# Magnitude 6.4 CROATIA

**Tuesday, December 29, 2020 at 11:19:54 UTC**

**Latitude** 45.422° N
**Longitude** 16.255° E
**Depth** 10 km

A magnitude 6.4 earthquake occurred 3 km (2 miles) west-southwest of Petrinja, Croatia at a depth of 10 km (6.2 miles). The current death toll is seven, including a 12-year-old girl in Petrinja and six more fatalities in the surrounding areas. There are many injured and significant destruction in Petrinja, southeast of the capital Zagreb. The earthquake was felt throughout Croatia, as well as in neighboring Serbia, Bosnia, Herzegovina, and southern Austria.


Petrinja, Croatia

IRIS
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A view of remains of a car covered by debris and buildings damaged in an earthquake in Petrinja, Croatia. (AP Photo)

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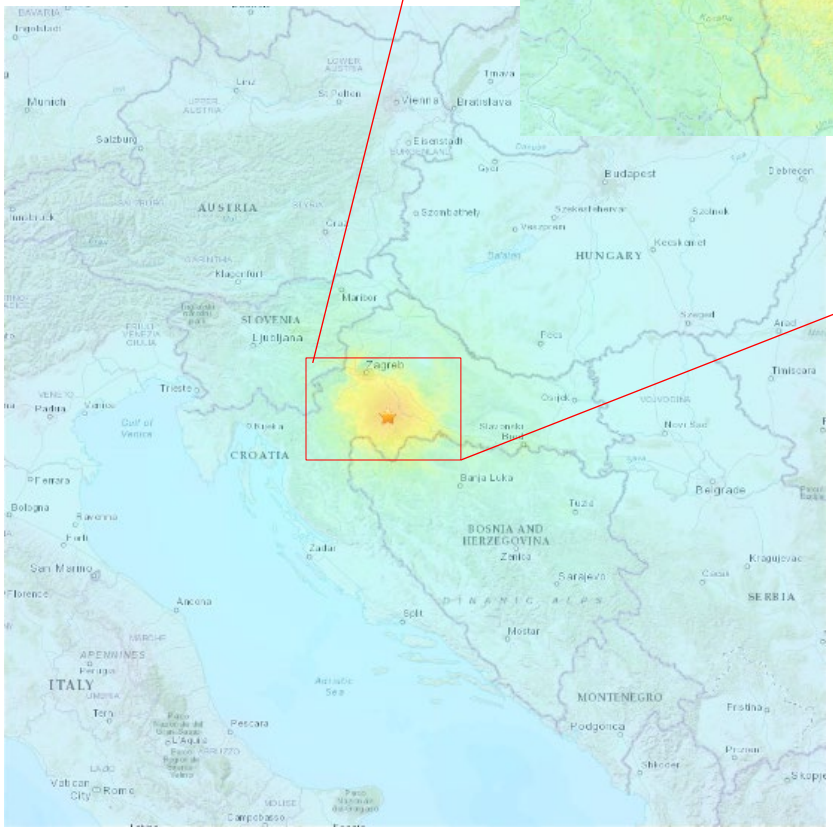
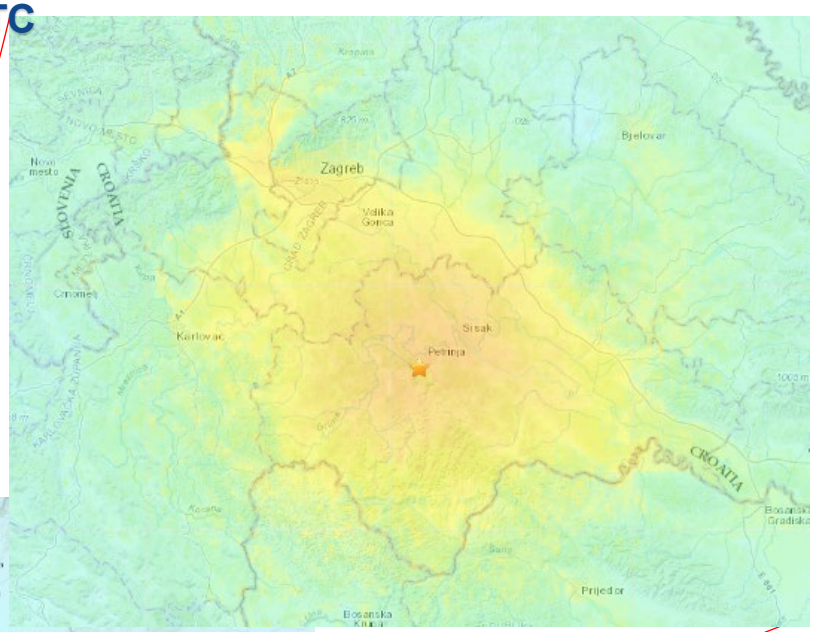
The Modified-Mercalli Intensity (MMI) scale is a twelve-stage scale, from I to XII, that indicates the severity of ground shaking. Intensity is dependent on the magnitude, depth, bedrock, and location.

