# Magnitude 7.0 JAPAN

## Saturday, March 20, 2021 at 09:09:45 UTC

**Latitude** 38.475° N
**Longitude** 141.607° E
**Depth** 54.0 km

A major magnitude 7.0 earthquake struck Saturday off the coast of Ishinomaki, a city located just 65 miles (104 km) from Fukushima, Japan at a depth of 54 km (34 miles).

The earthquake shook buildings as far as Tokyo and triggered a tsunami advisory for a part of the northern coast. No major damage was reported, but several people had minor injuries.

This earthquake can be considered an aftershock of the 2011 M 9.1 earthquake.

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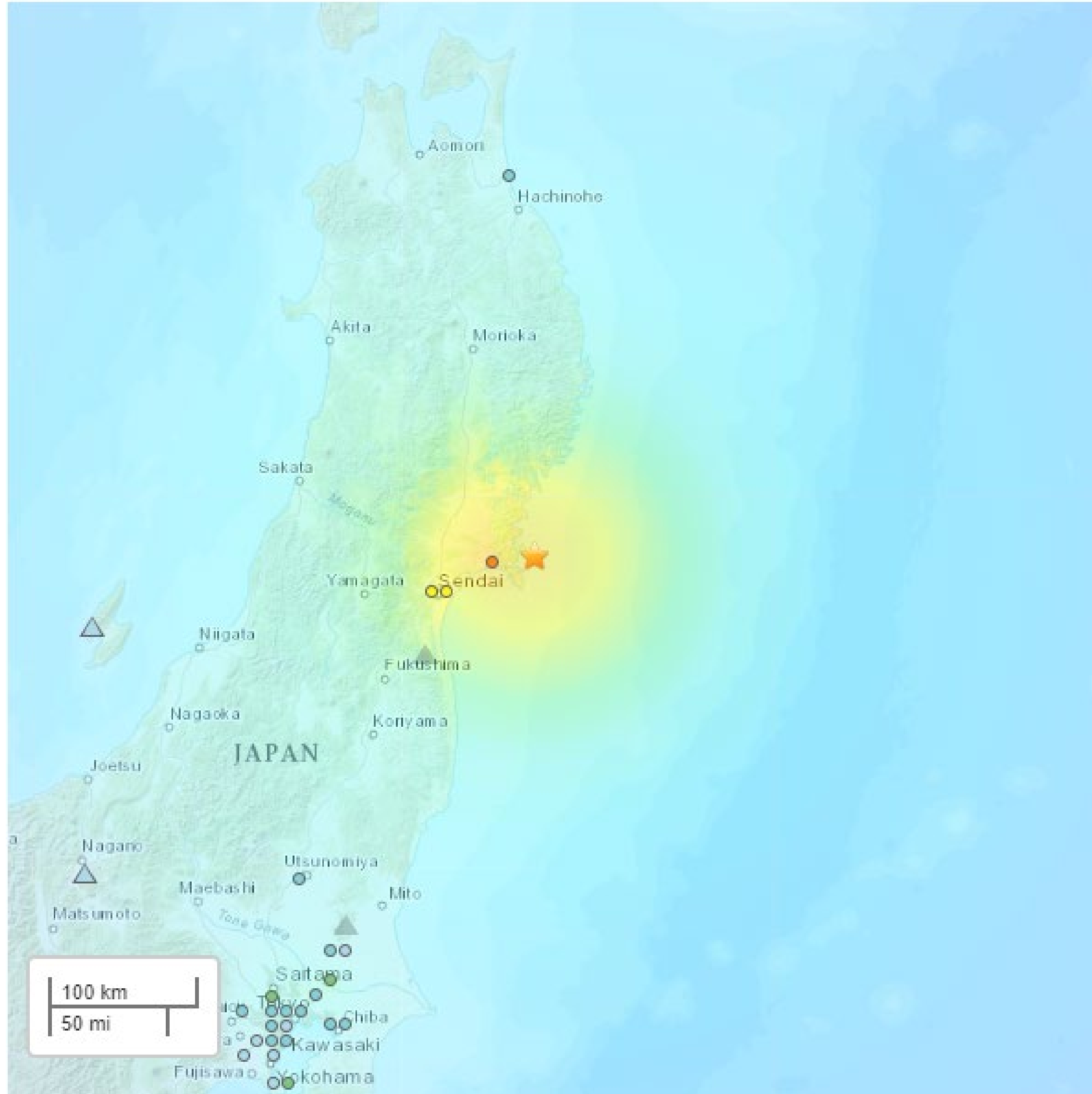
The Modified-Mercalli Intensity (MMI) scale is a ten-stage scale, from I to X, that indicates the severity of ground shaking. Intensity is based on observed effects and is variable over the area affected by an earthquake. Intensity is dependent on earthquake size, depth, distance, and local conditions.

