Magnitude 7.7 MYANMAR (BURMA)
Friday, March 28, 2025 at 06:20:54 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

1. **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
2. **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.
3. **NGSS Connections linked to questions in the Slide Guide are located in the notes sections below each slide guide.**
4. **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.

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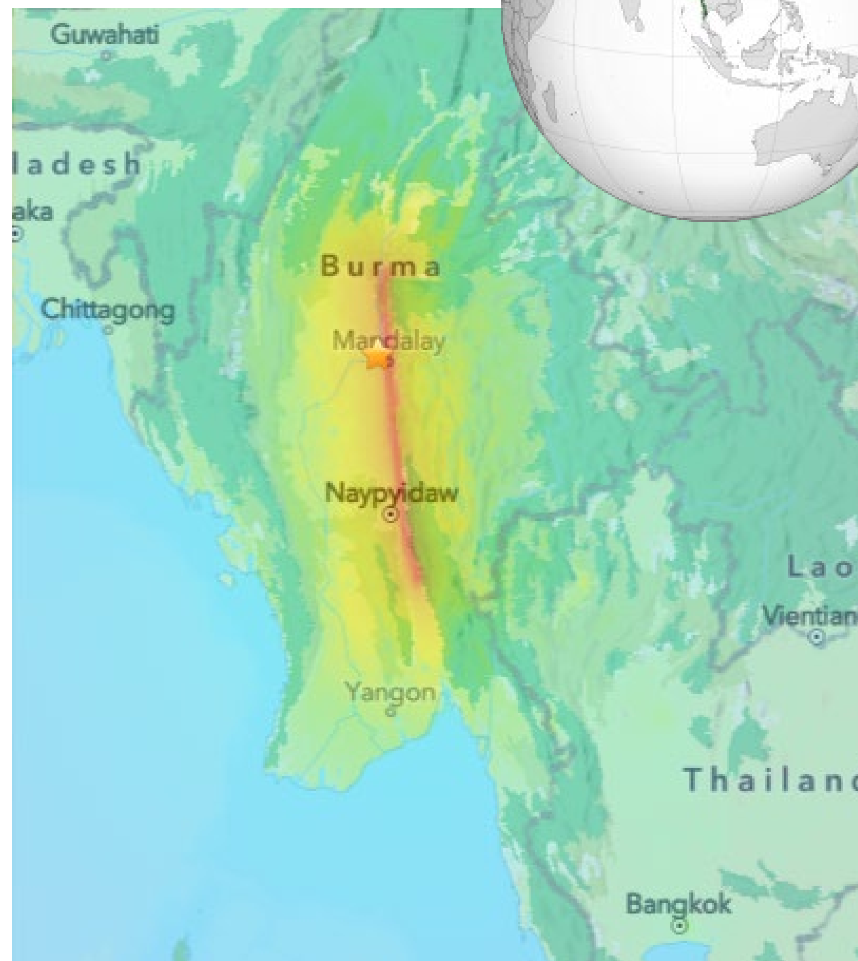
ALL

Latitude 22.013° N
Longitude 95.922° E
Depth 10 km

A magnitude 7.7 earthquake has struck central Myanmar, intensifying the challenges already faced by a country gripped by civil war and a humanitarian crisis. The earthquake's epicenter was located near Mandalay, Myanmar's second-largest city, and approximately 100 km (60 miles) north of the capital, Nay Pyi Taw. The earthquake was felt across the region, including in Thailand and southwest China.

The earthquake caused widespread destruction, including buckled roads in the capital and damaged buildings across the country. There are reports of over 1,500 homes damaged in the Mandalay region alone.

The official death toll has surpassed 2,000, with more than 3,900 injured and hundreds still missing. Rescue efforts are ongoing under extremely difficult conditions, with teams in Mandalay describing their efforts as "digging people out with our bare hands."



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ALL

A building is damaged after earthquake Friday, March 28, 2025, in Nay Pyi Taw, Myanmar.
(AP Photo/Aung Shine Oo)

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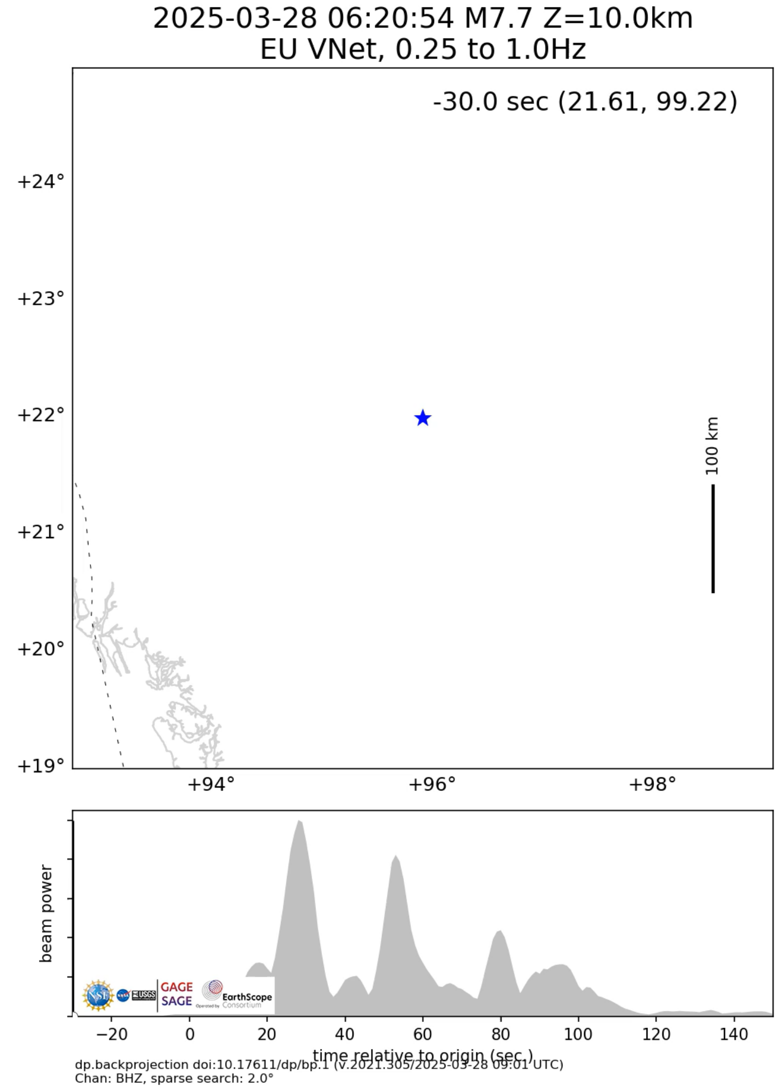
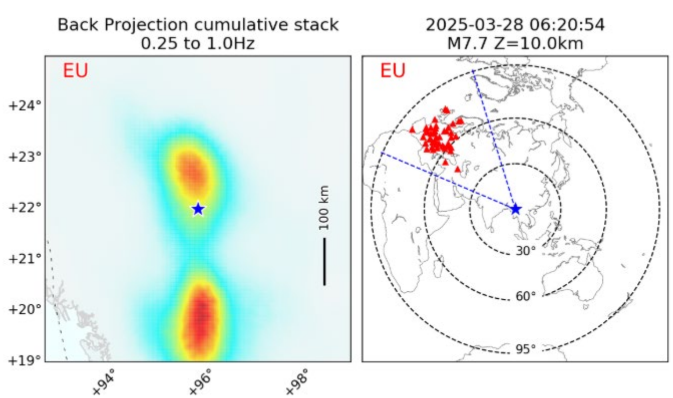
Back Projections are movies created from an automated data processing sequence that stacks up P wave energy recorded on many seismometers on a flat grid around the source region. This grid is meant to be a fault surface and creates a time and space history of the earthquake. This technique allows detailed and complex rupture propagation to be examined.

In the animated back projections, warmer colors indicate greater displacement on the fault.

The graph below the map shows the time distribution of rupture during the earthquake.



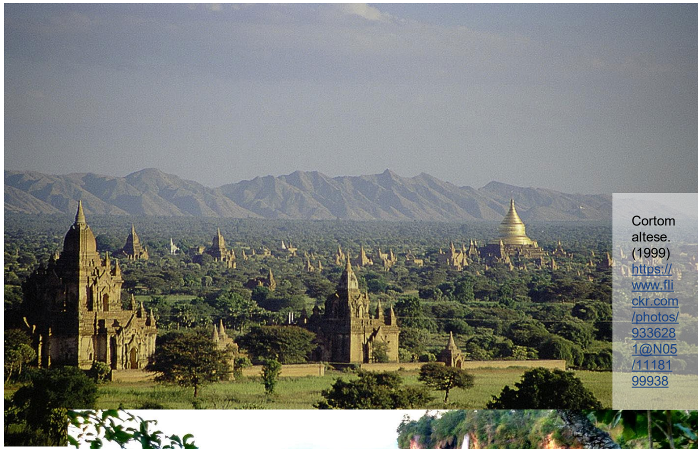


Cumulative stack and European Network used in analysis (48 Stations)

ALL

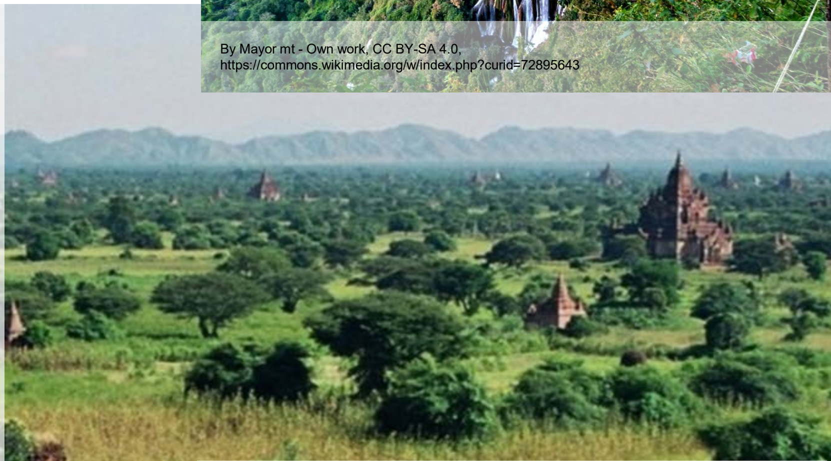
What About Myanmar?

