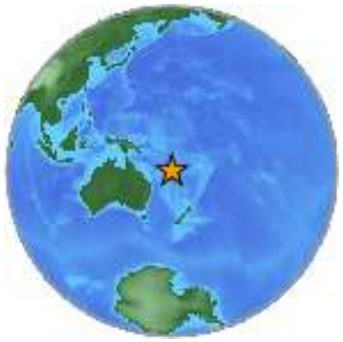
IRIS
Teachable Moments

Magnitude 7.3 VANUATU

Saturday, October 2, 2021, 06:29:18 UTC

Latitude 21.104° S
Longitude 174.895° E
Depth 535.8 km



A major earthquake struck in the southwest Pacific Ocean at a depth of 535.8 km in the Vanuatu Island Region.

There are no reports of damage or injuries.

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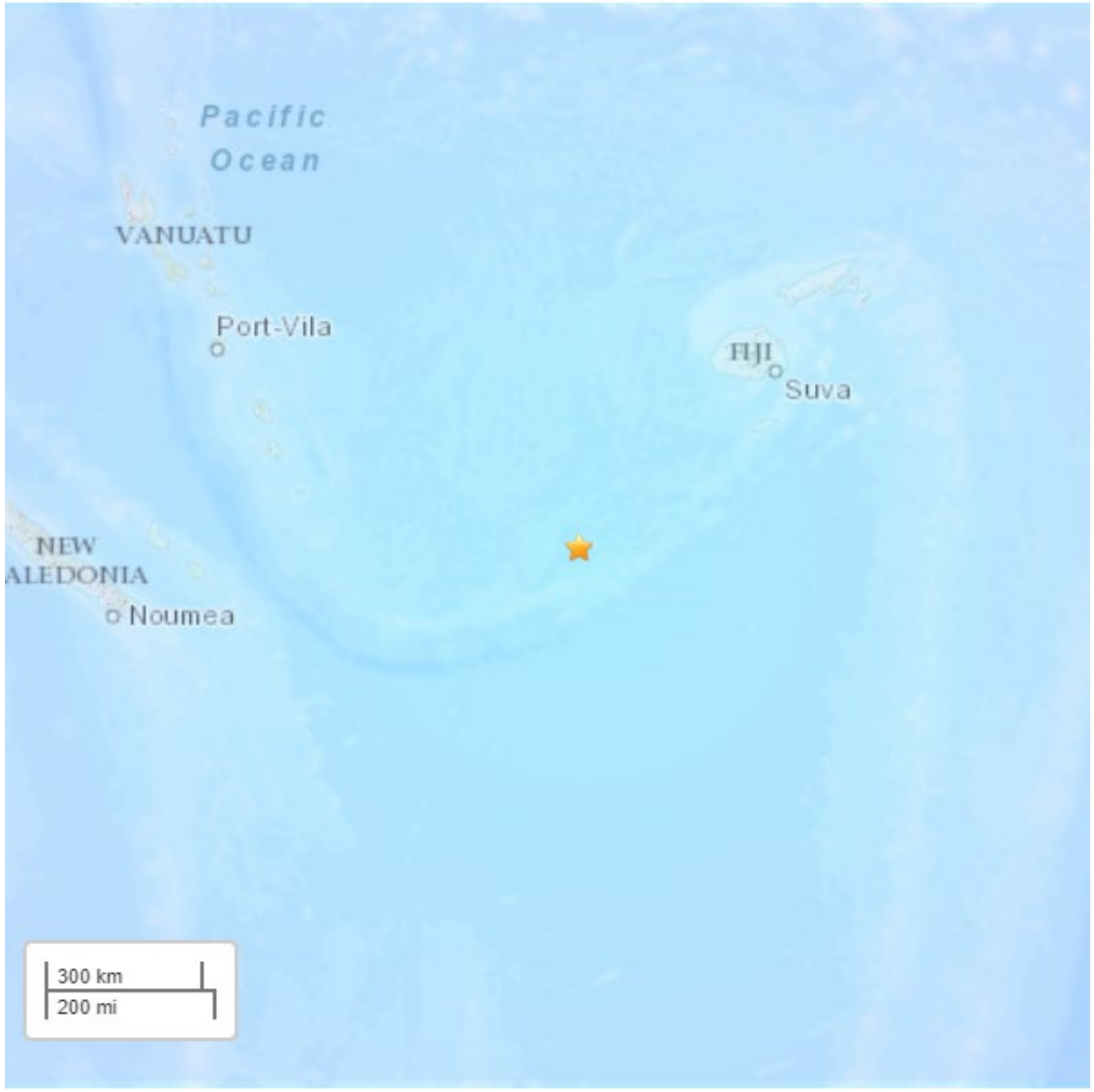
The Modified-Mercalli Intensity (MMI) scale is a ten-stage scale that indicates the severity of ground shaking. Intensity is dependent on the magnitude, depth, bedrock, and location.