| 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 7.0 Earthquake*

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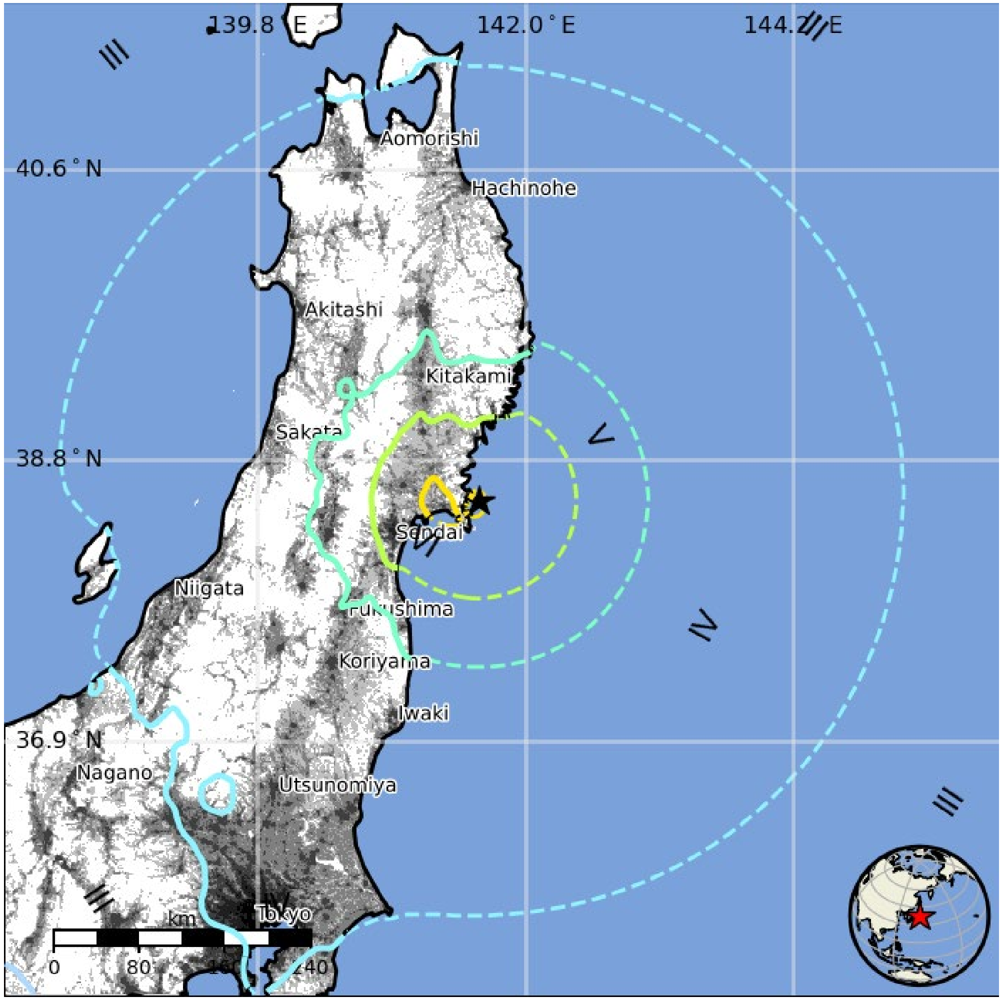
The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels.

The USGS estimates that 135,000 people felt very strong shaking from this earthquake.

