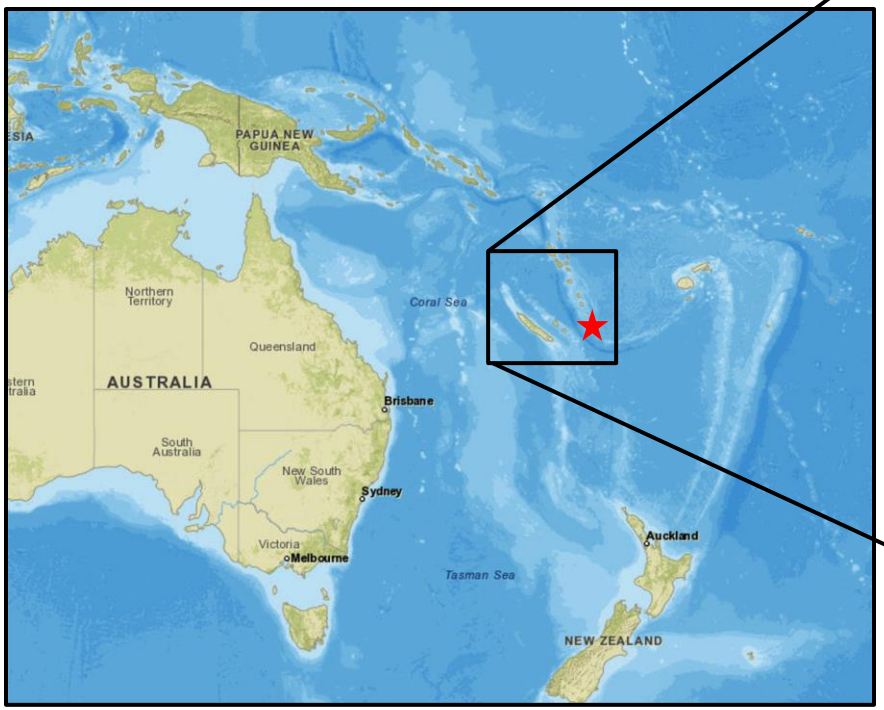
Magnitude 7.1 VANUATU

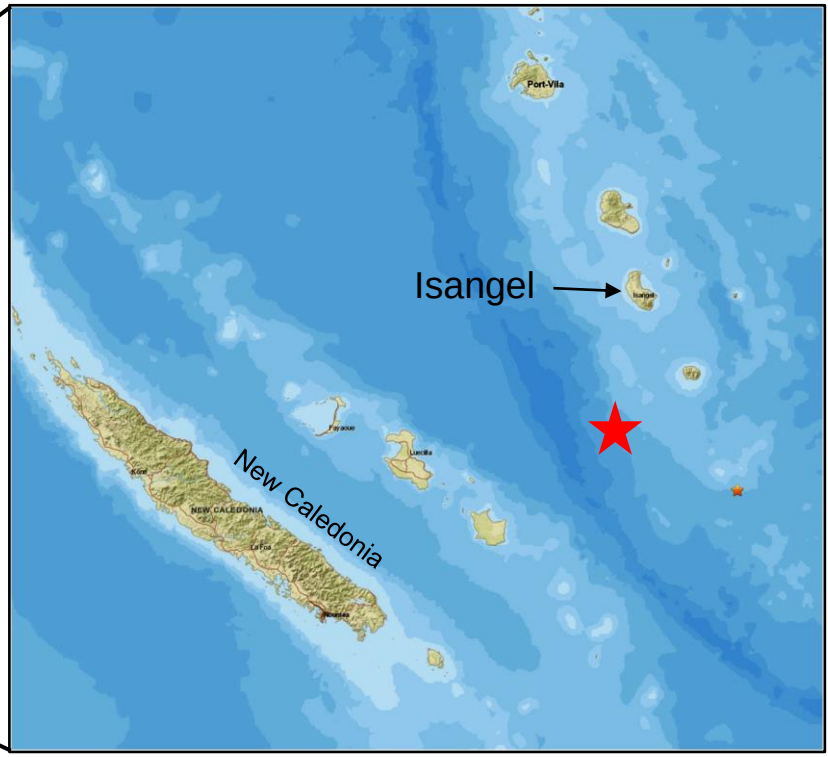
Thursday, December 7, 2023 at 12:56:30 UTC

Latitude 20.659° S
Longitude 169.206° E
Depth 48.4 km

A magnitude 7.1 earthquake struck just after 4:56 AM local time about 123 km (80 mi) south of Isangel, Vanuatu (population 1,200), the provincial administrative capital of Tafea Province which is the southernmost of the seven provinces of Vanuatu.

There are no reports of damage or injuries. A tsunami warning for the coasts of Vanuatu and New Caledonia has passed; the Pacific Tsunami Warning Center earlier said that hazardous tsunami waves were possible within 300 km (186 miles) of the epicenter along the coasts of Vanuatu and New Caledonia.