Myanmar is a country in Southeast Asia with over 57 million people, where most speak Burmese and follow Buddhism. Although it has a low-income economy, many people work in farming, mining, or logging. The country is known for its beautiful temples, mountains, lakes, and beaches. Visitors enjoy local foods like curry and tea-leaf salad, and instead of big malls or fancy hotels, they find small shops and guesthouses.



Cortomaltese. (1999) https://www.flickr.com/photos/9336281@N05/1118199938

By Mayor mt - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=72895643



Veraart, M. (2007, Nov 20). Myanmar Bagan https://wikitravel.org/shared/File:Myanmar_Banner.jpg

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High Biodiversity – but at Risk

Myanmar is part of the Indo-Burma biodiversity hotspot, a region with many different habitats that support thousands of plant and animal species. Some endangered animals found here include two types of tigers, pangolins, the saola (also called the “Asian unicorn”), and the Burmese bamboo shark, along with thousands of plants like the beaked magnolia.

Many of these species are at risk due to habitat loss and pollution. The biggest threats come from commercial logging, farming, mining, and extreme weather effects.

By H. Zell - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=16081429

By A. J. T. Johnsingh, WWF-India and NCF - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=79205863

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Dhttps://commons.wikimedia.org/wiki/File:Pseudoryx_nghetinhensis,_b.PNG

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Why is there so much biodiversity?

Myanmar has many different types of environments, including coastal areas, tropical rainforests, tall mountains, grasslands, and dry forests. It also has a variety of water habitats like coral reefs, rivers, lakes, wetlands, and coastal waters. The land rises from sea level up to Mount Hkakabo Razi, which is over 19,000 feet tall and part of the eastern Himalayas. This wide range of habitats supports many kinds of plants and animals.

By lexcell - Own work, CC0, https://commons.wikimedia.org/w/index.php?curid=155256972

Aungthet. (2017, Nov 25). Grandfather island. https://commons.wikimedia.org/wiki/File:Grandfather_Island.jpg#/media/File:Grandfather_Island.jpg

Silviculture at Vietnamese Wikipedia. - Originally from vi.wikipedia; description page is/was here, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=29702662

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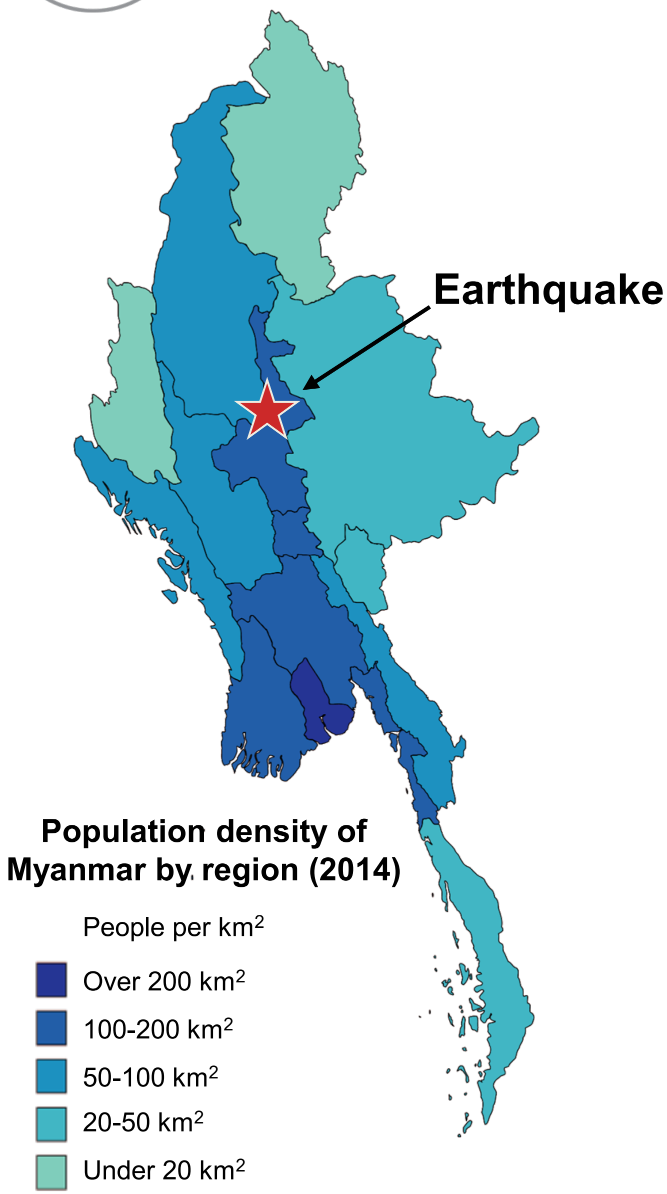

The March 28 earthquake occurred very close to Mandalay—the second largest city in Myanmar—with a population of over 1.2 million people.

The shallow depth of the earthquake (~6 mi, 10 km) amplified its impact. Shallow earthquakes produce more intense shaking at the surface, increasing the risk of structural damage, injuries, and fatalities—especially in densely populated urban areas like Mandalay.

Excerpt from *Earthquake Intensity–What controls the shaking you feel?*

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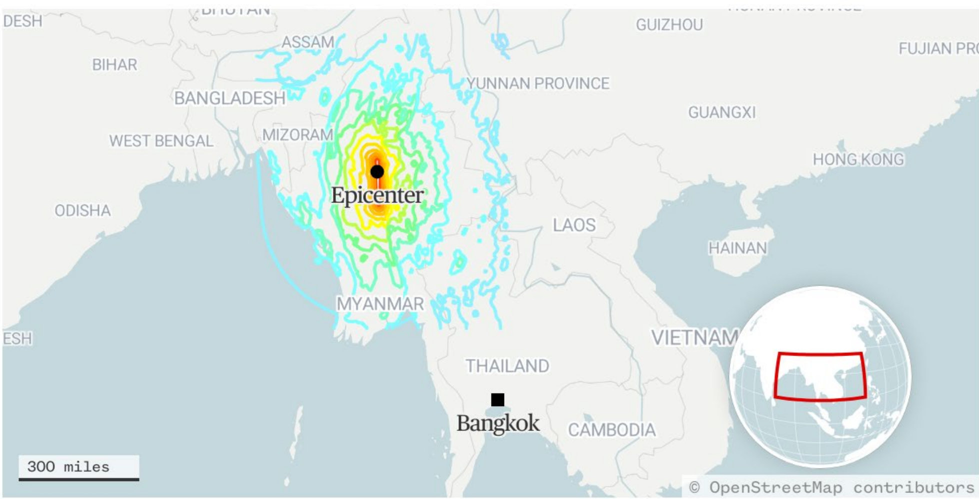
Despite being located more than 600 miles away from the earthquake's epicenter, Bangkok, Thailand experienced significant shaking from the earthquake.

Users on social media captured water spilling over from rooftop pools due to the shaking.



Video: TikTok/@bunnyhtet63

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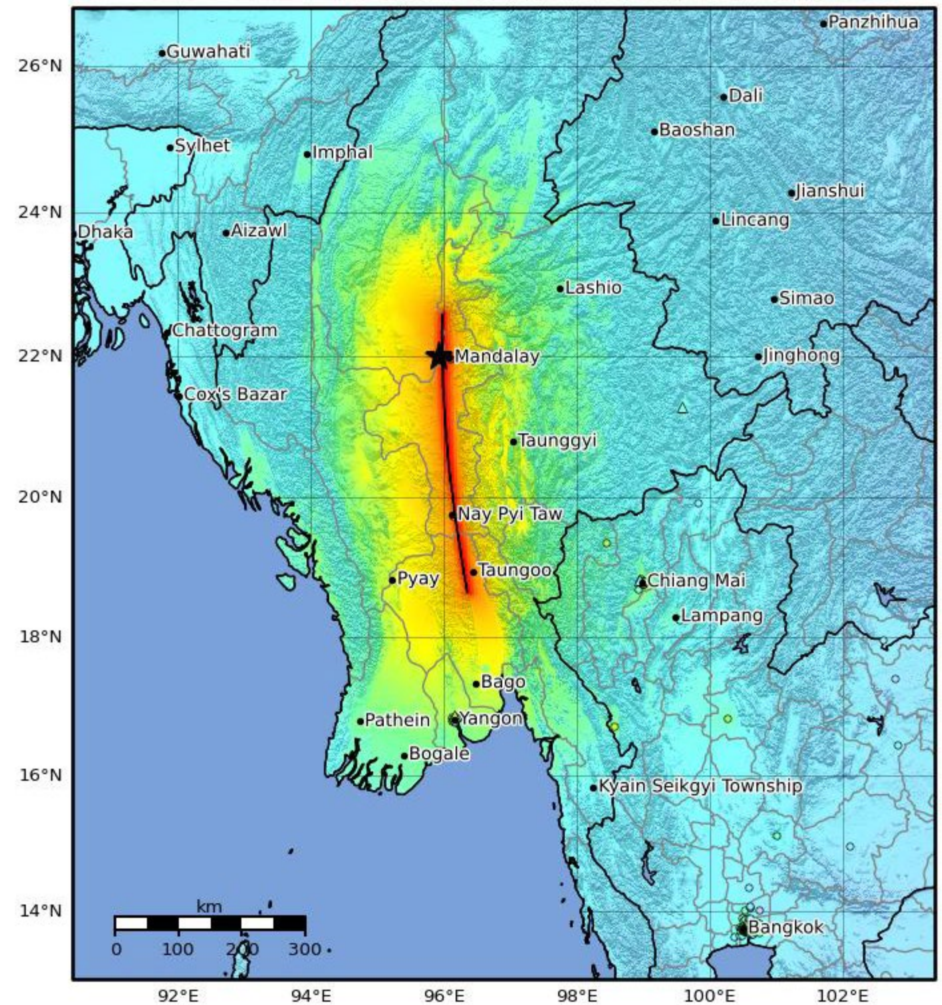
The Modified-Mercalli Intensity (MMI) scale is a ten-stage scale, from I to X, that indicates the severity of ground shaking.

