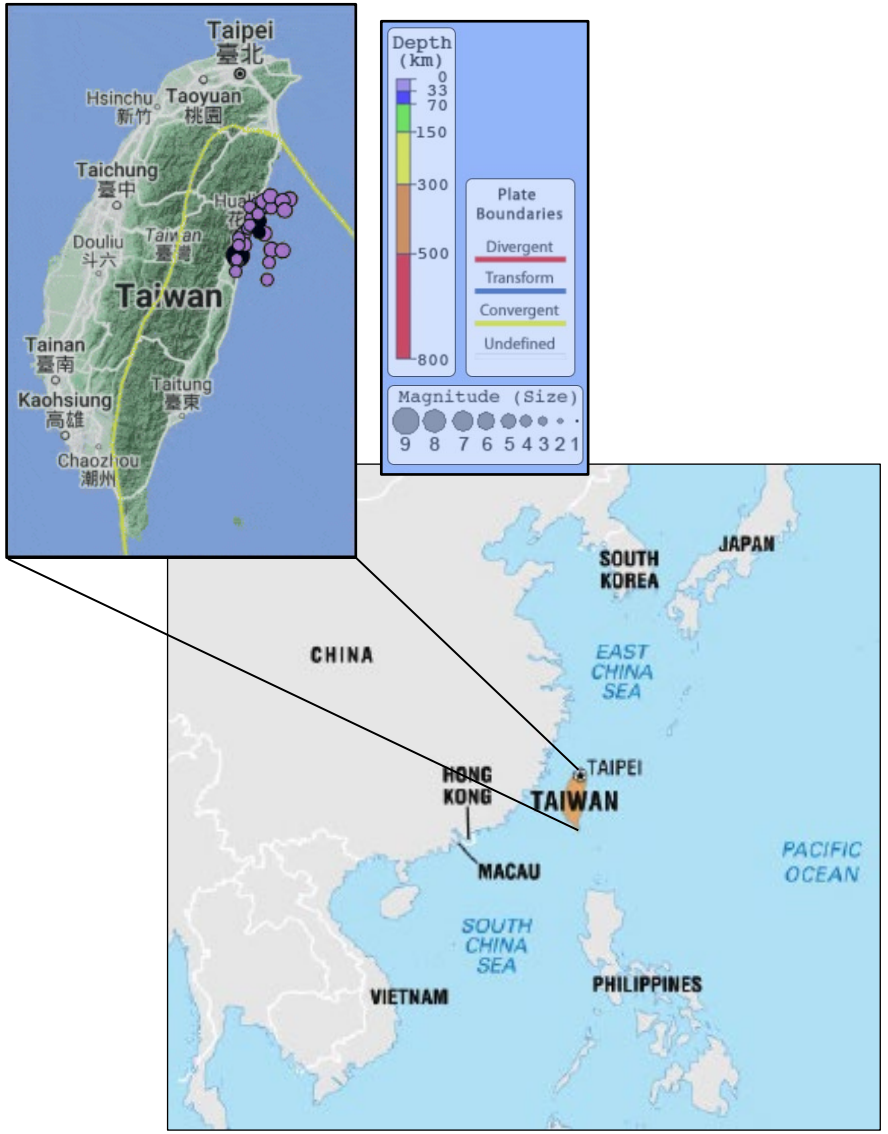
Magnitude 7.4 TAIWAN

Tuesday, April 2, 2024 at 23:58:11 UTC

Latitude 23.819°N
Longitude 121.562°E
Depth 34.8 km

A 7.4-magnitude earthquake, followed by >55 aftershocks >M4, struck off the east coast of Taiwan on Wednesday morning 18km (11.2 miles) SSW of Haulien City, Taiwan at a depth of 34.8 km (21.6 miles). At least 9 people were killed and more than 900 injured. The earthquake, which damaged buildings and caused landslides, was the largest to hit Taiwan in 25 years and was also felt in parts of China.

A tsunami warning was issued for Taiwan, Japan, and the Philippines as a result. A small tsunami washed ashore on southern Japanese islands but caused no damage. The tsunami threat has now passed.



Earthquake animation from www.iris.edu/ieb

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A building in Hualien, eastern Taiwan, is left tilting precariously following a powerful earthquake on April 2, 2024. (The Yomiuri Shimbun)

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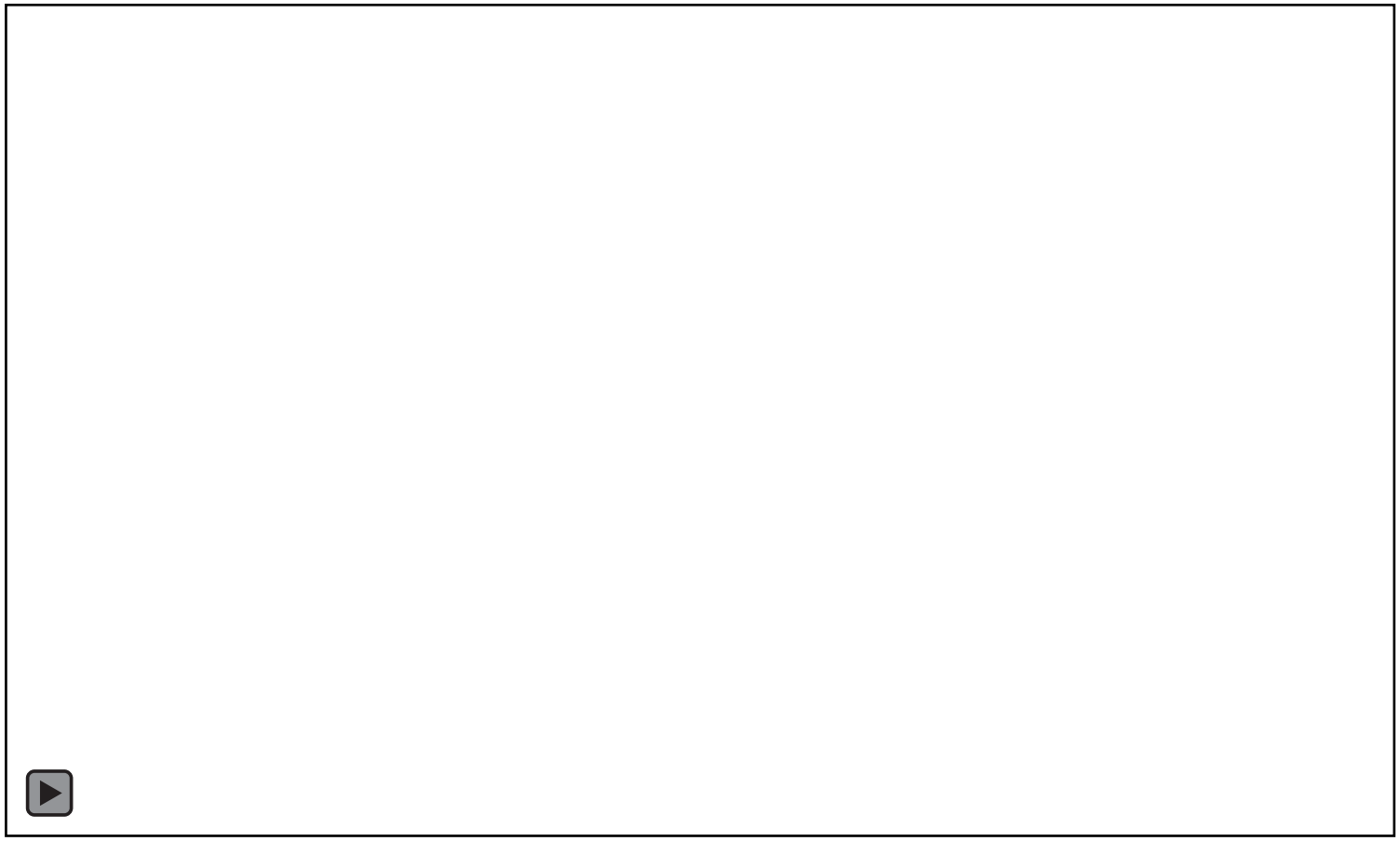
A dashcam camera captured a large landslide coming down a mountain in Taiwan, triggered by the earthquake. Landslides have cut off access along Hualien's Provincial Highway No. 8, which leads in and out of Taroko National Park.