Maps from US Geological Survey

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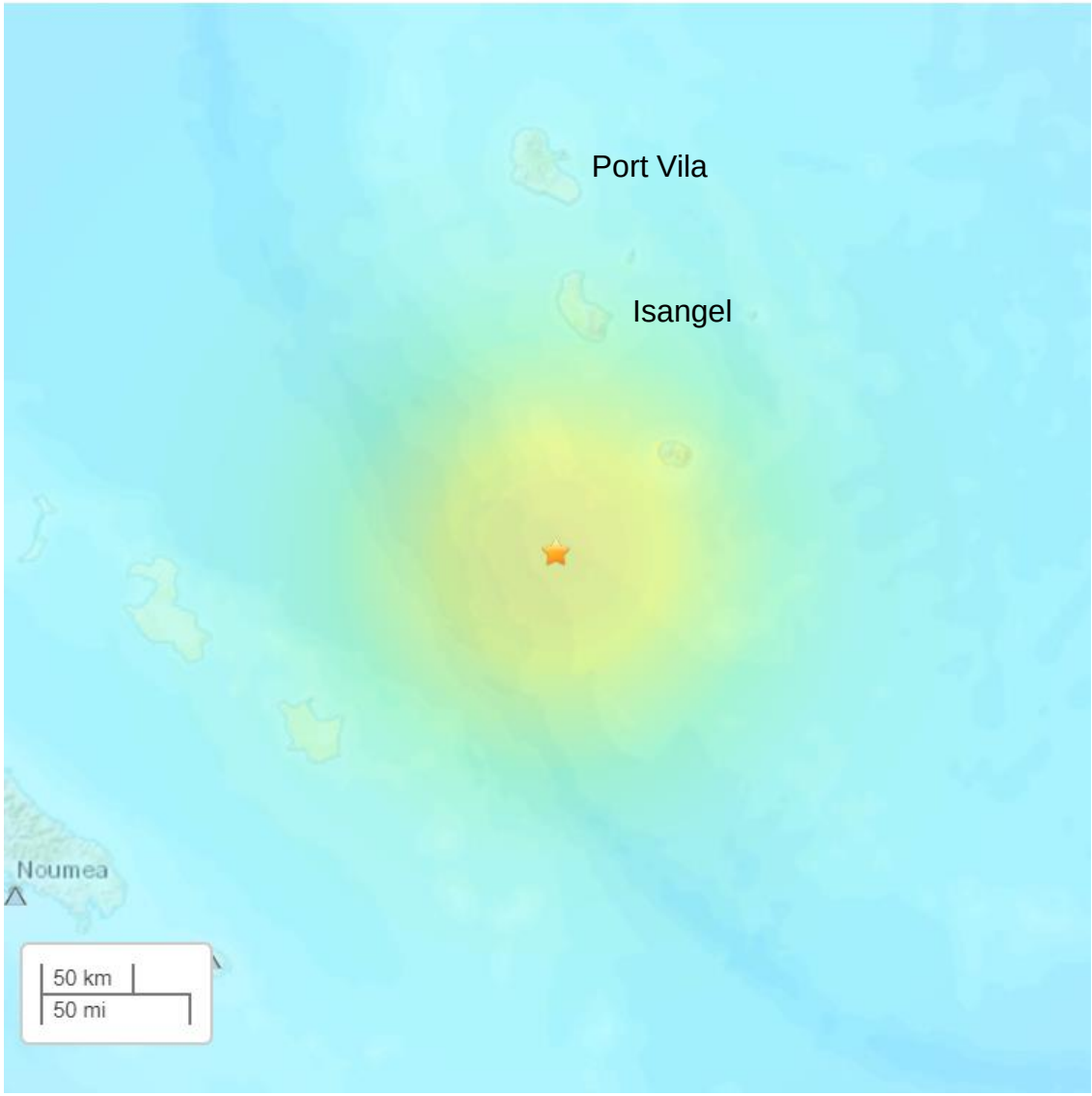
The Modified-Mercalli Intensity (MMI) scale is a ten-stage scale, from I to X, that indicates the severity of ground shaking. Intensity is based on observed effects and is variable over the area affected by an earthquake. Intensity is dependent on earthquake size, depth, distance, and local conditions.

