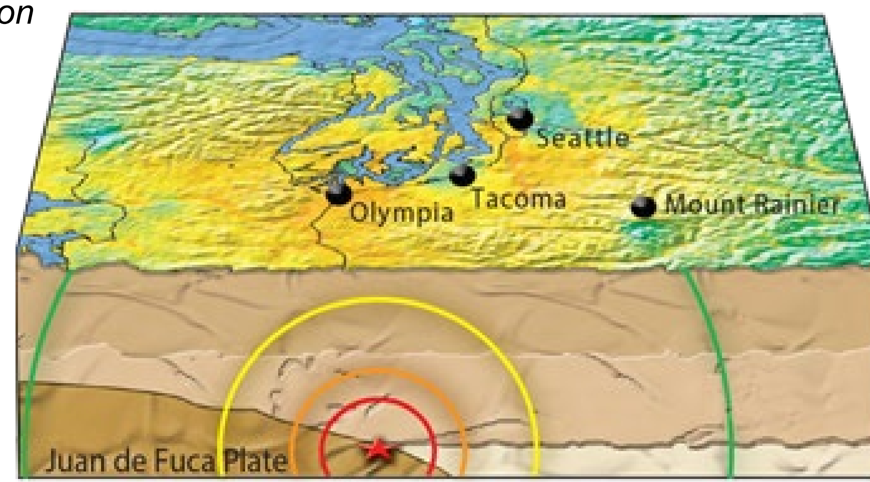
Magnitude 6.8 NISQUALLY
Wednesday, February 28, 2001 at 18:54:32 UTC

The magnitude 6.8 Nisqually earthquake occurred just before 11 AM local time on Wednesday, Feb. 28, 2001 at a depth of 51.8 km (32 miles). This earthquake was felt from central Oregon to southern British Columbia and as far east as northwestern Montana.

One person died and approximately 400 people were injured in this earthquake. There was damage from Seattle to Olympia with widespread landslides and liquefaction.

Epicenter location



Hypocenter location

IRIS Teachable Moments

Magnitude 6.8 NISQUALLY
Wednesday, February 28, 2001 at 18:54:32 UTC

The most significant damage from the M 6.8 Nisqually earthquake was in downtown Olympia, including the state capitol, and Pioneer Square in Seattle. Tacoma was largely spared.

Brick wall failure at the roof level in Seattle's Pioneer Square neighborhood

Image courtesy of the USGS

A van lies crushed under bricks that fell from a Seattle building during the Nisqually Earthquake.

Image courtesy FEMA

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Observations of liquefaction were widespread in parts of Olympia and South Seattle.

Liquefaction occurs when shaking from an earthquake turns loose, water-saturated sediment into a slurry, temporarily losing strength and acting as a fluid. Liquefied soil may then escape from the ground as sand boils. Liquefaction causes structures to fail during earthquakes due to the loss of soil strength. Animation below:

The northern boundary of observed liquefaction was found to begin near the southern end of the Alaskan Way Viaduct

Sand boils found in Union Pacific train yard

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Urban development on unconsolidated materials is vulnerable to liquefaction. Developments on unstable hill slopes are most susceptible to landslides.

US Highway 101 landslide. The curved headscarp of the landslide is 24 m wide

Images courtesy of the USGS

Embankment failure due to liquefaction, Capitol Interpretive Center, Olympia

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Built in the 1950's, the Alaskan Way Viaduct was a double-decker freeway that traveled through Downtown Seattle. In the Nisqually earthquake, the viaduct suffered minor damage, but later inspections found it to be vulnerable to total collapse in the event of another major earthquake.

In the years following this earthquake, the viaduct was completely removed and replaced with a tunnel. A tunnel was chosen because it's buried in the ground and would move with an earthquake as the ground moves. The tunnel is flexible; its outer shell is built from bolted-together rings. Each ring is made from several segments, with a rubber gasket in between them.

The tunnel is designed to withstand a magnitude 9.0 earthquake off the coast.