| MMI | Shaking | Population |
|---|---|---|
| I | Not Felt | 0 k* |
| II-III | Weak | 11,889 k* |
| IV | Light | 40,818 k |
| V | Moderate | 1,943 k |
| VI | Strong | 1,990 k |
| VII | Very Strong | 135 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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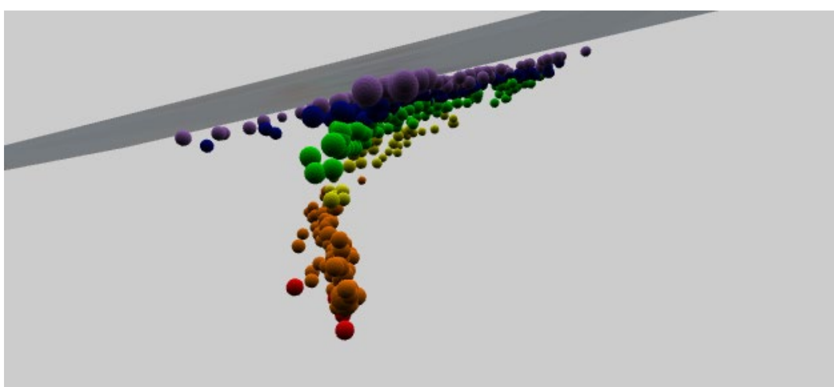
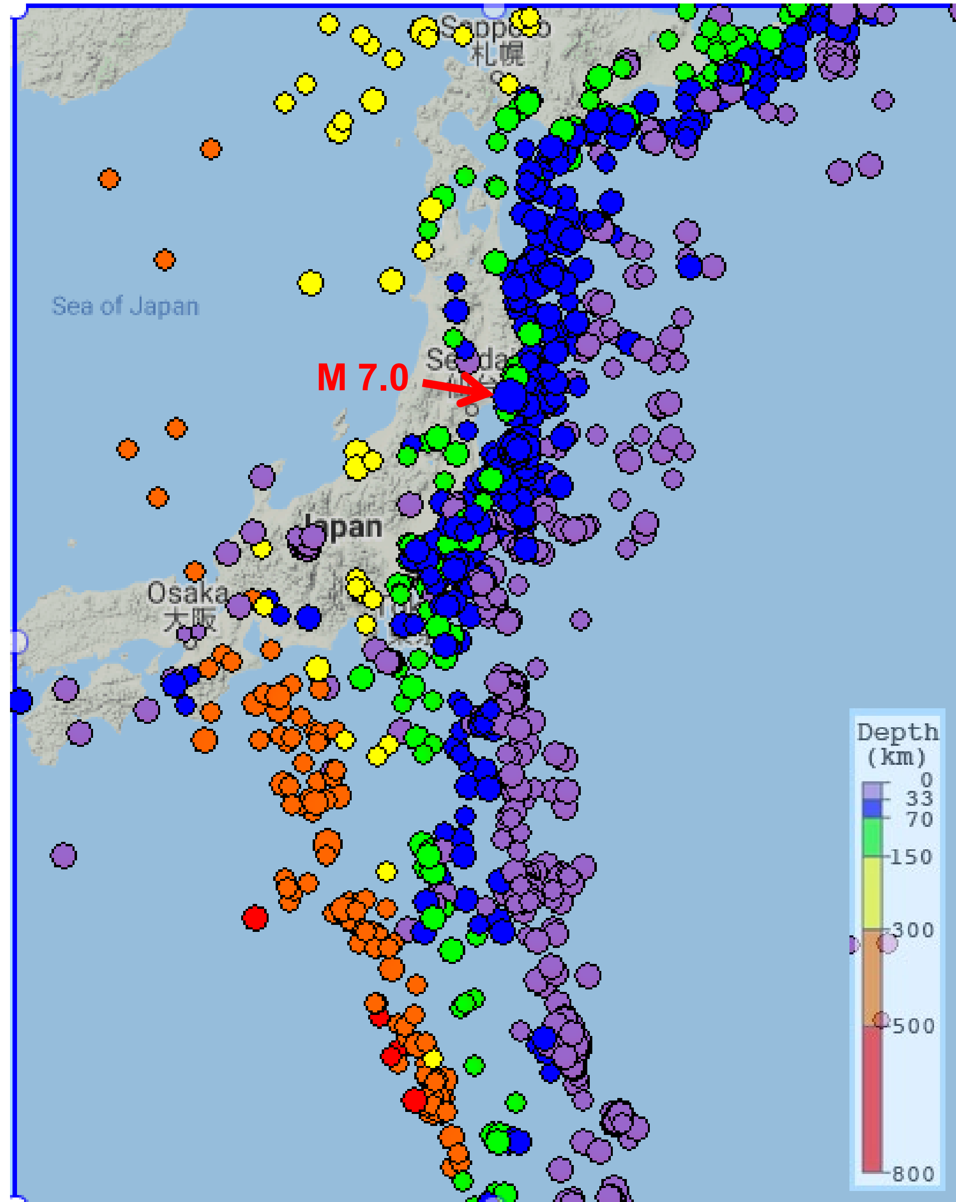
The map on the right shows the most recent 1000 earthquakes near the epicenter.

As shown on the cross section below, earthquakes are shallow (purple dots) at the Japan Trench and increase to 600 km depth (red dots) towards the west as the Pacific Plate dives deeper beneath Japan.

This earthquake hypocenter was 54 km deep, in the blue range of the scale.



*Seismicity Cross Section across the subduction zone showing the relationship between color and earthquake depth.*




