USGS
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Earthquake Fact and Earthquake Fantasy

Earthquakes are sudden rolling or shaking events caused by movement under the Earth's surface.

FACT: An earthquake is the ground shaking caused by a sudden slip on a fault. Stresses in the earth's outer layer push the sides of the fault together. Stress builds up and the rocks slips suddenly, releasing energy in waves that travel through the earth's crust and cause the shaking that we feel during an earthquake. An earthquake occurs when plates grind and scrape against each other. In California, for example, there are two plates the Pacific Plate (which extends from western California to Japan, including much of the Pacific Ocean floor) and the North American Plate (which is most of the North American continent and parts of the Atlantic Ocean). The Pacific Plate grinds northwestward past the North American Plate along the San Andreas Fault at a rate of about two inches per year. Parts of the San Andreas Fault system adapt to this movement by constant "creep" resulting in many tiny shocks and a few moderate earth tremors. In other parts, strain can build up for hundreds of years, producing great earthquakes when it finally releases. Large and small earthquakes can also occur on faults not previously recognized; recent earthquakes in Alabama and Virginia are good examples.

Can "Mega Quakes" really happen?

THEORETICALLY, YES. REALISTICALLY, NO. The magnitude of an earthquake is related to the length of the fault on which it occurs -- the longer the fault, the larger the earthquake. The San Andreas Fault is only 800 miles long. To generate an earthquake of 10.5 magnitude would require the rupture of a fault that is many times the length of the San Andreas Fault. No fault long enough to generate a magnitude 10.5 earthquake is known to exist. The largest earthquake ever recorded was a magnitude 9.5 on May 22, 1960 in Chile on a fault that is almost 1,000 miles long. The magnitude scale is open-ended, meaning that science has not put a limit on how strong an earthquake could be, and scientists can't rule out a "Mega Quake" because they've only been measuring earthquakes for 100 years, a blink of an eye in geologic time. However, scientists agree that "Mega Quakes" of magnitude 10 or more are implausible.

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Earthquakes only occur on the West Coast.

FICTION: Earthquakes can strike any location at any time. But history shows they occur in the same general patterns over time, principally in three large zones of the earth. The world's greatest earthquake zone, the circum-Pacific seismic belt, is found along the rim of the Pacific Ocean, where about 81 percent of the world's largest earthquakes occur. That belt extends from Chile, northward along the South American coast through Central America, Mexico, the West Coast of the United States, the southern part of Alaska, through the Aleutian Islands to Japan, the Philippine Islands, New Guinea, the island groups of the Southwest Pacific, and to New Zealand. The second important belt, the Alpide, extends from Java to Sumatra through the Himalayas, the Mediterranean, and out into the Atlantic. This belt accounts for about 17 percent of the world's largest earthquakes, including some of the most destructive. The third prominent belt follows the submerged mid-Atlantic ridge. The remaining shocks are scattered in various areas of the world. Earthquakes in these prominent seismic zones are taken for granted, but damaging shocks occur occasionally outside these areas. Examples in the United States are New Madrid, Missouri, and Charleston, South Carolina. Many decades to centuries, however, usually elapse between such destructive shocks.

The 1906 San Francisco earthquake was the deadliest ever.

FICTION: Though well known, the magnitude 7.8 San Francisco earthquake and ensuring fire killed 3,000 and razed large sections of the city. It was the most deadly in U.S. history, but that doesn't make it the worst the world has seen, by far. The deadliest earthquake in recorded history struck Shensi province in China in 1556, killing about 830,000 people. The 1976 magnitude 7.8 earthquake which struck Tangshan, China killed somewhere between 250,000 and 800,000 people. In 2003, the magnitude 6.5 earthquake in Bam, Iran killed more than 40,000 people. The earthquake in Chile on May 22, 1960, is the strongest in the world with magnitude 9.5, and killed more than 4,000. For the record, the largest U.S. earthquake occurred on March 28, 1964, in Alaska. It was a magnitude 9.2 quake and took 131 lives.

California has the most earthquakes in the United States.

PARTIALLY FACT: Alaska registers the most Earthquakes in a given year, with California placing second. California, however, has the most damaging earthquakes because of its greater population and extensive infrastructure. Most of Alaska's large earthquakes occur in remote locations such as along the Aleutian Island chain. Florida and North Dakota have the fewest earthquakes each year.

Earthquakes can occur just below the surface or deep below the surface.

FACT: Earthquakes occur in the crust or upper mantle, from the earth's surface to about 500 miles below the surface. Seismologists use earthquakes to study the interior of the earth and to pinpoint faults and geologic structures such as the core-mantle boundary, subduction zones, and the subsurface extent of the San Andreas Fault. Using earthquakes and waves from earthquakes, scientist can see all of the earth's interior.