Due to the earthquake depth, the region only experienced weak shaking 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



USGS estimated shaking intensity from M 7.3 Earthquake

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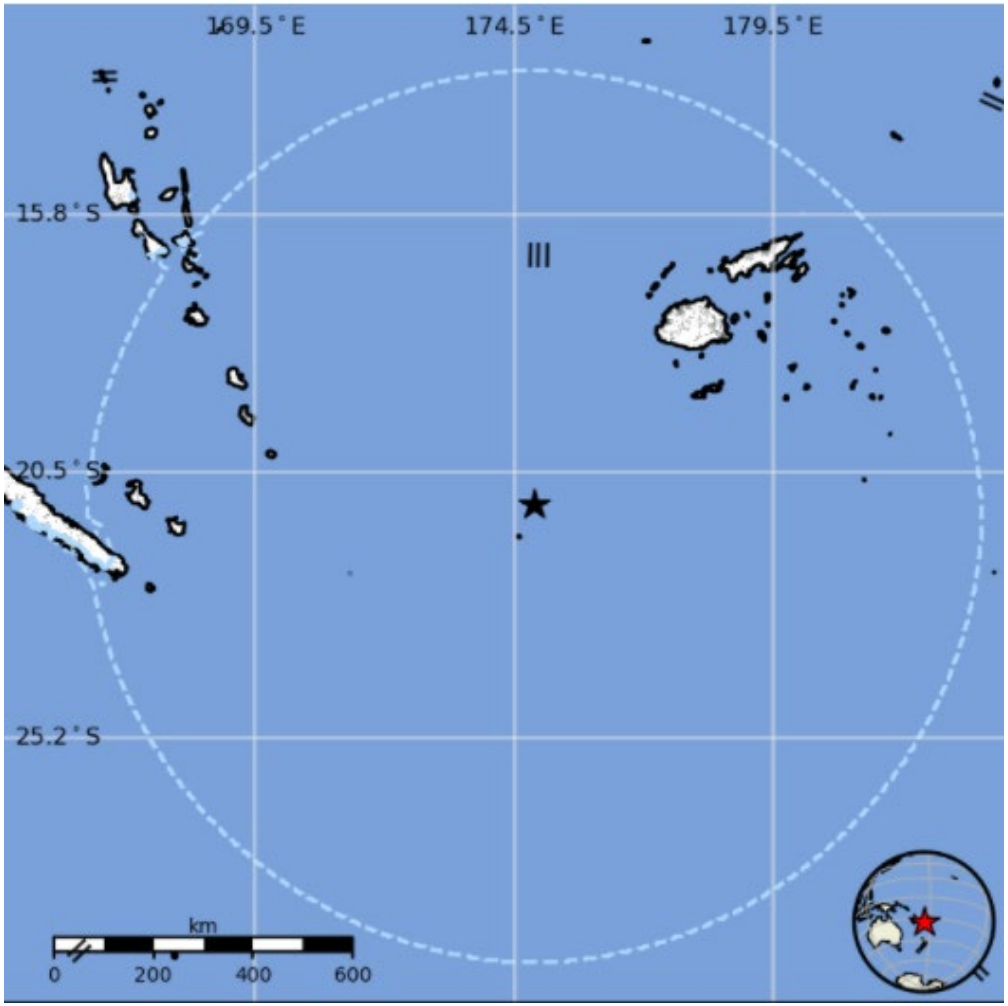
The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels.

