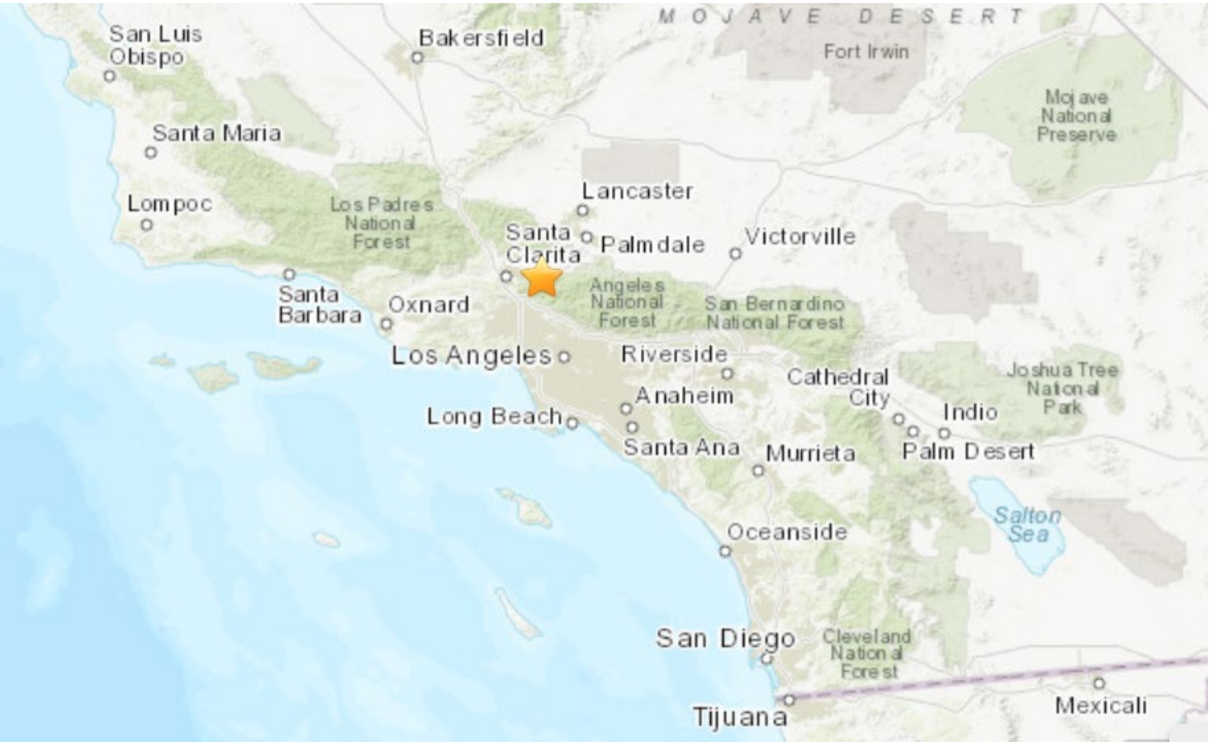
Magnitude 6.6 SAN FERNANDO
Tuesday, February 9, 1971 at 14:00:41 UTC

Teachable Moments

Fifty years ago, a magnitude 6.6 earthquake shook the San Fernando Valley north of Los Angeles in the early morning of February 9th. It destroyed homes, damaged hospitals and schools, knocked out power to more than 600,000 people, triggered over 1,000 landslides, and caused sections of elevated freeways to collapse. 64 people lost their lives and more than 2,500 were injured.

California is safer today because of this earthquake. It prompted action and legislation to protect people and reduce earthquake loss across the state.



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The Modified-Mercalli Intensity (MMI) scale is a ten-stage scale, from I to X, that indicates the severity of ground shaking. Intensity is based on observed effects and is variable over the area affected by an earthquake. Intensity is dependent on earthquake size, depth, distance, and local conditions.

Extreme shaking was felt in the area closest to the earthquake.

MMI	Perceived Shaking
X	Extreme
IX	Violent
VIII	Severe
VII	Very Strong
VI	Strong
V	Moderate
IV	Light
II-III	Weak
I	Not Felt