Severe shaking was felt in the area closest to the 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 |

*Image courtesy of the USGS*




*USGS estimated shaking intensity from M 6.4 Earthquake*

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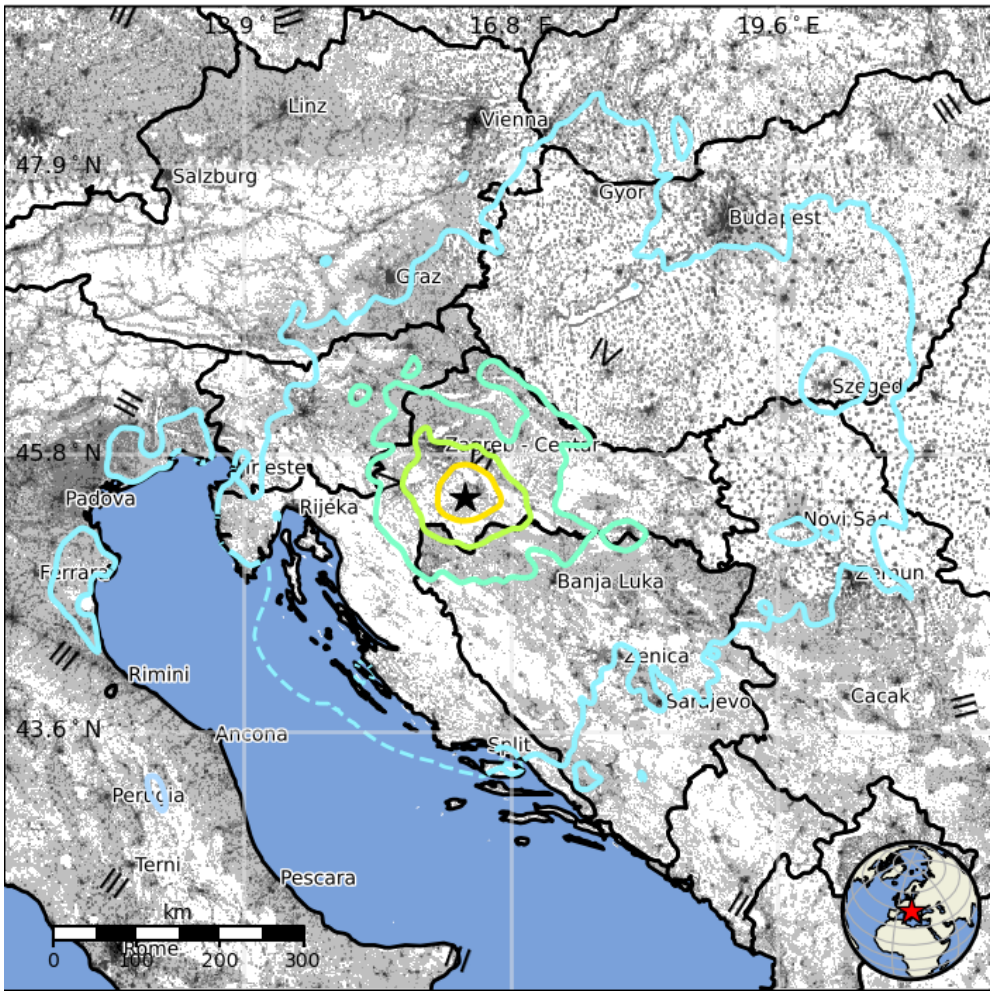
The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels.