The USGS estimates that over 1 million people felt weak shaking from this earthquake.

I	Not Felt	0 k*
II-III	Weak	1,548 k*
IV	Light	0 k
V	Moderate	0 k
VI	Strong	0 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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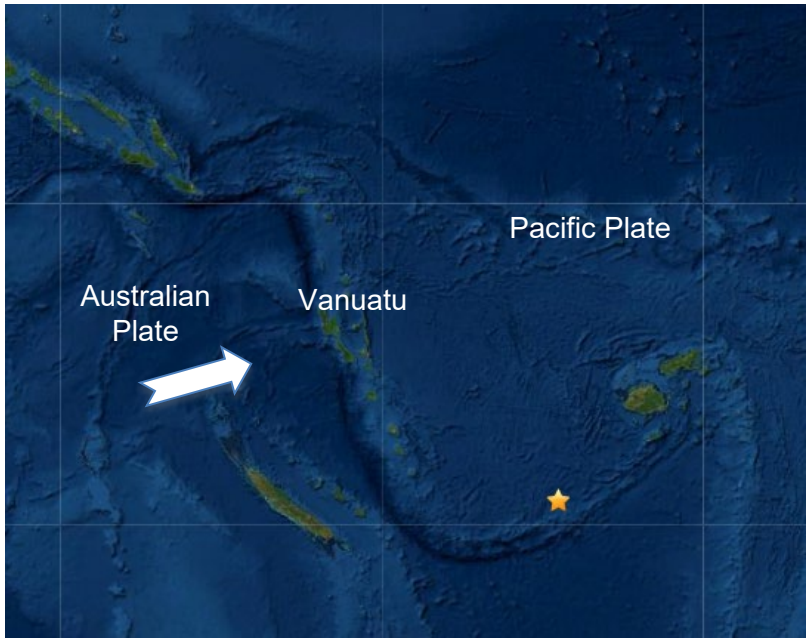

Image courtesy of the USGS

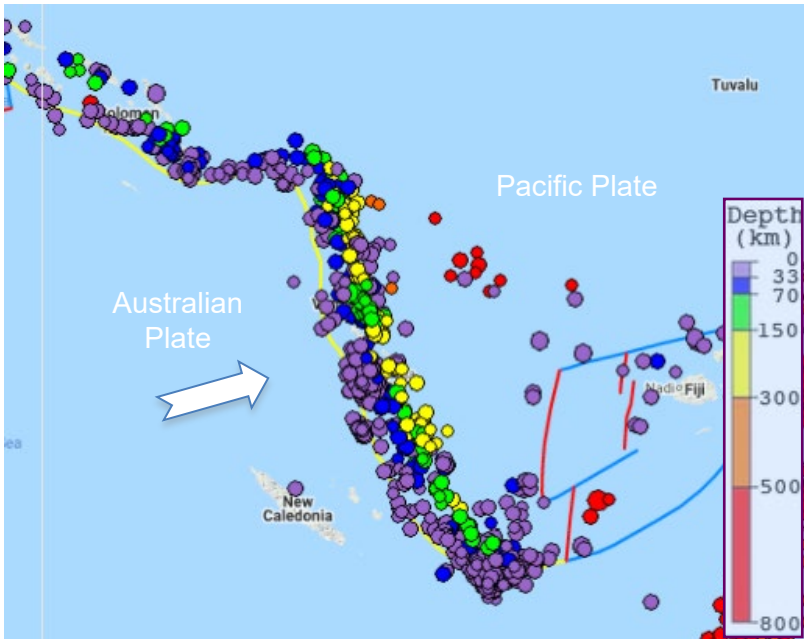

Image from IRIS Internet Earthquake Browser (IEB)

The Vanuatu Islands sit above the subduction zone where the Australian Plate dives beneath the Pacific Plate.

