Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

Teacher Guide

Welcome to Teachable Moments! Our goal is to provide timely and accurate information to develop knowledge about a newsworthy earthquake for audiences from middle school through college. Please use the slides to get a concise, but thorough overview of the recent earthquake and then use them as is, or customize it for your students and curriculum.

New for the 2024-25 school year:

1. **Color-coding for grade levels.** ALL **middle school +** HS **high school +** C **college**

2. **Check out the new Slide Guide: Slides or pdf that will guide your students through the slide deck:** middle school pdf high school pdf college pdf

3. **New Geography slide(s): A quick hit about the city or area that gives you cross-curricular connections:** geography, physics, chemistry, biology, environmental science or even history.

4. **NGSS Connections linked to questions in the Slide Guide are located in the notes sections below each slide guide.**

5. **Fill in the blank sub-plans:** The first two pages can be completed and used all year (hint: sheet protector). The rest are for you to modify or fill-in to customize your sub-plans to fit what you're doing.

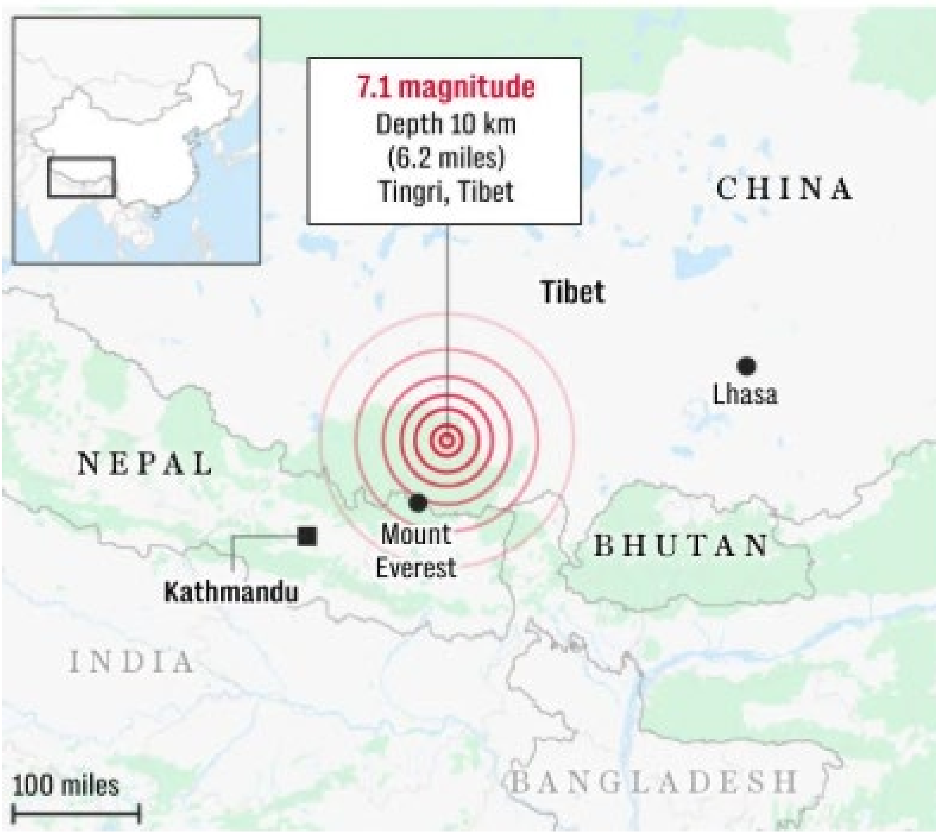
Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

ALL

Latitude 28.639°S
Longitude 87.361°E
Depth 10.0 km

A powerful earthquake struck the foothills of the Himalayas on the Tibetan Plateau Tuesday morning, killing at least 126 people and injuring 188. The magnitude 7.1 earthquake was located about 80 km (50 miles) north of Mount Everest and caused widespread destruction, flattening hundreds of homes in the Shigatse region, which is home to 800,000 people.



Rescue workers were seen pulling survivors from rubble, as temperatures in the earthquake-hit area plunged to as low as minus 16 degrees Celsius (3°F) overnight, adding to the plight of those left homeless.

Shaking was felt across Nepal, Bhutan, and northern India, though Nepalese authorities reported no damage or casualties around Mount Everest.

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

ALL

A building is damaged after a 7.1-magnitude earthquake on January 7, 2025.
(Photo by VCG/VCG via AP)

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

ALL

Tashi Lhunpo Monastery in Shigatse CC BY-SA 3.0,
https://commons.wikimedia.org/w/index.php?curid=302082

Xizang, also known as the Xizang or Tibet Autonomous Region, includes a lakes area with hot springs and salt or alkaline lakes, and a river region characterized by fertile valleys used for agriculture. The economy is primarily driven by agriculture, animal husbandry, and service sector-related businesses.

Interestingly, caterpillar fungus, used in traditional Chinese medicine, is harvested here despite its potential toxicity due to high levels of arsenic and heavy metals. Tourists can visit landmarks such as the Potala Palace in Lhasa, Jokhang Temple, Namtso Lake, and the Tashi Lhunpo Monastery in Shigatse. Mount Everest, standing at an altitude of over 29,031 feet, is nearby and was visited by 408 permitted climbers in 2021.

Yak By Alexandr frolov - Own work, CC BY-SA 4.0,
https://commons.wikimedia.org/w/index.php?curid=76950051

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

ALL

By Dan - Imported from 500px (archived version) by the Archive Team. (detail page), CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=72669678

The area of the earthquake, has alpine meadows and grasslands. Life on the Tibetan Plateau has evolved to survive the high elevation and extreme conditions. Adaptations like thick fur for insulation, specialized systems to optimize oxygen because of the high altitude, and camouflaging color help with survival.

By Bernard Landgraf - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=217881

Biodiversity is high due to its geography; it is surrounded by mountain ranges, which includes glaciers, ice sheets, forests, and grasslands. It also holds deposits of metals and energy reserves. There are concerns for the wildlife, the environment, and traditional lifestyles due to global climate concerns, and human activities new to the area.

By The poison of doubt - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=19584158

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

Continental collision and under thrusting of the India Plate beneath the Eurasia Plate generates numerous earthquakes and results in an extensive zone of seismic hazard across Asia. Although the Tibetan Plateau and many parts of Nepal are sparsely populated, Its populations are vulnerable due to the especially high seismic hazard. Remote villages, as well as larger towns farther from the earthquake, were impacted on January 7.