*Images created by the IRIS Earthquake Browser*

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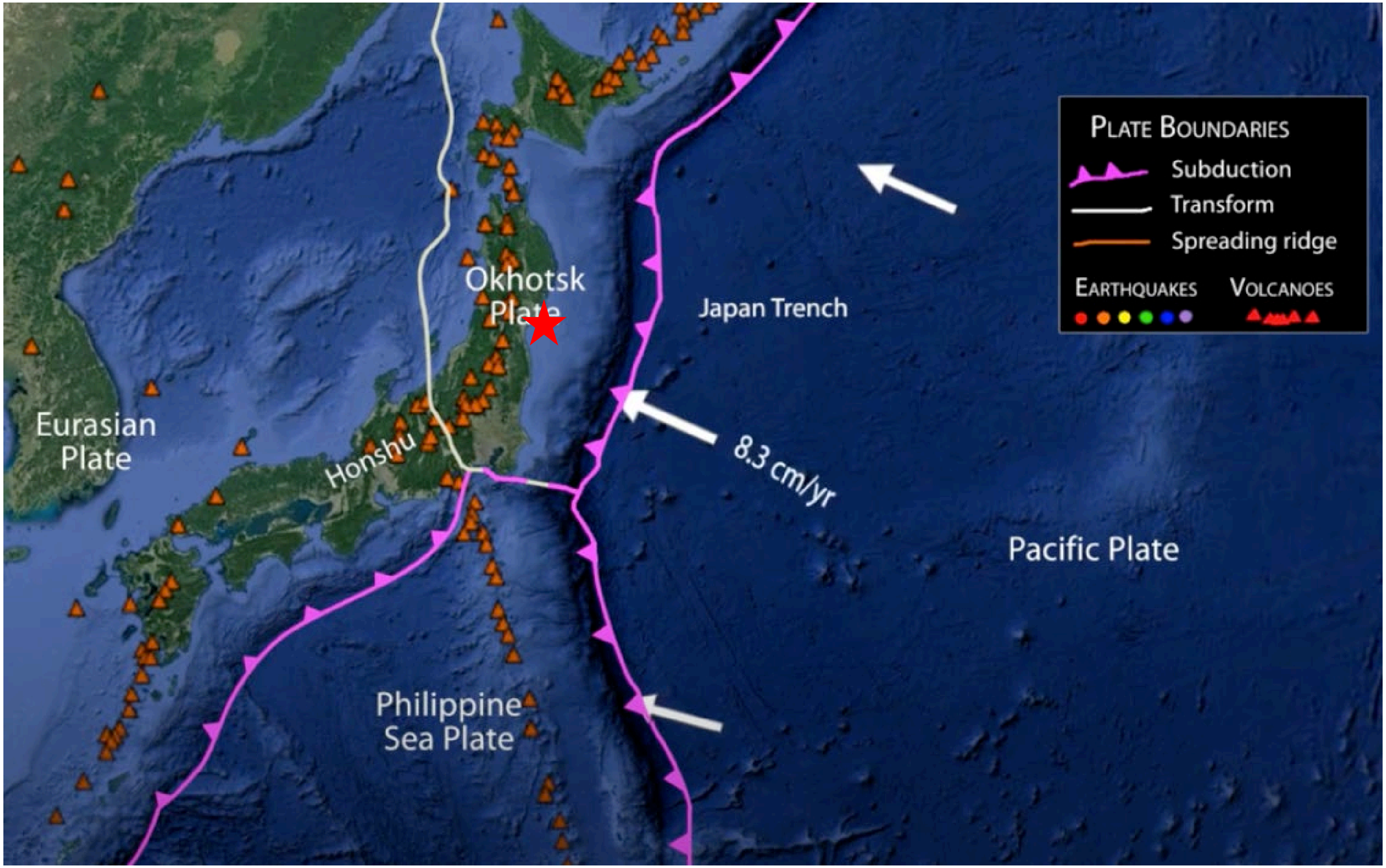


In Northern Honshu, the Pacific Plate subducts beneath the Okhotsk Plate at a rate of 8.3 cm/year. The epicenter of this magnitude 7.0 earthquake is shown by the red star.