Alaskan Way Viaduct

SR 99 Tunnel (WSDOT)

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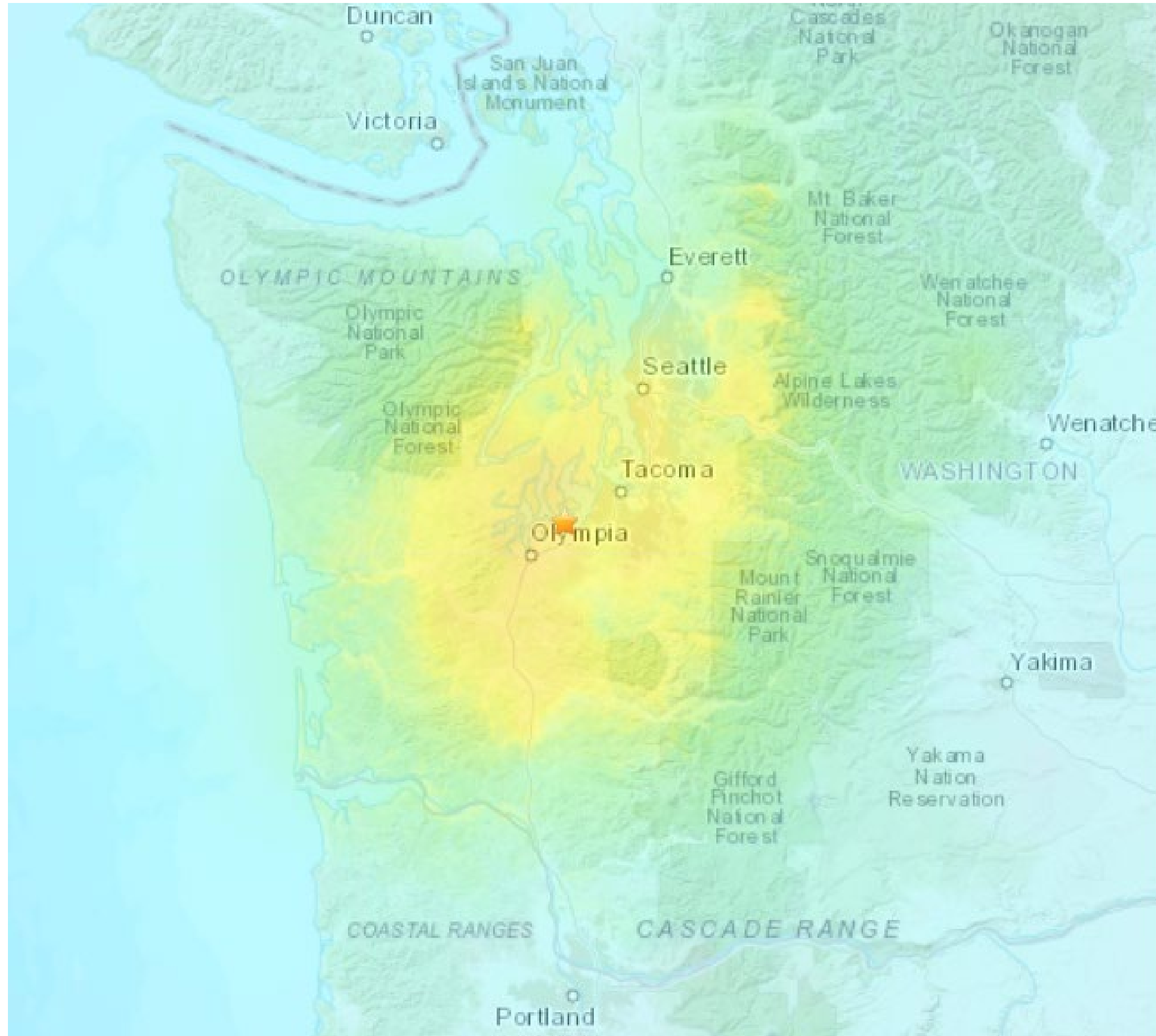
The Modified-Mercalli Intensity (MMI) scale is a ten-stage scale, from I to X, that indicates the severity of ground shaking. Intensity is based on observed effects and is variable over the area affected by an earthquake. Intensity is dependent on earthquake size, depth, distance, and local conditions.