Asia Earthquake Risk

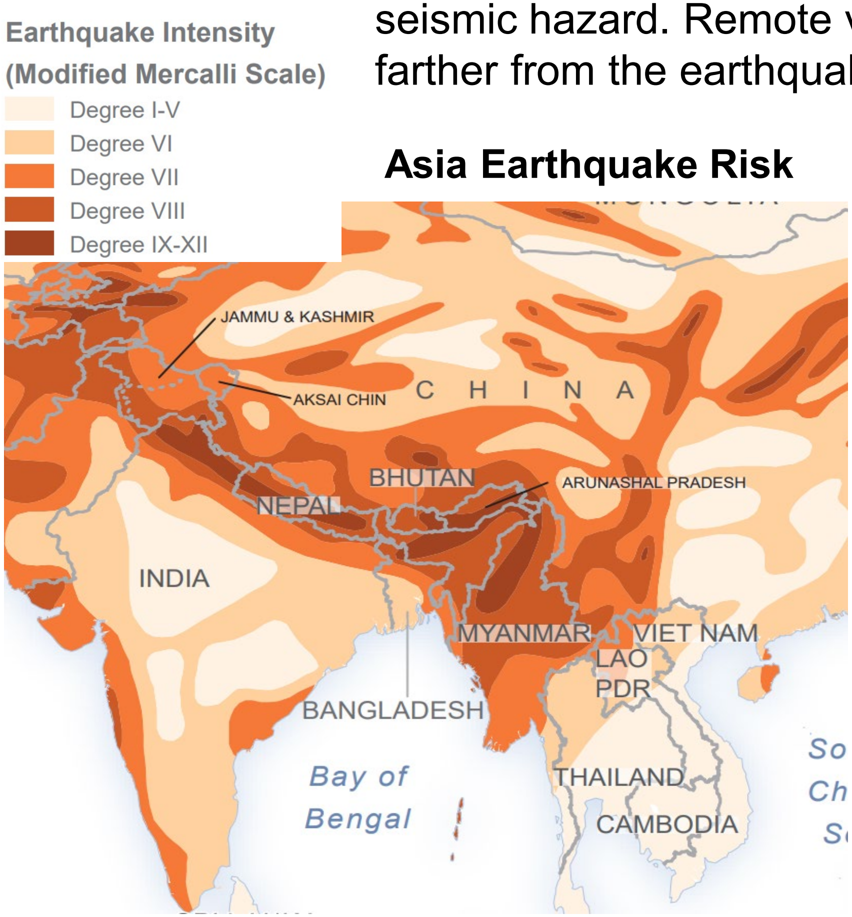


Image courtesy the OCHA

Population Density of Asia

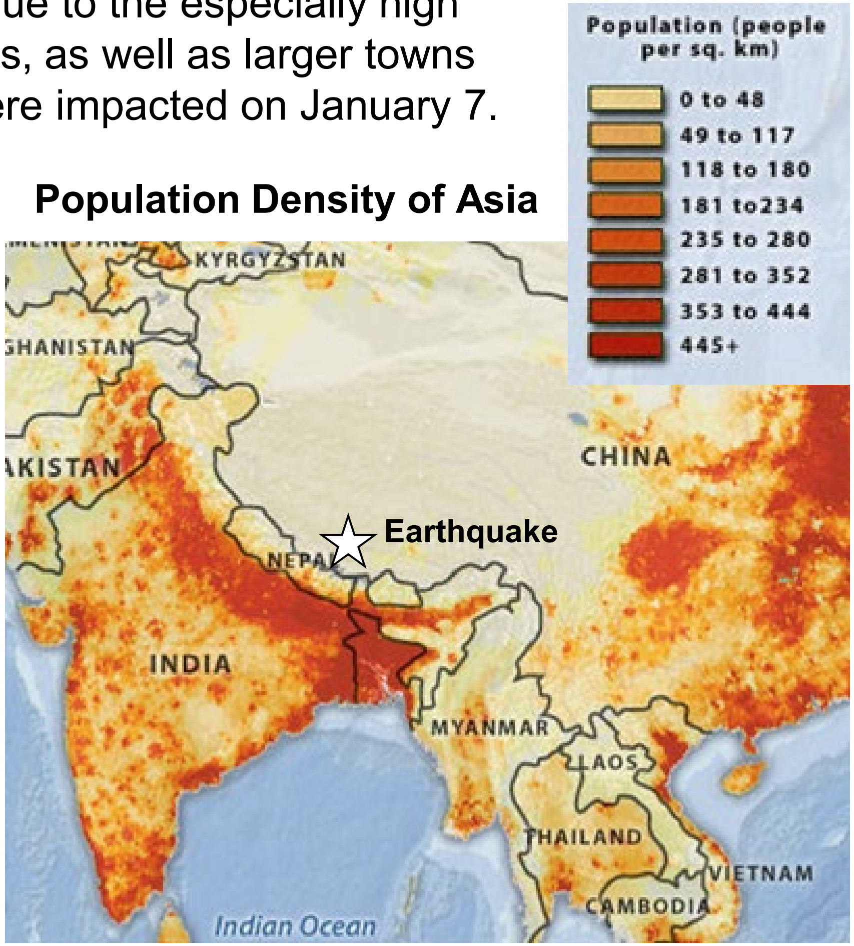


Image courtesy Strategic Forecasting, Inc.

ALL

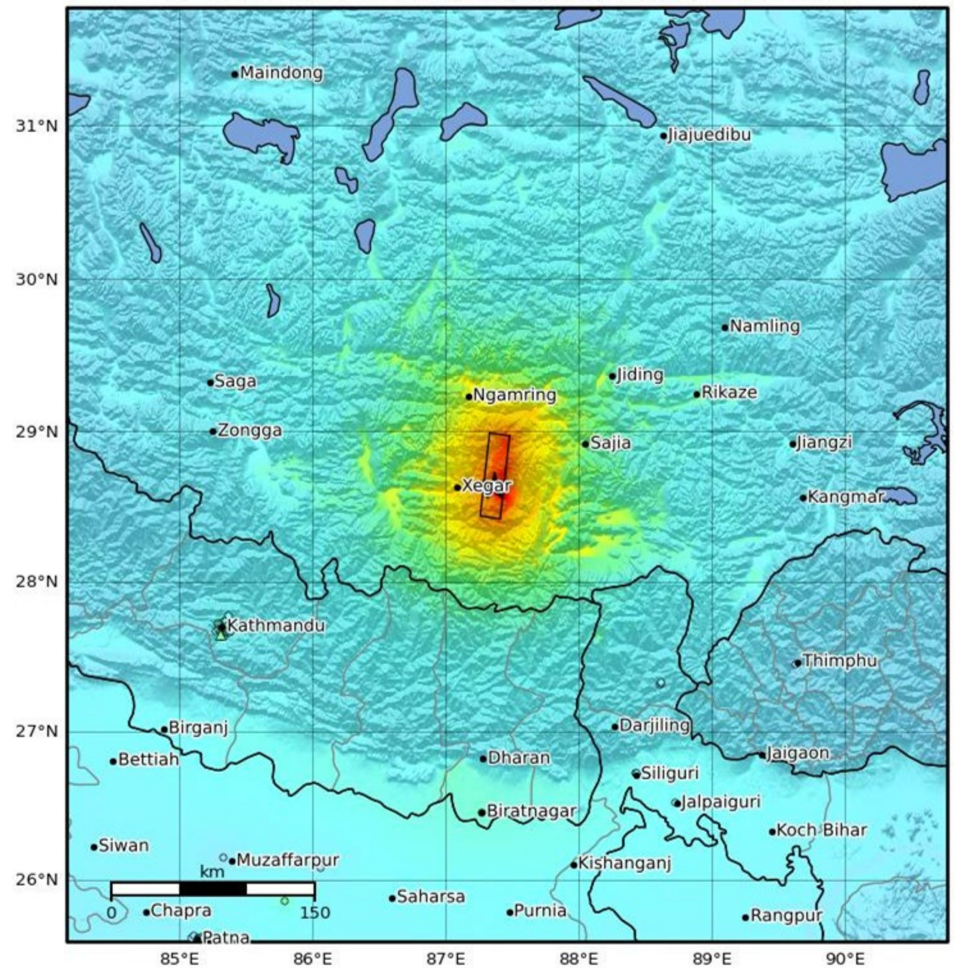
Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

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



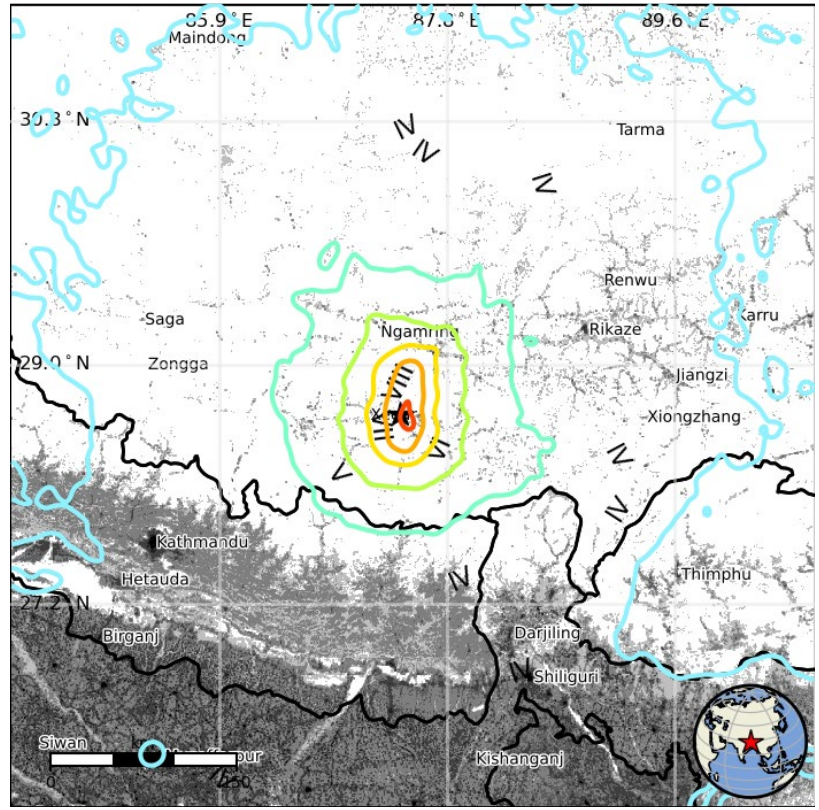
Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

ALL

The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels. The USGS estimates that approximately 7,000 people felt severe shaking from this earthquake.

MMI	Shaking	Population
I	Not Felt	0 k*
II-III	Weak	3,909 k*
IV	Light	130,865 k*
V	Moderate	147 k
VI	Strong	61 k
VII	Very Strong	28 k
VIII	Severe	7 k
IX	Violent	3 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 contour lines. The estimated population exposure to each MMI Intensity is shown in the table.

Image courtesy of the US Geological Survey

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

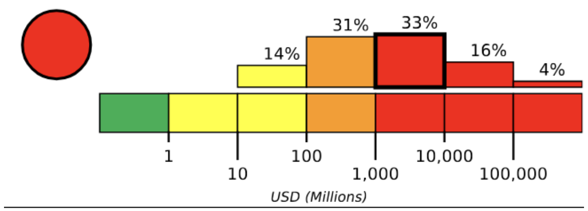
Tuesday, January 7, 2025 at 01:05:16 UTC

ALL

Estimated Economic Losses

The USGS PAGER rating system automatically calculates estimated fatality and economic loss numbers for large earthquakes within minutes of their occurrence anywhere on Earth. This information can be useful for the US and other countries in determining whether and how large of a relief response to undertake.

In the case of the M7.1 quake, estimated economic losses were significant (~$1 billion or more). The rugged terrain and shallow earthquake source likely contributed to many rock falls and landslides, which will be costly to address and may significantly hamper transportation and trade in the affected region, thus negatively impacting the local economy.