Video courtesy X @piroooooon3

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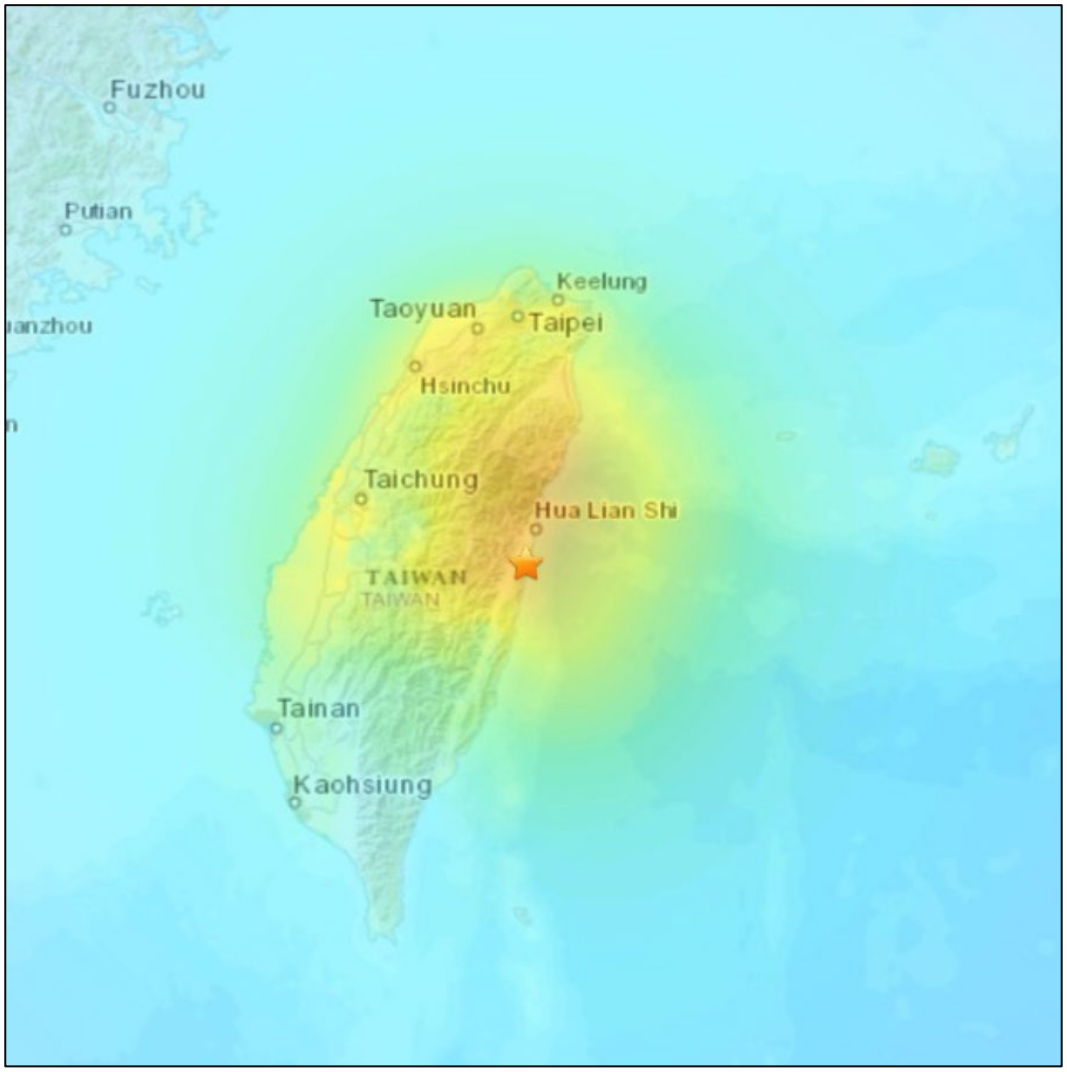
The Modified-Mercalli Intensity (MMI) scale is a ten-stage scale, from I to X, that indicates the severity of ground shaking.

Intensity is based on observed effects and is variable over the area affected by the earthquake and is dependent on earthquake size, depth, distance, and local conditions.

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



USGS estimated shaking intensity from M 7.4 Earthquake

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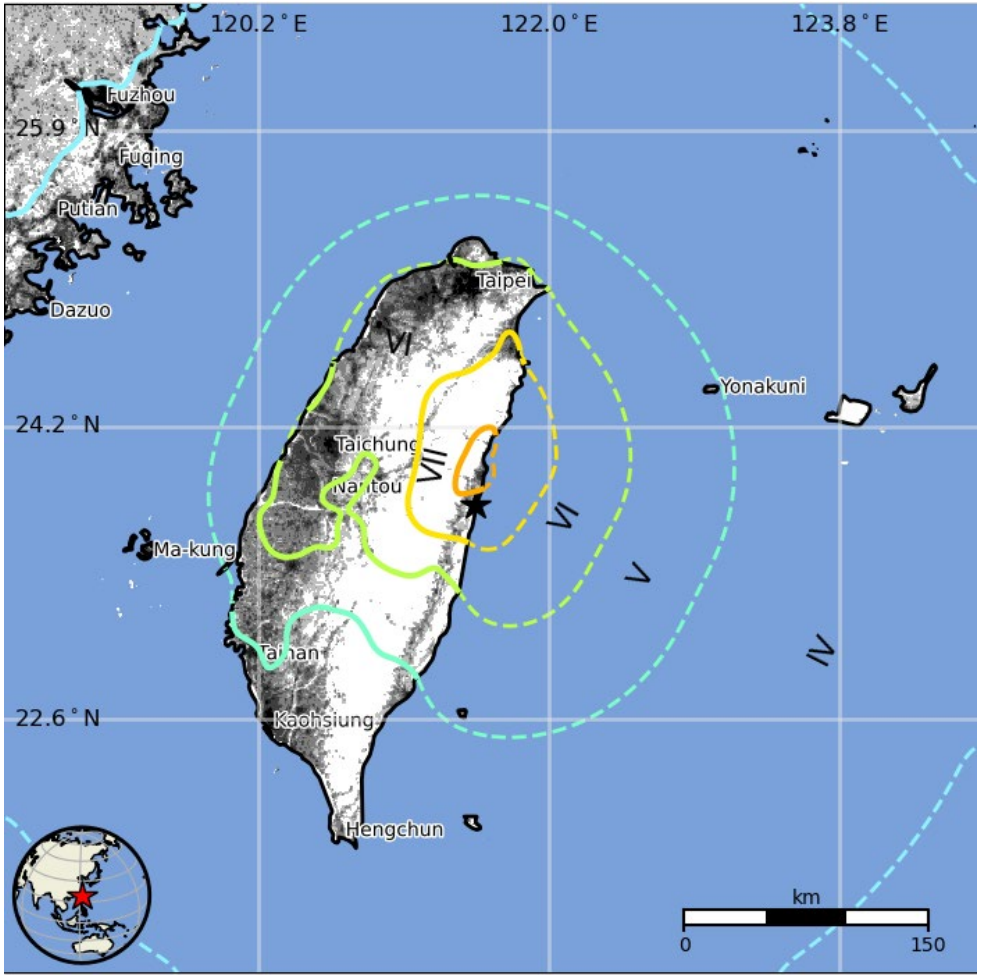
The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels. The USGS estimates that approximately 153,000 people felt severe shaking from this earthquake.