Intensity is based on observed effects and is variable over the area affected by 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



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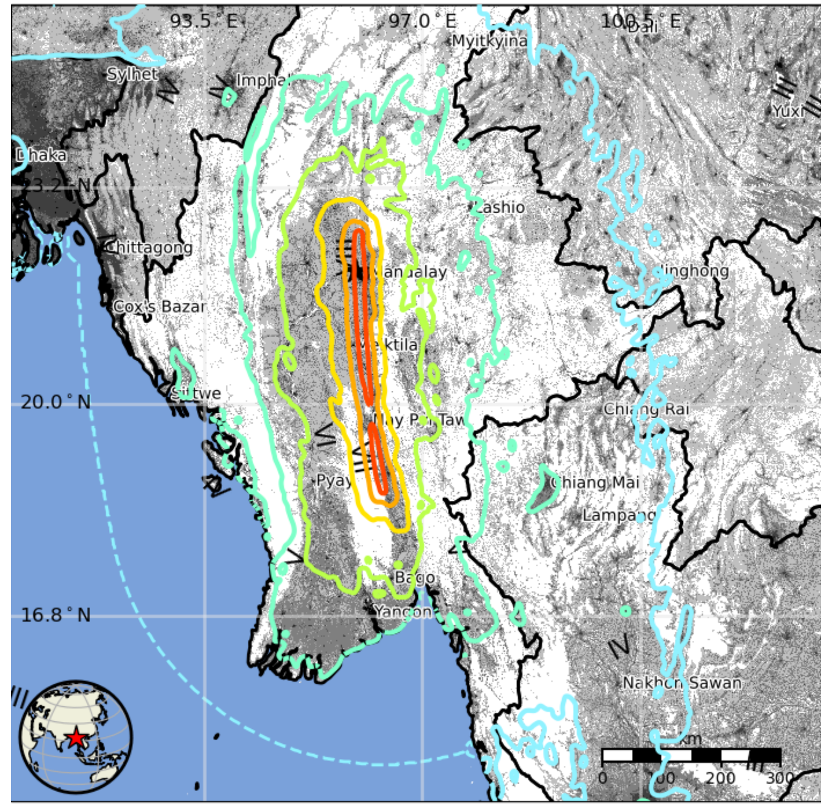
The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels. The USGS estimates that approximately 4,568,000 people felt severe shaking from this earthquake.

MMI	Shaking	Population
I	Not Felt	0 k*
II-III	Weak	62,933 k*
IV	Light	141,754 k
V	Moderate	31,312 k
VI	Strong	13,716 k
VII	Very Strong	3,307 k
VIII	Severe	4,568 k
IX	Violent	2,681 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

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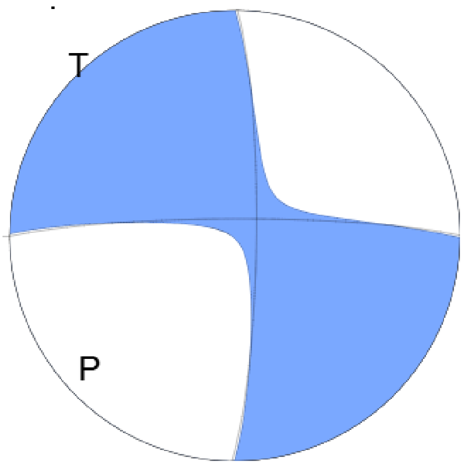
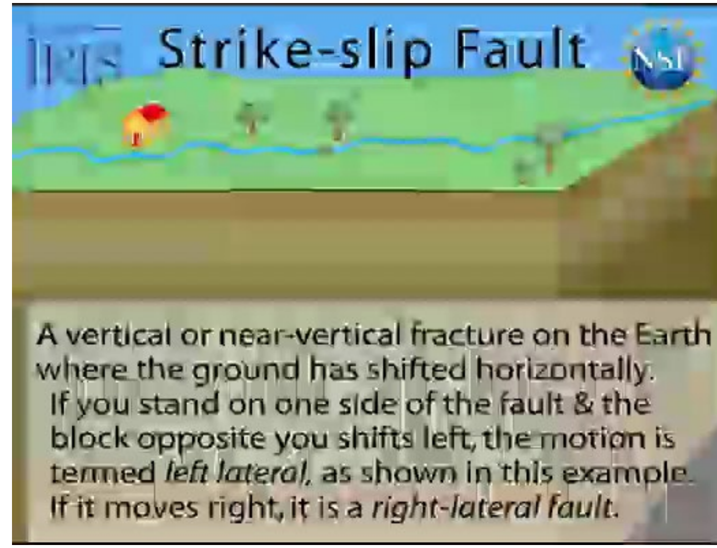
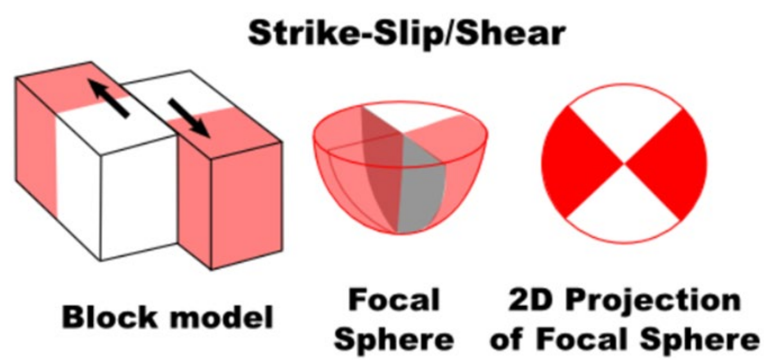
The focal mechanism is how seismologists plot the 3-D stress orientations of an earthquake. Because an earthquake occurs as slip on a fault, it generates primary (P) waves in quadrants where the first pulse is compressional (shaded) and quadrants where the first pulse is extensional (white). The orientation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



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.





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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.

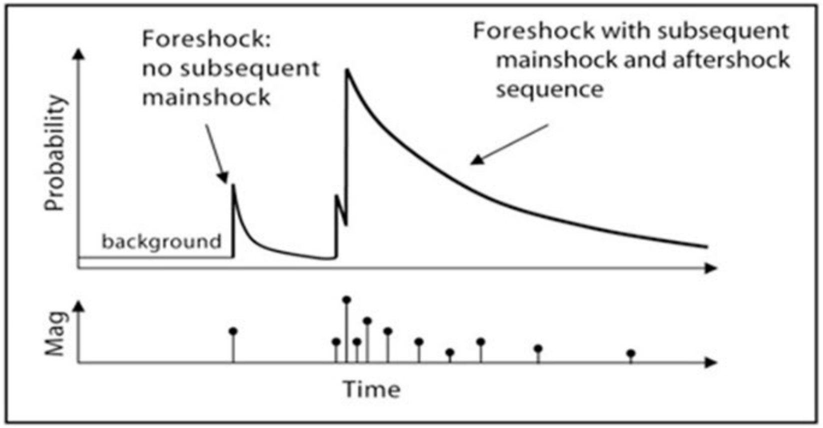
A **mainshock** is largest magnitude earthquake during an earthquake sequence.

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

This event has now been identified as the mainshock of an event sequence consisting of 27 earthquakes. These events took place all along the Sagaing fault with 6 foreshocks and as of 3/31/2025, 20 identified aftershocks.

Of these aftershocks the largest was a 6.7 magnitude event ~12 minutes after the mainshock took place.

Aftershock sequences vary in length but can last for years after a large mainshock. The size and frequency of aftershocks typically decreases with time, as shown in the graph at right.



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.

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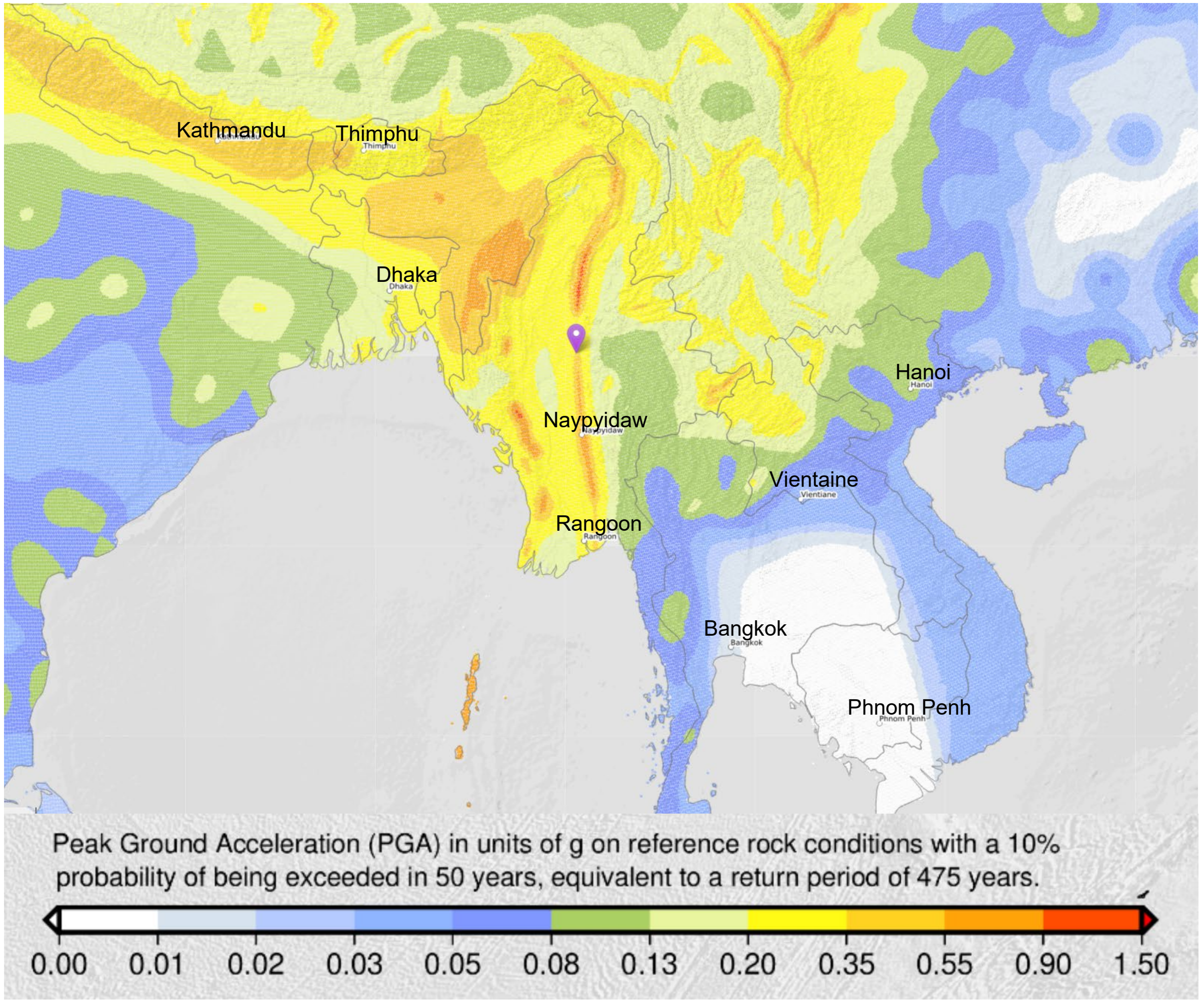
HS