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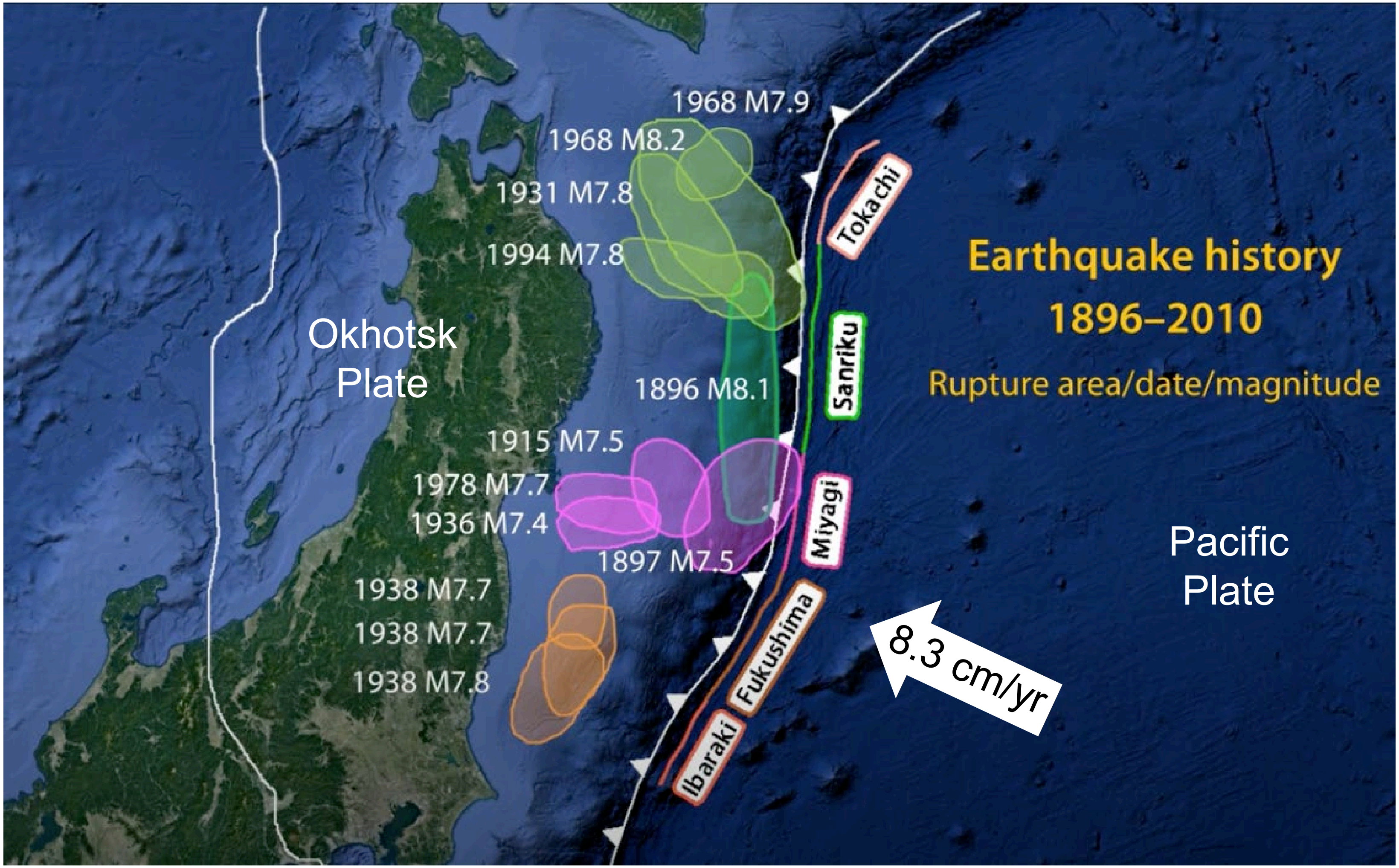


On this map, the year, magnitude, and rupture area are shown for magnitude 7.4 and larger earthquakes on the Pacific – Okhotsk subduction plate boundary from 1896 to 2010, just prior to the March 11, 2011 magnitude 9.1 great earthquake.

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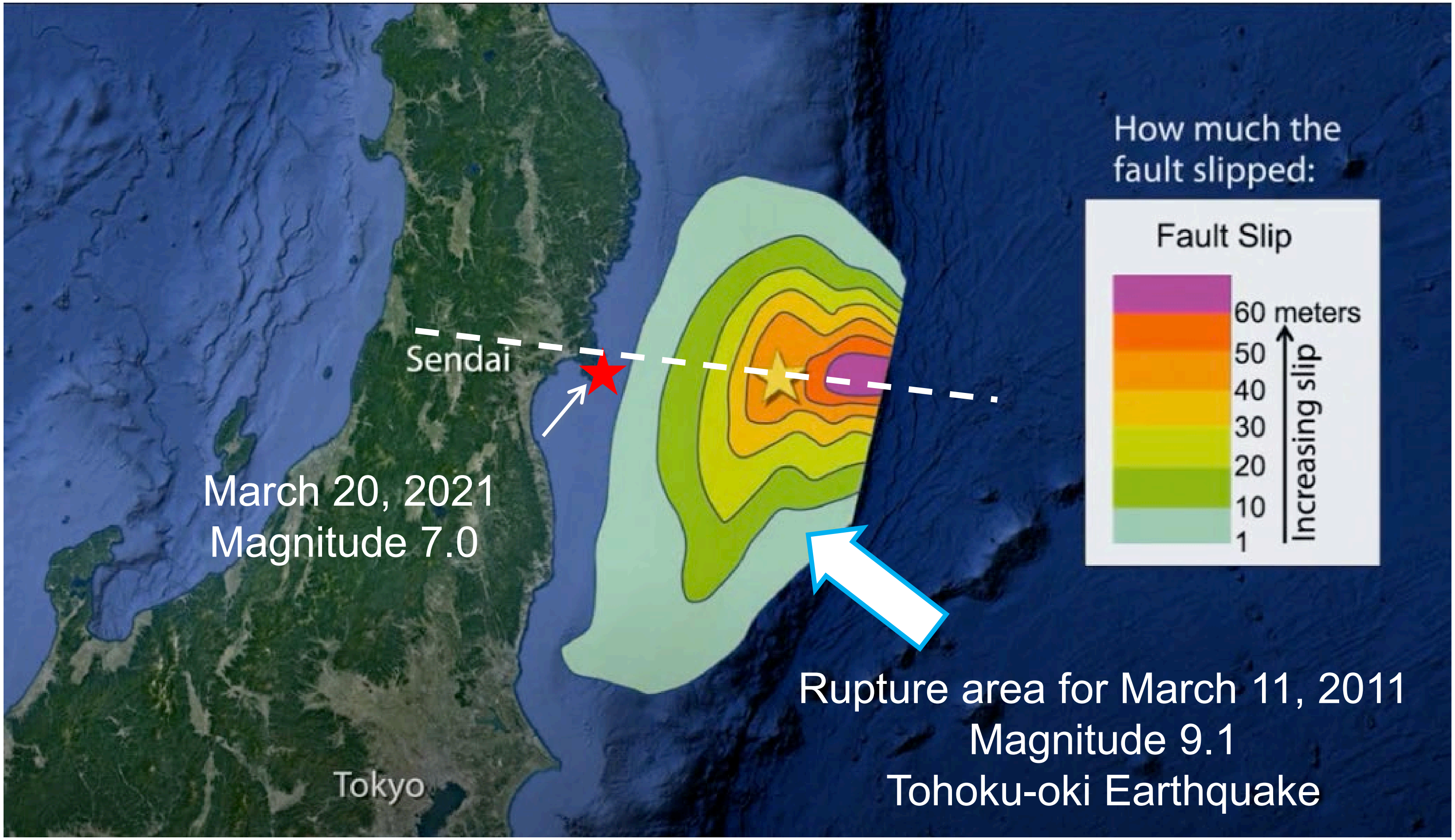