MMI	Shaking	Population
I	Not Felt	0 k*
II-III	Weak	1,117 k*
IV	Light	14,006 k
V	Moderate	3,911 k
VI	Strong	13,065 k
VII	Very Strong	2,922 k
VIII	Severe	153 k
IX	Violent	0 k
X	Extreme	0 k



The color-coded contour lines outline regions of MMI intensity. The total population exposure to a given MMI value is obtained by summing the population between the contour lines. The estimated population exposure to each MMI Intensity is shown in the table.

Image courtesy of the US Geological Survey

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This map shows regional tectonics along the northwestern margin of the Philippine Sea Plate. At the Ryukyu Trench, the Philippine Sea Plate subducts beneath the Eurasian Plate producing earthquakes up to 300 km depth. At the Manila Trench south of Taiwan, oceanic lithosphere of the Eurasian Plate subducts eastward beneath the Philippine Sea Plate. The island nation of Taiwan is a complex collision zone where the northern portion of the Philippine island arc is overriding the Eurasian continental margin. 3D model on the next slide shows the tectonic complexity of Taiwan.

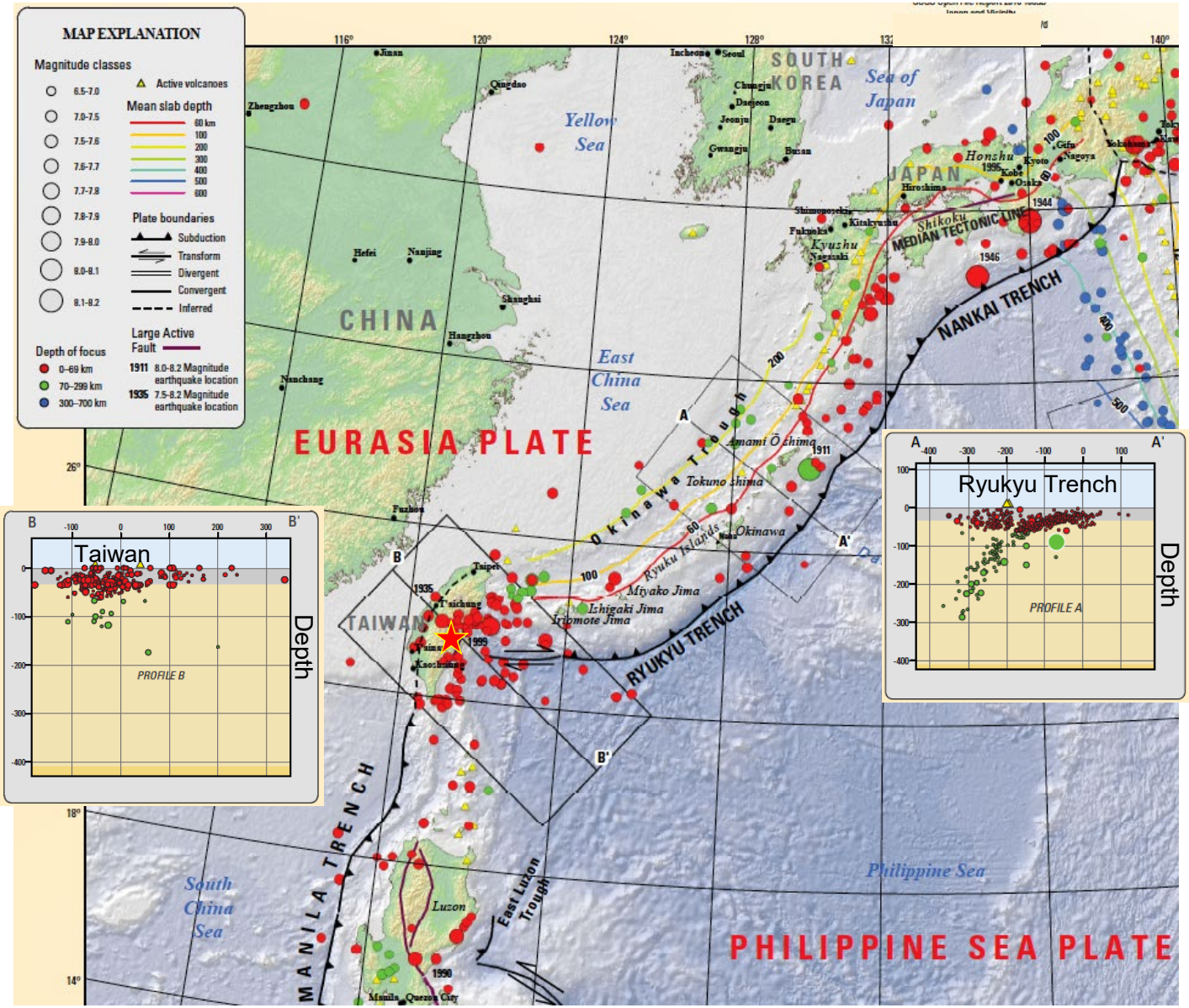

Image courtesy of US Geological Survey