Severe shaking was felt from this 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 6.8 Earthquake

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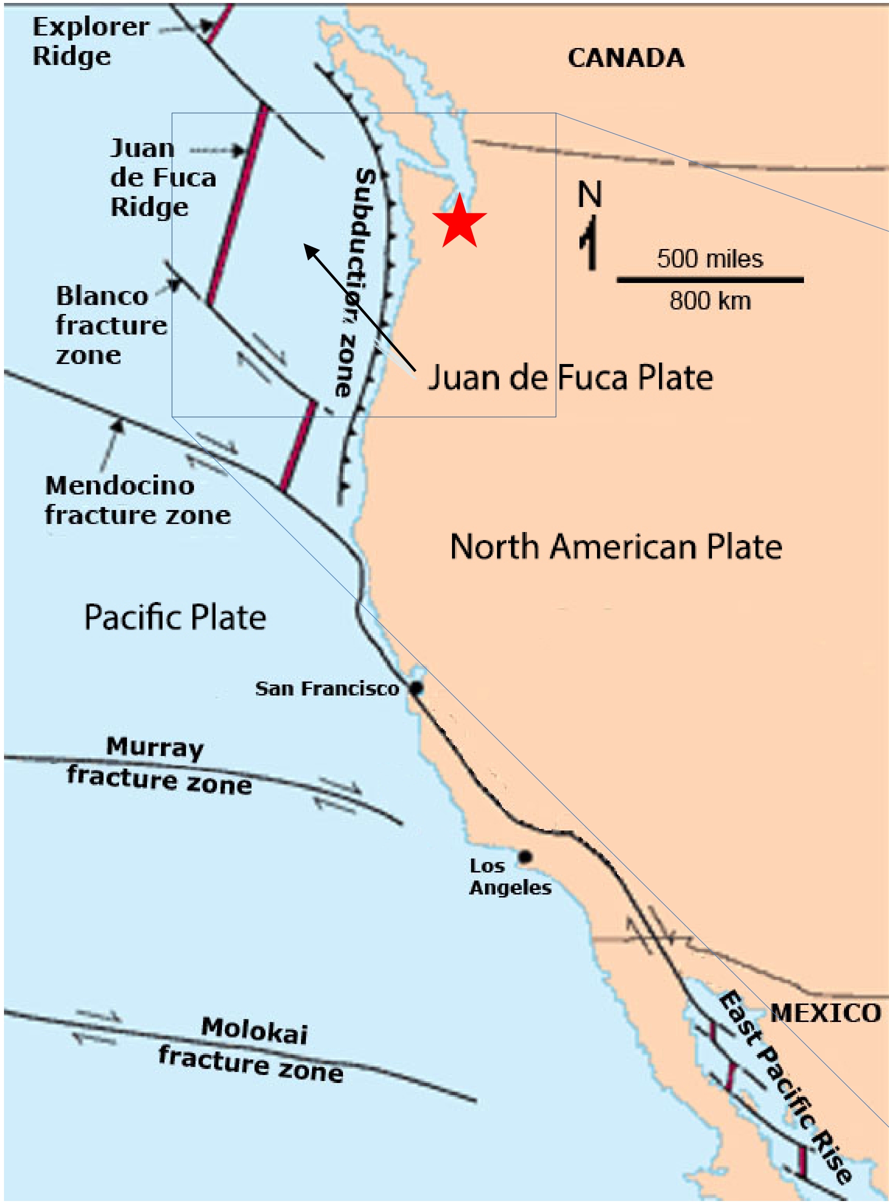
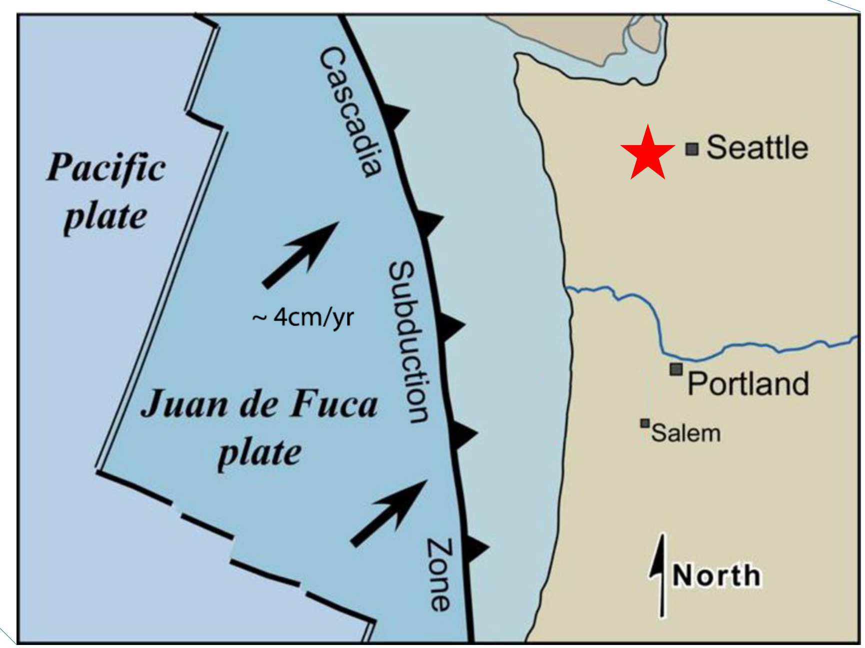