Seismic Hazards in Southeast Asia



Source: Johnson et al., 2023

- PGA measures the maximum ground acceleration experienced during earthquake shaking at a particular site.
- Measurement Units: PGA is commonly expressed as a fraction or percentage of Earth's gravitational acceleration (g = 9.81 m/s²).
- Hazard Maps: PGA values are depicted on seismic hazard maps to illustrate expected ground shaking levels across different regions, aiding in urban planning and construction standards.
- While PGA indicates the severity of ground motion at a site, it doesn't directly measure the total energy released by an earthquake, which is represented by magnitude scales.

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HS

Ground Failure Potential

Landslides

Estimated Area Exposed to Hazard

Little or no | Limited | Significant | Extensive

≤ 0.1 km² | 1 km² | 10 km² | 100 km² | ≥ 1,000 km²

Landslides triggered by this earthquake are estimated to be significant in number and (or) spatial extent.

Estimated Population Exposure

Little or no | Limited | Significant | Extensive

≤ 10 | 100 | 1,000 | 10,000 | ≥ 100,000

The number of people living near areas that could have produced landslides in this earthquake is significant. This is not a direct estimate of landslide fatalities or losses.

Liquefaction

Estimated Area Exposed to Hazard

Little or no | Limited | Significant | Extensive

≤ 1 km² | 10 km² | 100 km² | 1,000 km² | ≥ 10,000 km²

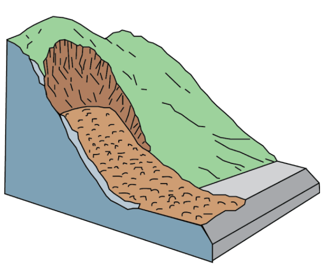
Liquefaction triggered by this earthquake is estimated to be extensive in severity and (or) spatial extent.

Estimated Population Exposure

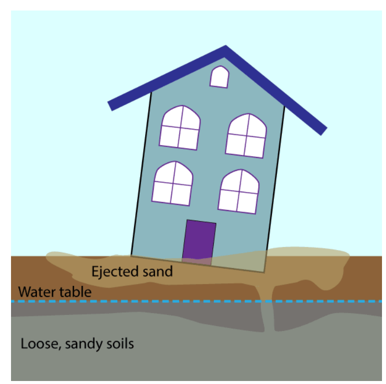
Little or no | Limited | Significant | Extensive

≤ 100 | 1,000 | 10,000 | 100,000 | ≥ 1,000,000

The number of people living near areas that could have produced liquefaction in this earthquake is extensive. This is not a direct estimate of liquefaction fatalities or losses.



Earthquakes can trigger landslides over wide areas causing societal disruptions by blocking roads, destroying infrastructure, and damming waterways causing flooding hazards.



Earthquake shaking can cause saturated soil to lose strength, resulting in the soil behaving more like a liquid than a solid.

Source: USGS

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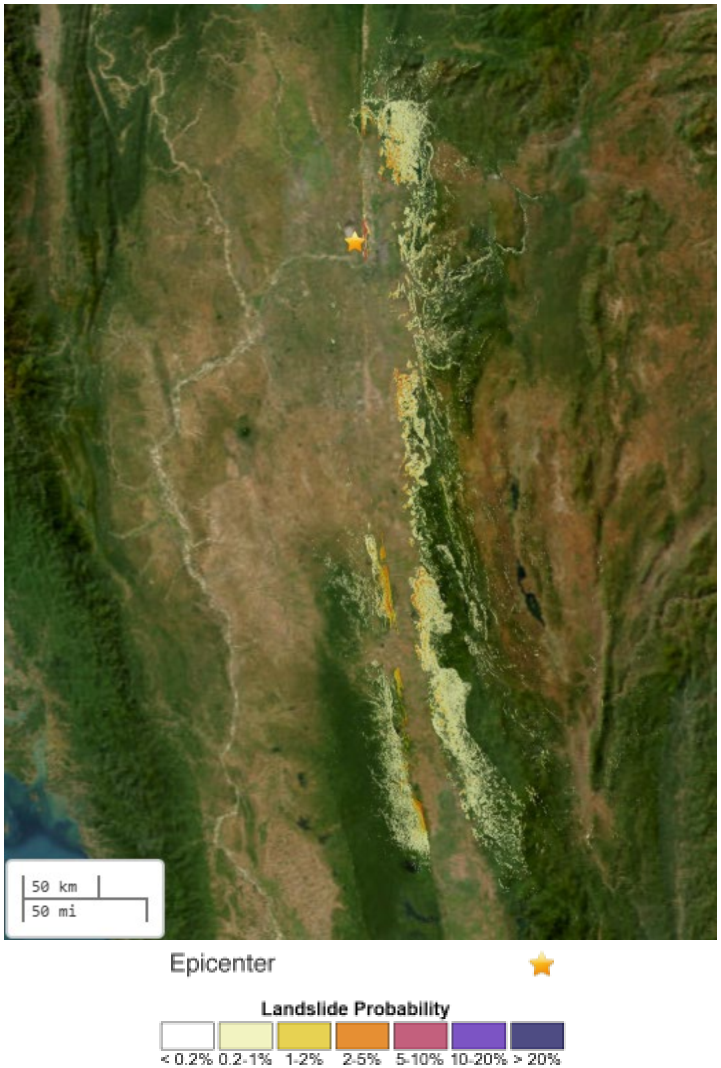
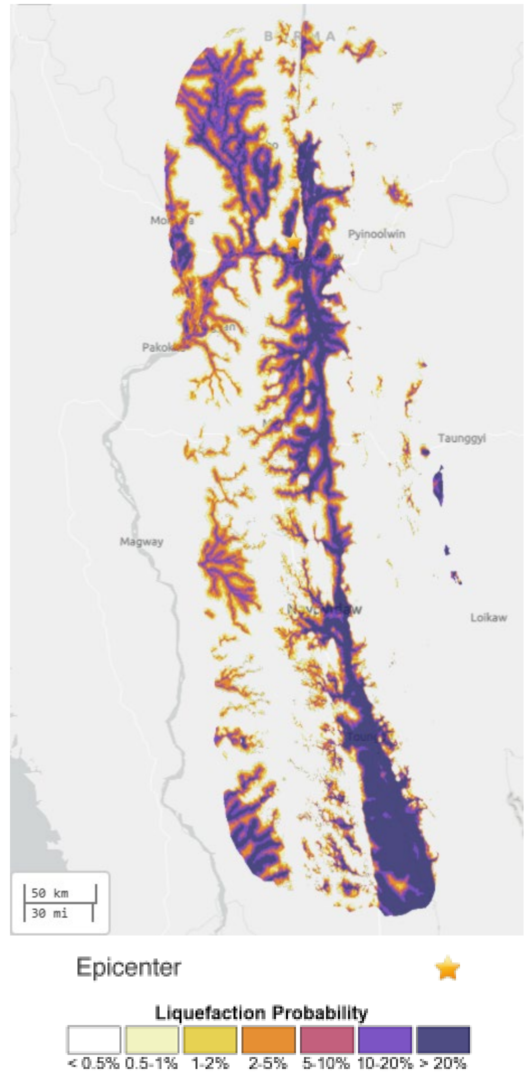
Ground Failure Potential

Landslide Probability



Liquefaction Estimate



Both of these maps show the probability that a specific hazard will take place.

- The landslide probability is estimated by considering ground shaking intensity, topographic slopes, and soil or geological conditions.
- The liquefaction estimate is calculated by considering the peak ground acceleration, the soil susceptibility and the depth to water table.