The USGS estimates that 15,000 people felt severe shaking from this earthquake.

| | | |
|---|---|---|
| I | Not Felt | 0 k* |
| II-III | Weak | 49,902 k* |
| IV | Light | 15,595 k |
| V | Moderate | 1,657 k |
| VI | Strong | 1,049 k |
| VII | Very Strong | 83 k |
| VIII | Severe | 15 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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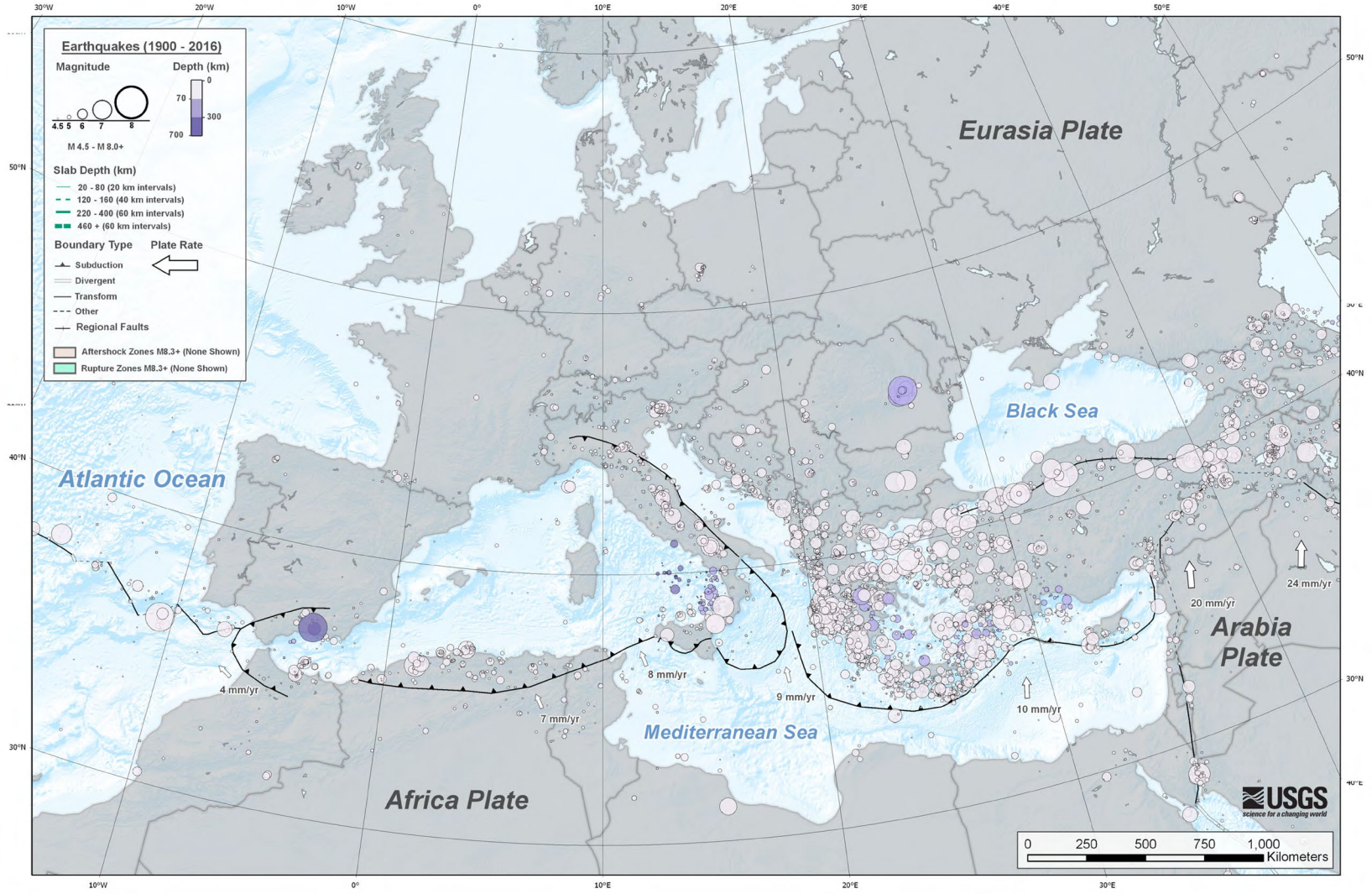
The Mediterranean region is seismically active due to the northward convergence (4-10 mm/yr) of the African Plate with the Eurasian Plate along a complex plate boundary.