The Juan de Fuca Plate is a small tectonic plate generated from the Juan de Fuca Ridge that is subducting under the North American Plate at the Cascadia Subduction Zone in the Pacific Northwest.

The Juan de Fuca Plate converges with the North American Plate at a rate of approximately 4 cm/year at the Cascadia Subduction Zone.



IRIS Teachable Moments

Magnitude 6.8 NISQUALLY
Wednesday, February 28, 2001 at 18:54:32 UTC

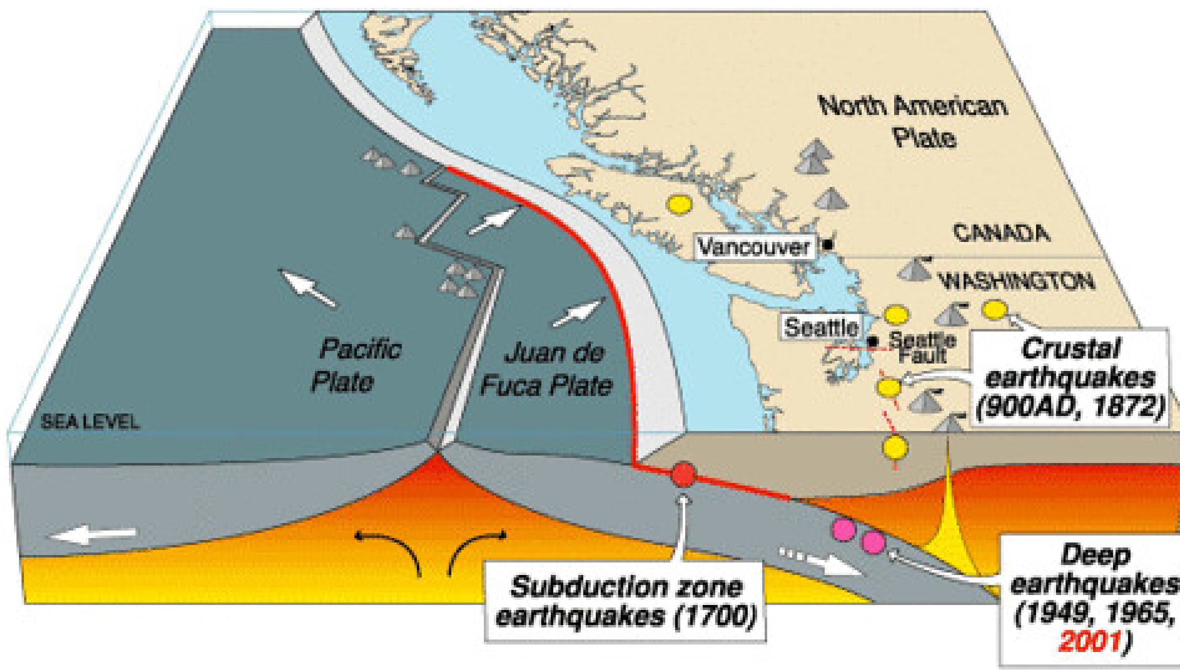
There are three types of earthquakes that pose seismic risk in the Pacific Northwest, and it's important to be prepared for all three.