Source: USGS

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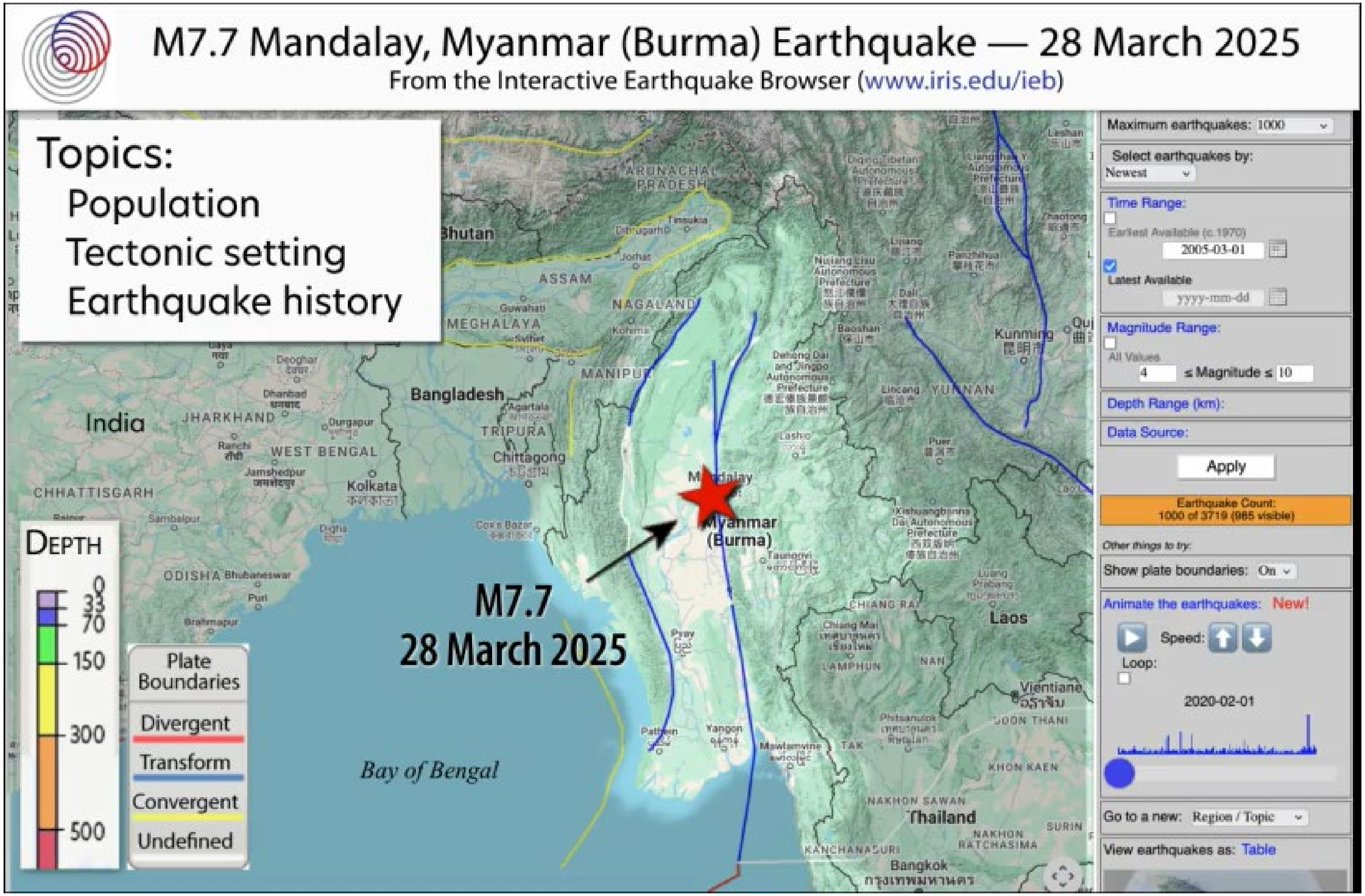

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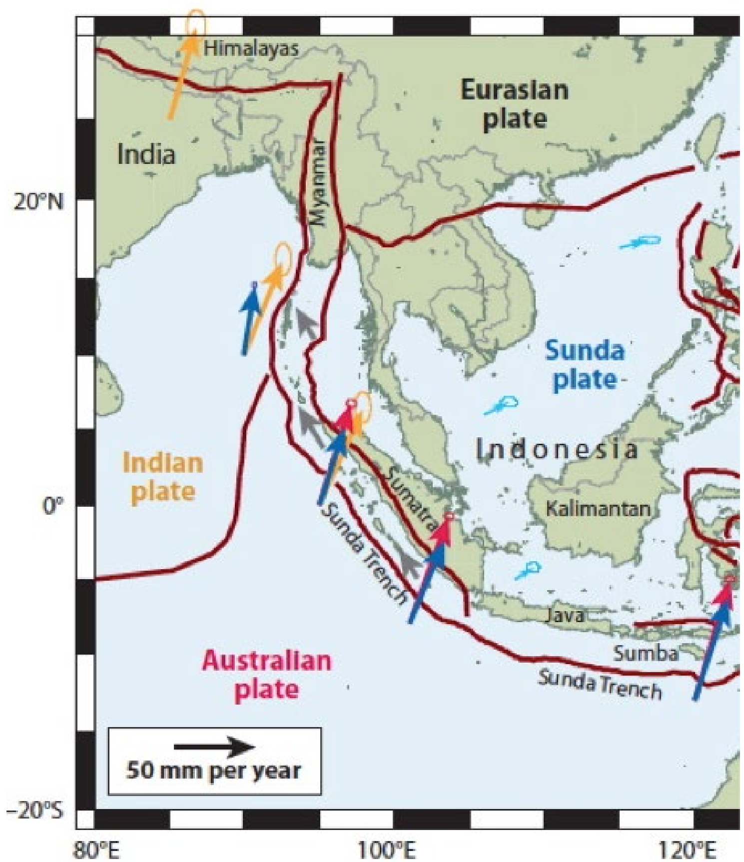
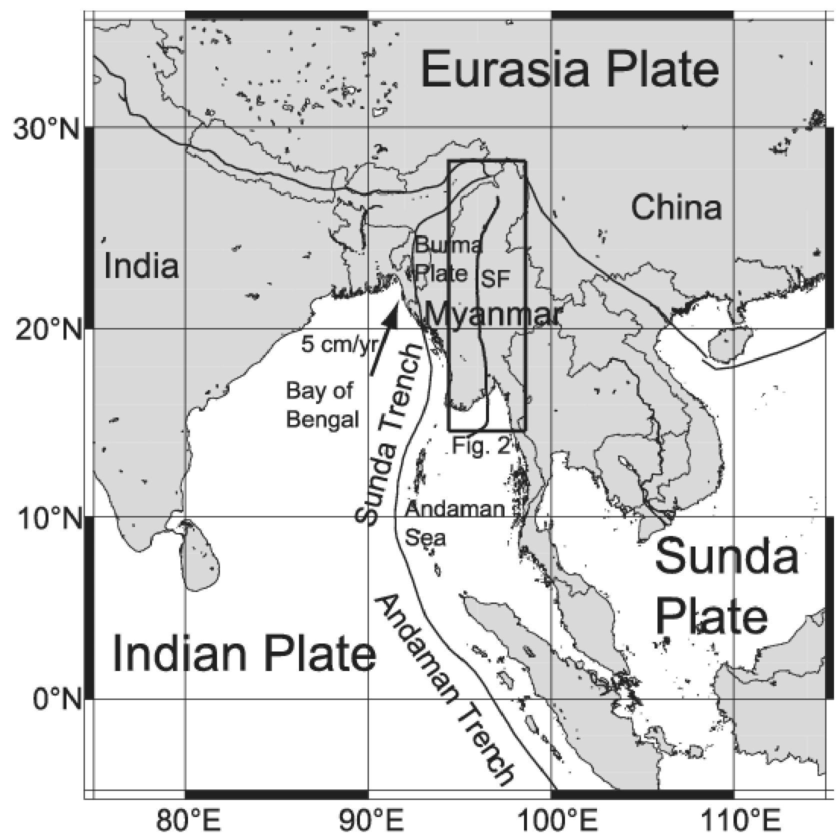
Different tectonic models and maps show varying interpretations of plate boundaries—particularly the extent and shape of the Sunda plate. This tectonic complexity reflects a mix of collision, subduction, and strike-slip faulting, all of which contribute to the region's high seismic hazard.



McCaffrey (2009)



Hurukawa and Maung Maung (2011)

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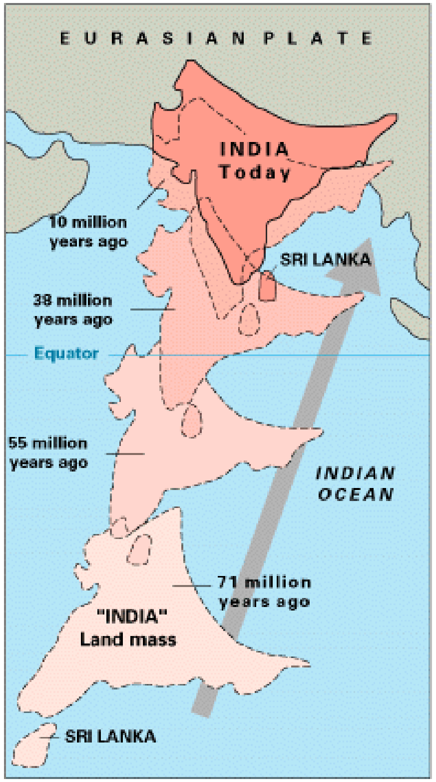
On simplified world maps, the Indian Plate is shown converging with the southern part of the Eurasian Plate. This movement causes the two landmasses to push against each other, creating mountains like the Himalayas and the high land of the Tibetan Plateau.



In the northwest, where India meets Tajikistan and Afghanistan, the land is also getting squeezed and deformed—this area is called the Hindu Kush region.

To the east, near the end of the Himalayas, the land is sliding (strike slip) and pushing (compressional deformation) at the same time. This area is called the Eastern Transform Boundary. The magnitude 7.7 March 28, 2025 earthquake near Mandalay, Myanmar occurred in this region.

