is a geophysicist and what a geophysicist does. Look through today's Chronicle for articles mentioning different jobs and classified job listings for jobs that you might like to have. Write a paragraph about each of the jobs that interest you.

SAN FRANCISCO CHRONICLE
IN EDUCATION

**Related Resources**:
http://www.earthscienceworld.org/careers/
http://earthquake.usgs.gov/4kids/become.html
http://education.usgs.gov/common/careers.htm



*Earthquake Science—Feature 9 of 10*

# How do we make buildings and roads safer?

Bay Area residents and visitors observe gigantic construction projects along our roads and bridges each day. Many of these projects are "seismic retrofits." A retrofit is a change in design and construction so that there are improvements; seismic retrofit means changes are made to a structure to reduce or eliminate loss of life and property during an earthquake.

We retrofit buildings and roads that were built using older techniques with designs that are less safe. Generally, it is cheaper and less disruptive to retrofit before hand than try to repair a structure damaged by an earthquake.

There are many ways a structure can be retrofitted, but two main ideas are most common. Sometimes, the best approach is to make a building stronger. Walls and foundations are designed to support the weight of the rest of the building pushing down on them. Earthquake shaking, however, pushes buildings side-to-side—a direction that they are not always designed to withstand. Shear walls and cross bracing (Pictures 1 and 2) provide strength and stiffness to resist future earthquakes. Shear walls can strengthen individual houses the same way they do for large buildings.

Another way to protect a building is to isolate it from the ground—a lot like adding shock absorbers to its foundation. The ground can move back and forth during shaking, but the building stays still (Pictures 3 and 4).

Because each building has unique architecture and a unique setting, there is a different retrofit solution that's right in each case. Earthquake engineers are people who come up with creative new ways to make these buildings safer than ever before.

By Dr. Mehmet Çelebi

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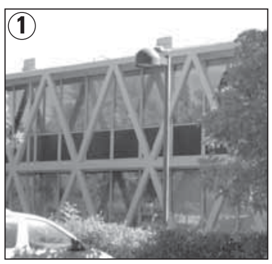
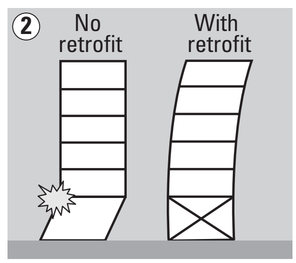
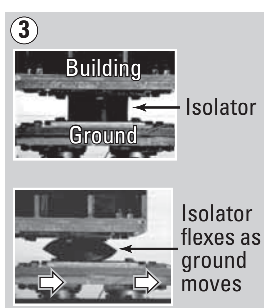


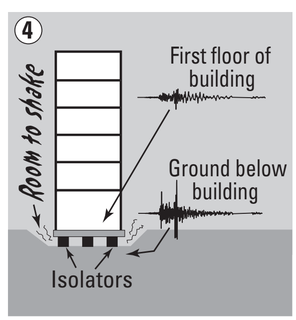

Cross-bracing strengthens the walls of this office building at the USGS in Menlo Park. Bracing can also be added inside walls.




During earth movement, even though the upper floors look fine (above left), the weak first floor could snap; strengthening it (above right) allows the whole building to flex gently.



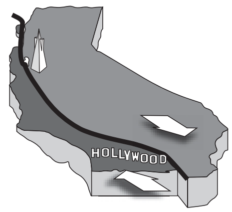

Base isolation allows the building to shake a lot less than the ground beneath it.




Engineers install instruments that record shaking to test if their retrofit designs worked.

SAN FRANCISCO CHRONICLE
IN EDUCATION

**Newspaper Activity**: This feature uses photos and graphics so readers can visualize the information in the text. Read today's Chronicle to find an article without a photo or graphic. Draw a picture and write a caption to accompany the article you chose.




*Earthquake Science—Feature 10 of 10*

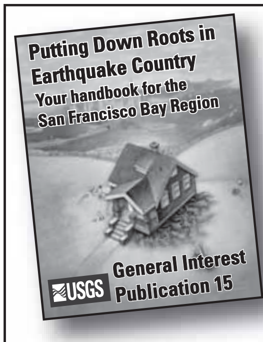
# Putting Down Roots in Earthquake Country

**If you live in the Bay Area, you live in earthquake country.** Earthquakes have helped sculpt the Bay Area's natural beauty – from it's dramatic ocean shoreline to the steep slopes of the East Bay hills and Santa Cruz mountains. Slight curves and bends in plate boundary faults cause the peaks to grow as plates slide past one another.