The ground can open up during an earthquake.

FICTION: A popular cinematic and literary device is a fault that opens during an earthquake to swallow up an inconvenient character. But unfortunately for principled writers, gaping faults exist only in movies and novels. The ground moves across a fault during an earthquake, not away from it. If the fault could open, there would be no friction. Without friction, there would be no earthquake. Shallow crevasses can form during earthquake induced landslides, lateral spreads, or other types of ground failures. Faults, however, do not gape open during an earthquake.

California will eventually fall into the ocean.

FICTION: The ocean is not a great hole into which California can fall, but it is itself land at a somewhat lower elevation with water above it. It's absolutely impossible that California will be swept out to sea.

Instead, southwestern California is moving horizontally northward towards Alaska as it slides past central and eastern California. The dividing point is the San Andreas fault system, which extends from the Salton Sea in the south to Cape Mendocino in the north. This 800 mile long fault is the boundary between the Pacific Plate and North American Plate. The Pacific Plate is moving to the northwest with respect to the North American Plate at approximately 46 millimeters (two inches) per year (the rate your fingernails grow). At

this rate, Los Angeles and San Francisco will one day (about 15 million years from now) be next-door neighbors, and in an additional 70 million years, Los Angeles residents will find themselves with an Alaska zip code!

An "Aftershock" can be greater than the initial earthquake.

PARTIALLY FACT: "Foreshock" and "aftershock" are relative terms. Foreshocks are earthquakes that precede larger earthquakes in the same location. Aftershocks are smaller earthquakes that occur in the same general area during the days to years following a larger event or "main shock". So if an "aftershock" is bigger than its "main shock", we change the names and call the first one the foreshock and the large "aftershock" becomes the main shock. Most aftershocks occur on the same fault as the main shock, but other faults nearby and extensions of the maintop fault will also produce aftershocks. Historically, deep earthquakes are much less likely to be followed by aftershocks than are shallow earthquakes.

Two major earthquakes occurred on the same day, so they must be related.

NOT LIKELY: Often, people wonder if an earthquake in Alaska may have triggered an earthquake in California; or if an earthquake in Chile is related to an earthquake that occurred a week later in Mexico. Over long distances, the answer is no. Even the Earth's rocky crust is not rigid enough to transfer stress efficiently over thousands of miles. There is evidence to suggest that earthquakes in one area can trigger seismic activity within a few hundred miles, including aftershocks clustered near the main shock. There is also evidence that some major earthquakes manage to trigger seismicity over much greater distances (thousands of miles), but these triggered quakes are small and very short lived.

People can cause earthquakes.

PARTIALLY FACT: Earthquakes induced by human activity have been documented in a few locations in the United States, Japan, and Canada. The cause was injection of fluids into deep wells for waste disposal and secondary recovery of oil, and the filling of large reservoirs for water supplies. Most of these earthquakes were minor. Deep mining can cause small to moderate quakes and nuclear testing has caused small earthquakes in the immediate area surrounding the test site, but other human activities have not been shown to trigger subsequent earthquakes. Earthquakes are part of a global tectonic process that generally occurs well beyond the influence or control of humans. The focus (point of origin) of an earthquake is typically tens to hundreds of miles underground, and the scale and force necessary to produce earthquakes are well beyond our daily lives.

People can stop earthquakes.

FICTION: We cannot prevent earthquakes from happening (or stop them once they've started). However, we can significantly mitigate their effects by characterizing the hazard (e.g., identifying earthquake faults, unconsolidated sediment likely to amplify earthquake waves, and unstable land prone to sliding or liquefying during strong shaking), building safer structures, and preparing in advance by taking preventative measures and knowing how to respond.

Nuclear explosions can start or stop earthquakes.