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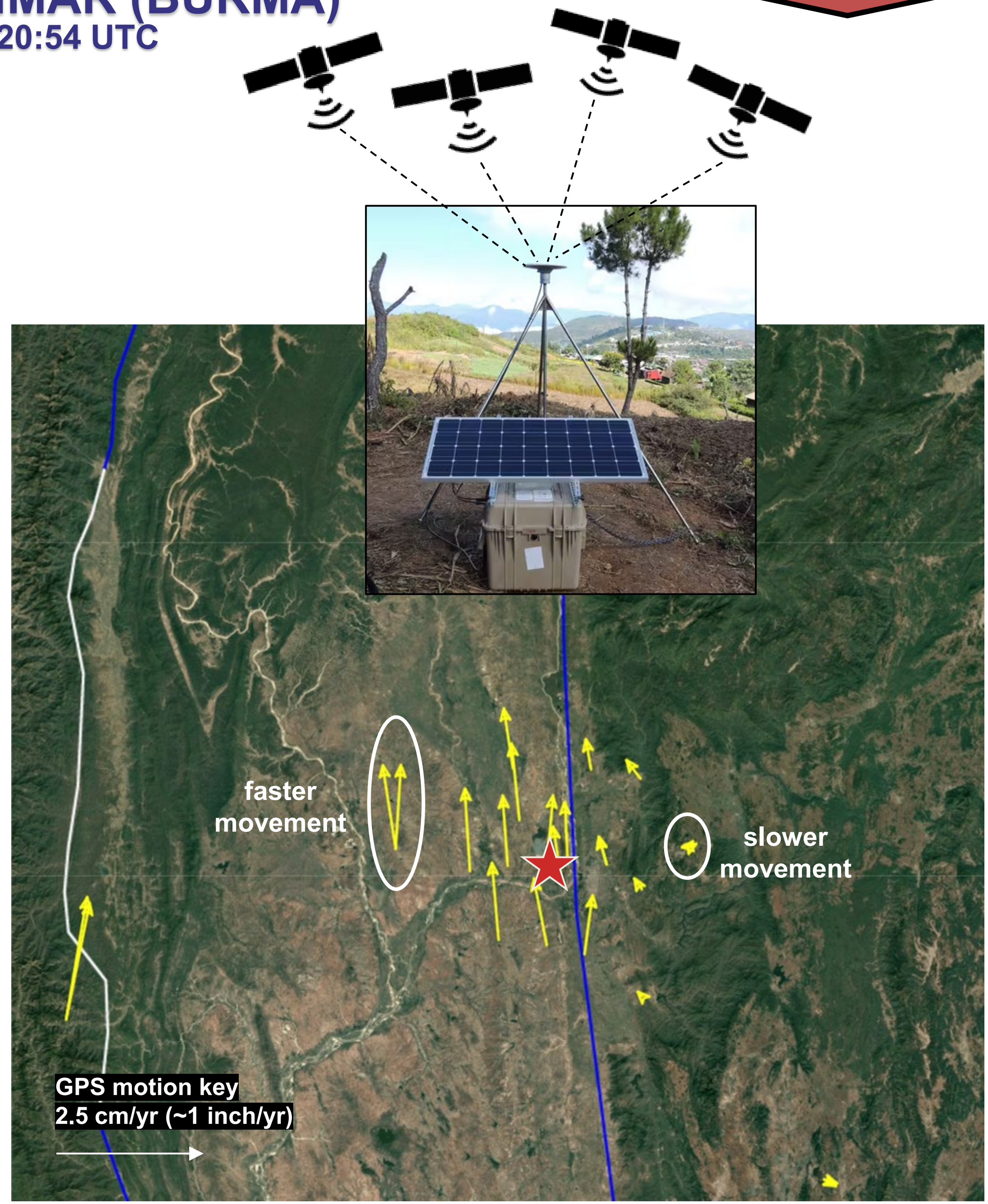
One of the ways we know the rates of plate motion is from GPS stations.

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).



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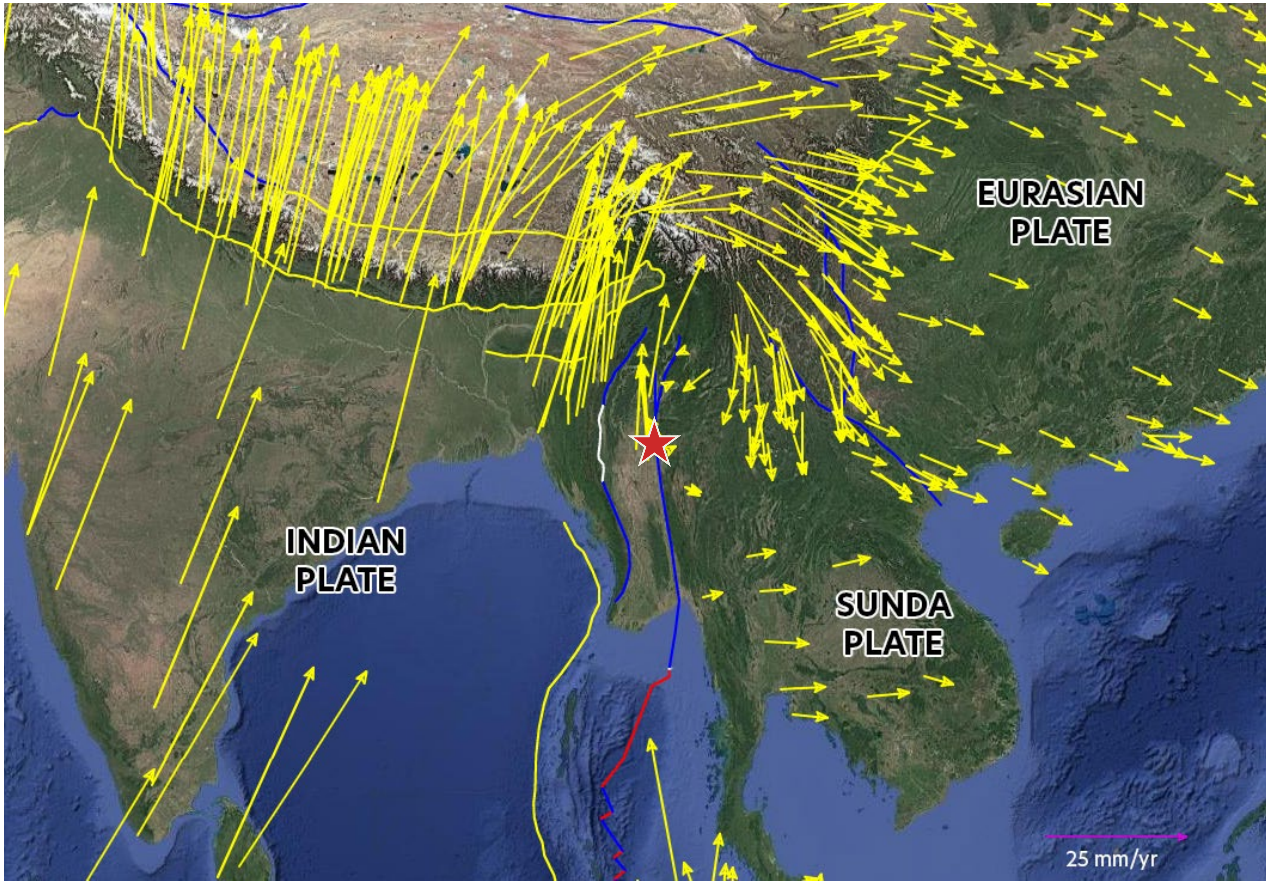
This region has GPS stations that record the long term motion from plate tectonics.

Compared to the Eurasian plate, stations in Burma west of the Sagaing Fault are moving around 2 cm/yr (0.75 inch/yr) to the north, as the Burma microplate Plate slides north toward the Eurasian Plate.

Over decades and centuries this friction between the plates accumulates and is occasionally released in earthquakes such as the magnitude 7.7 quake on March 28, 2025.



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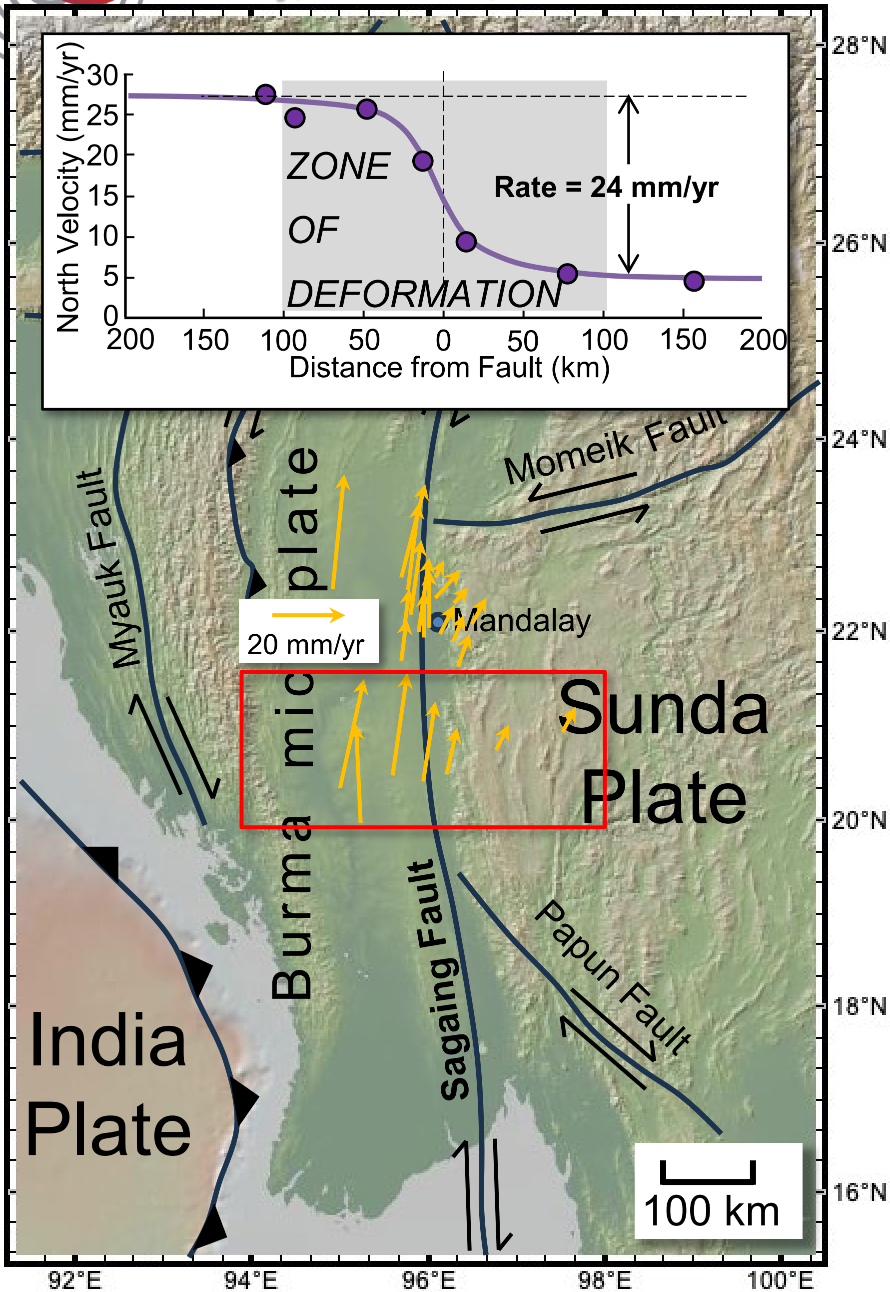

GPS technology measures tectonic motion with high precision by timing signals from satellites. With data from four or more satellites, a station's location can be determined to within millimeters. Tracking these positions over time reveals tectonic movements, shown as arrows (vectors) on maps. On this map, arrows show GPS-measured rates of motion across the central Sagaing Fault. Motion is measured relative to the interior of the Sunda Plate.