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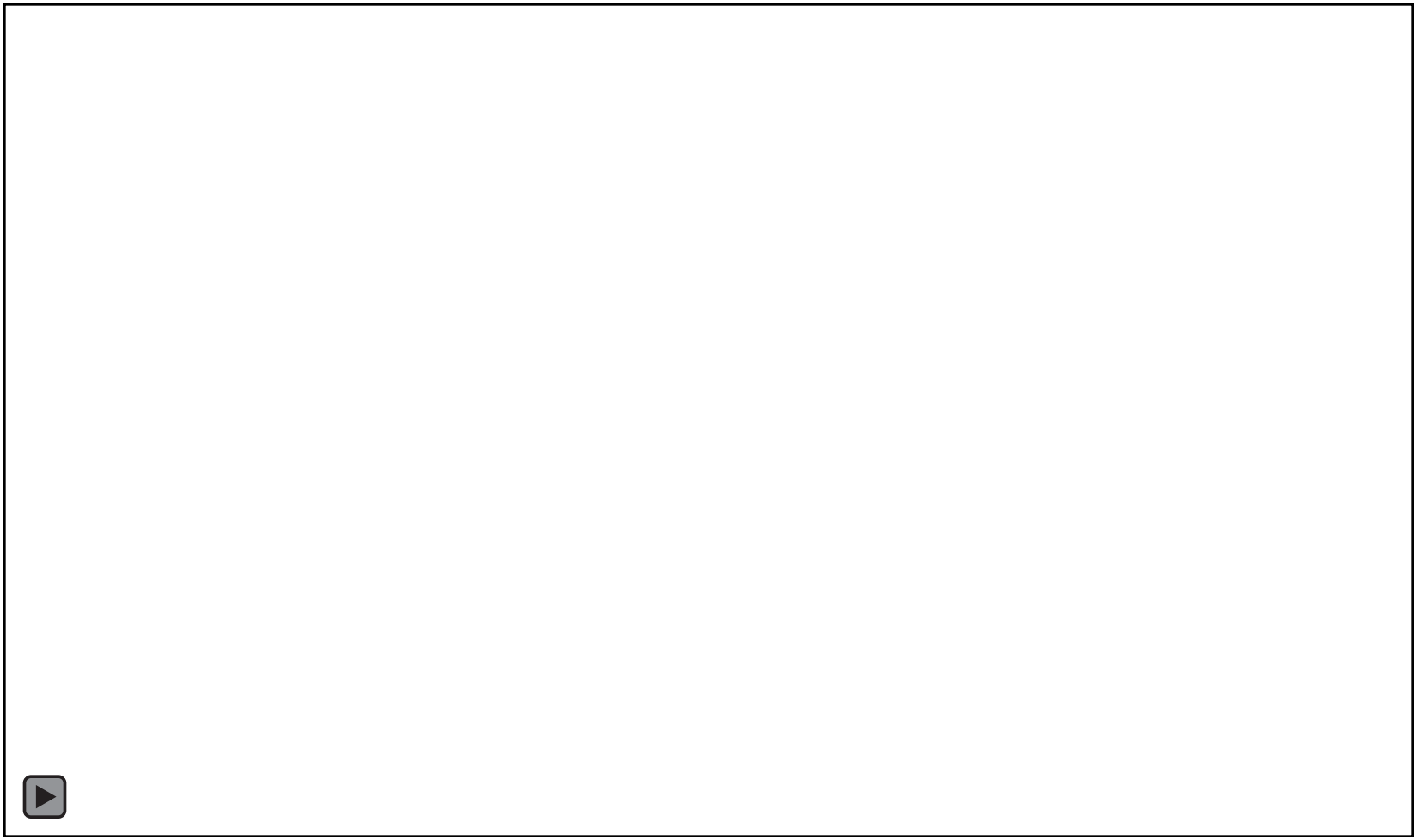
This animation explores the regional tectonics and a link to one of the greatest contributors to seismology from the early 1900's.