Earthquakes occur as the plates grind past each other. They are shallow on the west near the surface contact between the plates, and deeper to the east.

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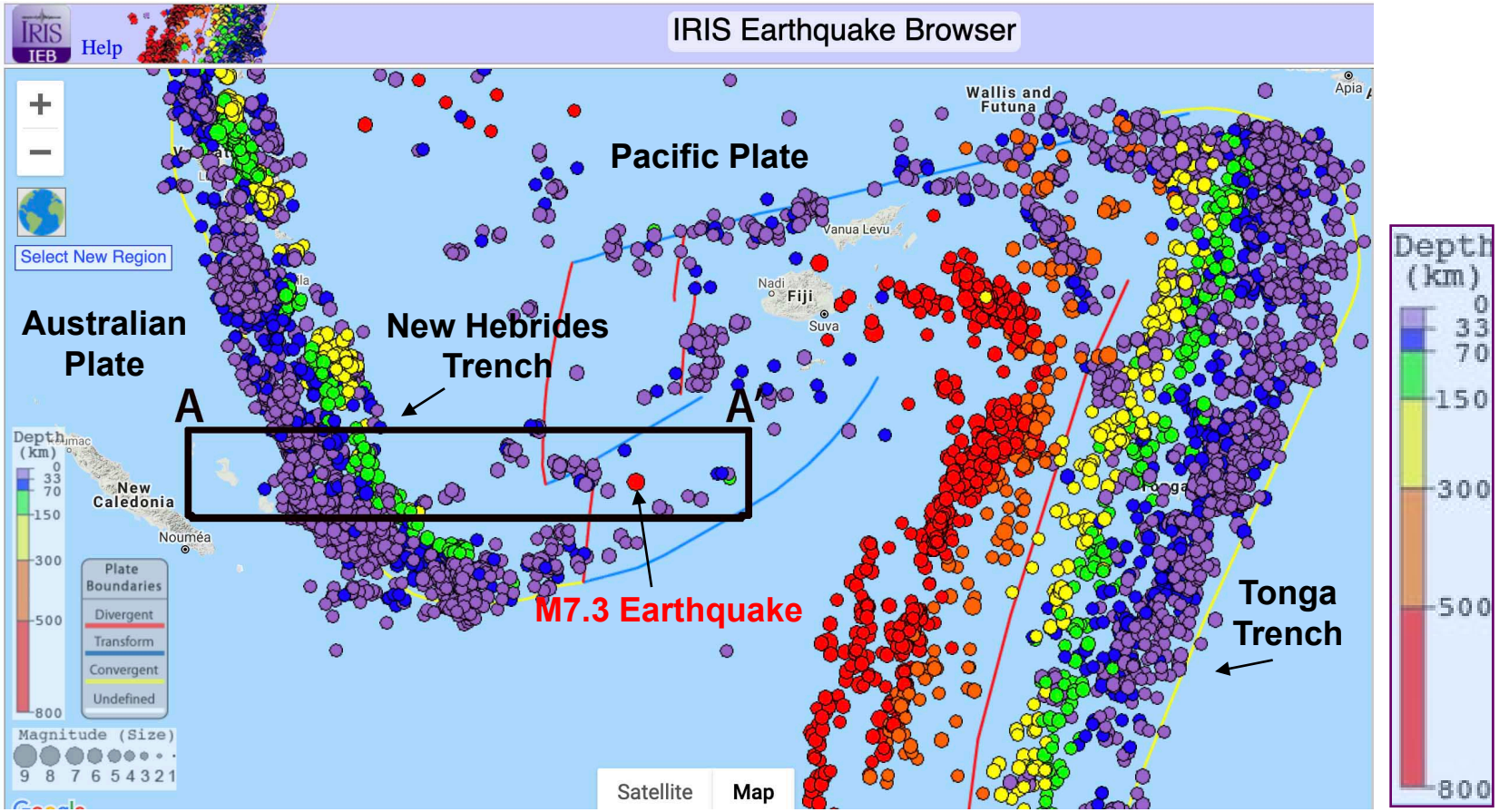

This map shows locations of the 5000 most recent regional earthquakes > M5. In the west, along the New Hebrides Trench, the Australian Plate subducts beneath the North Fiji Basin part of the Pacific Plate. To the east, the Pacific Plate subducts to the west at the Tonga Trench. The rectangle outlines the 3D view on the next slide.