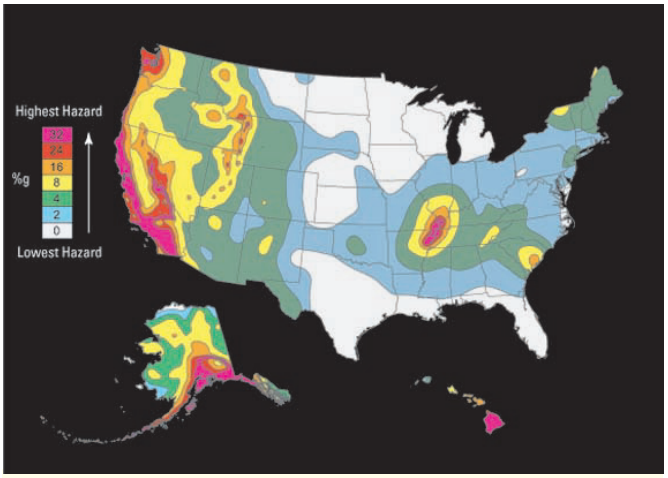
FICTION: Scientists agree that even large nuclear explosions have little effect on seismicity outside the area of the blast itself. The largest underground thermonuclear tests conducted by the United States were detonated in Amchitka at the western end of the Aleutian Islands, and the largest of these was the 5 megaton test code-named Cannikin that occurred on November 6, 1971 that did not trigger any earthquakes in the seismically active Aleutian Islands. On January 19, 1968, a thermonuclear test, code-named Faultless, took place in central Nevada. The code-name turned out to be a poor choice because a fresh fault rupture some 4,000 feet long was produced. Seismograph records showed that the seismic waves produced by the fault movement were much less energetic than those produced directly by the nuclear explosion. Locally, there were some minor earthquakes surrounding the blasts that released small amounts of energy. Scientists looked at the rate of earthquake occurrence in northern California, not far from the test site, at the times of the tests and found nothing to connect the testing with earthquakes in the area.

You can prevent large earthquakes by making lots of small ones, or by "lubricating" the fault with water

FICTION: Seismologists have observed that for every magnitude 6 earthquake there are about 10 of magnitude 5, 100 of magnitude 4, 1,000 of magnitude 3, and so forth as the events get smaller and smaller. This sounds like a lot of small earthquakes, but there are never enough small ones to eliminate the occasional large event. It would take

32 magnitude 5's, 1000 magnitude 4's, and 32,000 magnitude 3's to equal the energy of one magnitude 6 event. So, even though we always record many more small events than large ones, there are far too few to eliminate the need for the occasional large earthquake. As for "lubricating" faults with water or some other substance, if anything, this would have the opposite effect. Injecting high- pressure fluids deep into the ground is known to be able to trigger earthquakes—to cause them to occur sooner than would have been the case without the injection. This would be a dangerous pursuit in any populated area, as one might trigger a damaging earthquake.

We can predict earthquakes.



U. S. Geological Survey Earthquake Hazard Map for the United States showing areas in the country where earthquake hazards are the most (in red and orange) and least (white). This map is based on known seismic activity and the long-term rates that faults are moving. It takes into account how often earthquakes occur in a given area and at what magnitude. Some local areas may face higher hazards due to they way local geology and soils may make earthquake shaking worse.

FICTION: Earthquake prediction is the holy grail for earthquake scientists, but there currently is no accepted method to accomplish the goal of predicting the time, place and magnitude of an impending quake. Research into earthquake prediction continues. However, the USGS approach has been to focus on providing long-range forecasts of the likelihood locations and impacts of damaging earthquakes. For example, scientists estimate that over the next 30 years the probability of a major earthquake occurring in the San Francisco Bay area is 62%, and 60% in Southern California. Scientists are also able to predict the type of ground motion to expect based on the geology and the history of earthquake activity of the region. Engineers and building code developers use these models of site response to improve the safety of structures, thereby reducing the ultimate earthquake risk.

Animals can predict earthquakes.

FICTION: Changes in animal behavior cannot be used to predict earthquakes. Even though there have been documented cases of unusual animal behavior prior to earthquakes, a reproducible connection between a specific behavior and the occurrence of an earthquake has not been made. Because of their finely tuned senses, animals can often feel the earthquake at its earliest stages before the humans around it can. This feeds the myth that the animal knew the earthquake was coming. But animals also change their behavior for many reasons, and given that an earthquake can shake millions of people, it is likely that a few of their pets will, by chance, be acting strangely before an earthquake.

Some people can sense that an earthquake is about to happen.

MAYBE: There is no scientific explanation for the symptoms some people claim to have preceding an earthquake, and more often than not there is no earthquake following the symptoms.

It's been raining a lot, or very hot--it must be earthquake weather!

FICTION: Many people believe that earthquakes are more common in certain kinds of weather. In fact, no correlation with weather has been found. Earthquakes begin many kilometers (miles) below the region affected by surface weather. People tend to notice earthquakes that fit the pattern and forget the ones that don't. Also, every region of the world has a story about earthquake weather, but the type of weather is whatever they had for their most memorable earthquake.

The Golden Gate Bridge, Seattle Space Needle and other buildings will all eventually fall during an earthquake

.