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 7.1 Earthquake

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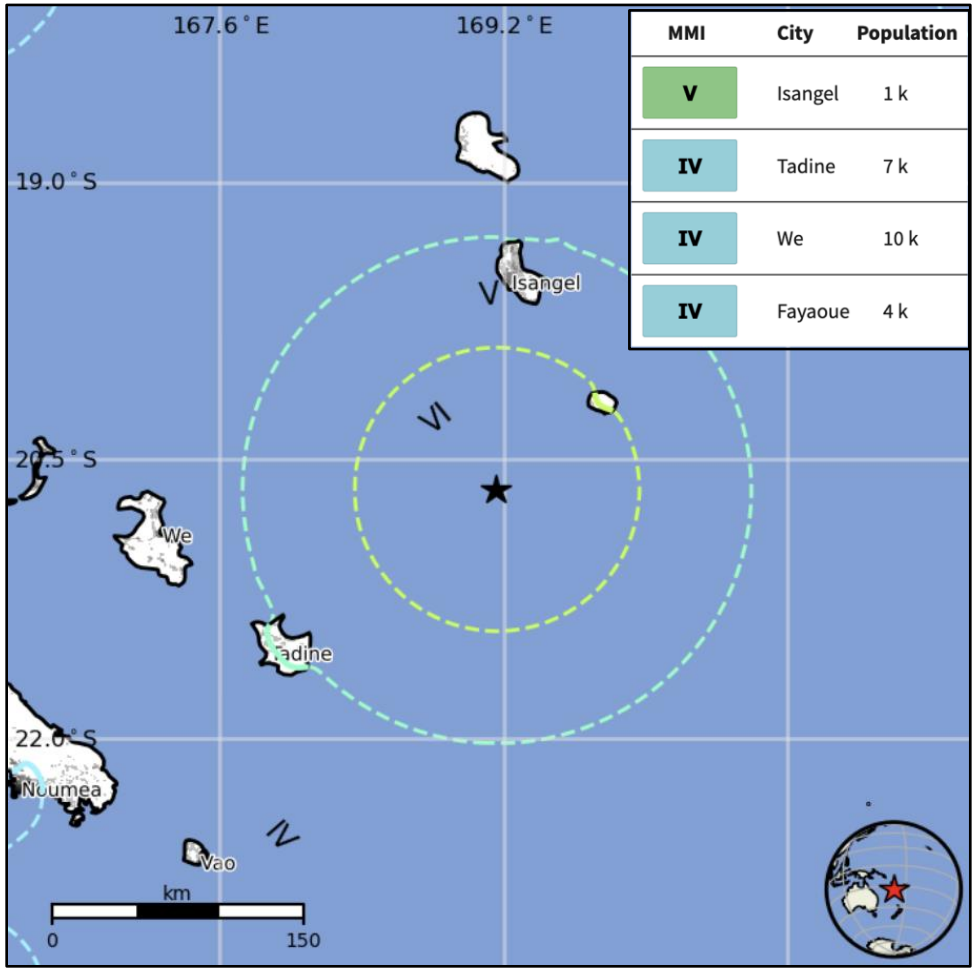
The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels.
The USGS estimates that 90,000 people felt light to moderate shaking from this earthquake. Inset shows populations and MMI levels for the islands in this image.

MMI	Shaking	Population
I	Not Felt	0 k*
II-III	Weak	126 k*
IV	Light	49 k
V	Moderate	41 k
VI	Strong	1 k
VII	Very Strong	0 k
VIII	Severe	0 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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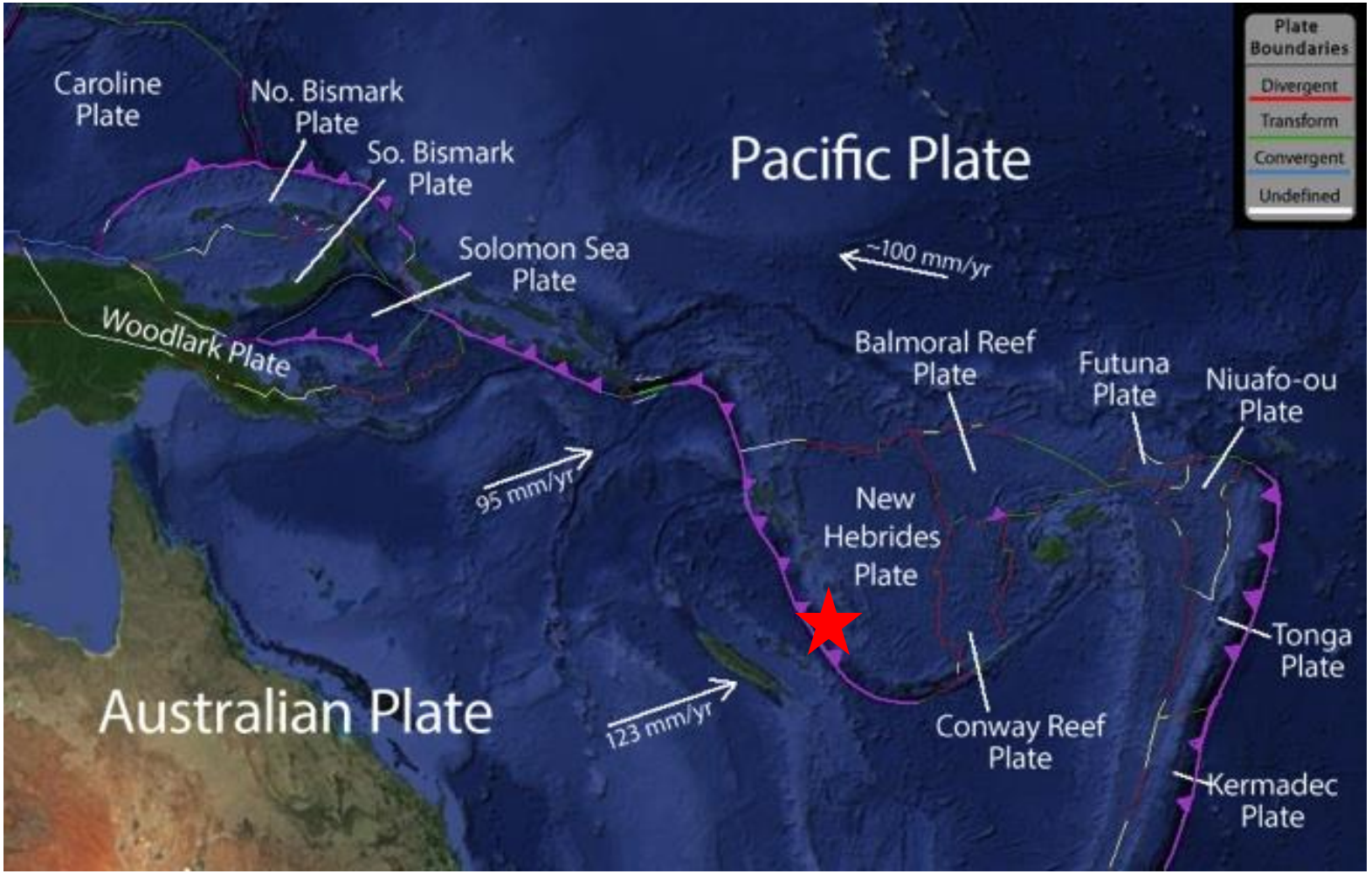
This regional map shows the complexity of plate boundaries and microplates resulting from the convergence between the Australian and Pacific Plates. The red star locates the epicenter of this magnitude 7.1 earthquake.