Estimated shaking intensity from M 6.6 Earthquake

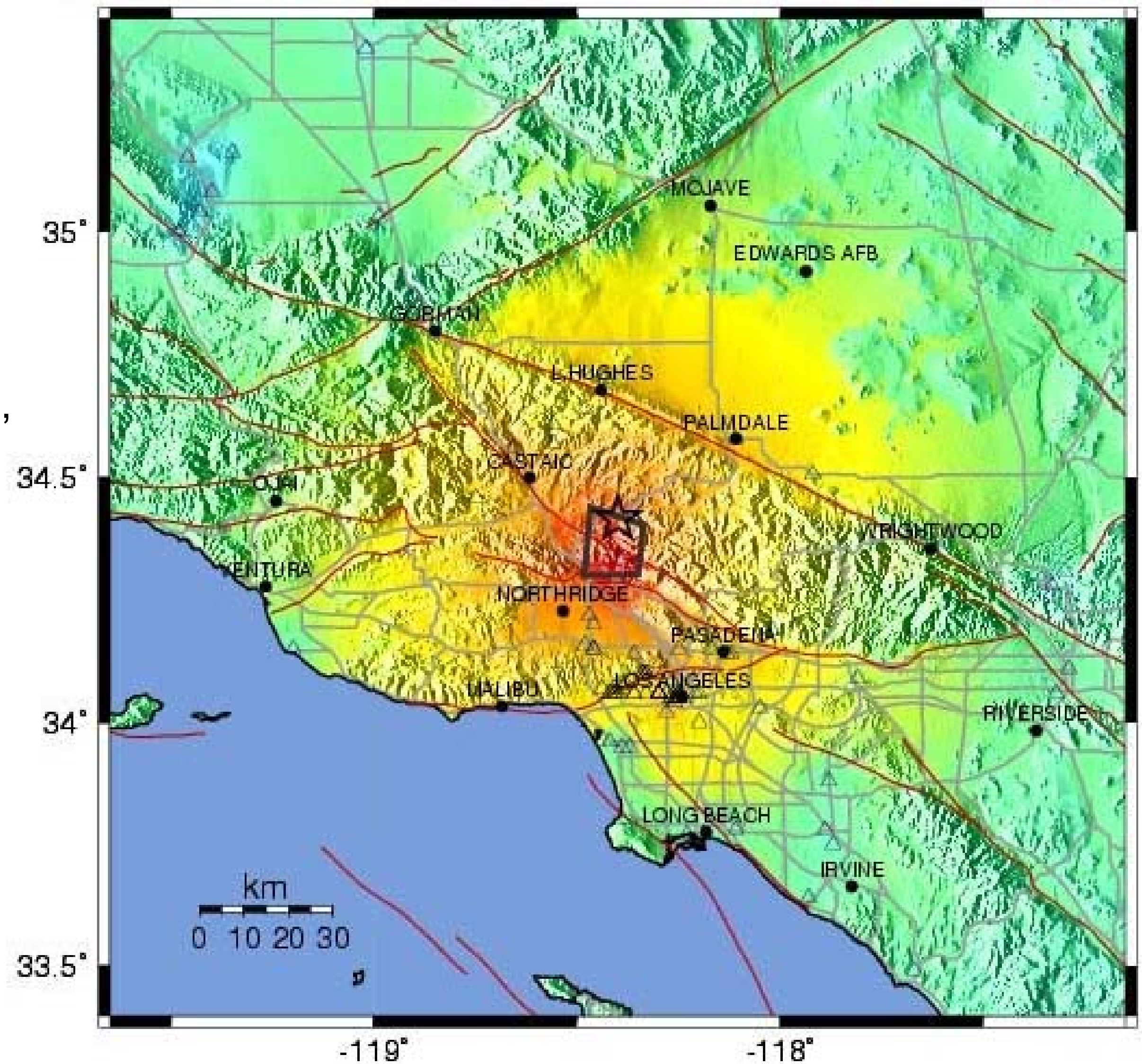

Image courtesy of the California Integrated Seismic Network

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This earthquake was widely felt throughout Southern California.

Main shock Mercalli intensities	
MMI	**Locations**
XI (*Extreme*)	Sylmar
X (*Extreme*)	San Fernando
IX (*Violent*)	Kagel Canyon
VIII (*Severe*)	Granada Hills, Newhall
VII (*Very strong*)	Los Angeles, Northridge
VI (*Strong*)	Malibu, Ontario
V (*Moderate*)	Santa Barbara, San Diego, Barstow
IV (*Light*)	Las Vegas, Parkfield, Bishop
III (*Weak*)	Merced, Moss Landing, Palo Verde
U.S. Earthquake Intensity Database, NGDC	

Image courtesy of the USGS

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Both the Veteran's Administration Hospital and Olive View Medical Center in Sylmar were severely damaged, accounting for most of the deaths from this earthquake.

The buildings that collapsed at the Veteran's Hospital were built prior to 1933 and were not required to have a seismic-resistant design.

A sheriff's deputy stands outside the collapsed Olive View Hospital following the earthquake.

Images courtesy of the Los Angeles Daily News

February 9, 1971. Rescue efforts at the Veteran's Hospital in Sylmar. Two of its buildings were completely destroyed by the earthquake.

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Because the earthquake occurred early in the morning local time (6:00 am), only a few deaths resulted from the collapsed highway overpasses and the dozen bridges that fell onto freeway lanes.

The principal highway link between northern and southern California was temporarily cut, and traffic had to be rerouted for several months.

Using lessons learned from this earthquake, the California Department of Transportation adopted seismic design practices.

Images courtesy of the USGS

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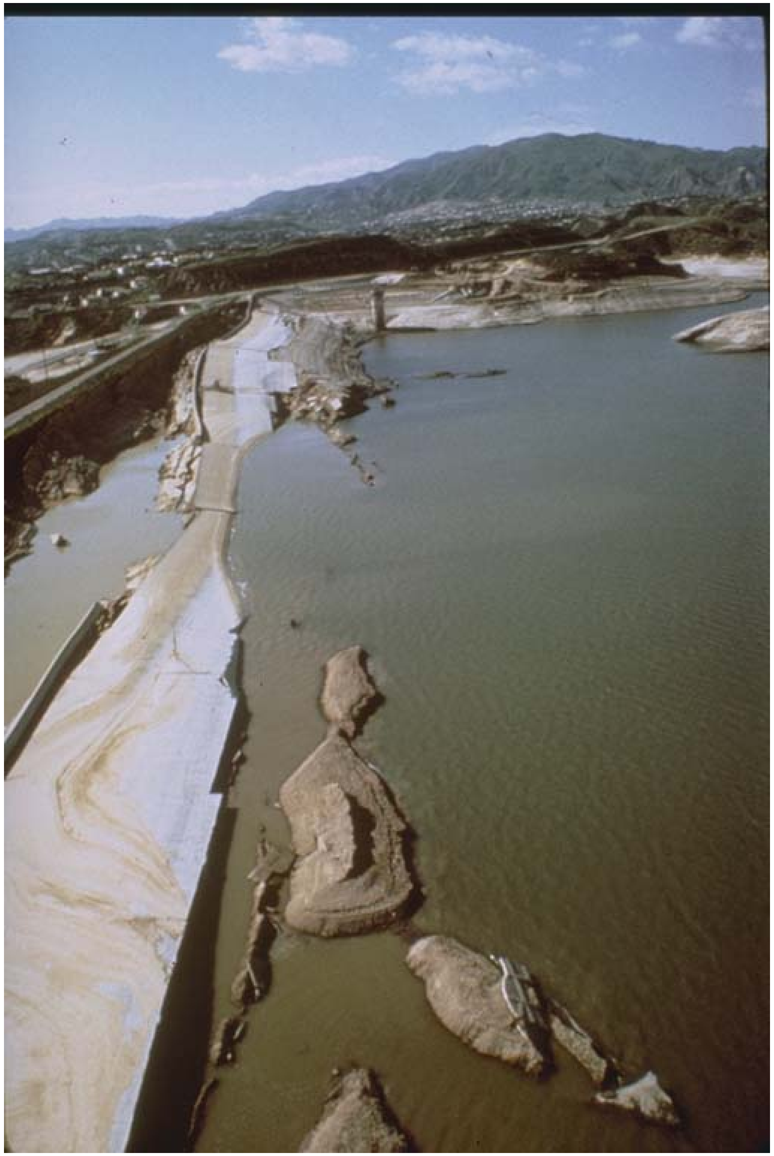