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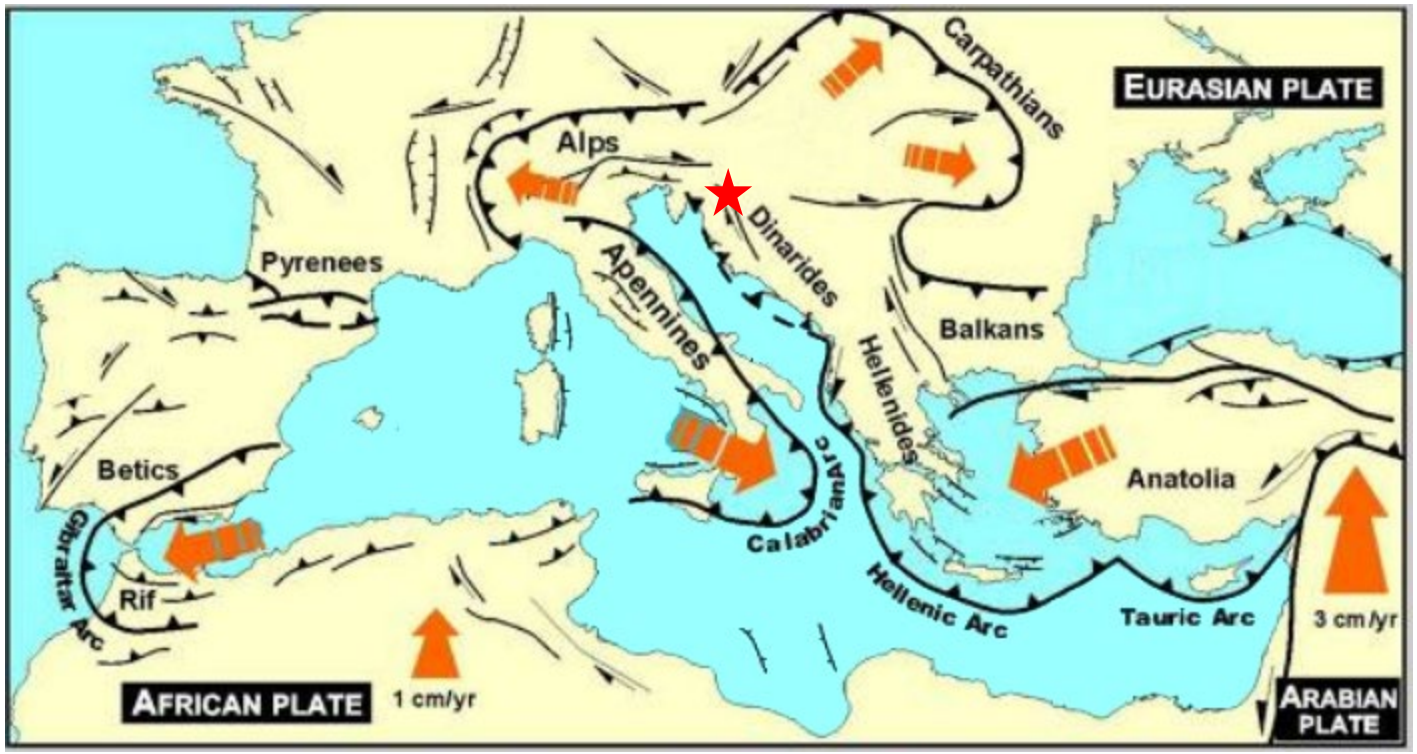
Tectonics of the Mediterranean Region, in the convergent boundary region between Africa and Eurasia involve motions of numerous microplates and regional-scale structures. The Adriatic block immediately west of today's earthquake (shown by the red star) is thought to move somewhat independently of Eurasia and Africa, driving surrounding faulting in Italy and along the eastern Adriatic coast from Croatia to Albania.