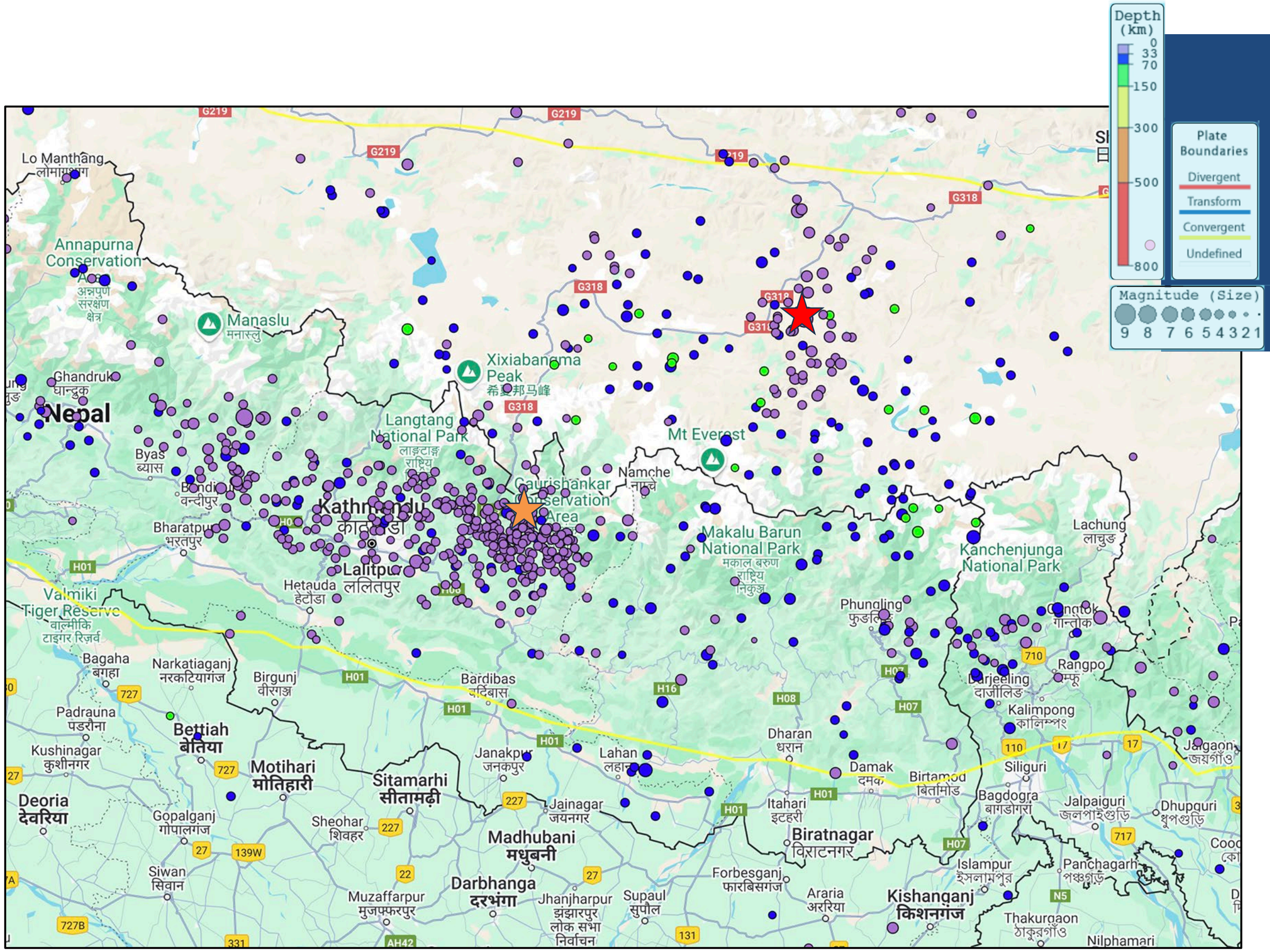
USGS PAGER economic loss estimate

Credit: @mihujun/Douyin, sourced from https://www.cnn.com/2025/01/06/china/china-tibet-earthquake-intl-hnk/index.html

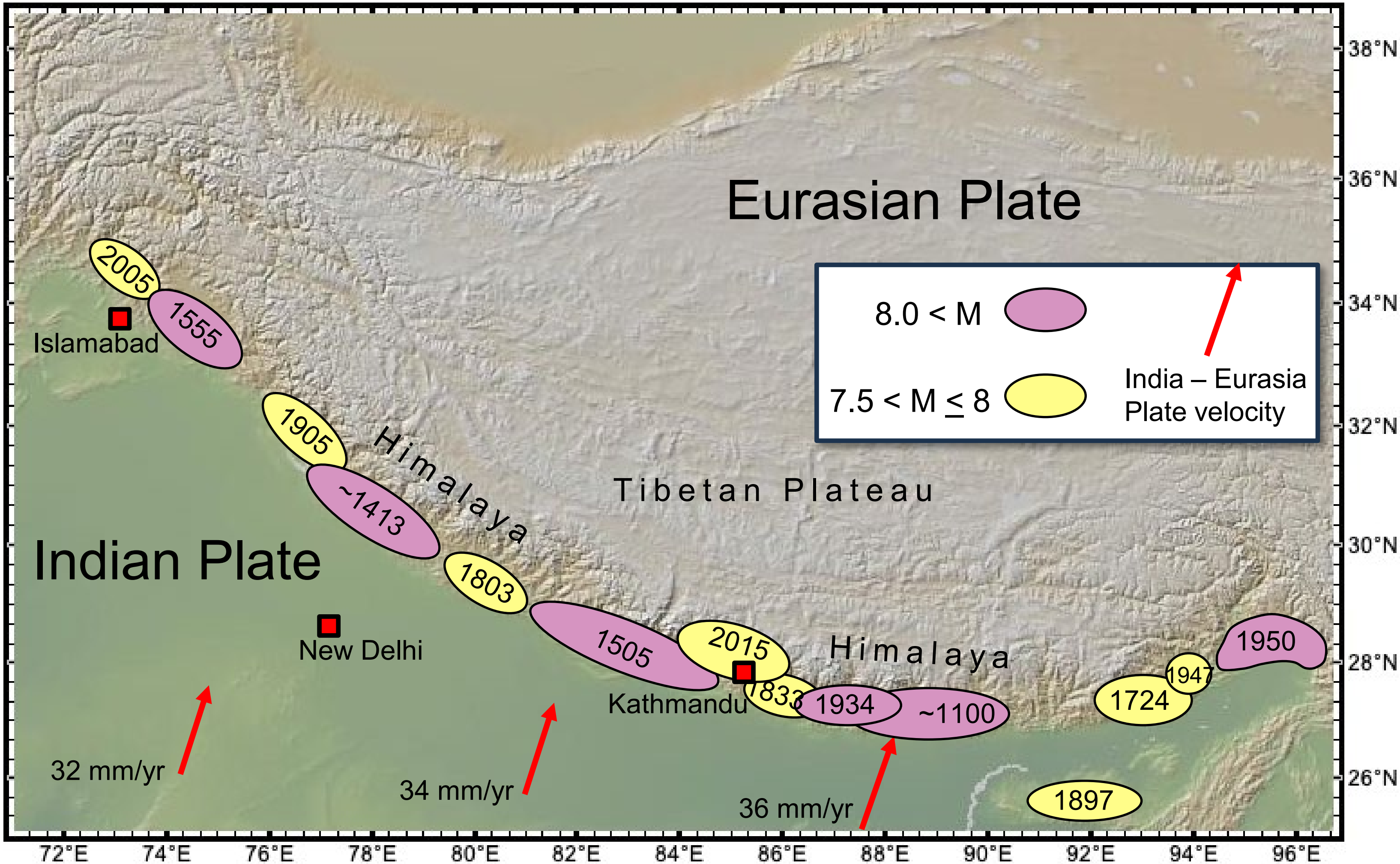
Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

This map shows all earthquakes greater than M4 since 1970. Red star (★) shows the location of the January 7 event. The orange star (★) shows the location of the 2015 Kathmandu earthquake, 160 km southwest of the January 7 quake. The map is from the EarthScope Interactive EarthScope Browser (IEB). To see this setup in the browser, click: Himalaya quakes >M4



Magnitude 7.1 SOUTHERN TIBETAN PLATEAU
Tuesday, January 7, 2025 at 01:05:16 UTC



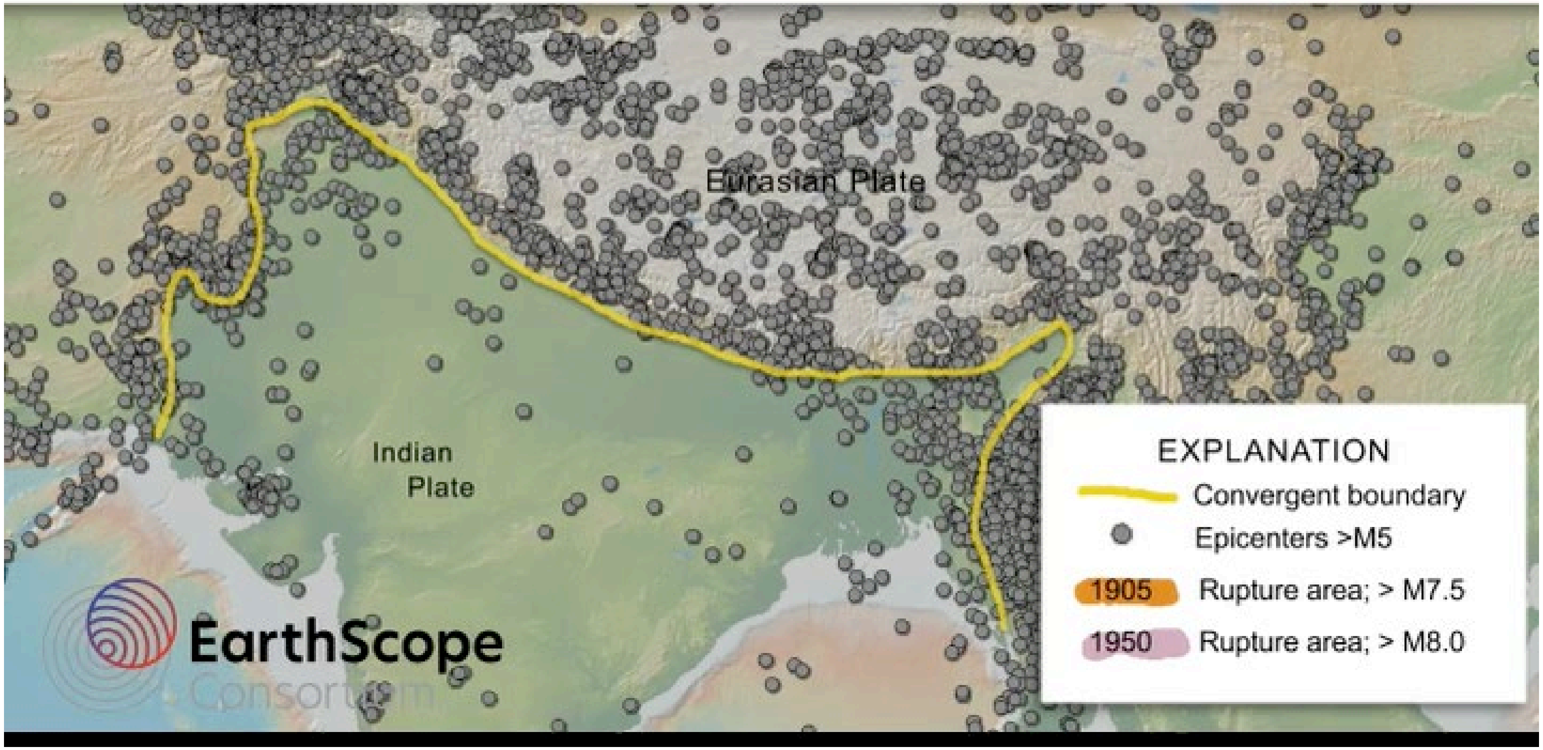
As anticipated in a continental collision zone, thrust-faulting earthquakes are found along the India – Eurasia plate boundary. All the historic earthquakes shown here were caused by thrust faulting. Indeed, thrust fault motions "jack up" the Himalaya Mountains. However, north of the Himalaya in the Tibetan Plateau, strike-slip and normal faults dominate the active tectonics.