The lower San Fernando dam sustained major damage in the earthquake. The dam experienced liquefaction during earthquake ground shaking, causing the top 30 feet to crumble. With large aftershocks occurring, including a magnitude 5.8 shortly after the main shock, there was fear the dam would collapse.

Authorities evacuated more than 80,000 people living downstream in an area of 10 square miles. The evacuation lasted four days as engineers lowered the water level and shored up the dam. Luckily, there was already much less water in the reservoir (3.6 billion gallons) compared to the 6.5 billion gallons of water the dam was holding a year earlier.

As a result of this near catastrophic event all dams in California were reevaluated and retrofitted.

Image courtesy of the USGS

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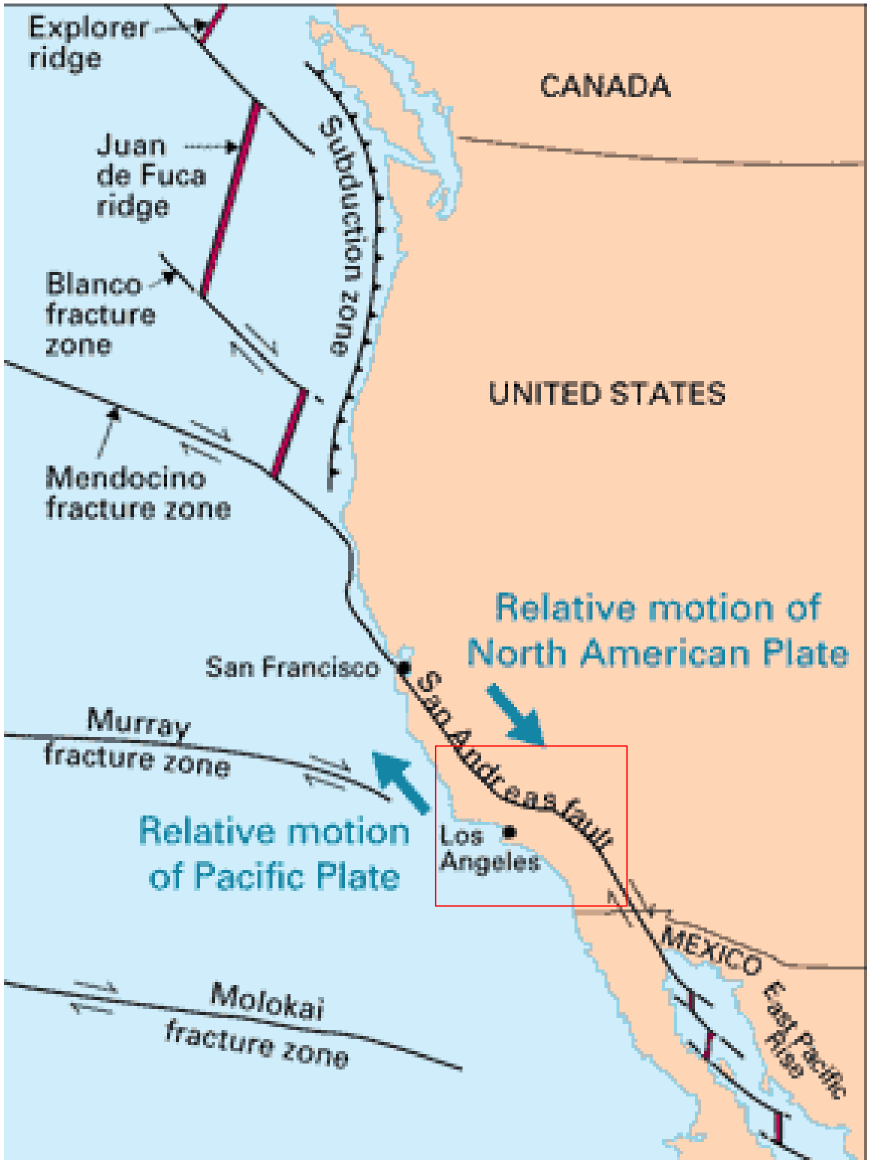

The relative motion between the North American Plate and the Pacific Plate is 50 mm/yr (~ 2 inches/yr), but that rate is distributed across all the faults that are part of the San Andreas Fault Zone.

The San Andreas Fault Zone includes the San Andreas Fault plus many sub-parallel faults that together take up the motion between the two plates.

In northern California, the zone includes the Northern San Andreas, Hayward, Calaveras, as well as many other faults.