Subduction Zone earthquakes
Potentially large, less frequent ruptures along the subduction zone fault that separates the two plates

Deep earthquakes
Earthquakes that occur on faults within the down going oceanic plate (like the Nisqually earthquake in 2001)

Crustal faults
Earthquakes along shallow faults within the North American Plate

Cascadia earthquake sources



Source	Affected area	Max. Size	Recurrence
Subduction Zone	W.WA, OR, CA	M 9	500-600 yr
Deep Juan de Fuca plate	W.WA, OR,	M 7+	30-50 yr
Crustal faults	WA, OR, CA	M 7+	Hundreds of yr?

Image courtesy USGS

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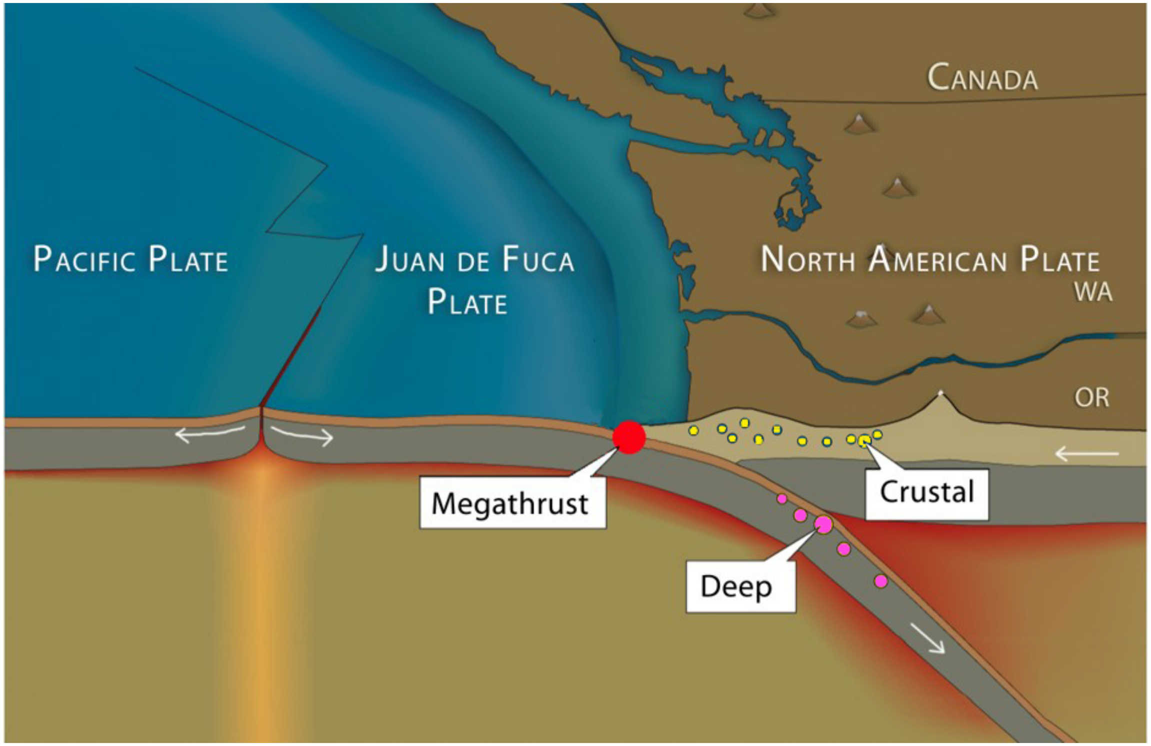
The Nisqually earthquake occurred within the top part of the subducting Juan de Fuca slab, the oceanic plate that is being thrust under the western edge of North America. The depth was in the deep range labeled in the simplified cross section the Cascadia Subduction Zone below.