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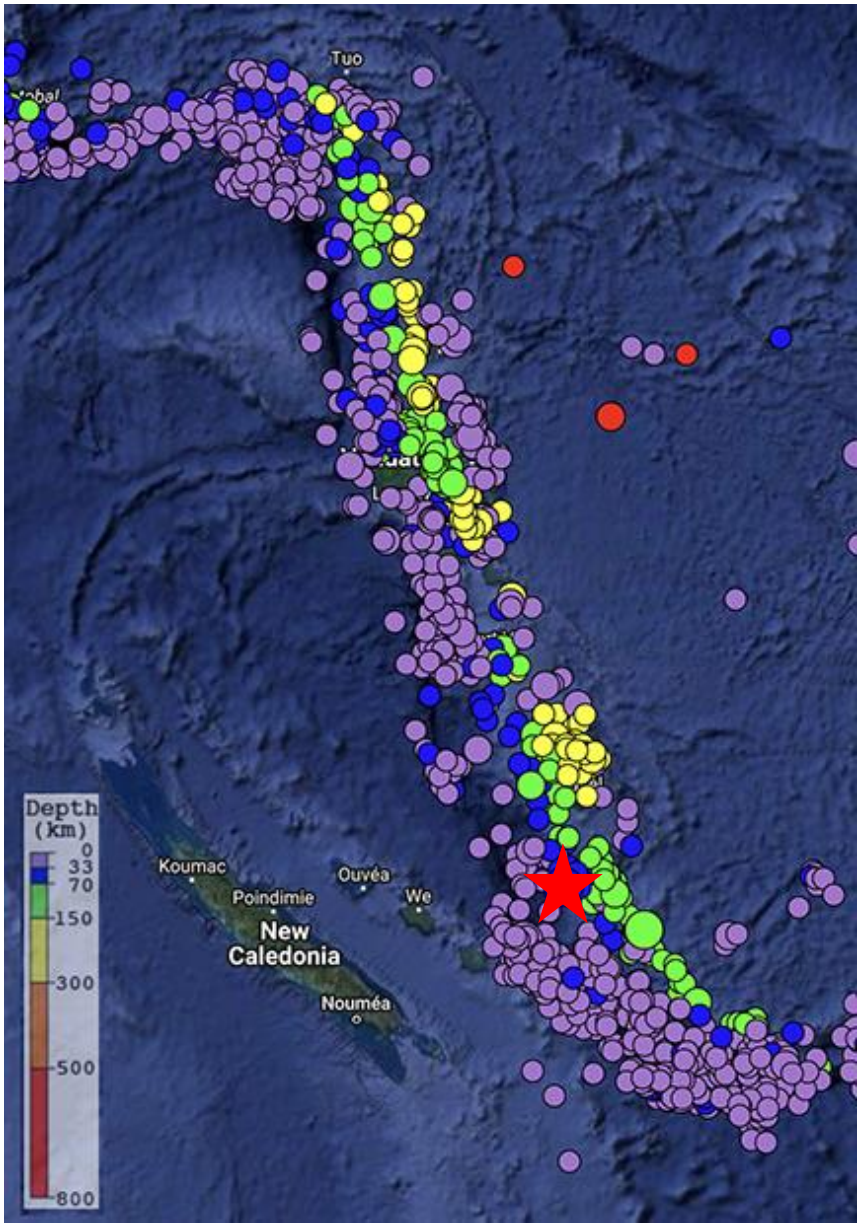
There have been over 1500 earthquakes greater than magnitude 5 in the past 10 years along this subduction zone where over 9000 measurable earthquakes have been recorded in that same period.

Red star indicates the M7.1 earthquake.

This is one of the most active subduction zones on earth, producing great earthquakes (magnitude 8.0 or greater), with potential for tsunami hazards across the region and beyond.