In southern California, the zone is even wider, encompassing the Southern San Andreas, the San Jacinto, and other faults. See the next slide for more detail in the Los Angeles area (red box).

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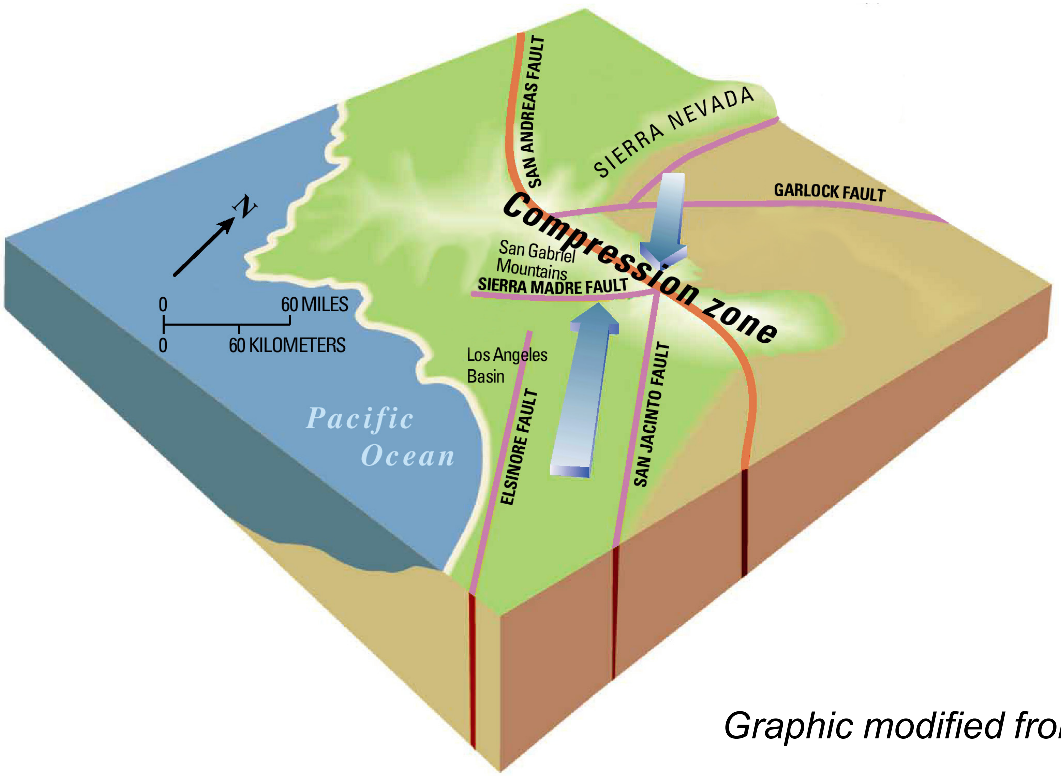
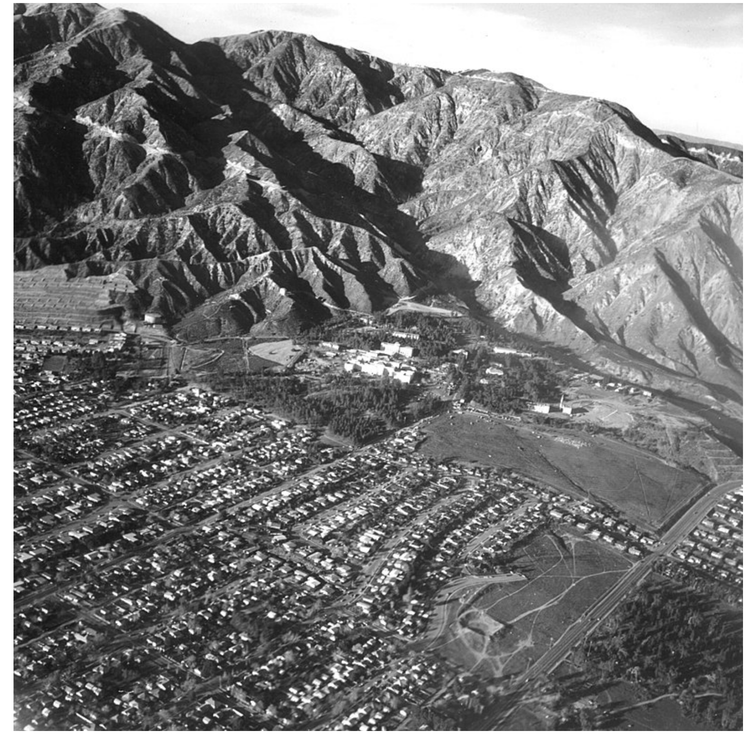
In southern California, the San Andreas Fault Zone encompasses the Southern San Andreas, the San Jacinto, and many other faults in the Los Angeles area. The San Andreas Fault makes a bend (called the Big Bend) that creates a region of compression. This compression causes thrust faults and folds creating uplift that has formed the San Gabriel Mountains.