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

Largest earthquakes on the Himalaya megathrust boundary

Video short extracted from full video: www.iris.edu/hq/inclass/animation/466



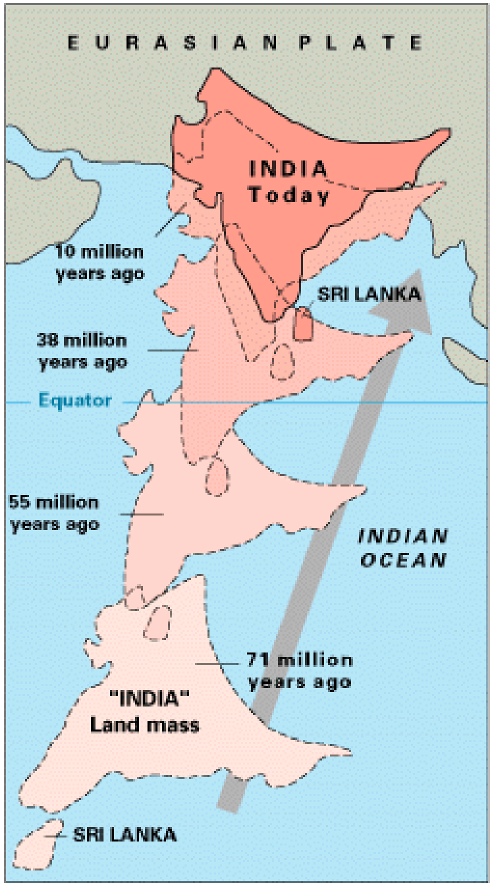
This animation, extracted from "Tectonics and Earthquakes of the Himalaya" animates the earthquakes noted in the previous slide. There have been 10 earthquakes >M6 within 250 km of the January 7, 2025, earthquake in 100 years.

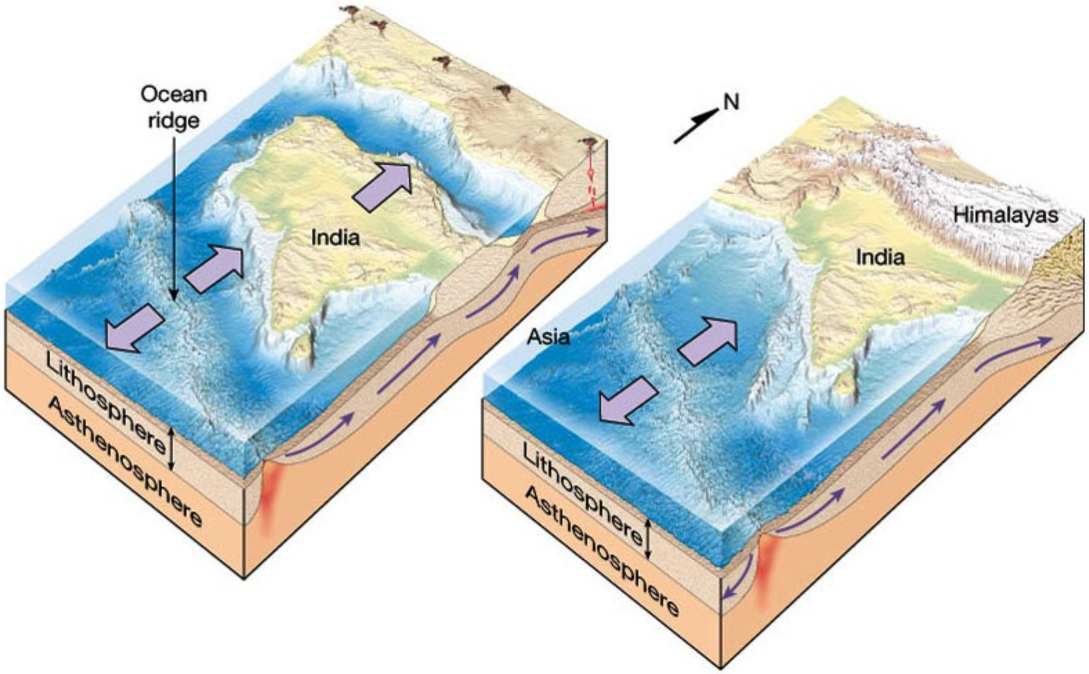
Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

ALL

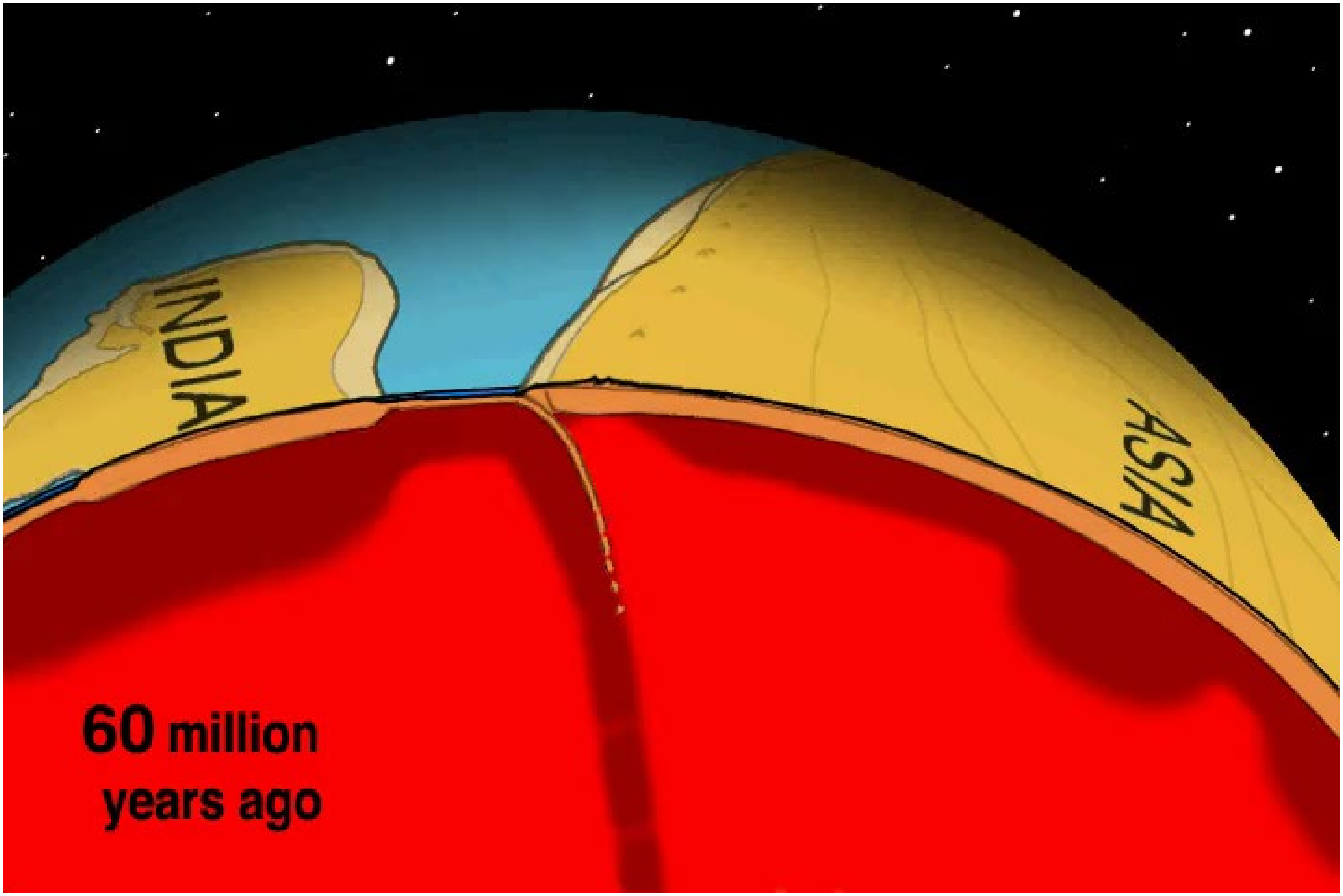
When Pangaea broke apart about 200 million years ago, India moved northward. From 200 until 50 million years ago, oceanic lithosphere north of the Indian continent subducted beneath the Eurasian continental plate. When India reached Asia about 50 million years ago, the plate boundary became a continent – continent collision zone. Continued northward motion thrust Indian continental crust partially under Eurasian continental crust while also compressing and thickening Eurasian crust. The result is the Himalaya Range and Tibetan Plateau, the highest mountain range and the largest continental plateau on Earth.