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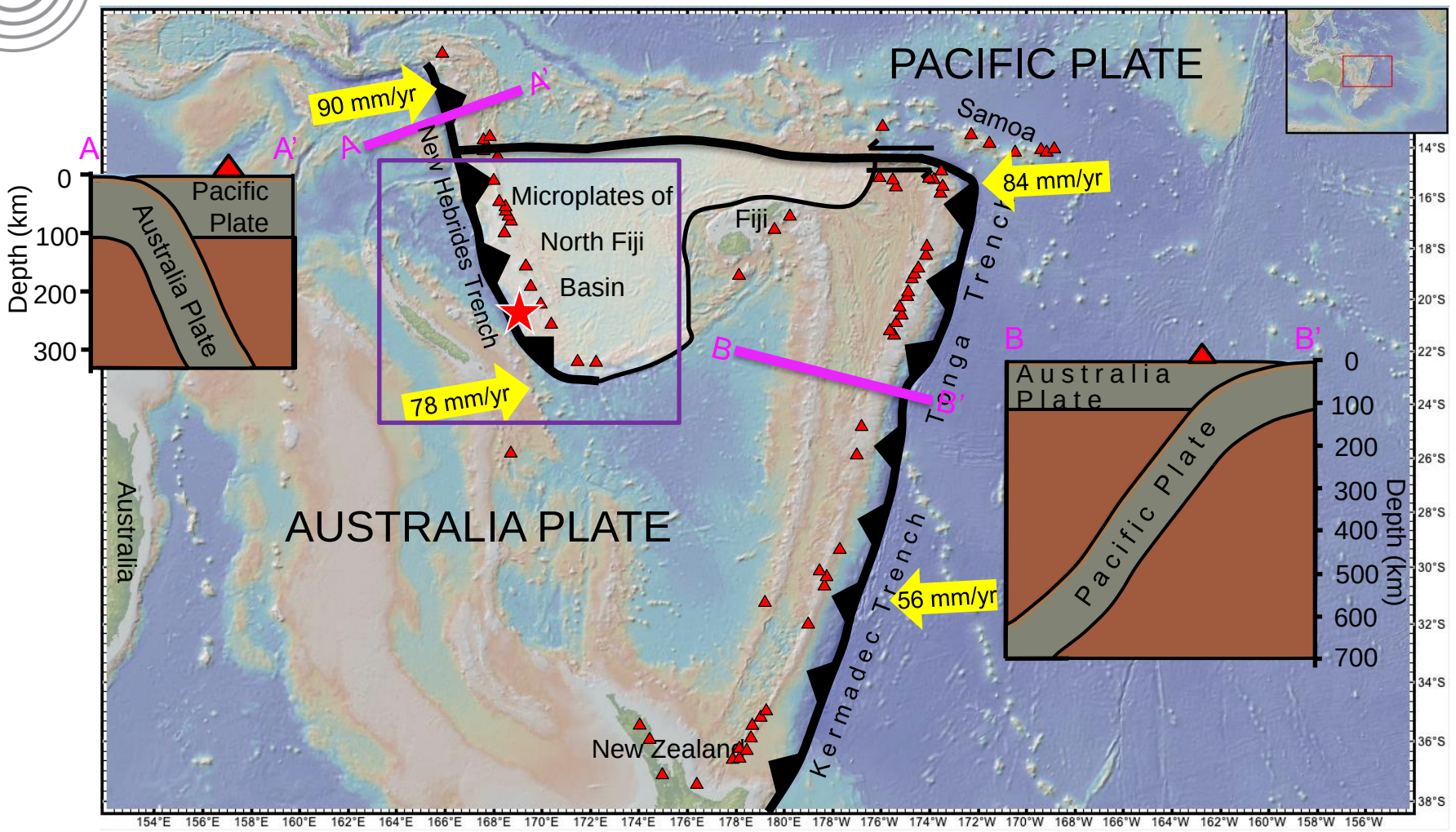

North of New Zealand, the Pacific and Australia plates converge across two major subduction zones. At the New Hebrides Trench, the Australia Plate subducts toward the east beneath the Pacific Plate and the North Fiji Basin. Farther east, the Pacific Plate subducts toward the west beneath the Australia Plate at the Tonga and Kermadec trenches. Cross sections are shown for the locations indicated by pink lines and rates of major plate motions are shown by the yellow arrows. The December 7 earthquake (star) occurred in the southern New Hebrides Trench. Details of tectonics within the area outlined by the purple square are shown in the next slide.