On March 11, 2011, the M 9.1 Tohoku-oki earthquake ruptured a 500-km-long by 200-km-wide area of the Pacific – Okhotsk megathrust plate boundary. Fault slip reached over 60 meters near the Japan Trench. This great earthquake, the largest in Japan's history, and the resulting tsunami took almost 20,000 lives and caused approximately $200 billion damage. Today's M 7.0 earthquake is located near the western edge of the Tohoku-oki rupture zone. A cross section along the dashed line is shown on the next slide.

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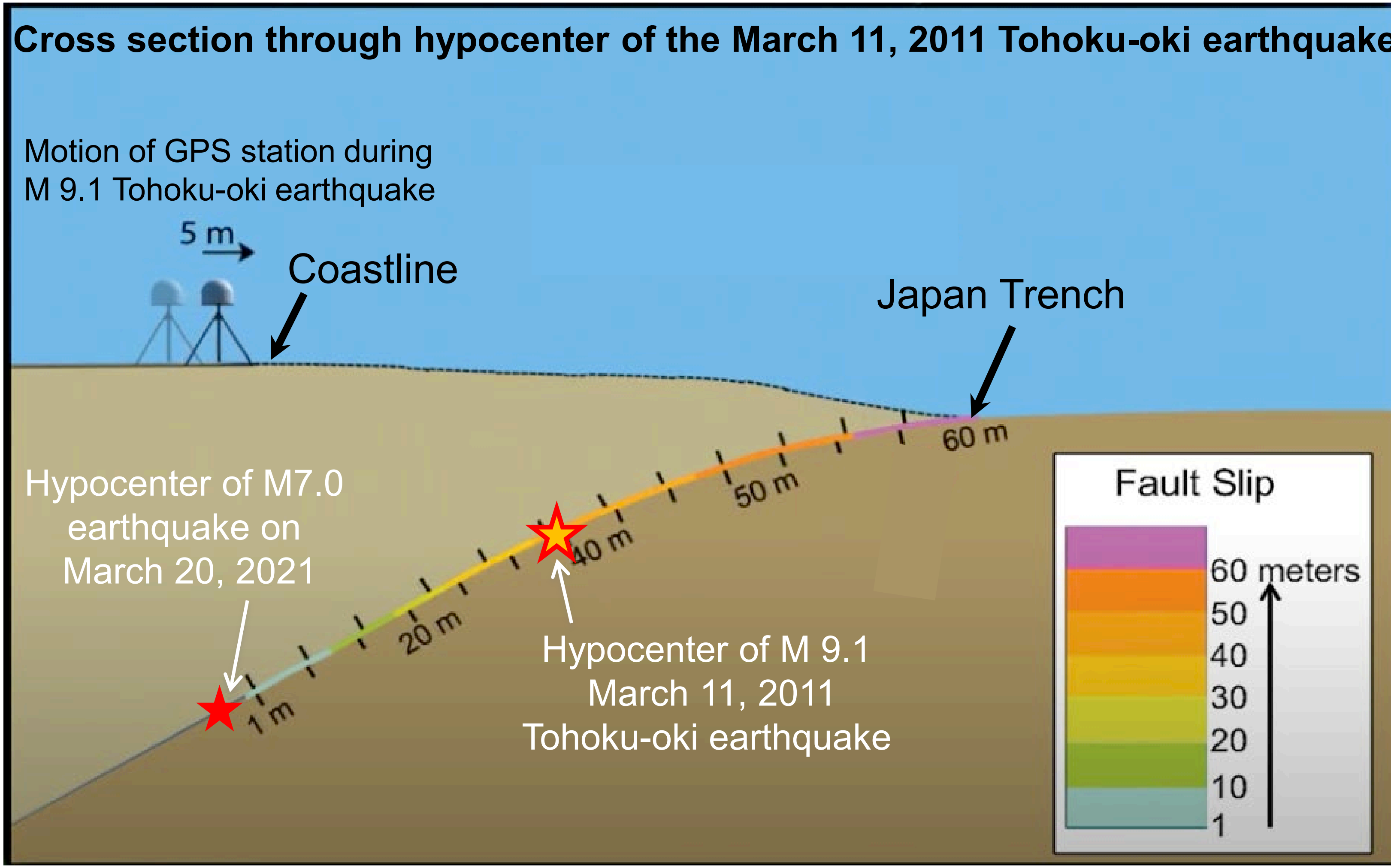