Magnitude 7.1 SOUTHERN TIBETAN PLATEAU
Tuesday, January 7, 2025 at 01:05:16 UTC

ALL



Animation by Tanya Atwater (http://emvc.geol.ucsb.edu) depicts the 60-million year history of the India-Asia continental collision

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

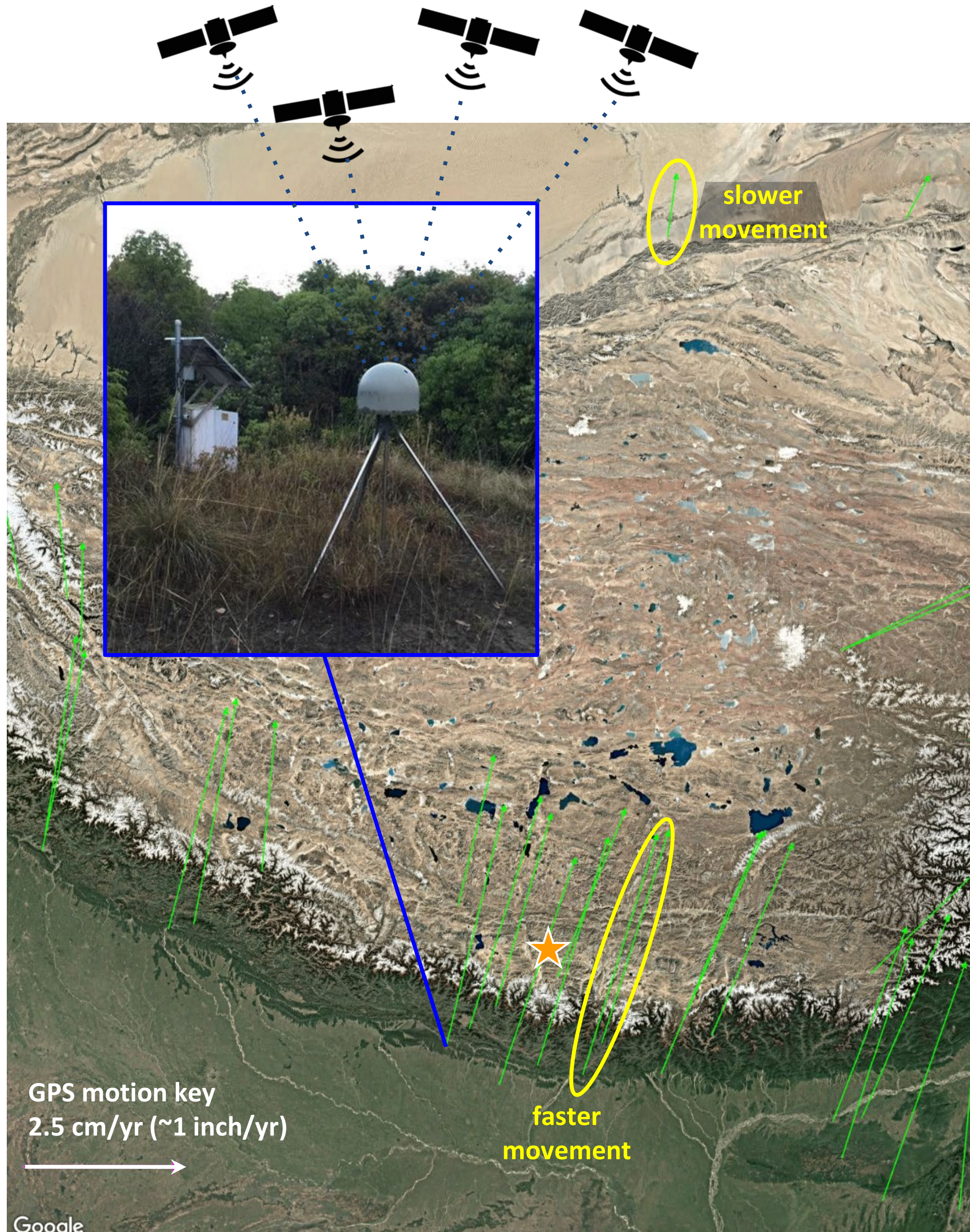
ALL

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

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 satellites, 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).



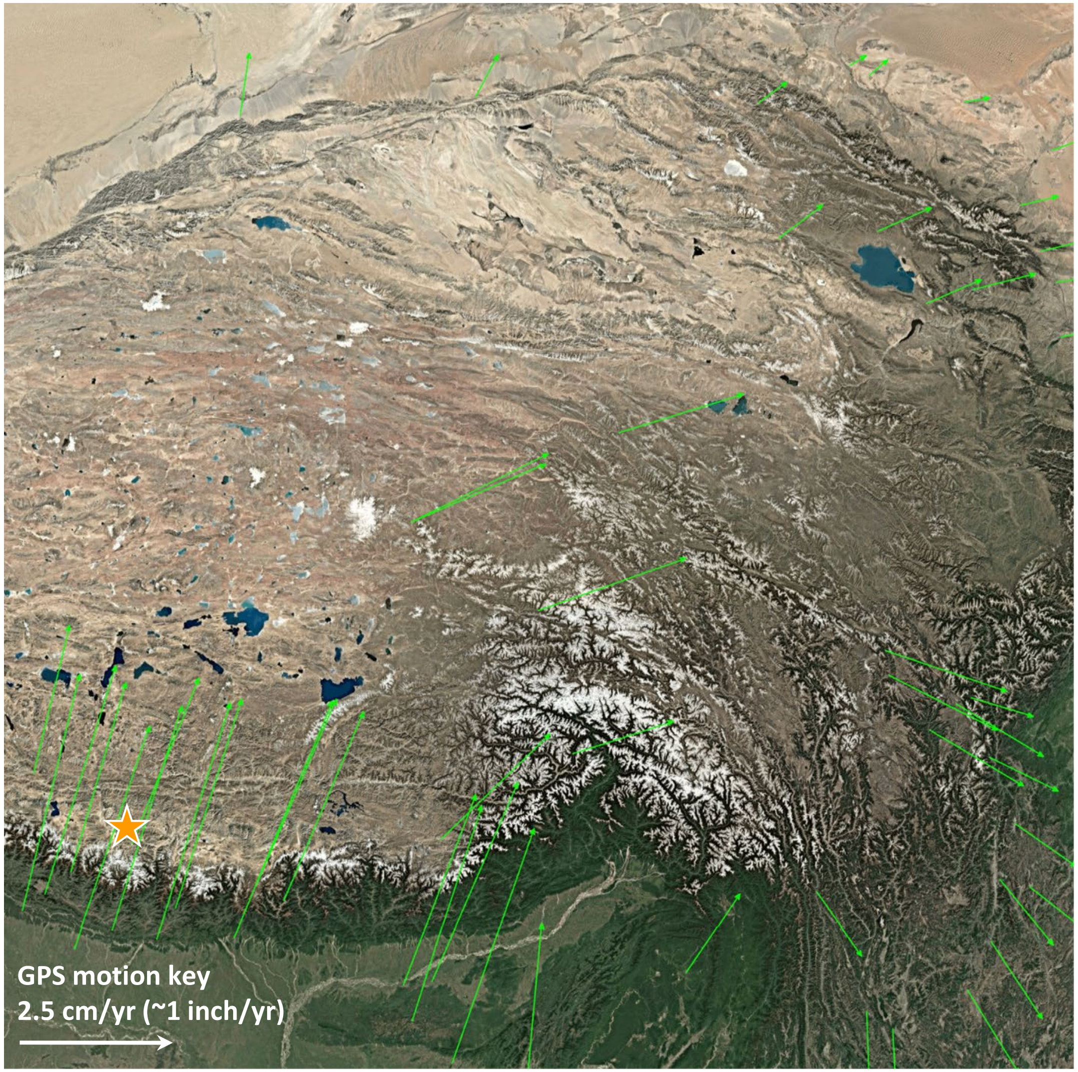
Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

This region has GPS stations that record the long term motion from plate tectonics.

Compared to northern Eurasia, stations in the Himalaya are moving as much as 4 cm/yr (~1.5 inch/yr) towards the north as the Indian Plate pushes into the Eurasian Plate. Over decades and centuries this compression accumulates and is occasionally released in earthquakes.