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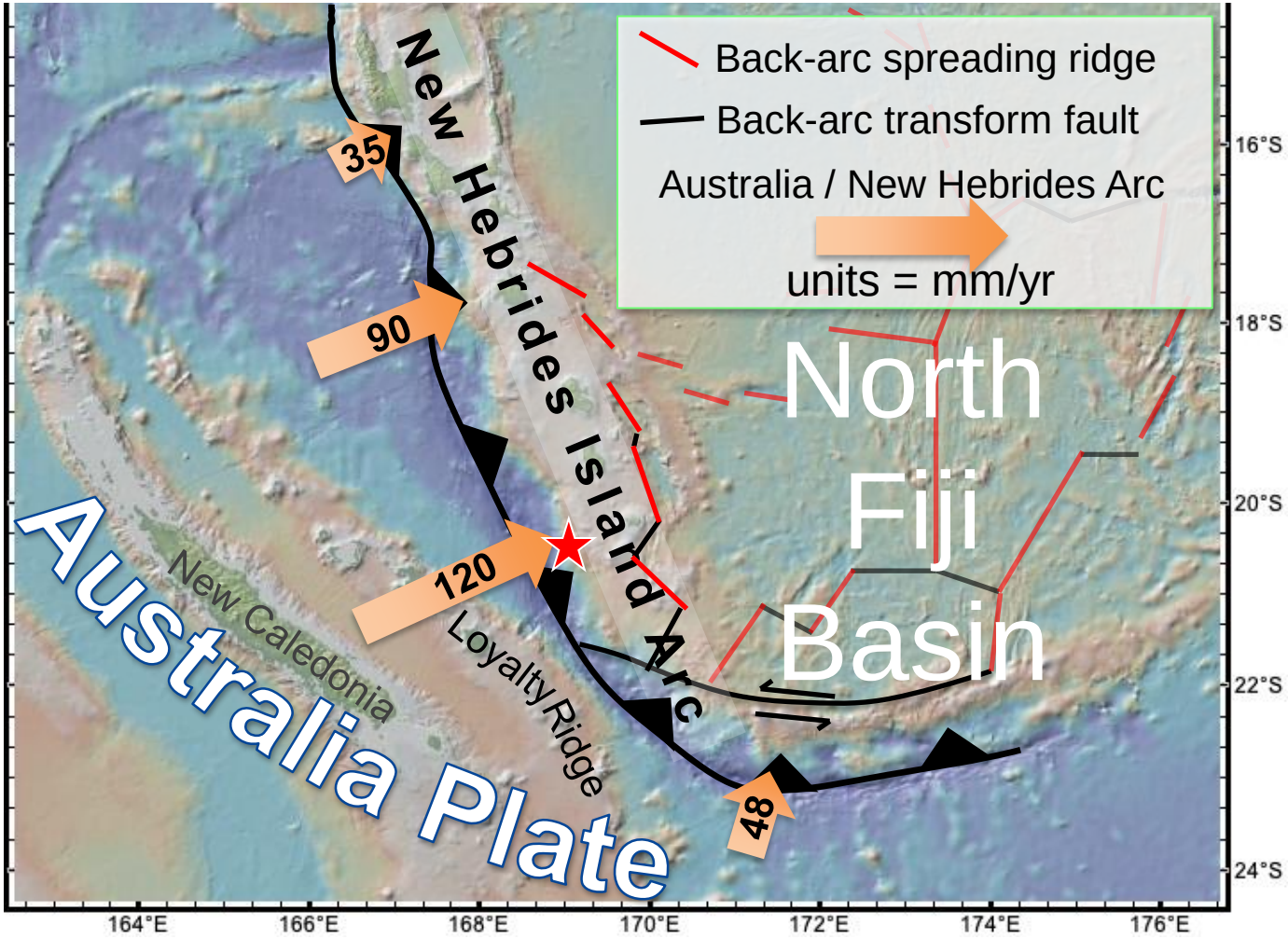
In the New Hebrides subduction zone, the overriding plate is a collection of microplates separated by back-arc spreading ridges and transform faults. So, the rate and direction of subduction of the Australia Plate changes along the length of the New Hebrides Trench. The December 7 earthquake (red star) occurred in the southern part of the New Hebrides Arc where back-arc spreading moves the island arc towards the New Hebrides Trench. The relative motion of the Australia Plate beneath this part of the arc is 120 mm/yr towards the east-northeast. The location of the epicenter, 48 km depth of the hypocenter, and the thrust-faulting focal mechanism all indicate that this earthquake occurred along or near the plate boundary megathrust between the subducting Australia Plate and the overriding New Hebrides Island Arc.



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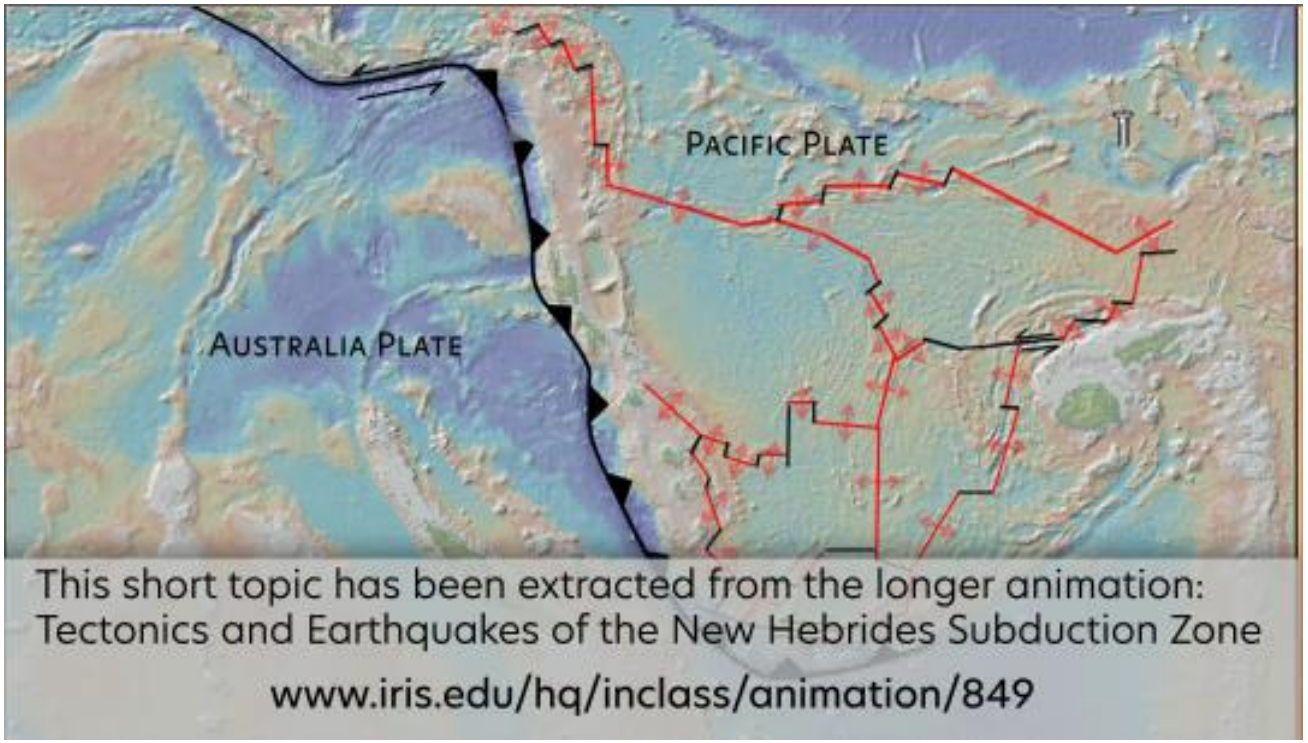
This short animation is part of a longer animation that explains seismicity and tectonics of the North Fiji Basin and the New Hebrides subduction zone.