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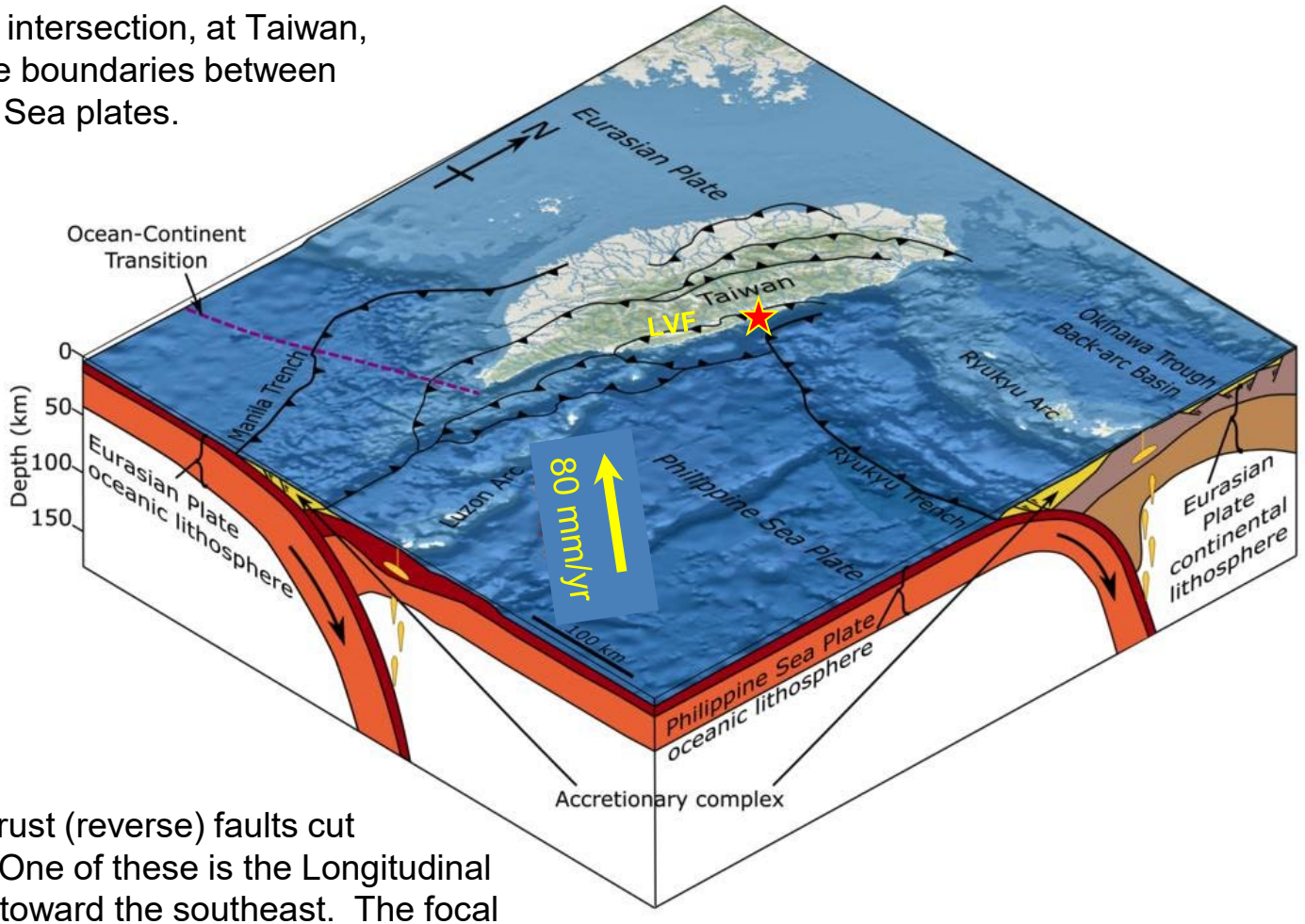
This block model shows the intersection, at Taiwan, of two subduction zone plate boundaries between the Eurasian and Philippine Sea plates.

The yellow arrow shows the 80 mm/yr motion of the Philippine Sea Plate toward the Eurasian Plate. The red star is the epicenter of the April 2, 2024 earthquake.

At the Manila Trench south of Taiwan and beneath Taiwan itself, the Eurasian Plate subducts eastward beneath the Philippine Sea Plate.



Several NE–SW oriented thrust (reverse) faults cut lengthwise across Taiwan. One of these is the Longitudinal Valley Fault (LVF) that dips toward the southeast. The focal mechanism of the April 2, 2024 earthquake has one NE–SW nodal plane dipping about 60°to the southeast. This matches the subsurface geometry of the Longitudinal Valley Fault making it a likely source of the April 2 earthquake.

Image created by Mike Norton
https://commons.wikimedia.org/w/index.php?curid=116285712

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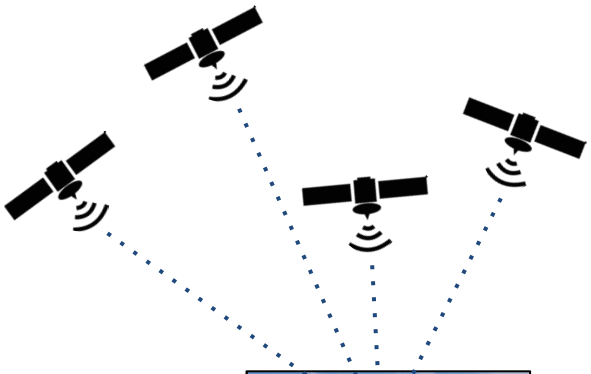
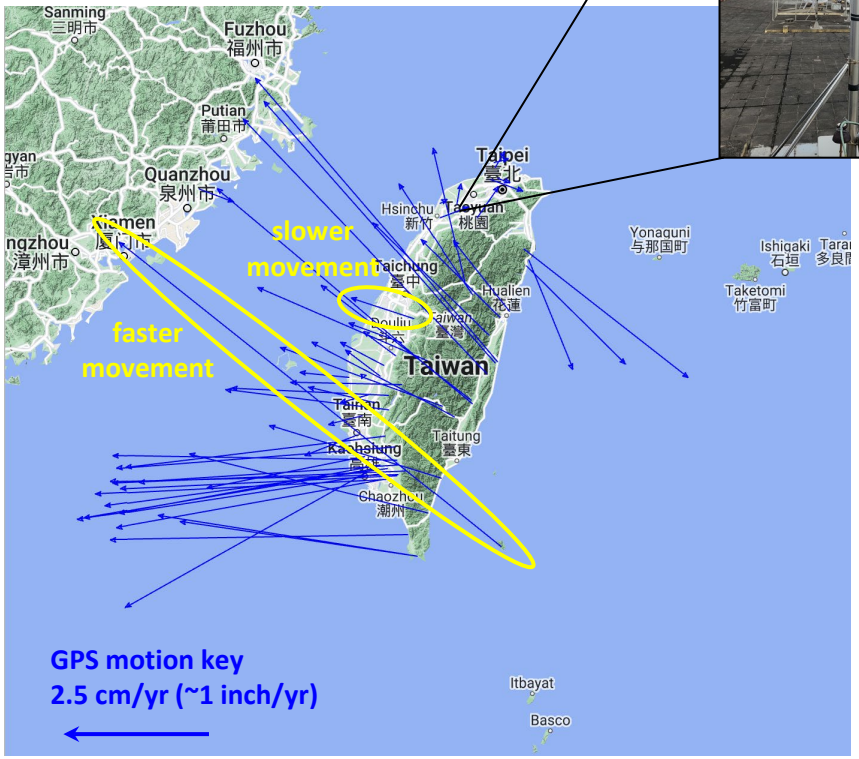
One of the ways we know the rates of plate motion is from GPS observations.