The hypocenter of the quake, the point in the earth at which the energy from the earthquake was released, was 51.8 km (32 miles) beneath the surface, which reduced the ground motion experienced in Seattle relative to other earthquakes of that size.



Still from animation “Tectonic Earthquakes of the Pacific Northwest” www.iris.edu/hq/inclass/animation/376

IRIS Teachable Moments

Magnitude 6.8 NISQUALLY
Wednesday, February 28, 2001 at 18:54:32 UTC

An animation comparing the 2001 Nisqually earthquake with the 1949 Olympia & 1965 Seattle earthquakes.

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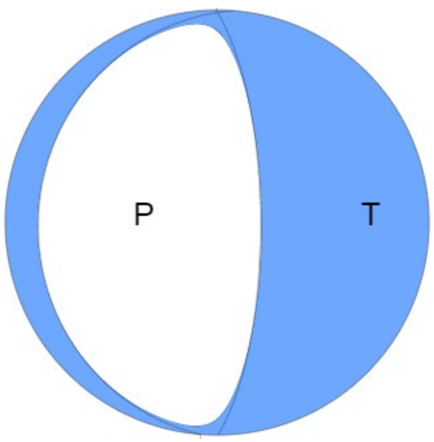
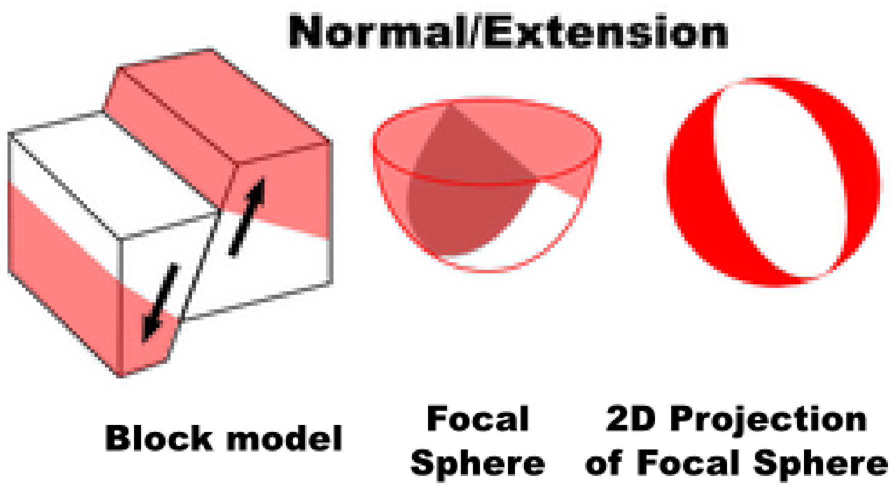
Wednesday, February 28, 2001 at 18:54:32 UTC

The focal mechanism is how seismologists plot the 3-D stress orientations of an earthquake. Because an earthquake occurs as slip on a fault, it generates primary (P) waves in quadrants where the first pulse is compressional (shaded) and quadrants where the first pulse is extensional (white). The orientation of these quadrants determined from recorded seismic waves determines the type of fault that produced the earthquake.



USGS W-phase Moment Tensor Solution



The tension axis (T) reflects the minimum compressive stress direction. The pressure axis (P) reflects the maximum compressive stress direction.

In this case, the focal mechanism indicates this earthquake occurred as the result of normal faulting within the subducting Juan de Fuca Plate.

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In the 20 years since this earthquake, community safety and emergency preparation in the Pacific Northwest has improved immensely. Another recent advancement for protecting life and critical infrastructure is the ShakeAlert® Earthquake Early Warning (EEW) system!

If you live in King, Pierce, and Thurston Counties in Washington State *and have opted in to receive this test*, you will receive a **TEST** Wireless Emergency Alert (WEA) Thursday (2/25) at 11AM as a public demonstration of the ShakeAlert earthquake early warning system.