Summary tectonic map of Mediterranean Region.
*Modified from Zvi Ben-Avraham, Tel-Aviv University, Israel*

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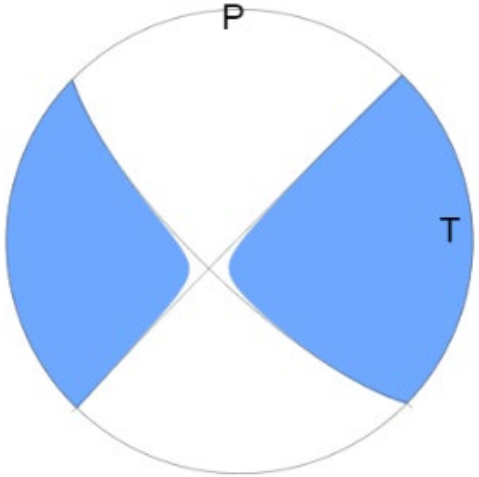
The focal mechanism is how seismologists plot the 3-D stress orientations of an earthquake. Because an earthquake occurs as slip on a fault, it generates primary (P) waves in quadrants where the first pulse is compressional (shaded) and quadrants where the first pulse is extensional (white). The orientation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

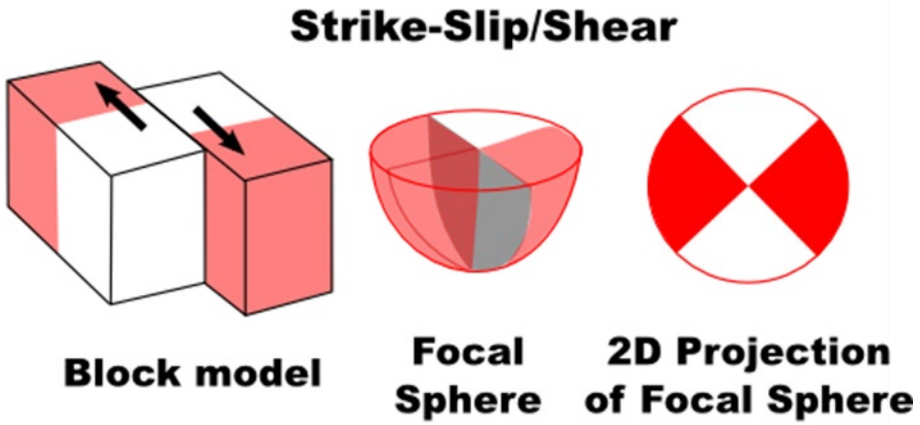



*USGS W-phase Moment Tensor Solution*

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

This intraplate earthquake occurred as a result of shallow strike-slip faulting within the Eurasia Plate.

Rupture occurred on a nearly vertical fault striking either to the southeast or southwest.



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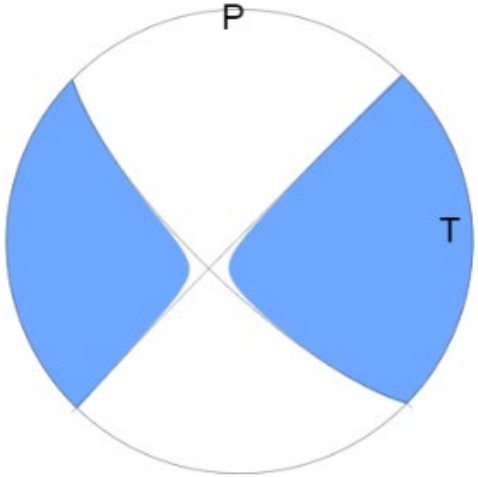
This animation explores the motion of a strike-slip fault, and how strike-slip faults are represented in a focal mechanism.