The animation examines how GPS observations were essential to understanding microplate motions within the New Hebrides Island Arc. In turn, those microplate motions explain how and why the rates and directions of Australia Plate subduction change along the length of the New Hebrides Trench.



Full animation: www.youtube.com/watch?v=7ewdkZ-H0oY
Or download:
Part 1—Tectonics & earthquakes: www.iris.edu/hq/inclass/animation/849
Part 2—12 million year history unfolded: https://www.iris.edu/hq/inclass/animation/850

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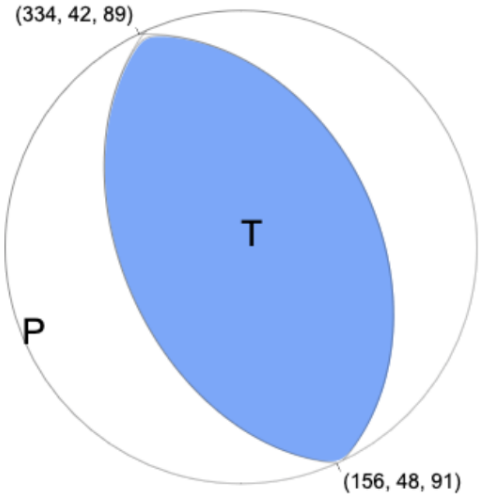
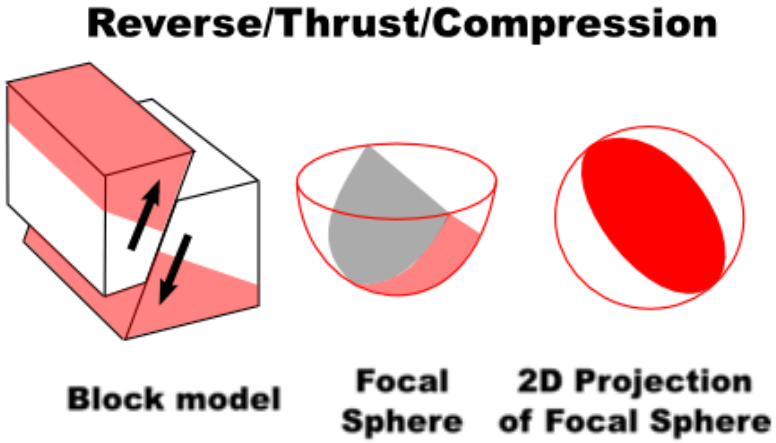
The focal mechanism is how seismologists plot the 3-D stress orientations of an earthquake. Because an earthquake occurs as slip on a fault, it generates primary (P) waves in quadrants where the first pulse is compressional (shaded) and quadrants where the first pulse is extensional (white). The orientation of these quadrants calculated 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 earthquake occurred as the result of thrust faulting on or near the plate boundary at an intermediate depth, approximately 48 km (29.8 miles) .



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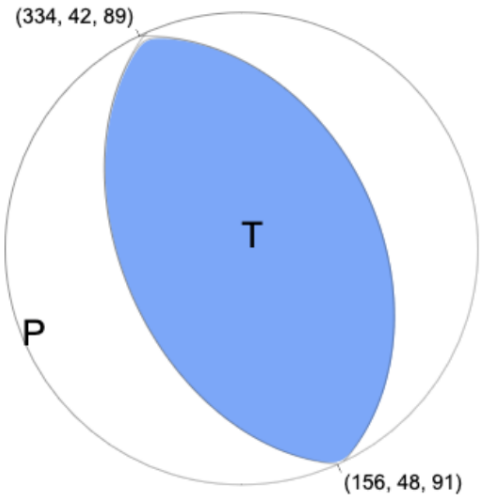
This animation explores the motion of a thrust fault, and how it is represented in a focal mechanism.

Remember, this was the focal mechanism solution for this earthquake. It was estimated by an analysis of observed seismic waveforms, recorded after the earthquake, observing the pattern of "first motions", that is, whether the first arriving P waves push up or down.