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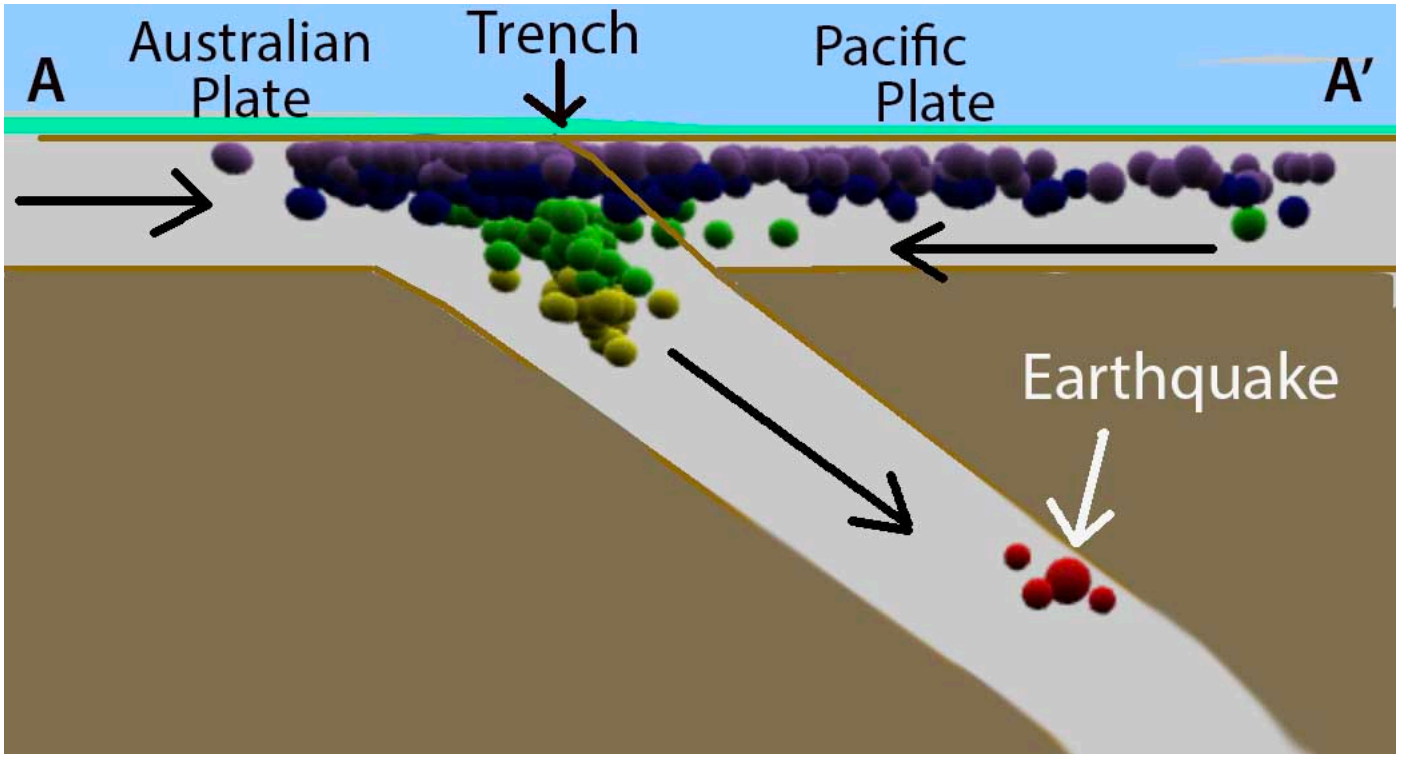

Plotting the earthquakes in 3D, the hypocenter of this earthquake fits the general pattern of increasing depths of earthquakes from west to east across the subduction zone.