WEA is like an AMBER alert, and you must opt in to receive the test alert if you live in these three counties. More information on how to opt in is available at mil.wa.gov/alerts

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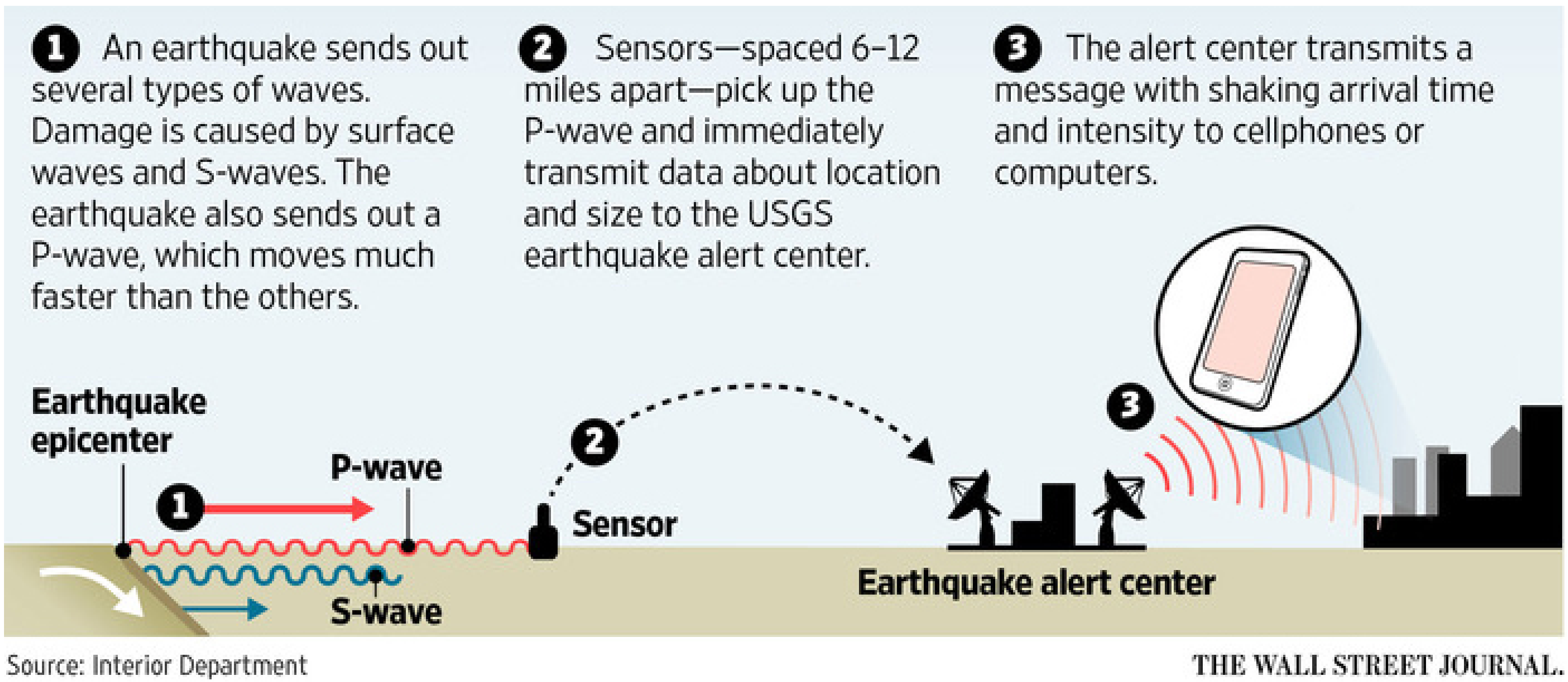
Earthquake Early Warning (EEW) is not earthquake prediction. Seismometers in the field detect an earthquake that has already begun and data from it is sent to a ShakeAlert Processing Center.

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.



IRIS Teachable Moments

Magnitude 6.8 NISQUALLY
Wednesday, February 28, 2001 at 18:54:32 UTC

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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Magnitude 6.8 NISQUALLY
Wednesday, February 28, 2001 at 18:54:32 UTC

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.

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