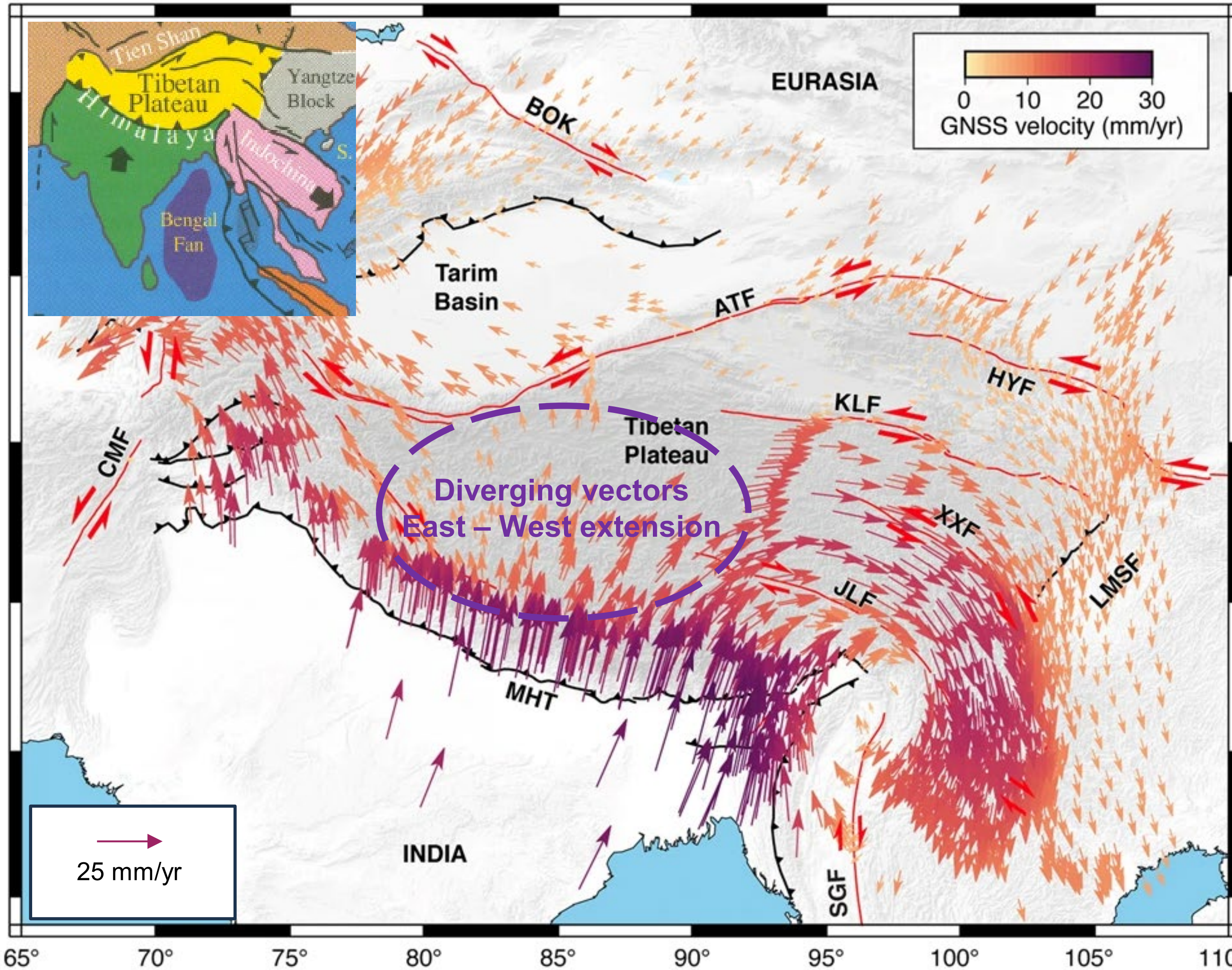
Many of the earthquakes in this region are on thrust faults from the northward compression. But the magnitude 7.1 quake on January 7, 2025, actually occurred on a normal fault. Eastern Asia is also being squeezed eastward, that is released in occasional normal faulting, even in this region.



Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

A fundamental concept of India – Asia collision is “extrusion tectonics”. The inset map shows northward motion of India pushing the Indochina block southeast while the eastern Tibetan Plateau is “extruded” eastward against the Yangtze block.

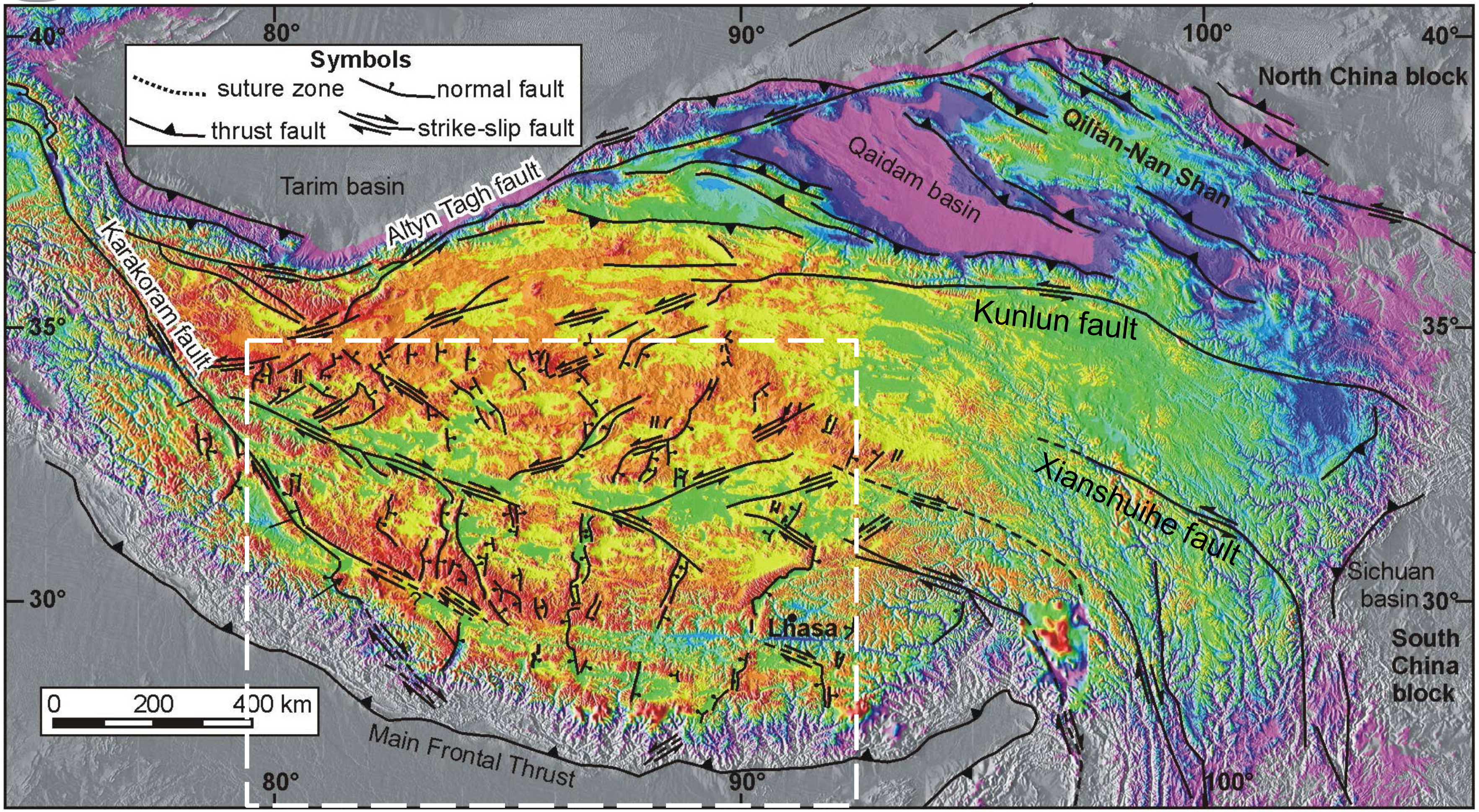


The large map shows horizontal motions of GPS stations across the collision zone. Notice the diverging vectors indicating extension of the Tibetan Plateau toward the east and west. Resulting strike-slip and normal faults that accommodate extension of the plateau interior are shown on the next slide.