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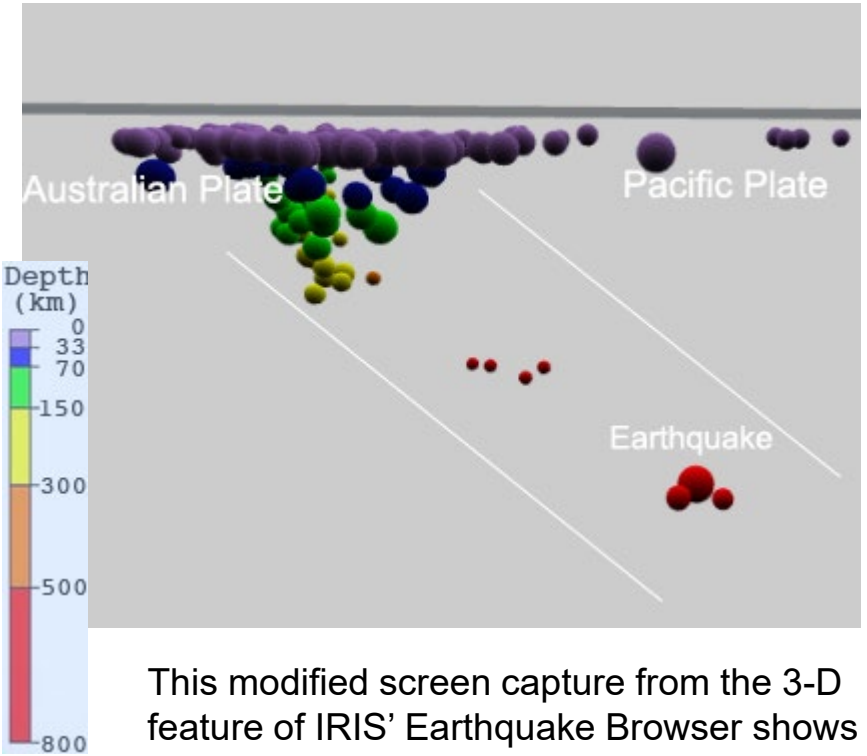
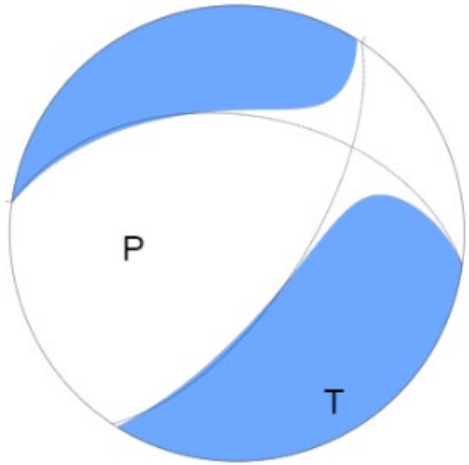
A deep-focus earthquake has a hypocenter depth exceeding 300 km. Deep earthquakes occur exclusively within subducting oceanic lithosphere, especially within old oceanic lithosphere that is subducting rapidly.

The physical mechanism of rupture of deep focus earthquakes is different than earthquakes that occur at a shallow depth. This earthquake occurred within the subducting Australian Plate.



This modified screen capture from the 3-D feature of IRIS' Earthquake Browser shows a cross sectional view of the earthquakes.