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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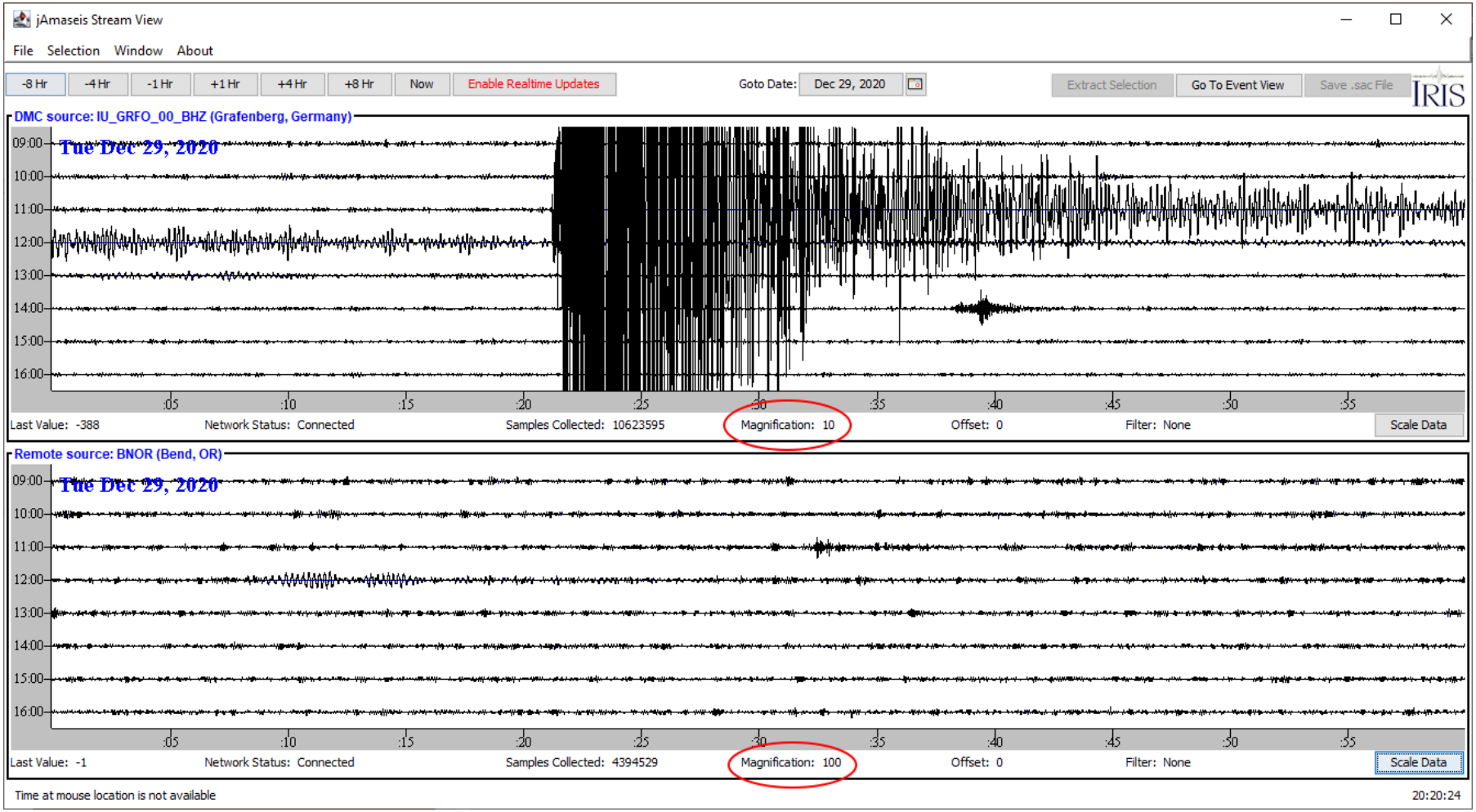
Compare the seismograms from the station in GRFO in Grafenberg, Germany with station BNOR in Bend, Oregon, United States. (Note, the magnification for each station is different)