View to north northeast. San Gabriel Mountains in background; Veterans Hospital that was damaged in the earthquake is the complex of white structures at center of photo

Image courtesy of the USGS
Graphic modified from the Southern California Earthquake Center

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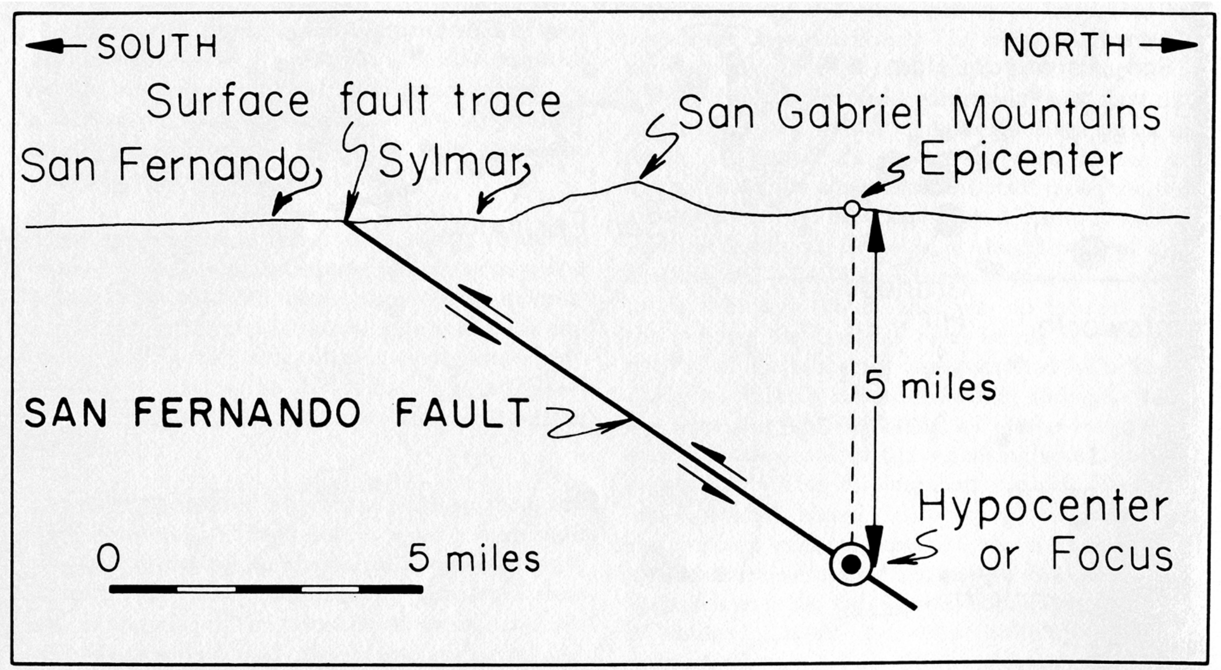
The magnitude 6.6 earthquake that occurred in 1971 started at the hypocenter, ~5 miles beneath the San Gabriel Mountains. The rupture then propagated southward and upward until it broke the surface in the San Fernando-Sylmar area. The maximum vertical displacement observed was about 6 feet and there was a smaller horizontal displacement that moved the mountains west relative to the valley.

The fault plane dips back underneath the San Gabriel Mountains at an angle of about 35° . The hanging wall (upper San Gabriel Mountains block) moved southwesterly or up and west relative to the foot wall (lower San Fernando Valley block). The focal mechanism solution (from Hauksson et al. (1995)) confirms this oblique-slip reverse faulting.