- The graph at the top displays northward velocities of GPS stations located within the red box spanning the fault.
- Stations west of the fault (on the Burma microplate) are moving northward faster than those east of the fault (on the Sunda Plate).
- The Burma microplate is moving northward relative to the Sunda Plate at a rate of **24 mm/yr**, consistent with **right-lateral motion** along the Sagaing Fault.
- The rate of northward motion gradually changes across a zone about 100 km wide on either side of the fault. This gradual shift indicates that rocks in this region are **bending** as **shear stress builds** in a locked fault zone.

When the accumulated shear stress exceeds friction along the fault:

- The fault suddenly slips, causing an earthquake.
- Surrounding areas shift position abruptly.
- Elastic energy stored for decades or even centuries is rapidly released.

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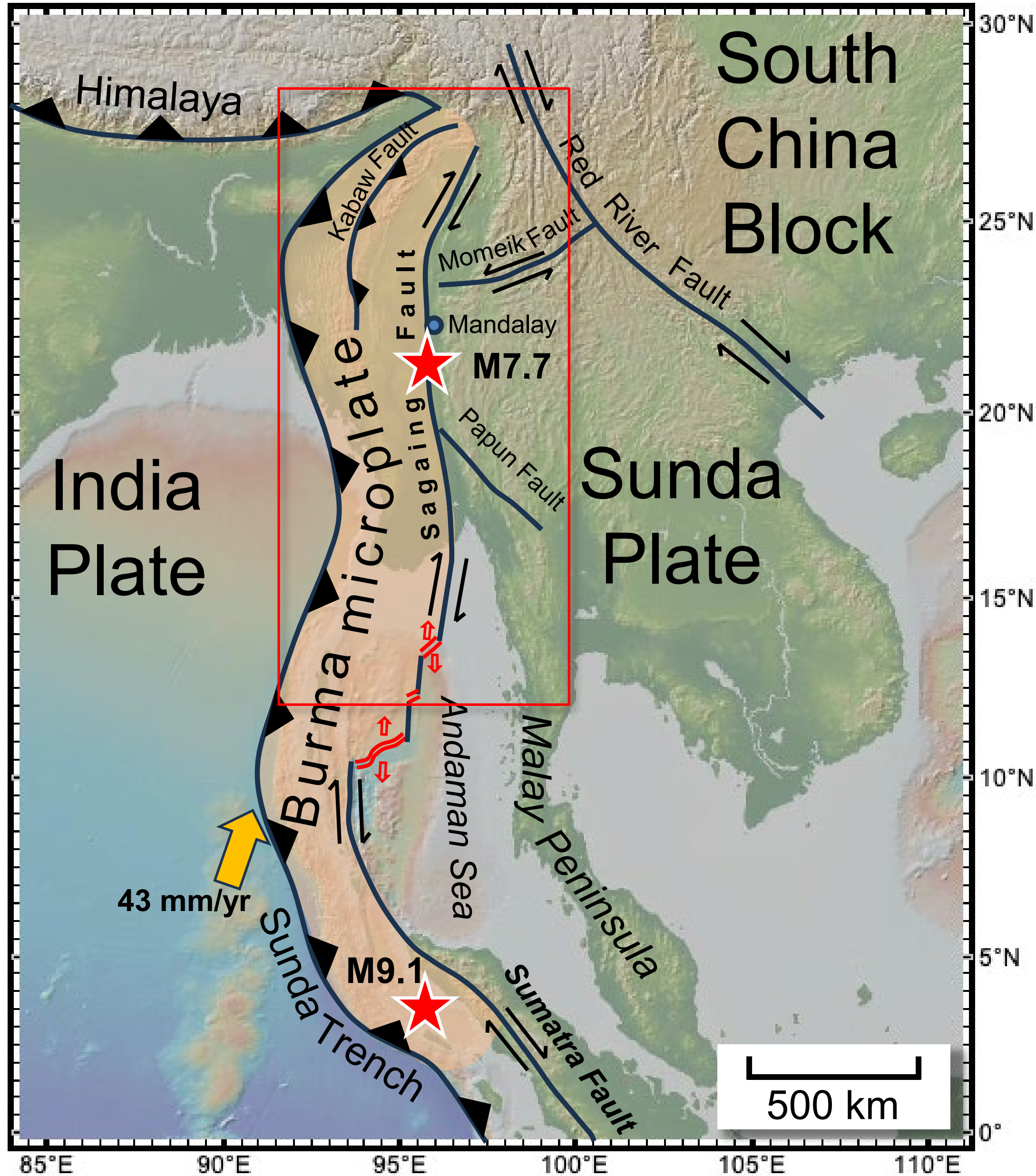
- This map highlights major faults in the Eastern Transform Boundary region.
- At the Sunda Trench, the India Plate is subducting beneath the Burma microplate.
  - The subduction zone here ruptured in December 2004, producing a magnitude 9.1 great earthquake (epicenter marked by red star) and the devastating Indian Ocean tsunami.
- Subduction of the India Plate is highly oblique to the trench, causing the Burma microplate to slide northward nearly parallel to the Sunda Trench.
- The eastern boundary of the Burma microplate consists of:
  - The Sumatra Fault in the south
  - The Sagaing Fault in the north
  - Both the Sumatra and Sagaing faults are over 1,000 km long and are right-lateral strike-slip faults.
- The red star labeled M7.7 marks the epicenter of the March 28, 2025 earthquake, which occurred on the Sagaing Fault near Mandalay.



The next slide zooms in on the area outlined in red.

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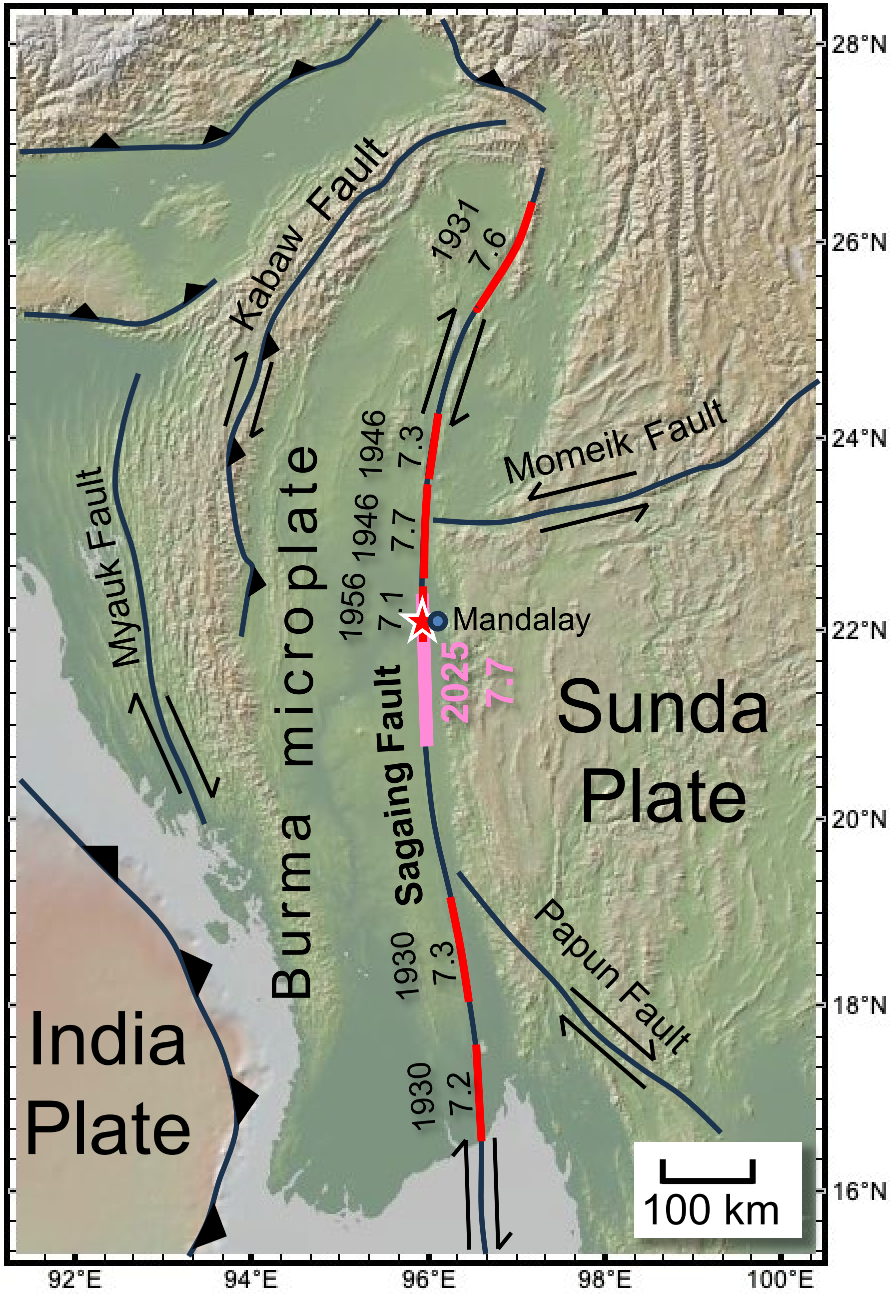

During the 1900s, six magnitude 7 or larger earthquakes occurred along the Sagaing Fault.