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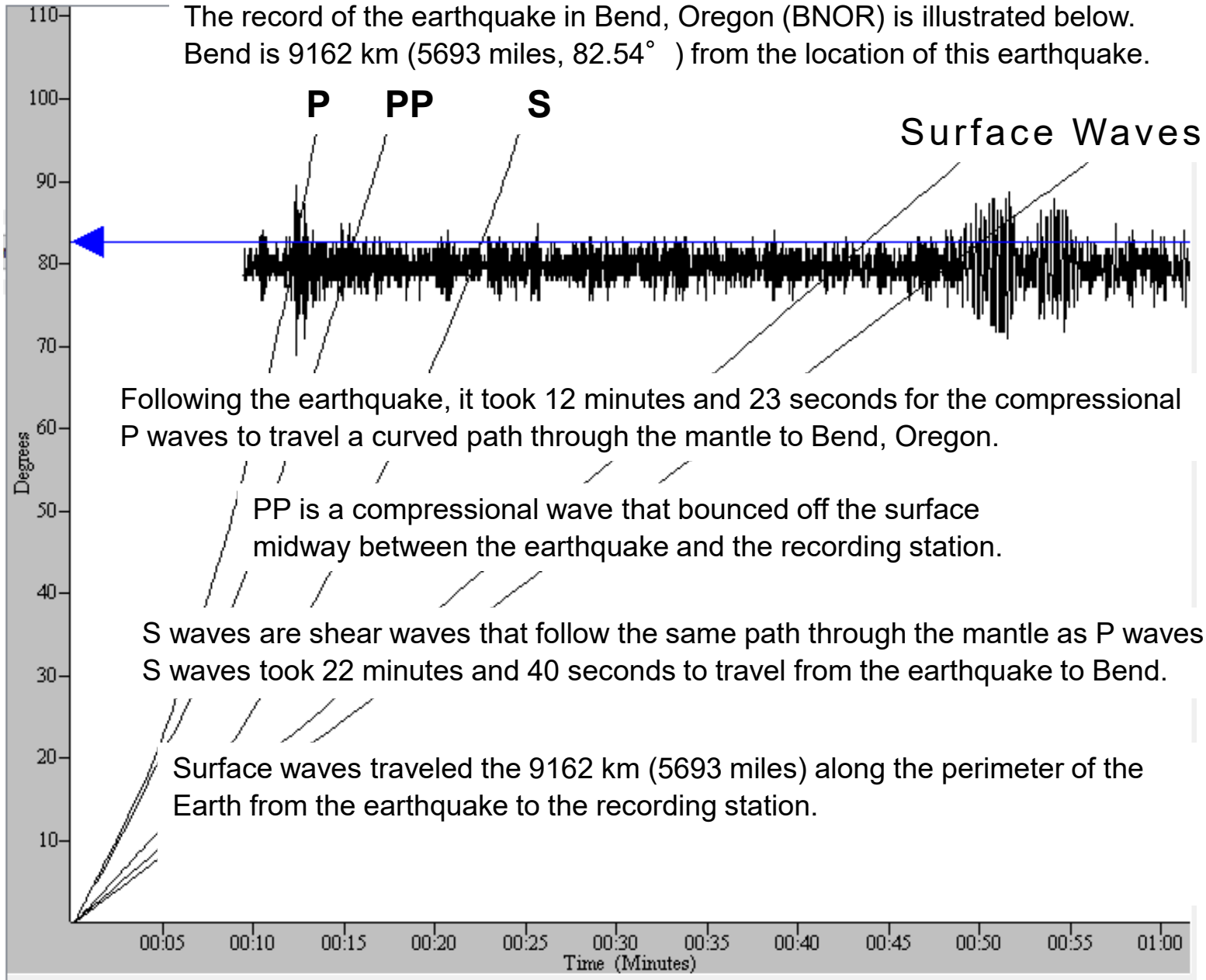
The record of the earthquake in Bend, Oregon (BNOR) is illustrated below. Bend is 9162 km (5693 miles, 82.54° ) from the location of this earthquake.




Following the earthquake, it took 12 minutes and 23 seconds 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 22 minutes and 40 seconds to travel from the earthquake to Bend.

Surface waves traveled the 9162 km (5693 miles) along the perimeter of the Earth from the earthquake to the recording station.

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