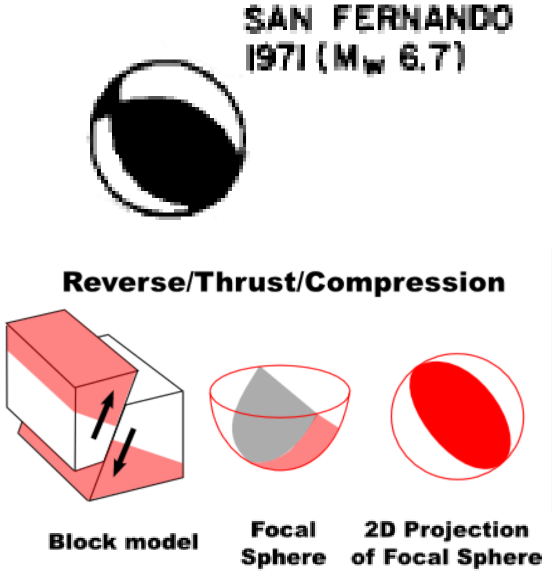


Image courtesy C. Allen, Caltech

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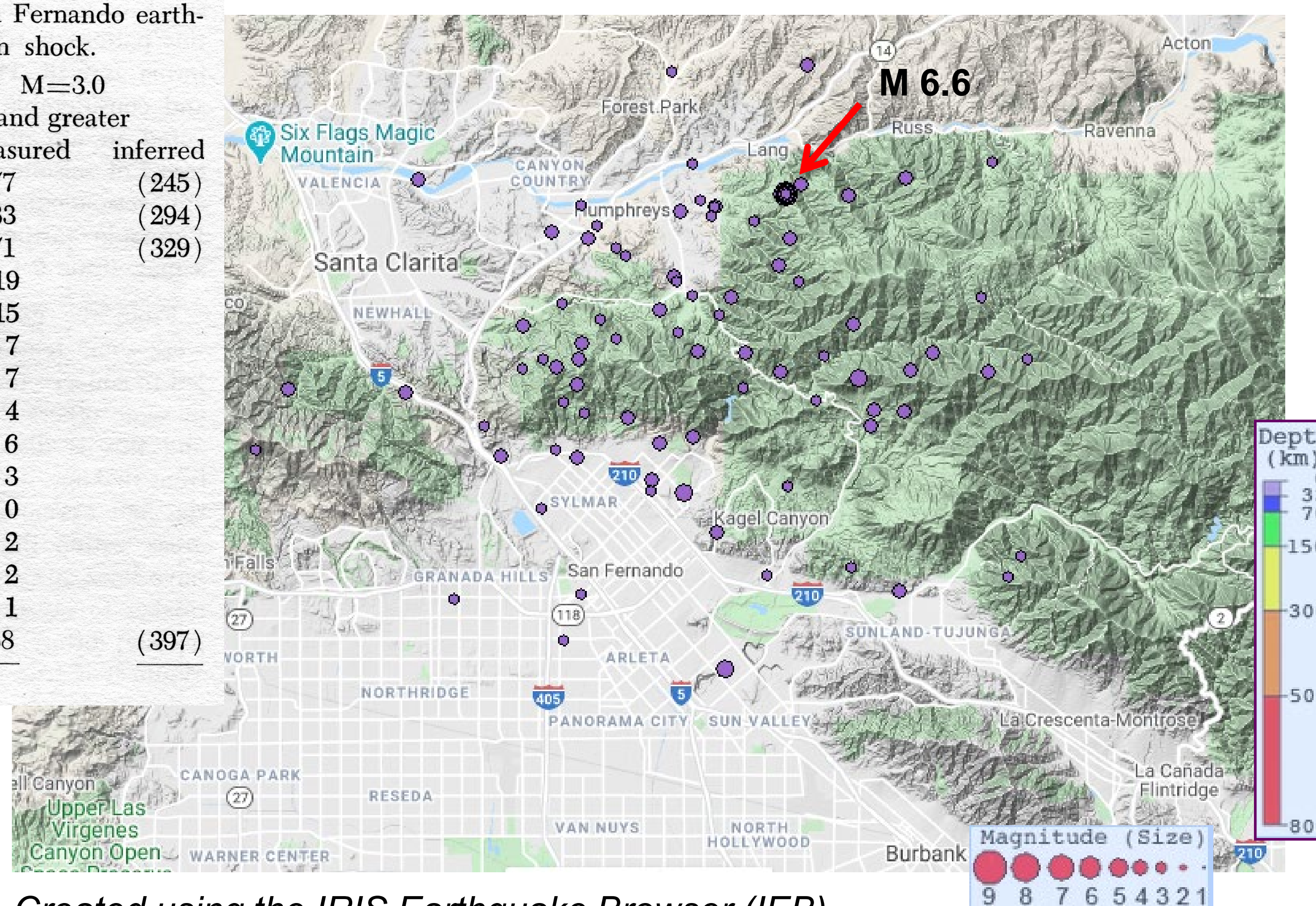
The image below is plotting the first 10 hours of seismicity on February 9, 1971. This only includes the main shock and the first 144 measured aftershocks. In the days and months that followed, the aftershocks continued. The table captures a summary of the regional seismicity in 1971.

Summary of aftershock data of the San Fernando earthquake for the year following the main shock.

	M=4.0 and greater	M=3.0 and greater measured	M=3.0 and greater inferred
First hour	35	77	(245)
First day	42	183	(294)
February, 1971	47	271	(329)
March	4	19	
April	4	15	
May	0	7	
June	1	7	
July	0	4	
August	0	6	
September	0	3	
October	0	0	
November	0	2	
December	0	2	
January, 1972	0	1	
Total through 2-8-72 (first year)	56	338	(397)

Table courtesy C. Allen, Caltech



Created using the IRIS Earthquake Browser (IEB)

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Map showing epicenter of the main shock and larger aftershocks during the year following the San Fernando earthquake.

Smallest dots represent earthquakes of magnitude 3.0-3.9, and larger dots represent earthquakes of magnitude 4.0 and above.

Open circles represent relative city population.

The fault trace shown is where the San Fernando fault breaks the surface. This graphic is based on data from the Seismological Laboratory, California Institute of Technology.