USGS Centroid Moment Tensor Solution

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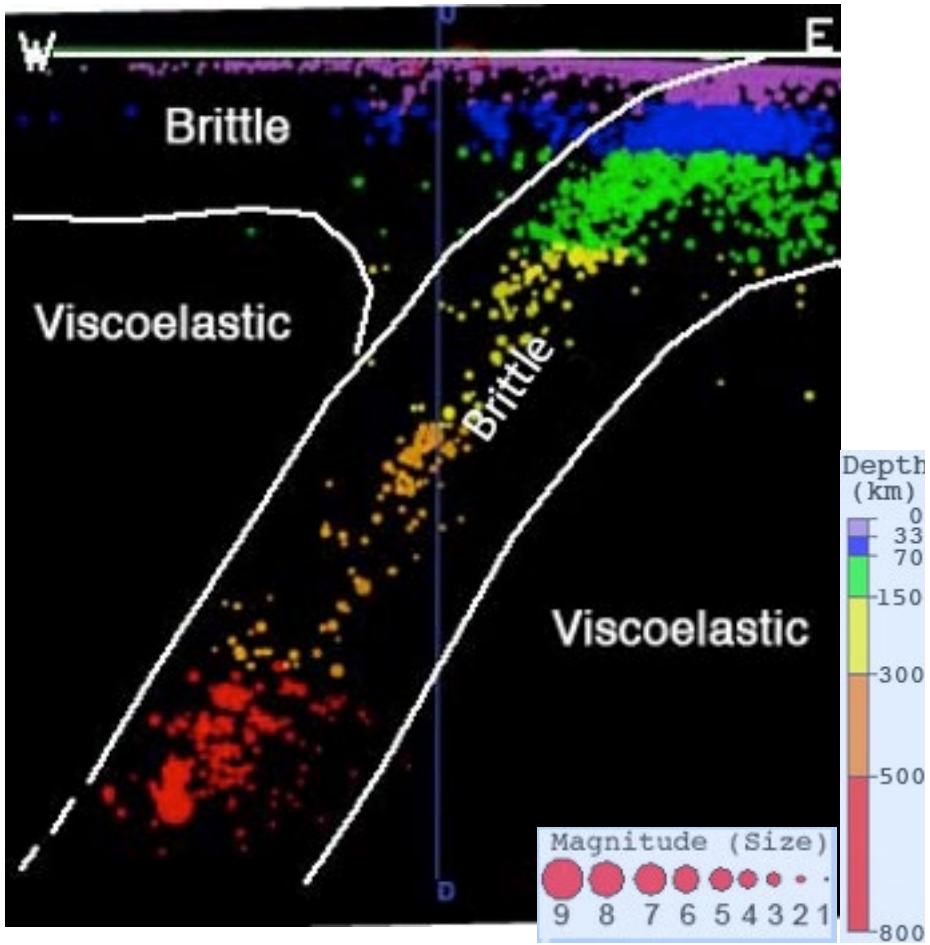
To produce earthquakes, rocks must be brittle. Brittle rock accumulates elastic energy as they bend then rapidly releases that energy during earthquake rupture.

With the exception of subducting oceanic plates, rock in Earth's mantle below about 100 km depth is viscoelastic and cannot rupture to produce earthquakes. Rocks are brittle at low temperatures but become viscoelastic when they reach temperatures of about 600° C.

Rapidly subducting cool oceanic plates, however, can remain brittle up to about 700 km in the hot mantle. The deepest earthquakes are thought to be due to phase changes of minerals in the high pressure and temperature conditions at those depths.



Exploring a generalized three-dimensional view from the IRIS Earthquake Browser.