GPS stations receive signals from satellites and use the time offset between when the signal leaves the satellite and when it arrives at the station to determine distance. If a station receives signals from 4 or more stations, it is able to determine its location (6 or more satellites is much better).

This is the same way GPS works in phones and other devices but the high-precision stations can determine location within millimeters (<¼ inch) rather than 5-10 meters (15-30 feet).

Over time, changing locations allow scientists to determine station movement from plate tectonics, which are shown as vectors (arrows).





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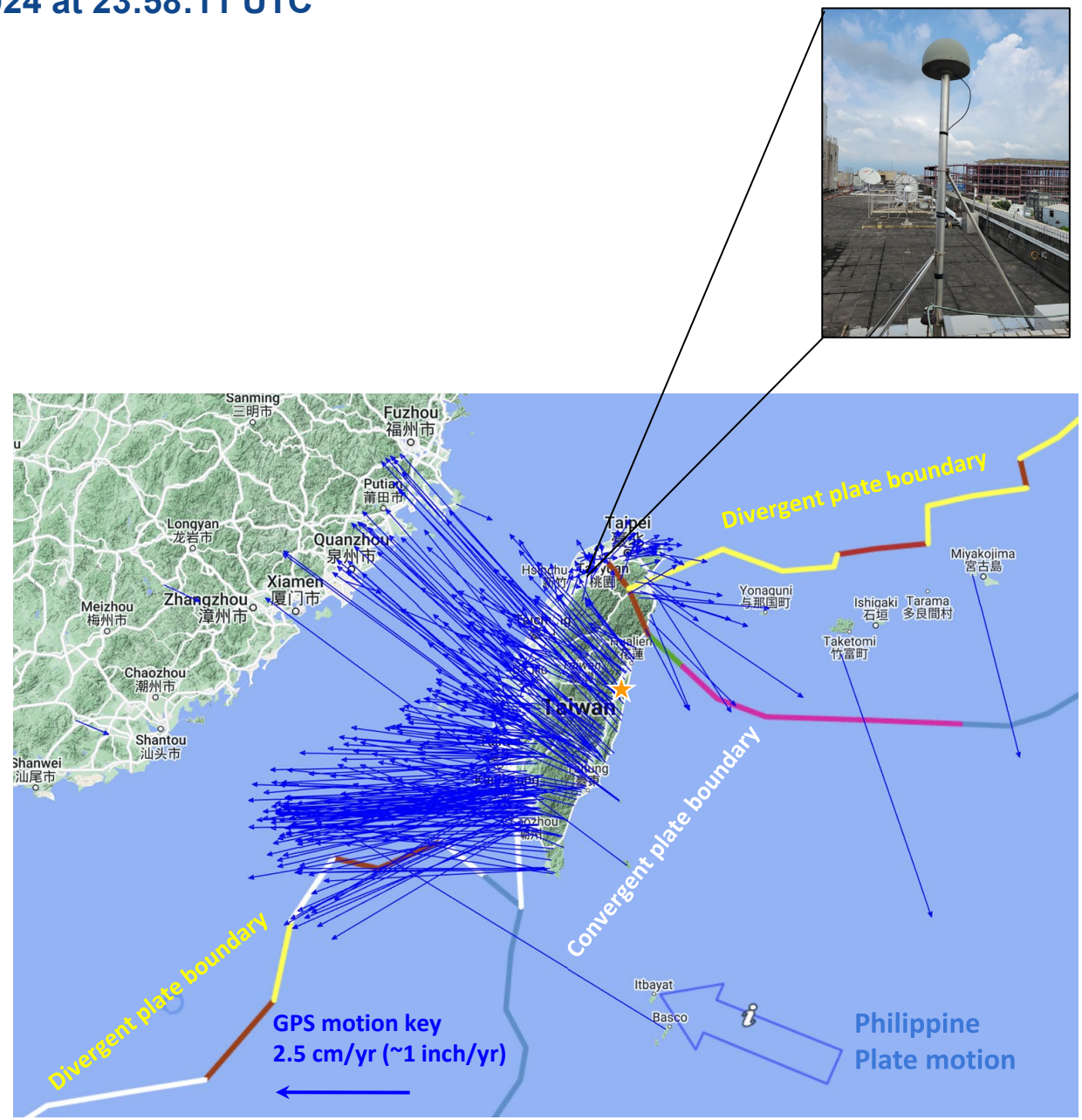
Taiwan has many GPS stations that record the long-term motion from plate tectonics.

Compared to mainland Asia, some stations are moving as much as 8 cm/yr (~3 inch/yr) towards the northwest as the Philippine Sea Plate pushes into Taiwan.

Over decades and centuries this compression accumulates and is occasionally released in earthquakes such as the magnitude 7.4 quake on April 2, 2024.



Magnitude 7.4 TAIWAN

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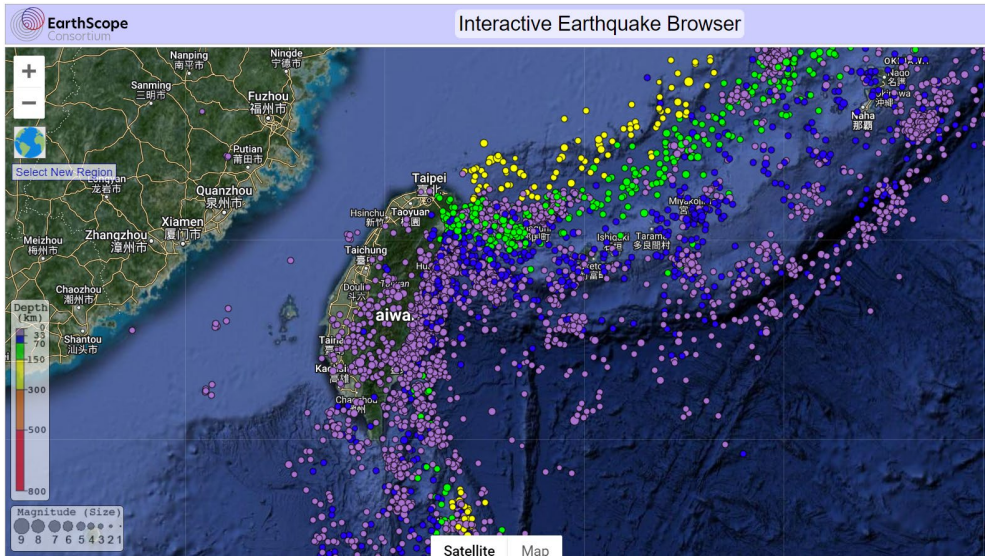
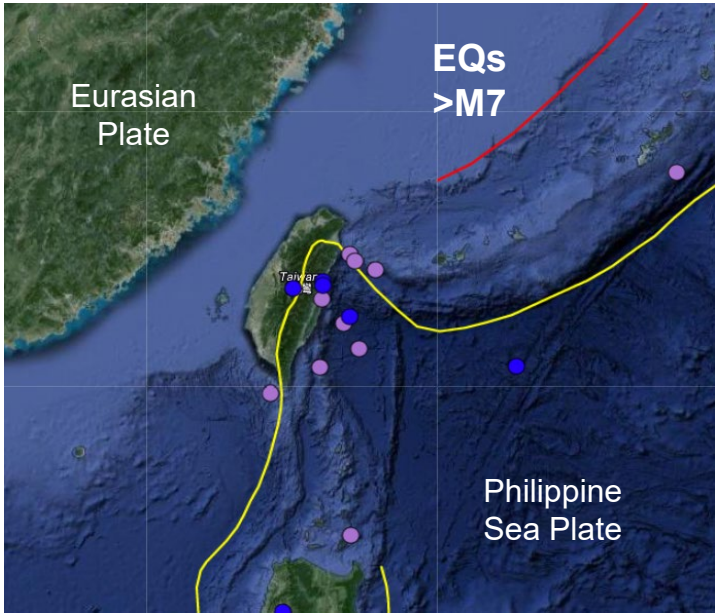
Taiwan is at the intersection of two subduction zone plate boundaries between the Eurasian and Philippine Sea plates.