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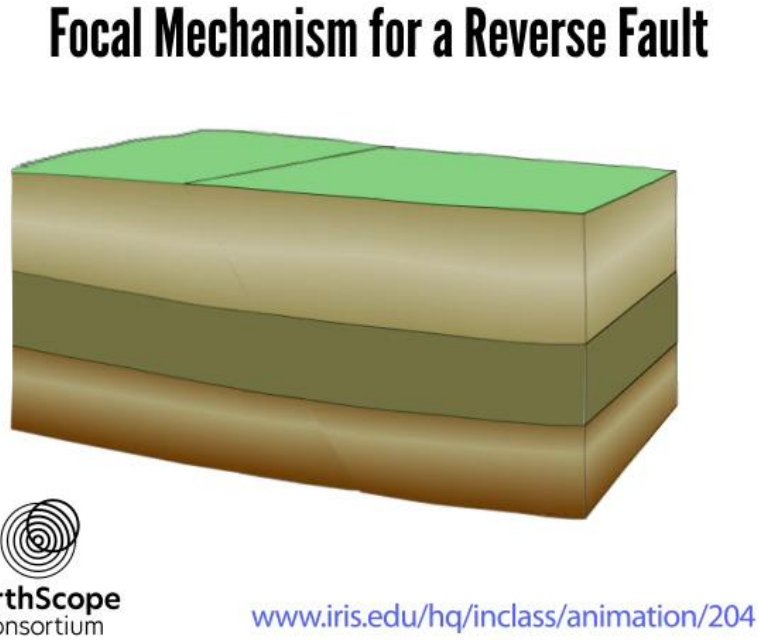

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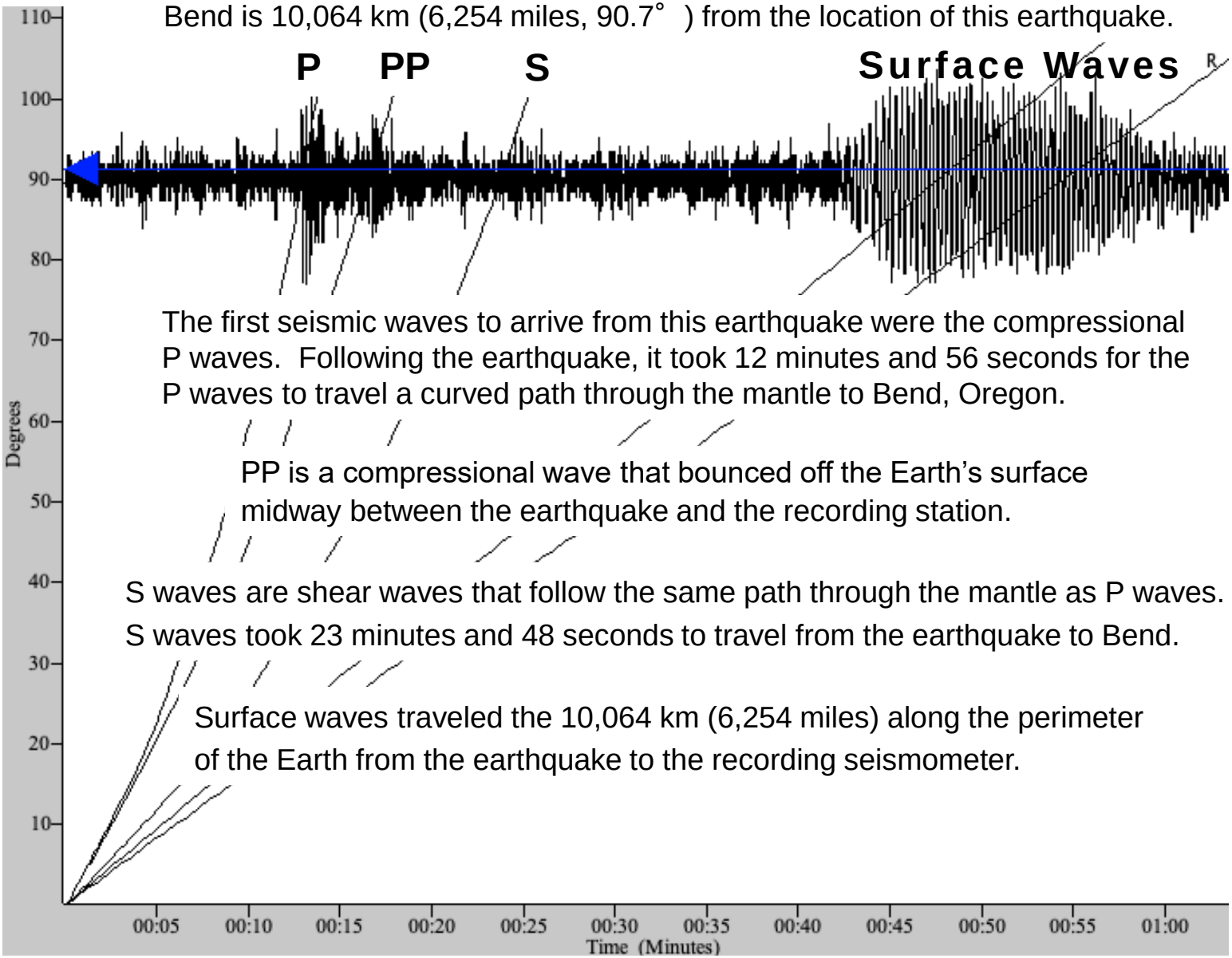
The record of the earthquake in Bend, Oregon (BNOR) is illustrated below. Bend is 10,064 km (6,254 miles, 90.7˚) from the location of this earthquake.



The first seismic waves to arrive from this earthquake were the compressional P waves. Following the earthquake, it took 12 minutes and 56 seconds for the P waves to travel a curved path through the mantle to Bend, Oregon.

PP is a compressional wave that bounced off the Earth's 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 48 seconds to travel from the earthquake to Bend.

Surface waves traveled the 10,064 km (6,254 miles) along the perimeter of the Earth from the earthquake to the recording seismometer.

Teachable Moments are a service of

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