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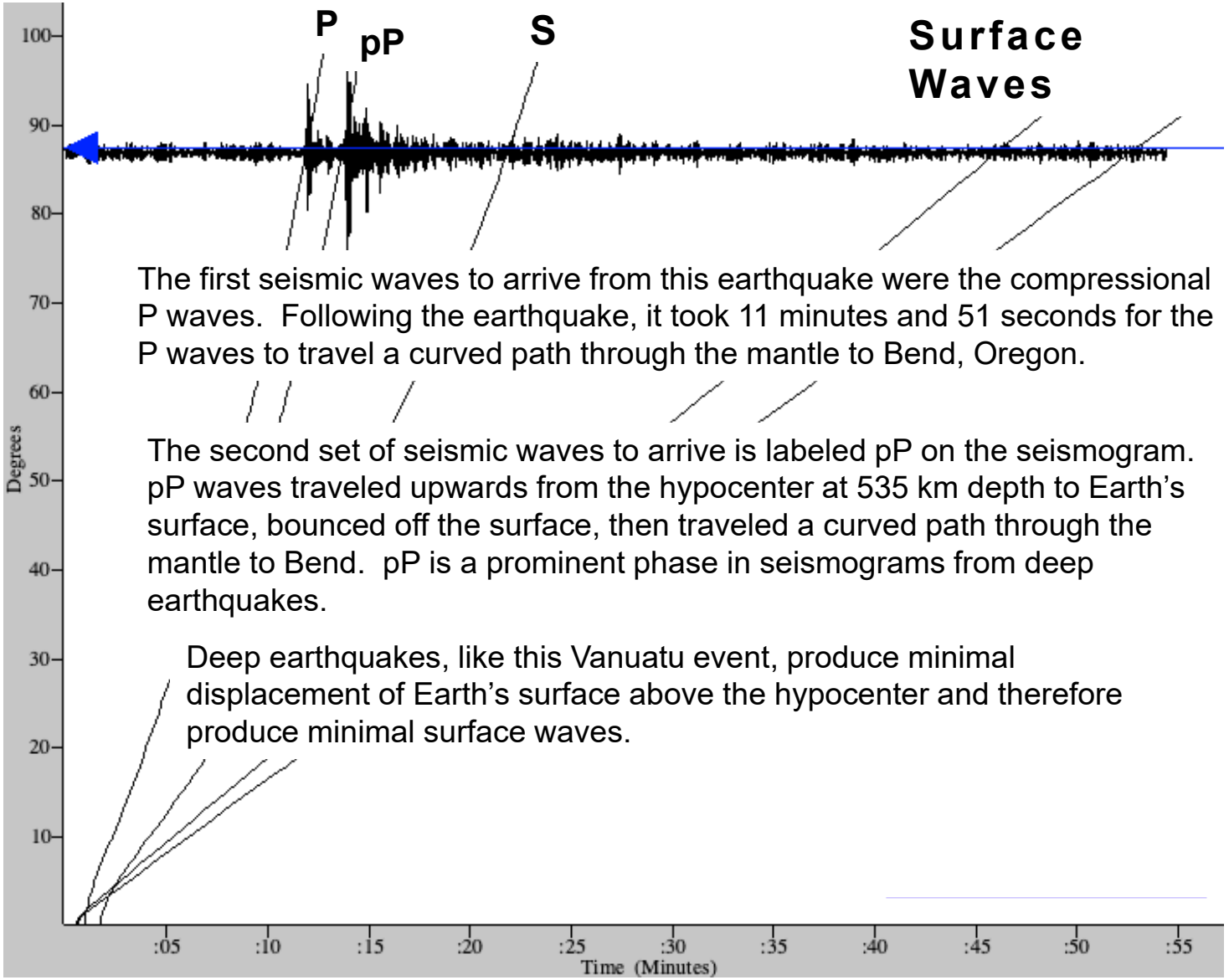
The record of the earthquake in Bend, Oregon (BNOR) is illustrated below. Bend is 9,711 km (6,034 miles, 87.4°) from the location of this earthquake.



The first seismic waves to arrive from this earthquake were the compressional P waves. Following the earthquake, it took 11 minutes and 51 seconds for the P waves to travel a curved path through the mantle to Bend, Oregon.

The second set of seismic waves to arrive is labeled pP on the seismogram. pP waves traveled upwards from the hypocenter at 535 km depth to Earth's surface, bounced off the surface, then traveled a curved path through the mantle to Bend. pP is a prominent phase in seismograms from deep earthquakes.

Deep earthquakes, like this Vanuatu event, produce minimal displacement of Earth's surface above the hypocenter and therefore produce minimal surface waves.

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