The upper map shows the 4000 most recent earthquake in the region, color coded by depth.

Over the preceding 50 years there have been 12 earthquakes above a magnitude 7, shown in the bottom map, that have occurred along the island of Taiwan.

The largest recorded earthquake in this region occurred in 1920, a M8.2 located east of the April 2, 2024 earthquake.





Images from the Interactive Earthquake Browser (IEB)

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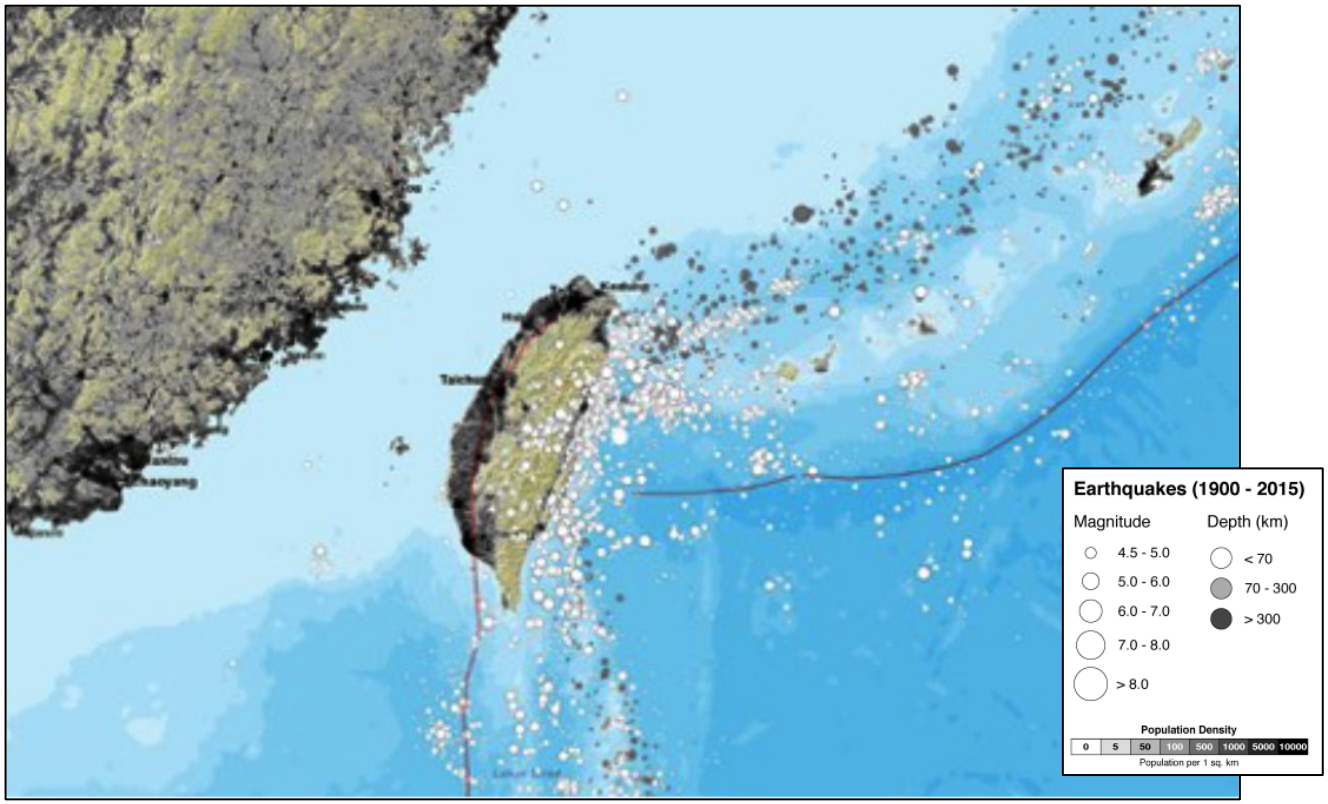
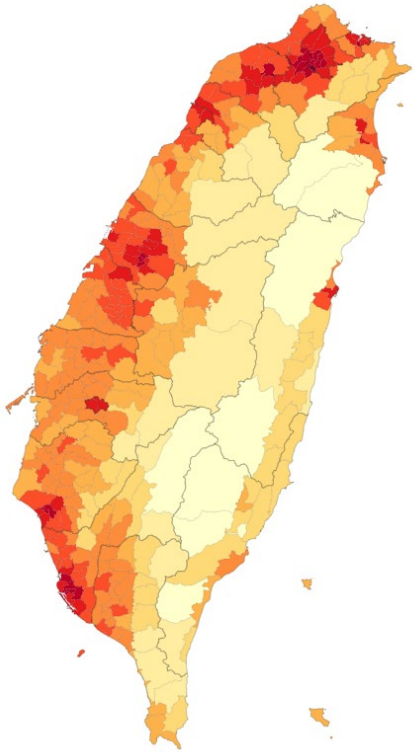
While nearly all earthquakes in Taiwan occur along the island's east coast, the vast majority of the country's population lives along the west coast. So, for most earthquakes, large population centers experience shaking but not much damage. However, when a major earthquake does occur in western Taiwan, the impacts can be devastating.



Map data from the US Geological Survey (legend rescaled for readability)

Population Density of Taiwan by district (2020)



Inhabitants per square km

- ≥32 000/km^2
- 10 000–31 999/km^2
- 3 200–9 999/km^2
- 1 000–3 199/km^2
- 320–999/km^2
- 100–319/km^2
- 32–99/km^2
- 10–31/km^2
- 0–9/km^2

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The April 1935 M7.1 Shinchiku-Taichū earthquake was the deadliest in Taiwan history, claiming 3,276 lives.

The second-deadliest earthquake in Taiwan's recorded history, occurred just 25 years ago, on September 21, 1999. The M 7.7 earthquake occurred in Jiji (Chi-Chi), Nantou County, Taiwan. There were 2,415 fatalities, 11,305 injured, 100,000 people made homeless, and $10 billion (US) worth of damage.