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

C

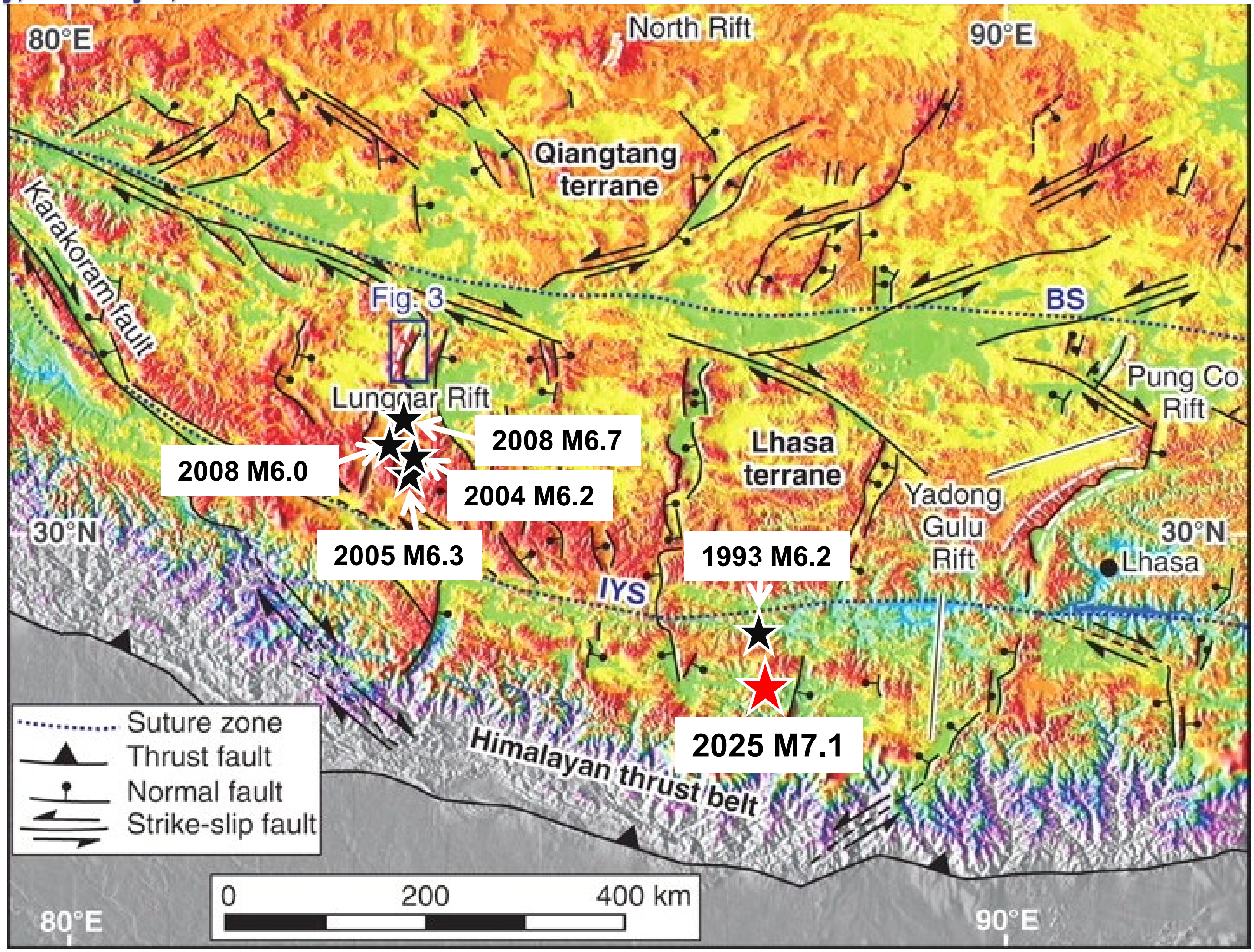


Large strike-slip faults, including the Altyn Tagh, Karakoram, Kunlun, and Xianshuihe faults, form the northern boundary and slice through the Tibetan Plateau. In addition, there are scores of normal faults, dominantly oriented north – south, within the central and southern plateau. These faults accommodate east – west extension. The next slide shows the January 7, 2025 earthquake on a more detailed map of the area within the dashed square. *Map courtesy of Paul Kapp, University of Arizona*

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

C



A red star marks the epicenter of the magnitude 7.1 January 7, 2025 earthquake. Although not on a mapped normal fault, the January 7 earthquake is in a region dominated by north-south oriented normal faults. Also shown are epicenters of all shallow (depths < 20 km) magnitude 6 and larger earthquakes since 1980. All were produced by north-south oriented normal faulting. The January 7, 2025 earthquake is the largest since 1980.

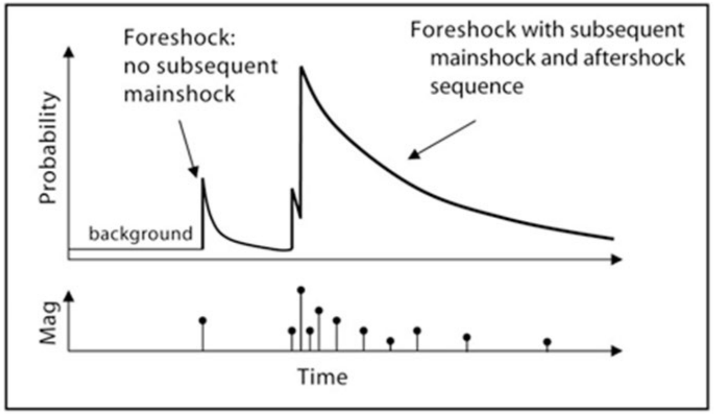
Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

A **foreshock** is a smaller magnitude earthquake that precedes the mainshock. There are no special characteristics of a foreshock that let us know it is a foreshock until the mainshock occurs.

A **mainshock** is largest magnitude earthquake during an earthquake sequence.

Aftershocks are smaller earthquakes occurring after a large earthquake as the fault adjusts to the new state of stress.



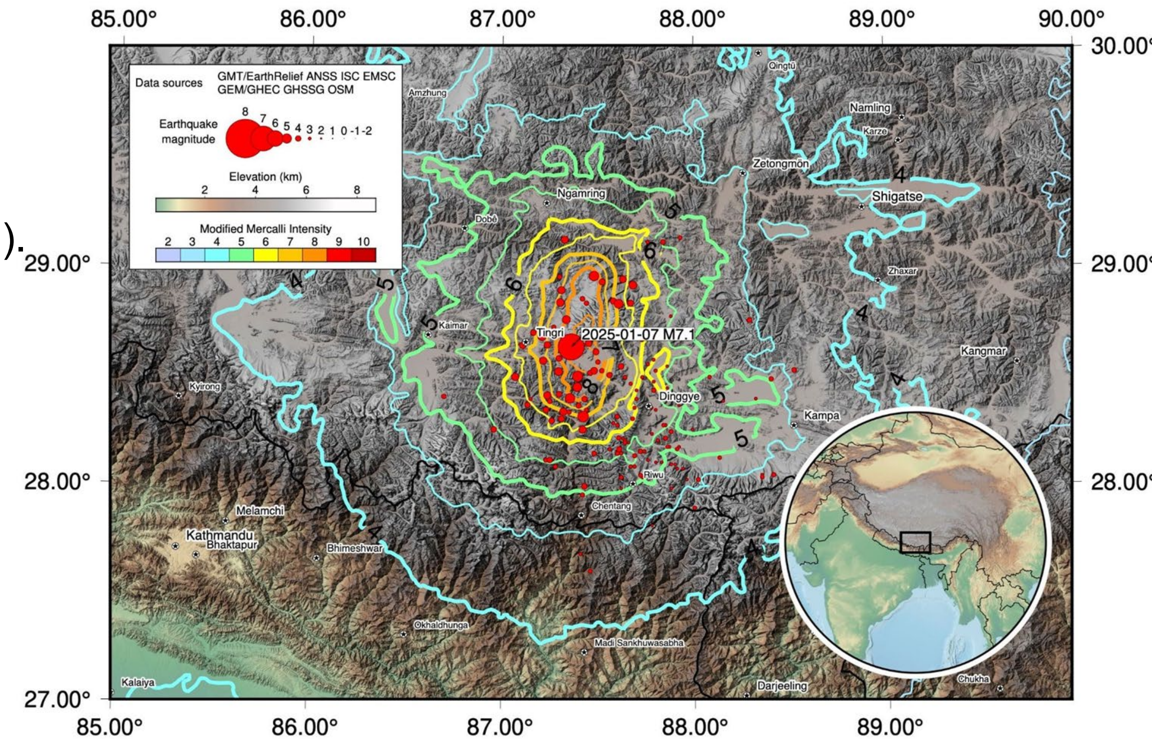
The graph shows how the number of aftershocks and the magnitude of aftershocks decay with increasing time since the main shock. The number of aftershocks also decreases with distance from the main shock.

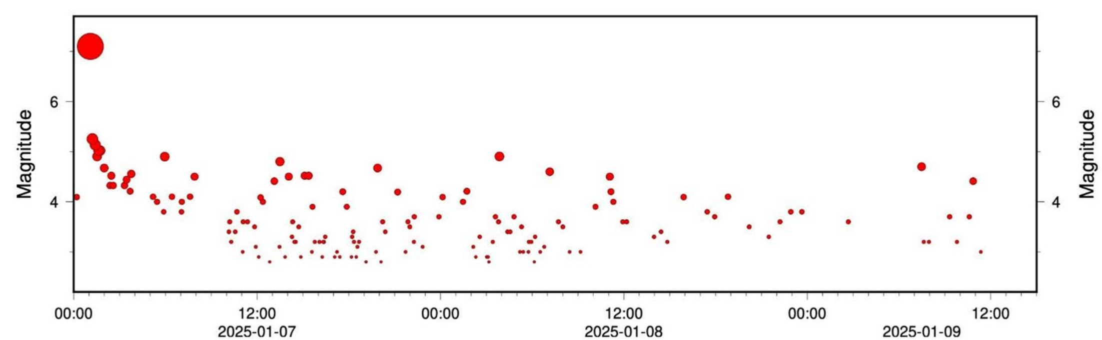
Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

As of ~2 days after the M7.1 quake, there have been approximately 23 aftershocks >M4 reported by the USGS (and many more that are <M4). These aftershocks have tended to cluster within ~50-100km of the mainshock epicenter in the southern Tibetan Plateau.

If you look at the lower plot, you'll notice that the size (vertical axis) of the aftershocks peak at about 1 to 2 magnitude units smaller than the mainshock (M7.1). This is as expected and is seen for aftershocks worldwide. You may also be able to make out a slight decrease in the size of the recorded aftershocks with time. This too is a common feature seen for aftershock sequences–events become smaller and less frequent with time.