NOT LIKELY: Architects and engineers are using knowledge learned from past earthquakes to make roads, bridges, and buildings safer in the event of major earthquakes. Local officials are also enacting new building codes to ensure new buildings are built with earthquake safety in mind. This includes both improving the design of new buildings and bridges as well as strengthening older units to incorporate the latest advances in seismic and structural engineering. Landmark buildings and infrastructure, as well as houses, apartments, hospitals, schools and other public and private facilities in earthquake prone areas can be at risk. But the best building codes in the world do nothing for buildings built before that code

was enacted. While the codes have been updated, the older buildings are still in place. Fixing problems in older buildings—also known as retrofitting—is the responsibility of the building's owner.

Earthquakes don't kill people, buildings and their contents do.

FACT: The greatest risk in an earthquake is the severity of the shaking it causes to manmade and natural structures and the contents within these that may fail or fall and injure or kill people. There have been large earthquakes with very little damage because they caused little shaking and/or buildings were built to withstand that shaking. In other cases, smaller earthquakes have caused great shaking and/or buildings collapsed that were never designed or built to survive shaking. Much depends on two variables: geology and engineering. From place to place, there are great differences in the geology at and below the ground surface. Different kinds of geology will do different things in earthquakes. For example, shaking at a site with soft sediments can last 3 times as long as shaking at a stable bedrock site such as one composed of granite. Local soil conditions also play a role, as certain soils greatly amplify the shaking in an earthquake. Seismic waves travel at different speeds in different types of rocks. Passing from rock to soil, the waves slow down but get bigger. A soft, loose soil will shake more intensely than hard rock at the same distance from the same earthquake. The looser and thicker the soil is, the greater the energy movement will be. Fires are another major risk during earthquakes as gas lines may be damaged and particularly hazardous.

During an earthquake you should head for the doorway.

FICTION: That's outdated advice. In past earthquakes in unreinforced masonry structures and adobe homes, the door frame may have been the only thing left standing in the aftermath of an earthquake. Hence, it was thought that safety could be found by standing in doorways. In modern homes doorways are no stronger than any other parts of the house and usually have doors that will swing and can injure you. YOU ARE SAFER PRACTICING THE "DROP, COVER, AND HOLD" maneuver under a sturdy piece of furniture like a strong desk or table. If indoors, stay there. Drop to the floor, make yourself small and get under a desk or table or stand in a corner. If outdoors, get into an open area away from trees, buildings, walls and power lines. If in a high-rise building, stay away from windows and outside walls, stay out of elevators, and get under a table. If driving, pull over to the side of the road and stop. Avoid overpasses and power lines. Stay inside your

car until the shaking is over. If in a crowded public place, do not rush for the doors. Crouch and cover your head and neck with your hands and arms. You should practice the "DROP, COVER AND HOLD" method at work and at home at least twice a year.

Everyone will panic during the Big One.

FICTION: A common belief is that people always panic and run around madly during and after earthquakes, creating more danger for themselves and others. Actually, research shows that people usually take protective actions and help others both during and after the shaking. Most people don't get too shaken up about being shaken up!

You can't plan ahead for an earthquake.

FICTION: There are plenty of things you can do right now to prepare if you live in an earthquake-prone area.

1. Make sure each member of your family knows what to do no matter where they are when earthquakes occur:
·Establish a meeting place where you can all reunite afterward.
· Find out about earthquake plans developed by children's school or day care.
· Remember transportation may be disrupted, so keep some emergency supplies--food, liquids, and comfortable shoes, for example--at work.
2. KNOW where your gas, electric and water main shutoffs are and how to turn them off if there is a leak or electrical short. Make sure older members of the family can shut off utilities.
3. LOCATE your nearest fire and police stations and emergency medical facility.
4. TALK to your neighbors--how could they help you, or you them after an earthquake?
5. TAKE Red Cross First Aid and CPR Training Course.
6. MAKE your disaster supply kit. Beyond the usual flashlights, batteries and radios, include a

first-aid kit; work gloves; sturdy shoes or boots; a week's supply of any presciption medications you or your family might need; credit card and cash; personal identifcation; extra set of keys; matches in a waterproof container; map of your area; phone numbers of family and other important people (doctors, veterinarians, etc.); copies of insurance policies and other important documents; special needs equipment (diapers, baby formula, hearing aid batteries; spare eyeglasses, etc.); three gallons of water per person; three-day supply of food per person; hand tools; a portable ABC fire extinguisher; sanitation supplies for you and your family; entertainment (toys, books, coloring books and crayons, playing cards)

7: BOLT bookcases, china cabinets, tall furniture, file cabinets, etc. to wall studs. Brace or anchor heavy electronics and other heavy items. Secure items that might fall. Move heavy or fragile items to lower shelves. Fasten drawers and cabinet doors with latches or locks. Brace overhead light fixtures. Strap your water heater to wall studs and bolt down any gas appliances. Look for other non-structural steps you can take in your home and workplace to reduce your chances for injury and loss.