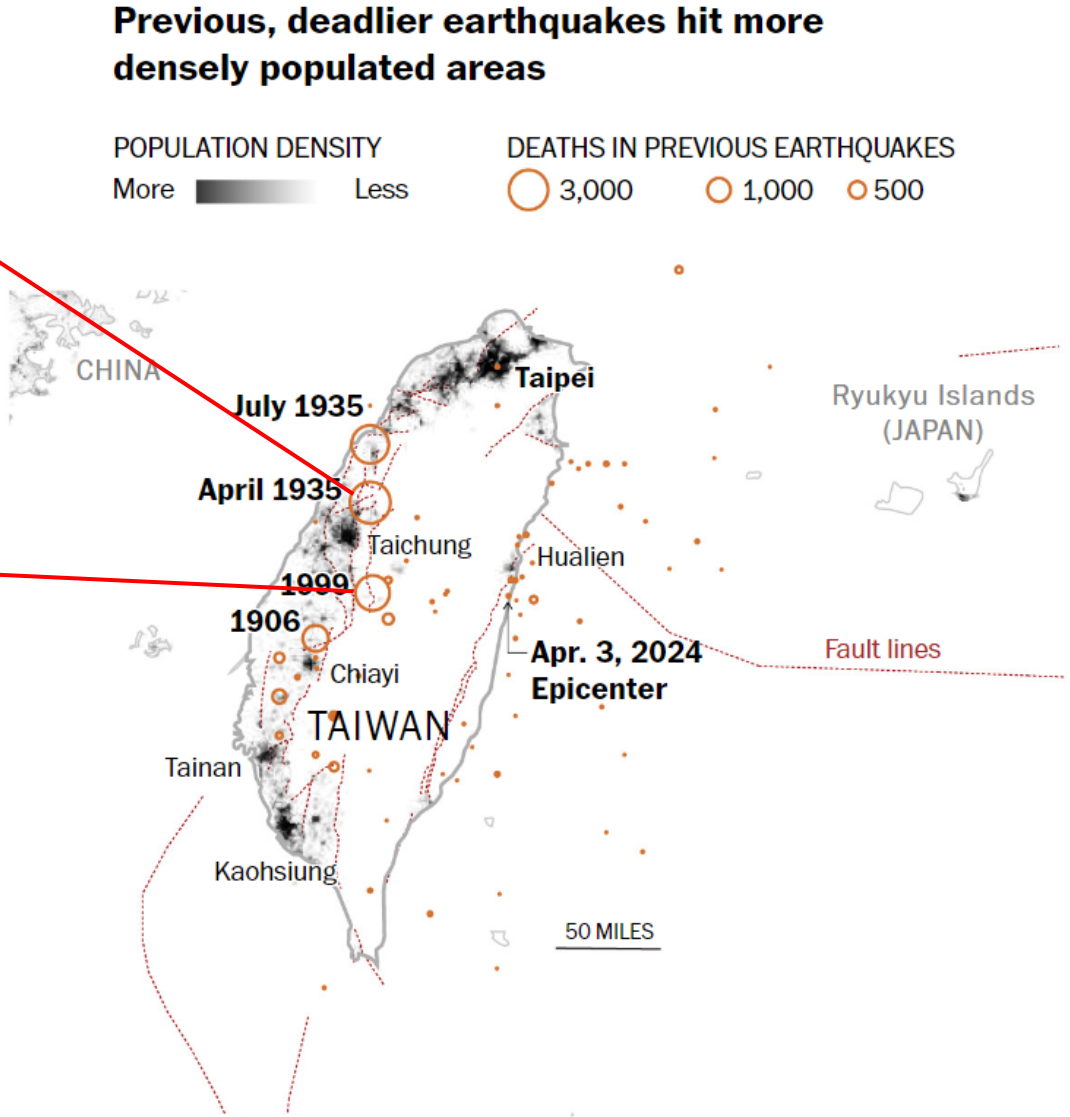

Image courtesy NOAA, SAMUEL GRANADOS AND JÚLIA LEDUR / THE WASHINGTON POST

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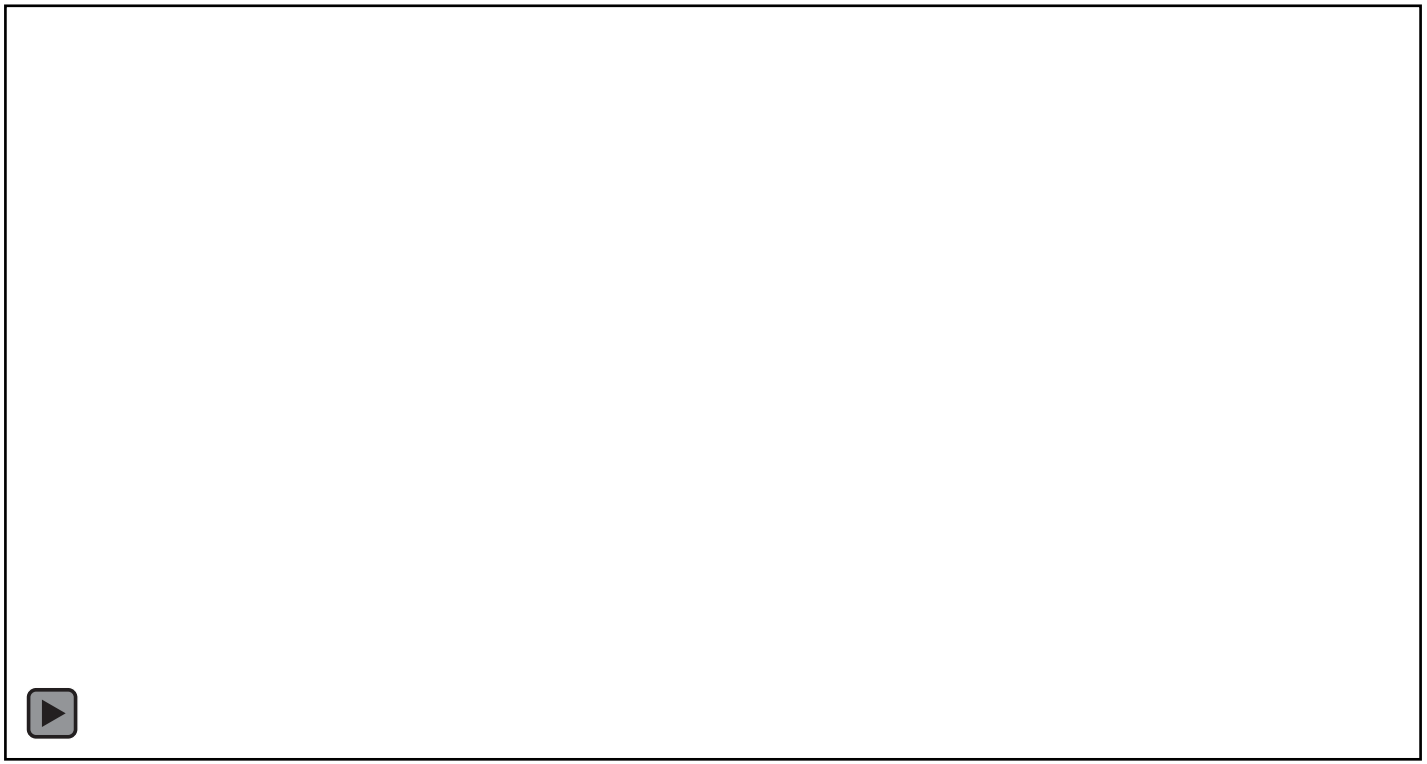
Within 24 hours of the mainshock, 41 aftershocks occurred, ranging in magnitude from 4.1 to 6.4. The largest aftershock, measuring magnitude 6.4, occurred just 13 minutes after the mainshock. It is anticipated that the aftershocks will persist for many weeks following the earthquake, gradually decreasing in frequency over time.



