Magnitude 6.3 AFGHANISTAN

Sunday, October 15, 2023 at 03:36:00 UTC

Latitude 34.609° N
Longitude 62.112° E
Depth 6.3 km

A fourth magnitude 6.3 earthquake has struck western Afghanistan. This is the latest in a sequence of 27 earthquakes that have occurred since October 7, 2023.

Each of these large earthquakes have caused strong ground shaking throughout the smaller towns that surround the epicenters, which are clustered in a small area in the Herat Valley. Shaking has caused horrific building damage and collapse, and considerable loss of life. Damage was exacerbated by the repeated earthquakes, which likely caused already weakened structures to collapse.

As the aftershocks continue, many people have evacuated buildings due to the shaking, which may have reduced the impact of these later earthquakes.

This M 6.3 was about 30 kilometers (19 miles) outside Herat, the provincial capital, at a depth of 6.3 kilometers (3.9 miles).

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An Afghan girl carries donated aid to her tent, after an earthquake in Zenda Jan district in Herat province, western of Afghanistan, Thursday, Oct. 12, 2023. Another strong earthquake shook western Afghanistan on Wednesday morning after an earlier one killed more than 2,000 people and flattened whole villages in Herat province in what was one of the most destructive quakes in the country's recent history. (AP Photo/Ebrahim Noroozi)

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Afghan boys stand amid debris after a powerful earthquake in Herat province, western of Afghanistan, Sunday, Oct. 15, 2023. (Save the Children via AP)

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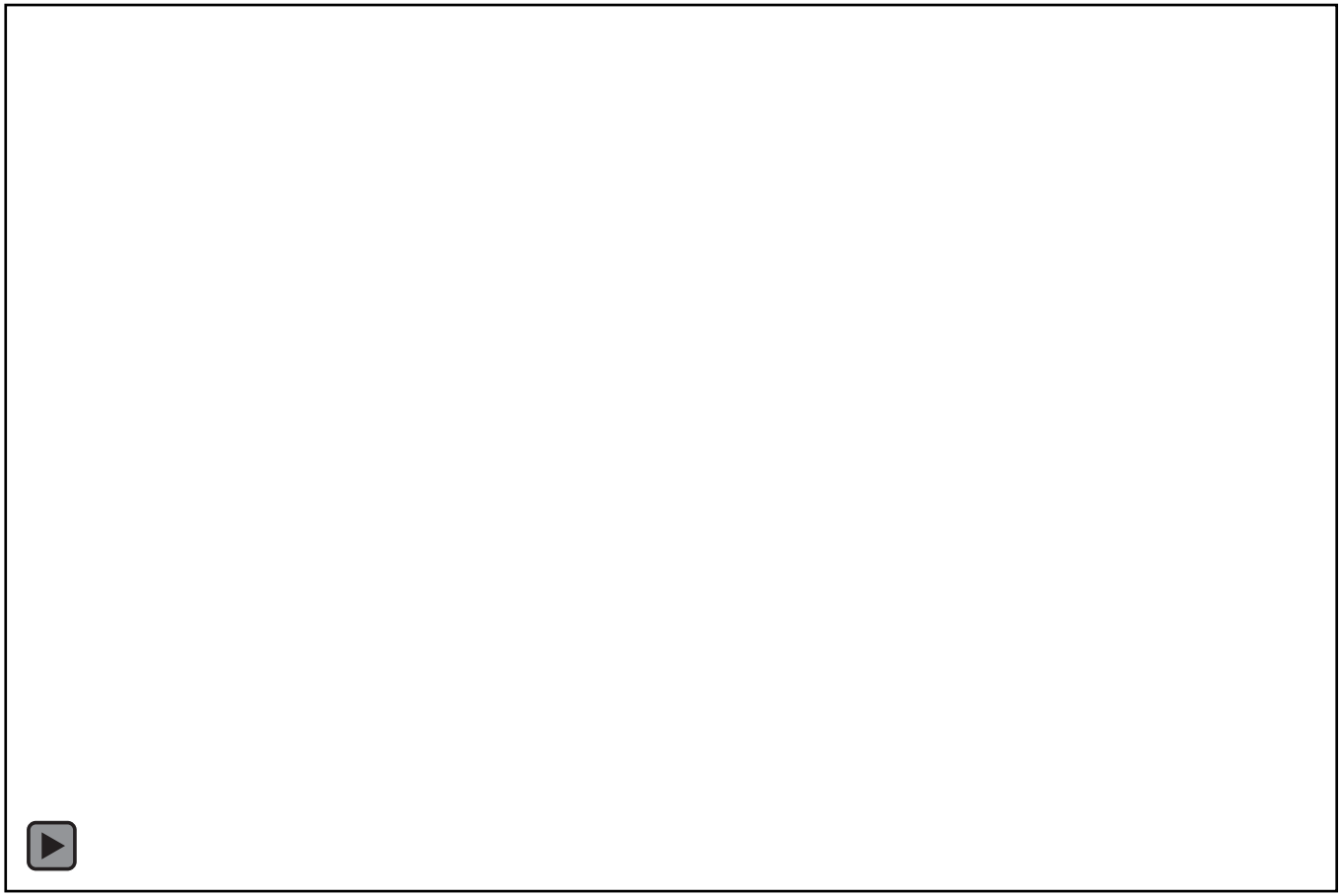
Animation of the full earthquake sequence including the four M 6.3 earthquakes, as well as the 23 smaller aftershocks ranging from M 4.1 to M 5.9.