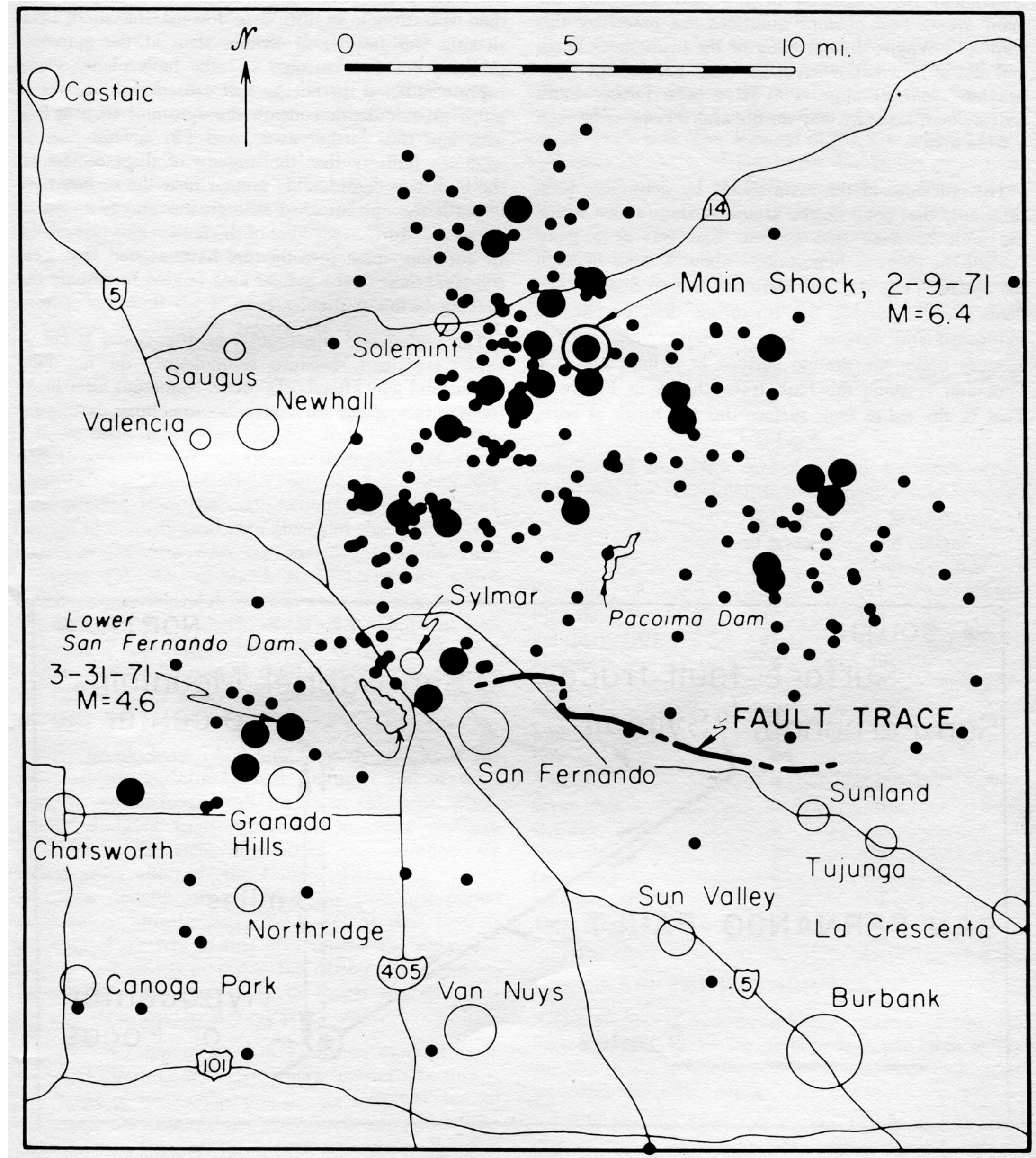

Image courtesy C. Allen, Caltech

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Along the zone where the fault broke the surface, all structures that were built across it were damaged or destroyed. This prompted California to take action. In the aftermath of this earthquake, the Alquist-Priolo Earthquake Fault Zoning Act was passed.

This Act created a requirement to characterize all the active faults (ones that have ruptured in the last 11,000 years) in the state of California and to regulate construction in the zones surrounding the surface traces of active faults.

Wherever an active fault exists, if it has the potential to rupture the surface, a structure for human occupancy cannot be placed over the fault and must be a minimum distance away (~ 50 feet).

Images courtesy of the USGS

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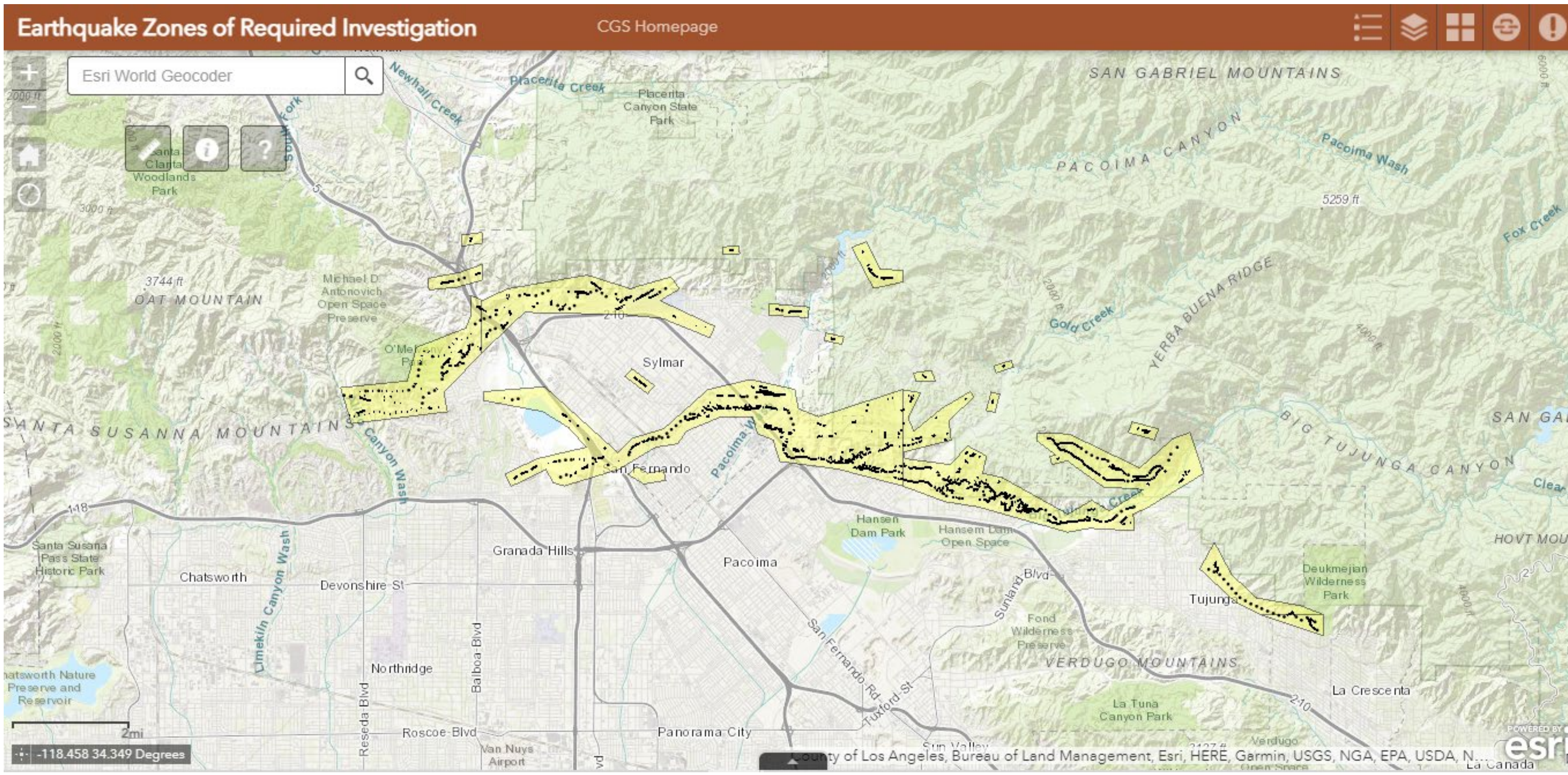
The Earthquake Zones that were defined in this region (and throughout California) can be seen in the State of California Geological Survey (CGS) online map of earthquake zones.