Fault slip during the M 9.1 Tohoku-oki earthquake is shown on this cross section through the hypocenter at ~25 km depth. Fault slip was 40 meters at the hypocenter and increased to over 60 meters at the Japan Trench. Fault slip decreased downdip from the hypocenter to about 1 meter at ~50 km depth. The hypocenter of today's M 7.0 earthquake projects into this cross section at the downdip limit of the 2011 rupture.

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An animation prepared for the 10th Anniversary of the March 11, 2011 M9.1 Japan earthquake and tsunami featuring lessons learned from that natural disaster.

IRIS Teachable Moments

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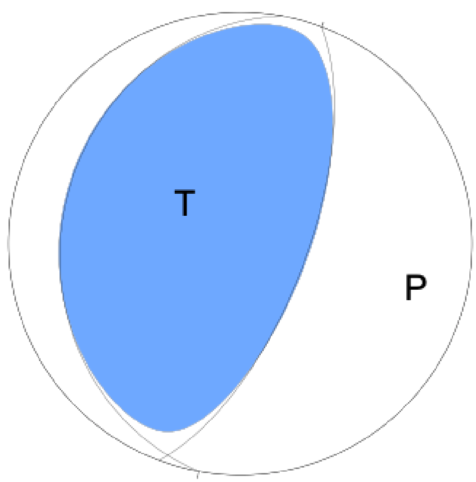
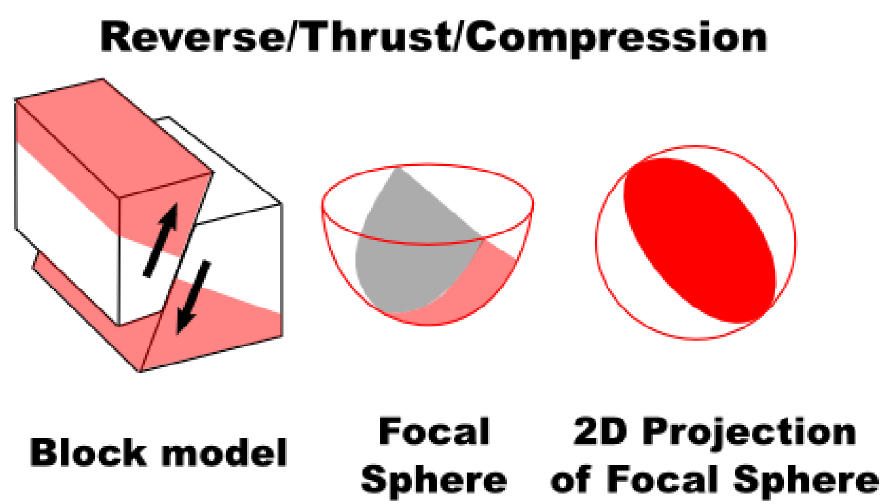
The focal mechanism is how seismologists plot the 3-D stress orientations of an earthquake. Because an earthquake occurs as slip on a fault, it generates primary (P) waves in quadrants where the first pulse is compressional (shaded) and quadrants where the first pulse is extensional (white). The orientation 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 location and focal mechanism indicate it was due to thrust faulting on the plate boundary between the subducting Pacific Plate and the overriding Okhotsk Plate.



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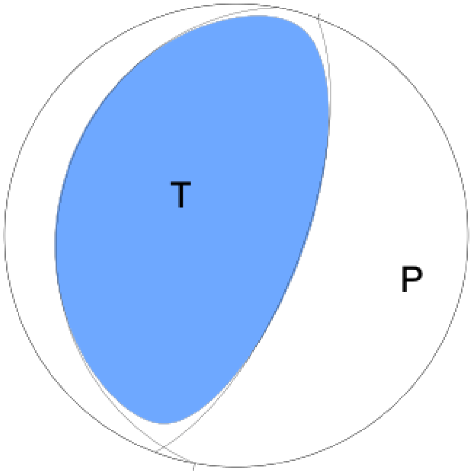
This animation explores the motion of a reverse fault, and how reverse faults are represented in a focal mechanism.