Most of the time (when faults are locked tight), the mountains stay still. When an earthquake happens, the mountains rise suddenly in a dramatic growth spurt that may push them a few inches or a few feet higher. These violent events that shape our landscape make the Bay Area a beautiful place to live, but also pose a hazard to people living here.

Large, damaging earthquakes will likely strike the Bay Area during your lifetime. Building codes and innovative construction techniques make structures a lot safer in the Bay Area than in many other parts of the world, so we don't expect the next large earthquake to claim as many lives as the recent earthquakes in Asia. However, many buildings in the Bay Area were built before modern building codes. Depending on when your home was built, it may be a good candidate for a seismic retrofit.

Earthquakes may seem a little frightening, but you can do a lot to prepare yourself. Start by knowing what to expect: a major earthquake will have a huge impact. The power will go out as power stations are damaged, water may stop flowing as pipes break, some roads and bridges may be unusable, and phones may not function in your neighborhood.




Want to know how to make your family safer? Order a free earthquake preparedness handbook online:
http://pubs.usgs.gov/gip/2005/15

Being prepared for these events will make your family safer. The box to the right shows five quick and inexpensive things you can do now to get prepared.

By Dr. Matthew d'Alessio

U.S. Geological Survey
Earthquake Hazards Team

**Try not to be scared of earthquakes – instead, be prepared!**

1. Prevent things from falling on your head during earthquake shaking by moving heavy objects away from high places — especially above your bed or desk.
2. Create a family disaster plan. Discuss where you will meet, and don't expect to rely on phones (cell, landline, or Internet) to get in touch after a quake. It may be easier to reach a friend outside California, so know her phone number and have your family use her as a central contact point.
3. Create a disaster kit. Have enough food and water for the entire family for at least three days.
4. When you feel an earthquake, drop to the ground, take cover, and hold on. Shaking makes it hard to move around, so don't try to run.
5. After a quake, be ready to help others in your neighborhood.

SAN FRANCISCO CHRONICLE
IN EDUCATION

**Newspaper Activity**: Using the Weather Page of today's Chronicle, mark on the Bay Area map the locations of your family members during week days. Then determine a meeting location during a disaster. What form of transportation will your family members use to get there? How far will they travel?

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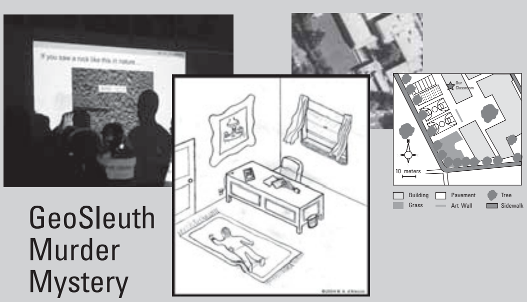
Find answers to your questions about earthquakes. Plus puzzles, games, and more!

Download this booklet online: http://pubs.usgs.gov/gip/2006/21/

## *Take more field trips!*

Rock Stories

Schoolyard Mapping



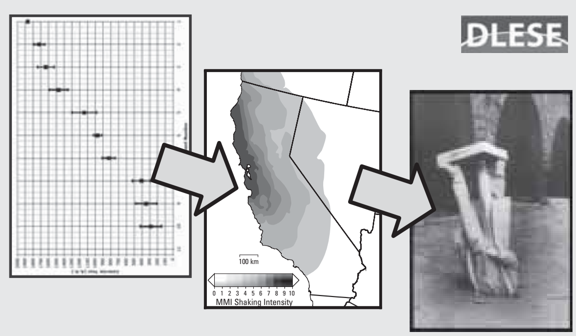
GeoSleuth Murder Mystery

### Schoolyard Geology

http://education.usgs.gov/schoolyard

Urban schoolyards full of asphalt may seem unlikely field trip destinations, but this website shows you how to unlock the history of the ground beneath your feet.

## Living in earthquake country




### Virtual Teaching Box

http://teachingboxes.org/earthquakes

Learn how and why earthquakes cause damage. This complete curriculum has classroom activities, background information, and the glue that ties it all together.

d'Alessio, ed.—**Earthquake Science Explained**—U.S. Geological Survey General Interest Product 21

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