Explore the official zone maps for fault rupture, liquefaction, and seismic landslide hazards throughout California with the CGS map at: https://maps.conservation.ca.gov/cgs/EQZApp/app/ .

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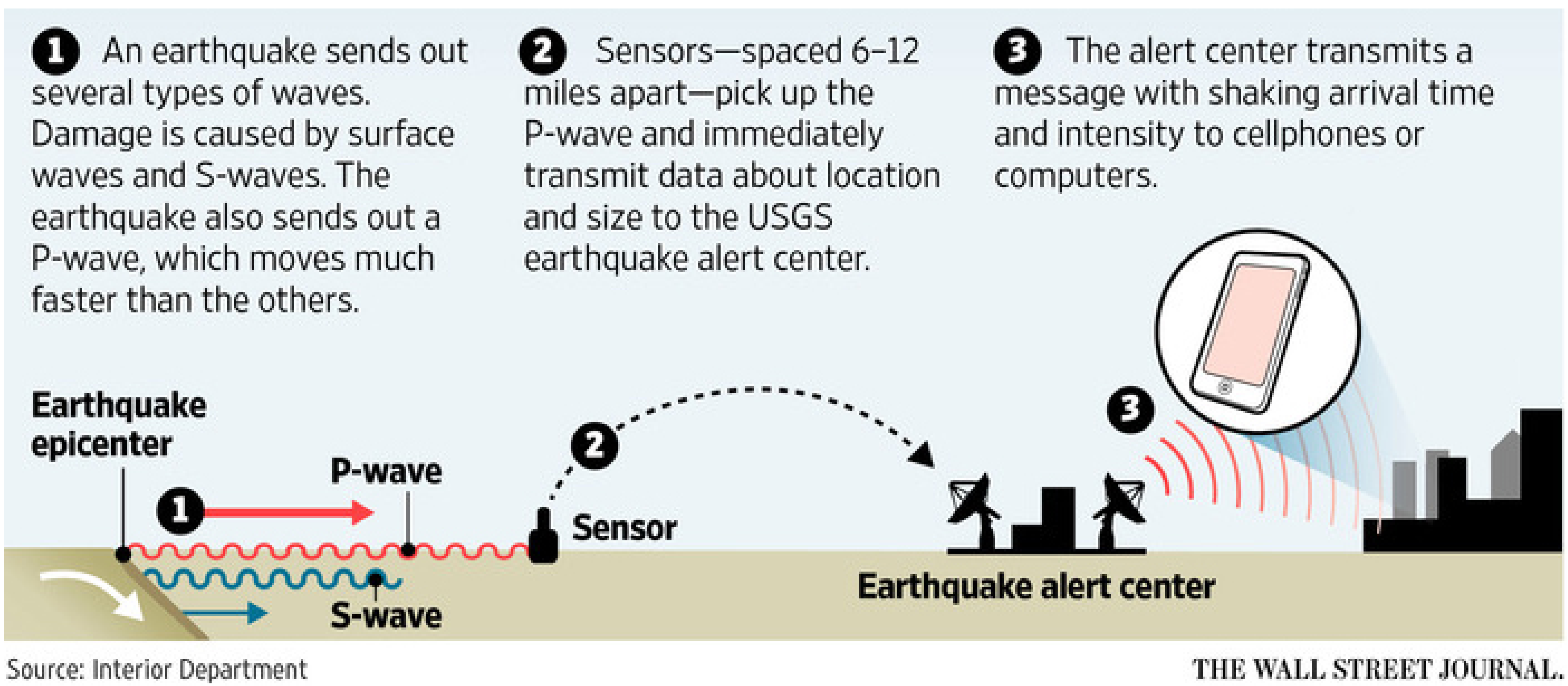
Another advancement for protecting life and critical infrastructure is the ShakeAlert® Earthquake Early Warning (EEW) system, which is now operating in California, Oregon, and Washington! EEW is not earthquake prediction. Seismometers in the field detect an earthquake that has already begun and data from it is sent to a ShakeAlert Processing Center.

ShakeAlert quickly estimates the earthquake location, size, and expected shaking. If the earthquake fits the right profile the USGS issues a ShakeAlert Message which is used by distribution partners to develop and deliver alerts to people and automated systems.



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With this animation, explore how the ShakeAlert system works and how even a few seconds of warning can help people and automated systems prepare for earthquake shaking.

Learn more about ShakeAlert at https://www.ShakeAlert.org

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What do you do if you feel shaking or get a ShakeAlert powered alert? You may only have a few seconds warning before the shaking starts. Use that time to protect yourself!

DROP where you are onto your hands and knees.

- This position protects you from being knocked down and also allows you to stay low and crawl to shelter if nearby.

COVER your head and neck with one arm and hand

- If a sturdy table or desk is nearby, crawl underneath it for shelter
- If no shelter is nearby, crawl next to an interior wall (away from windows)
- Stay on your knees; bend over to protect vital organs

HOLD ON until shaking stops

- Under shelter: hold on to your shelter with one hand; be ready to move with it if it shifts
- No shelter: hold on to your head and neck with both arms and hands.

Teachable Moments are a service of

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