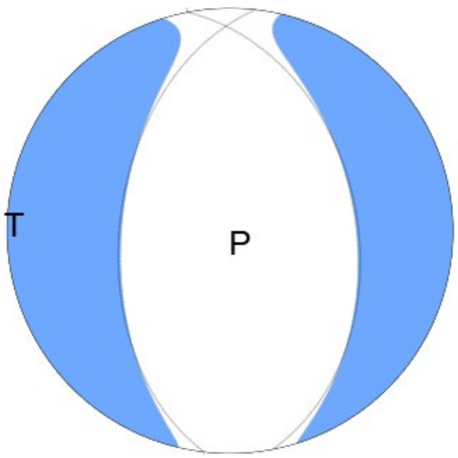
Plots from [Earthquake Insights substack]

C

Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC

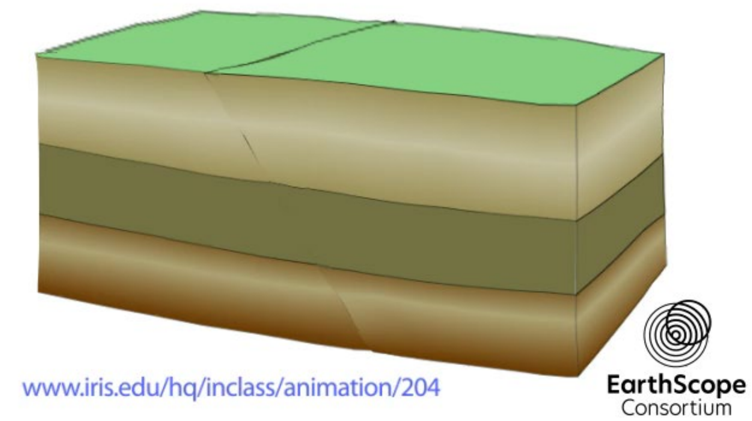
The focal mechanism is how seismologists plot the 3-D stress orientations of an earthquake. Because an earthquake occurs as slip on a fault, it generates primary (P) waves in quadrants where the first pulse is compressional (shaded) and quadrants where the first pulse is extensional (white). The orientation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

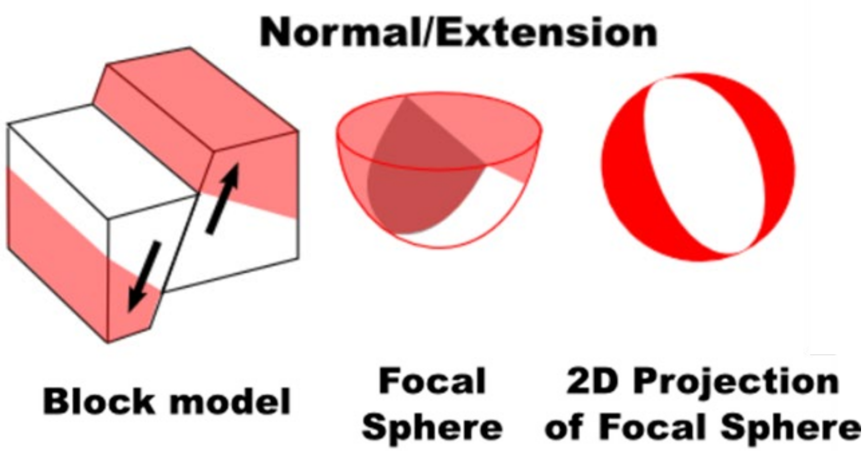


USGS W-phase Moment Tensor Solution

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

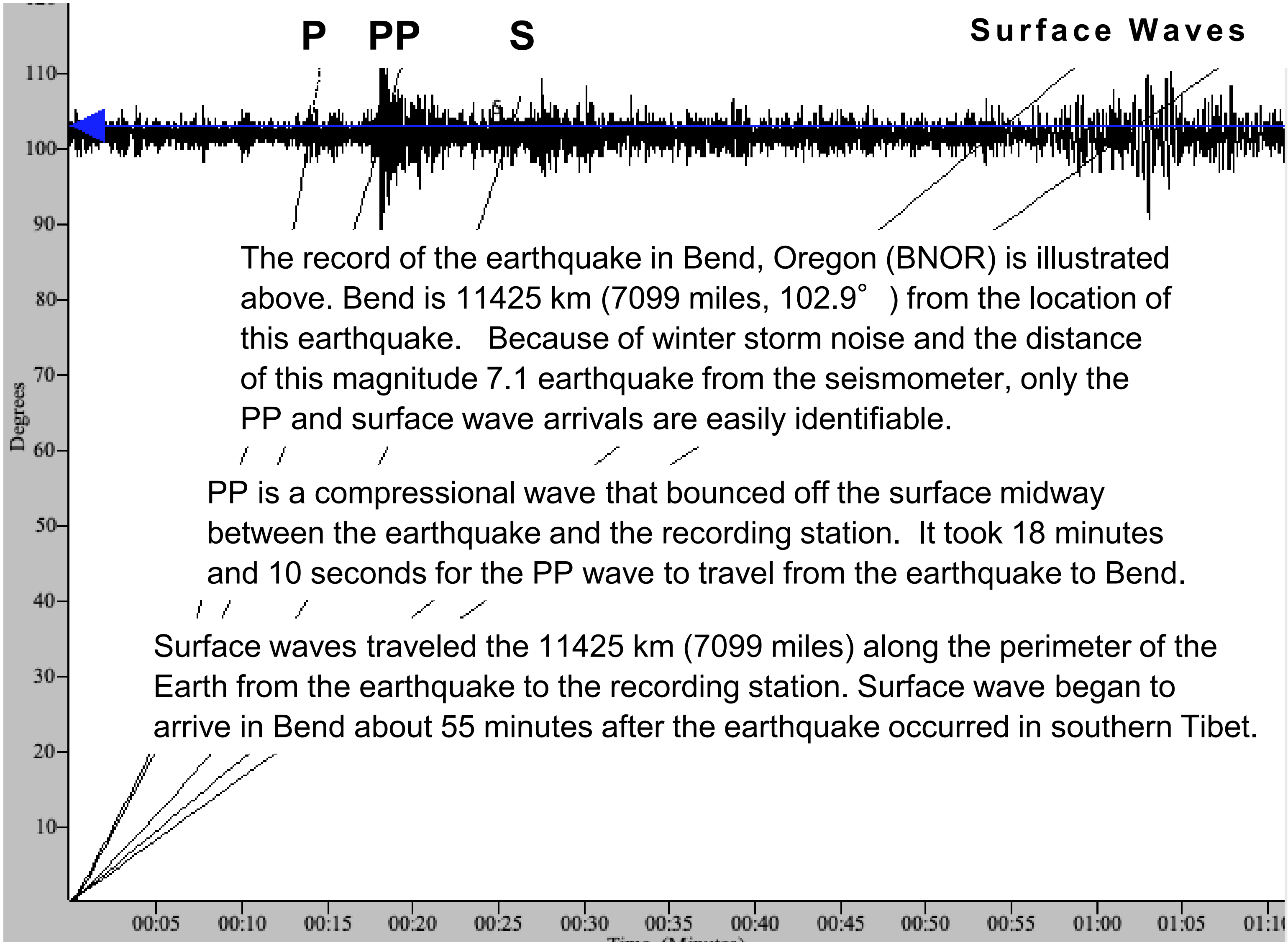
Focal Mechanism for a Normal Fault





Magnitude 7.1 SOUTHERN TIBETAN PLATEAU

Tuesday, January 7, 2025 at 01:05:16 UTC



ALL

Slide Guide

1. Where was the epicenter of this earthquake? (What city/region was it closest to?) When did the earthquake happen? What was its magnitude?
2. How many people are estimated to have felt the earthquake?
3. Which type of boundary is this earthquake related to?
4. What impact did the earthquake have on the location in which it was felt the strongest? (buildings, streets, animals, people…)
5. What additional hazards occurred in addition to the ground shaking? (tsunamis, floods, sinkholes, landslides, fires, volcanoes…)
6. How long did it take the first P-wave to travel to the seismic station in this slide stack?
7. What are 2 more questions you have about earthquakes that can NOT be answered with this slide stack?

Extension Questions

1. Seismic waves travel through the earth. Why did you or did you not feel the earthquake?
2. If you were going to write a news story on this earthquake, what would the headline be? *HINT: Think about where this earthquake occurred, the impact it had on the people living in the area, any effects the earthquake had on the area itself.*

Slide Guide

1. Where was the epicenter of this earthquake? (What city/region was it closest to?) When did the earthquake happen? What was its magnitude?
2. How many people are estimated to have felt the earthquake?
3. What relationship is shown between the seismic hazard map and population density?
4. Which plates are involved and what type of boundary are they creating?
5. What impact did the earthquake have on the location in which it was felt the strongest? (buildings, streets, animals, people…)
6. What additional hazards occurred in addition to the ground shaking? (tsunamis, floods, sinkholes, landslides, fires, volcanoes…)
7. How long did it take the first P-wave to travel to the seismic station in this slide stack?
8. What are 2 more questions you have about earthquakes that can NOT be answered with this slide stack?

Extension Questions

1. Seismic waves travel through the earth. Why did you or did you not feel the earthquake?
2. If you were going to write a news story on this earthquake, what would the headline be? *HINT: Think about where this earthquake occurred, the impact it had on the people living in the area, any effects the earthquake had on the area itself.*

C

Slide Guide

1. Where was the epicenter and hypocenter of this earthquake? (What city/region was it closest to? Longitude/latitude/depth?) When did the earthquake happen? What was its magnitude?
2. What impact did the earthquake have on the location in which it was felt the strongest? *(buildings, streets, animals, people…)*
3. Draw the block model of the fault for this earthquake. Overlay a drawing of the focal mechanism to show how the 2D projection was created. Label it with the type of fault.
4. How are the related tectonic plates involved in creating the nearby boundary? *(Include the type of boundary, and the velocity and name of the plates.)*
5. What additional hazards occurred in addition to the ground shaking? *(tsunamis, floods, sinkholes, landslides, fires, volcanoes…)*
6. Relate the area's population density to its seismic hazard level and earthquake history

Extension Question

1. What efforts have there been to mitigate impacts from earthquakes? What additional mitigation efforts should be implemented?

Teachable Moments are a service of

The EarthScope Consortium

Please send feedback to tammy.bravo@earthscope.org

To receive automatic notifications of new Teachable Moments
send a blank email to earthquakes+subscribe@earthscope.org

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