8. ASK AN ENGINEER about the seismic safety of your home and/or business. It's well known that unreinforced masonry structures can fail quickly during earthquakes. An inspection by a structural engineer now can help you decide if retrofitting will help your property withstand shaking.

USGS is a worldwide leader in earthquake hazard research, information and mitigation.

FACT: The U.S. Geological Survey performs the following functions related to earthquake hazard mitigation:

Receives, analyzes, maintains, and distributes data on earthquake activity worldwide. Seismograph stations located around the country and the world are linked in real-time to USGS offices and to analysis centers run by our partner institutions that continuously monitor, detect and locate earthquake activity.

Provides rapid notification of earthquake events to civil defense and government officials in the affected area, and to the public through the Internet and news media.

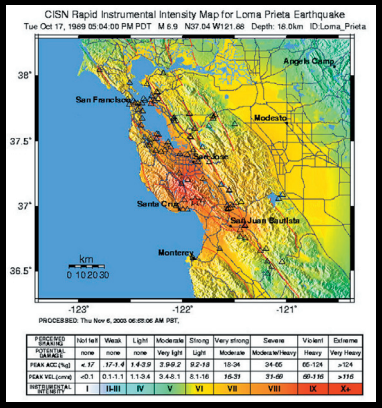
Produces regional assessments of earthquake hazards in conjunction with State and local governments. This information is used by: local planners and building officials in setting appropriate building and retrofitting standards, government and civil defense officials in planning for disaster recovery; professionals conducting detailed site assessments; and researchers engaged in engineering and seismologic research.

Engages in basic research to learn more about the nature of earthquake activity.

Provides education on earthquake hazards and safety to the public by publishing and distributing literature, and through a variety of other outreach efforts.

But more can be done.

ABSOLUTELY: Earthquakes pose a significant risk to 75 million Americans in 39 states. The USGS is the only Federal agency with responsibility for recording and reporting earthquake activity nationwide. Citizens, emergency responders and engineers rely on USGS for accurate and timely information on where an earthquake occurred, how much the ground shook in different locations and what is the likelihood of future significant ground shaking. USGS is working to improve its earthquake monitoring and reporting capabilities through the Advanced National Seismic System (ANSS). In the past three years, USGS has installed about 300 new earthquake- monitoring instruments in the San Francisco, Seattle, Salt Lake City, Anchorage, Reno, Las Vegas and Memphis areas. Full implementation of the ANSS will result in nearly 7,000 new high-tech instruments in the ground or in buildings. And once in place, the ANSS will provide emergency personnel with near real-time information on the intensity and distribution of ground shaking that can be used to guide emergency response efforts. Similarly, information on building shaking will equip engineers with the data they need to improve building designs in the future.



There's great information available online about preparing for an earthquake

FACT! There are literally hundreds of websites that focus on earthquake safety. For more factual information on earthquakes, earthquake myths and earthquake preparedness, see the Earthquakes, "Mega-quakes," and the Movies sheet that accompanies this sheet and visit:

USGS web site for earthquake information:
http://earthquake.usgs.gov

List of recent earthquakes in the United States:
http://earthquake.usgs.gov/recenteqs/

USGS earthquake preparedness information:
http://quake.usgs.gov/prepare/prepare.html
http://earthquake.usgs.gov/hazards/prepare.html

Worldwide list of recent earthquakes:
http://earthquake.usgs.gov/recenteqsww/index.html

Did you feel it? Report an earthquake here:
http://pasadena.wr.usgs.gov/shake/

Earthquake information for kids:
http://earthquake.usgs.gov/4kids/

Cool earthquake facts (not just for kids!):
http://earthquake.usgs.gov/4kids/facts.html

USGS earthquake research projects:
http://earthquake.usgs.gov/about_us/index_p1.html

Information about ShakeMap:
http://earthquake.usgs.gov/shakemap/sc/shake/index.html

"Putting Down Roots in Earthquake Country" (designed for Southern California, but an excellent resource for anyone living in earthquake country!)
http://www.earthquakecountry.info/roots/roots.html

The American Red Cross's earthquake page.
http://www.redcross.org/services/disaster/0,1082,0_500_,00.html http://www.redcross.org/services/disaster/0,1082,0_583_,00.html

The Federal Emergency Management Agency's earthquake page.
http://www.fema.gov/hazards/earthquakes/.