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.




*USGS W-phase Moment Tensor Solution*

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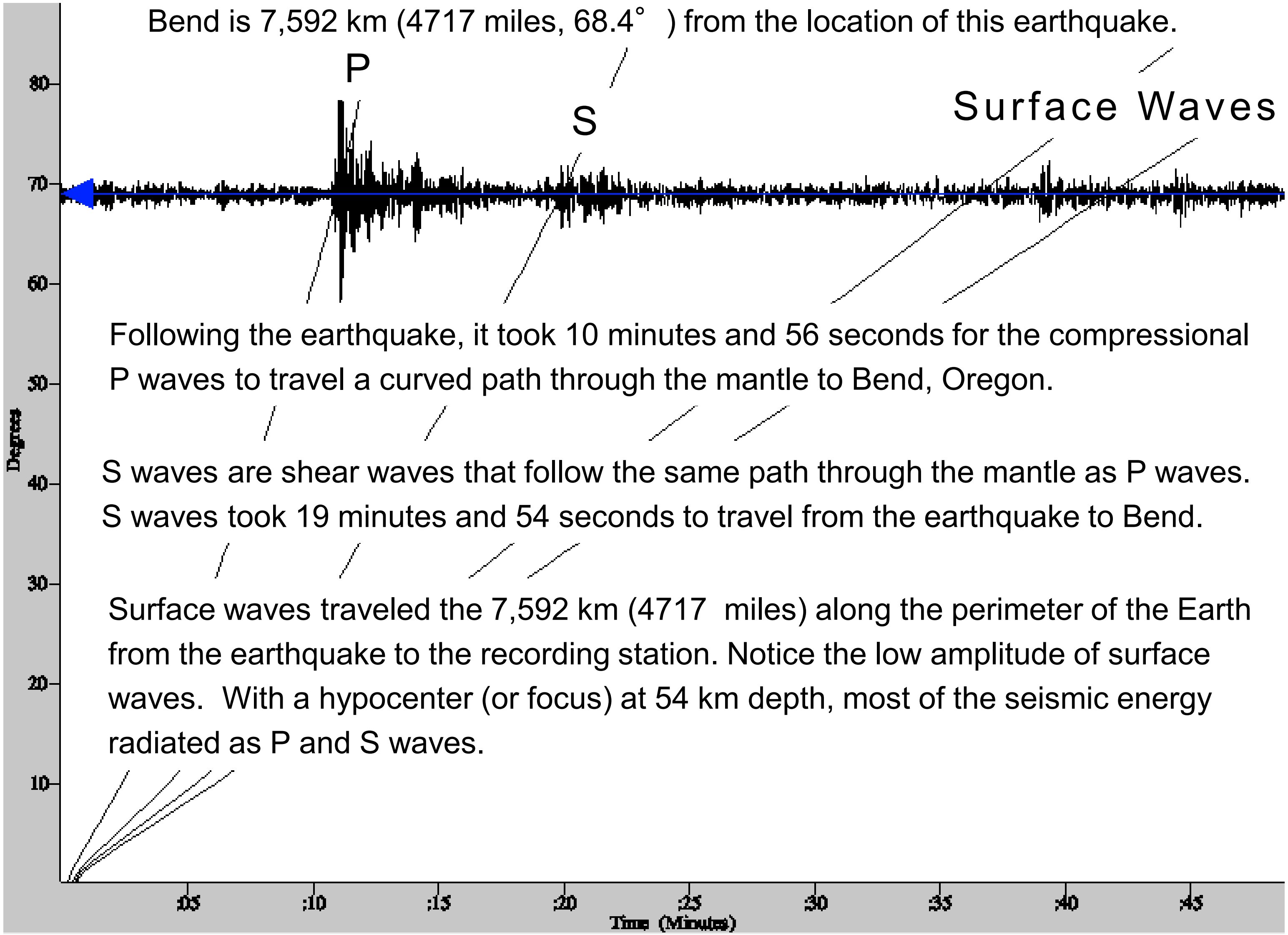
The record of the earthquake in Bend, Oregon (BNOR) is illustrated below. Bend is 7,592 km (4717 miles, 68.4° ) from the location of this earthquake.




Following the earthquake, it took 10 minutes and 56 seconds for the compressional P waves to travel a curved path through the mantle to Bend, Oregon.

S waves are shear waves that follow the same path through the mantle as P waves. S waves took 19 minutes and 54 seconds to travel from the earthquake to Bend.

Surface waves traveled the 7,592 km (4717 miles) along the perimeter of the Earth from the earthquake to the recording station. Notice the low amplitude of surface waves. With a hypocenter (or focus) at 54 km depth, most of the seismic energy radiated as P and S waves.

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