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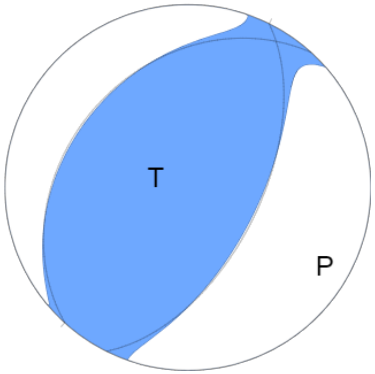
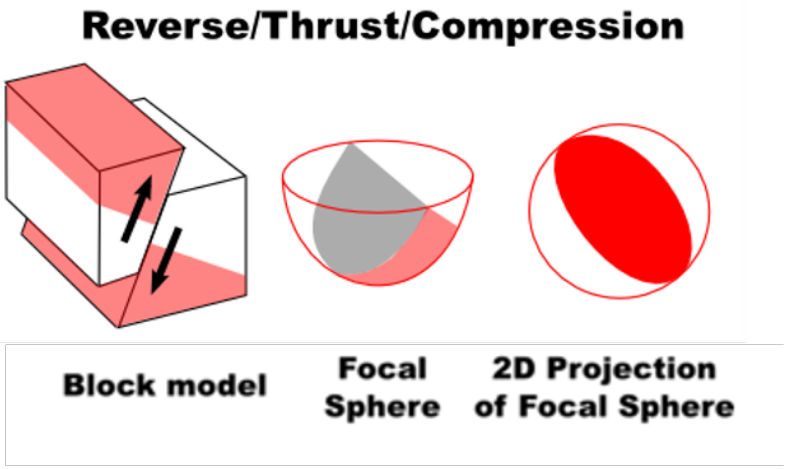
The focal mechanism is how seismologists plot the 3-D stress orientations of an earthquake. Because an earthquake occurs as slip on a fault, it generates primary (P) waves in quadrants where the first pulse is compressional (shaded) and quadrants where the first pulse is extensional (white). The orientation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



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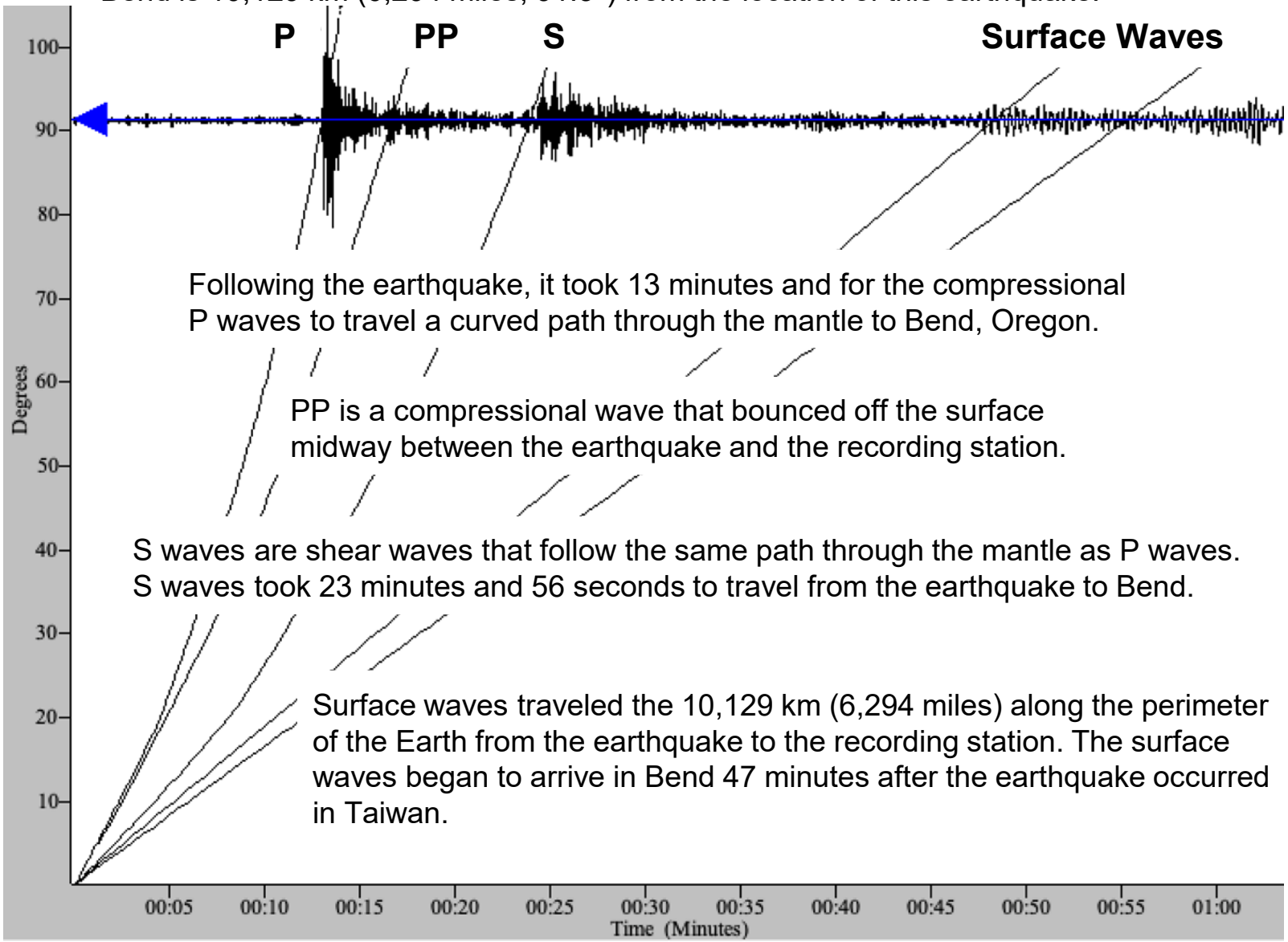
The record of the earthquake in Bend, Oregon (BNOR) is illustrated below.
Bend is 10,129 km (6,294 miles, 91.3°) from the location of this earthquake.



Following the earthquake, it took 13 minutes and for the compressional P waves to travel a curved path through the mantle to Bend, Oregon.

PP is a compressional wave that bounced off the surface midway between the earthquake and the recording station.

S waves are shear waves that follow the same path through the mantle as P waves. S waves took 23 minutes and 56 seconds to travel from the earthquake to Bend.

Surface waves traveled the 10,129 km (6,294 miles) along the perimeter of the Earth from the earthquake to the recording station. The surface waves began to arrive in Bend 47 minutes after the earthquake occurred in Taiwan.

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These resources have been developed as part of the SAGE facility operated by the EarthScope Consortium via support from the National Science Foundation.