- Red lines on the map show the approximate rupture lengths of these past earthquakes, labeled by year and magnitude.
- The March 28, 2025 earthquake is shown with a pink line (rupture length) and a star (epicenter).The northern end of the 2025 rupture overlaps the southern part of the 1946 rupture.
- A “seismic gap” exists between the two 1930 earthquakes (in the south) and the 1956 earthquake (in the center of the fault).In 2011, this gap was identified as a fault segment that hadn’t had a major earthquake since 1839.
- Scientists predicted it was likely to rupture in the early 2000s.The 2025 earthquake has now ruptured about half of that seismic gap.

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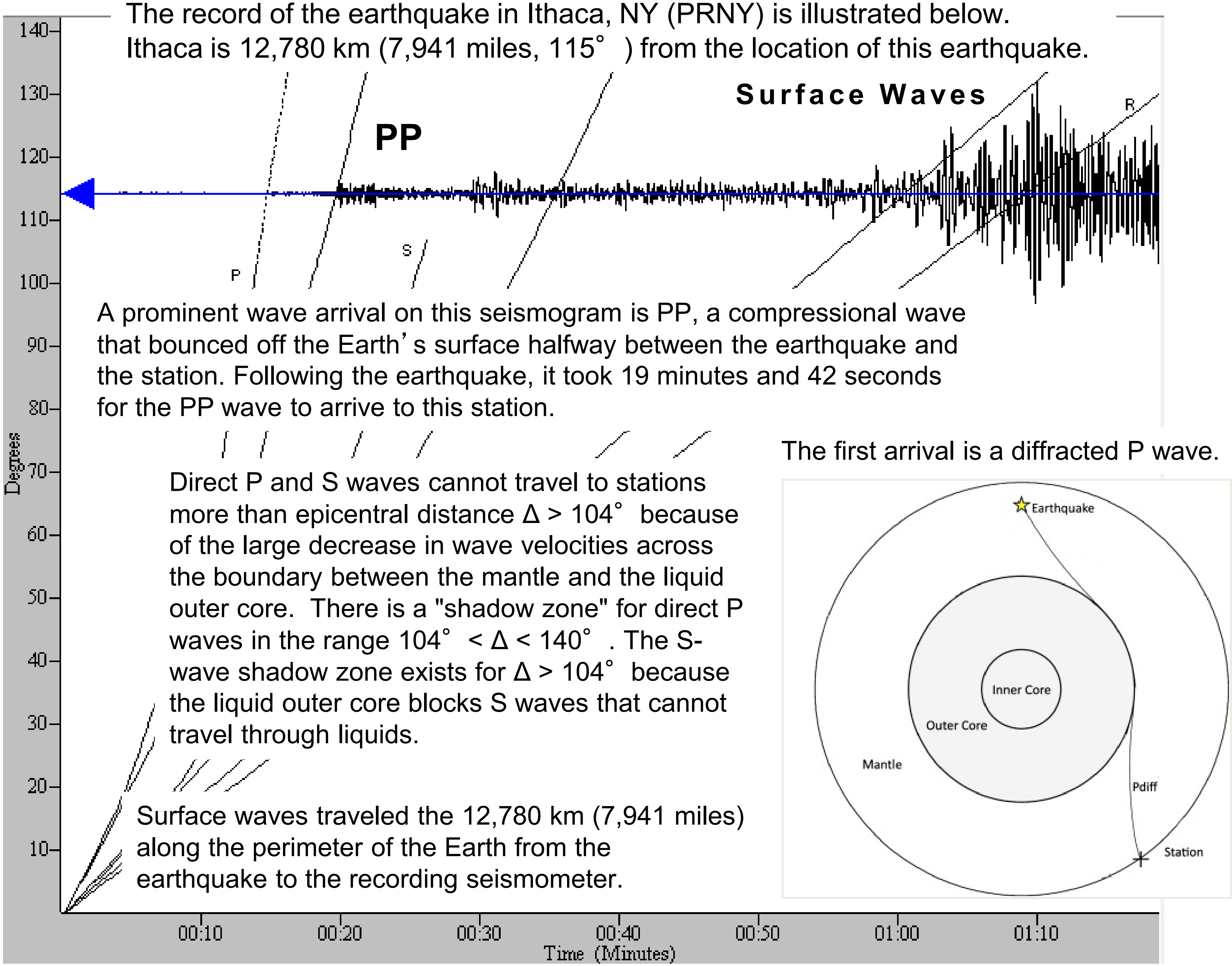
The record of the earthquake in Ithaca, NY (PRNY) is illustrated below. Ithaca is 12,780 km (7,941 miles, 115°) from the location of this earthquake.



A prominent wave arrival on this seismogram is PP, a compressional wave that bounced off the Earth's surface halfway between the earthquake and the station. Following the earthquake, it took 19 minutes and 42 seconds for the PP wave to arrive to this station.

Direct P and S waves cannot travel to stations more than epicentral distance Δ > 104° because of the large decrease in wave velocities across the boundary between the mantle and the liquid outer core. There is a "shadow zone" for direct P waves in the range 104° < Δ < 140° . The S-wave shadow zone exists for Δ > 104° because the liquid outer core blocks S waves that cannot travel through liquids.

Surface waves traveled the 12,780 km (7,941 miles) along the perimeter of the Earth from the earthquake to the recording seismometer.

The first arrival is a diffracted P wave.

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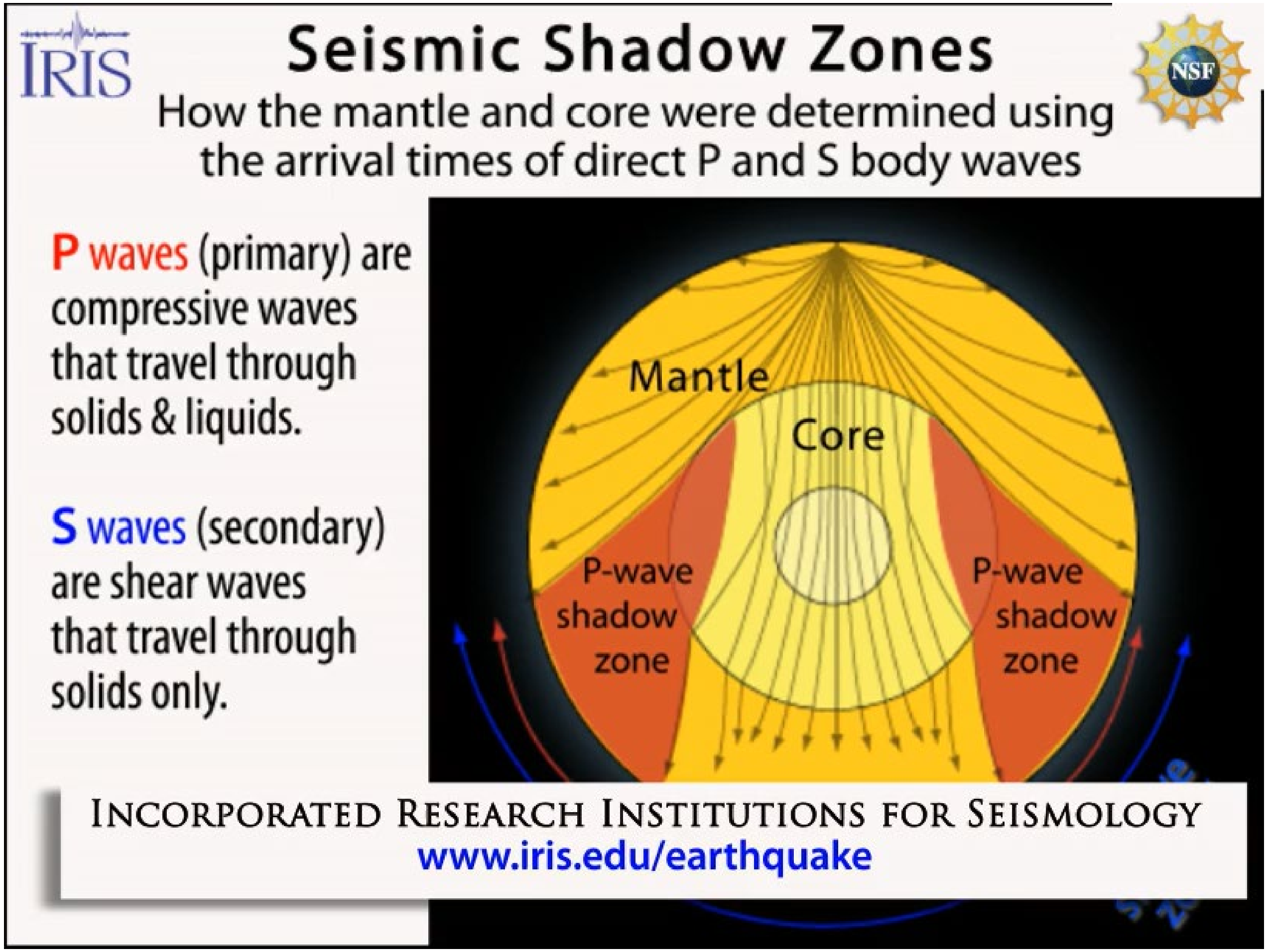
Animation explaining the seismic shadow zone.

Epicentral distance is the angle formed by the intersection of the line from the earthquake to Earth's center with the line from the observing point to the Earth's center.

S waves are observed up to a distance of 104° from an earthquake, but direct S waves are not recorded beyond this distance.

P waves also have a shadow zone between 104° and 140°.



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?

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