These earthquakes have all occurred northwest of the city of Herat.



MMI	Perceived Shaking
X	Extreme
IX	Violent
VIII	Severe
VII	Very Strong
VI	Strong
V	Moderate
IV	Light
II-III	Weak
I	Not Felt

Map generated from the Interactive Earthquake Browser (www.iris.edu/ieb)

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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.

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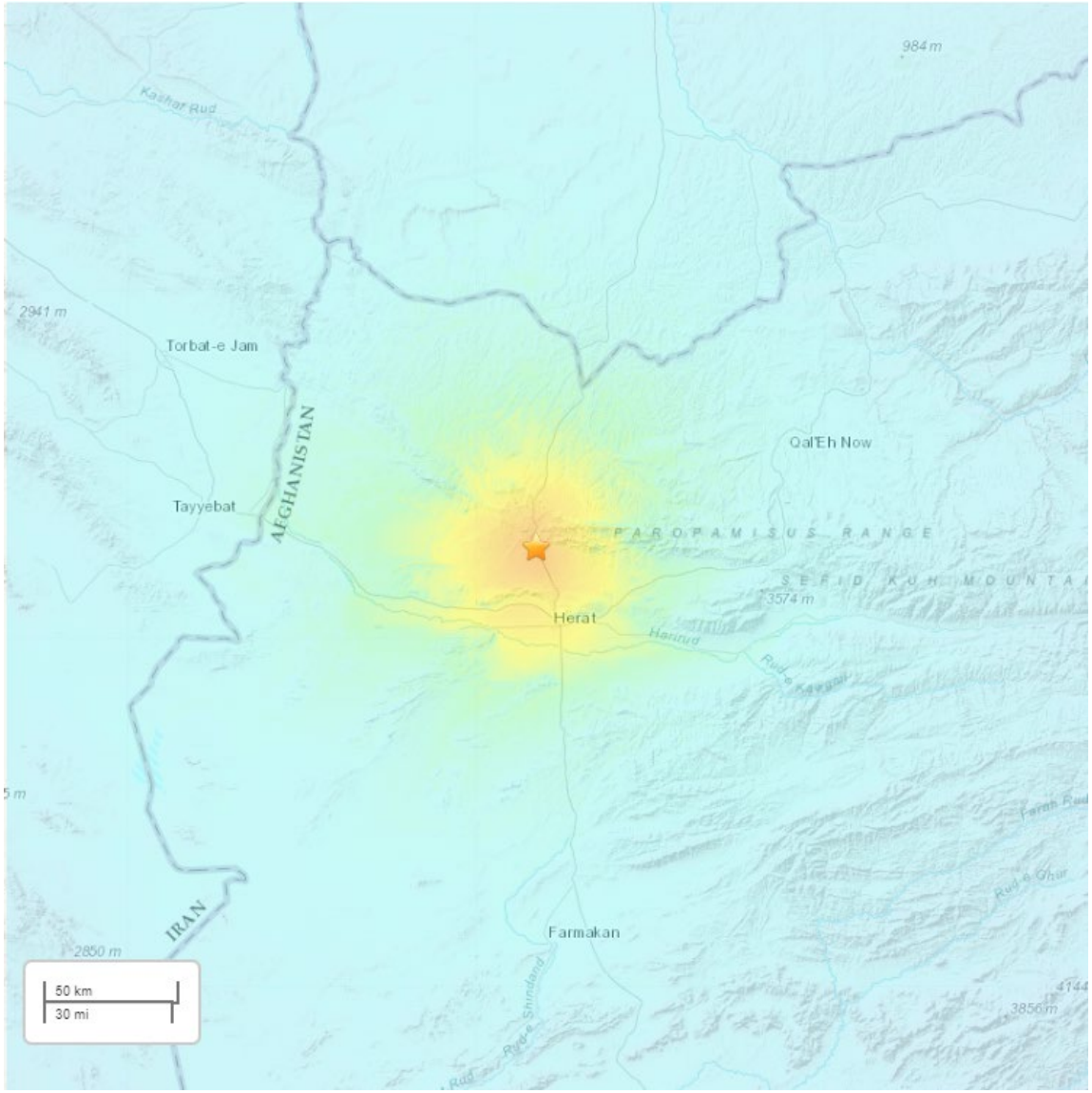

USGS estimated shaking intensity from M 6.3 Earthquake

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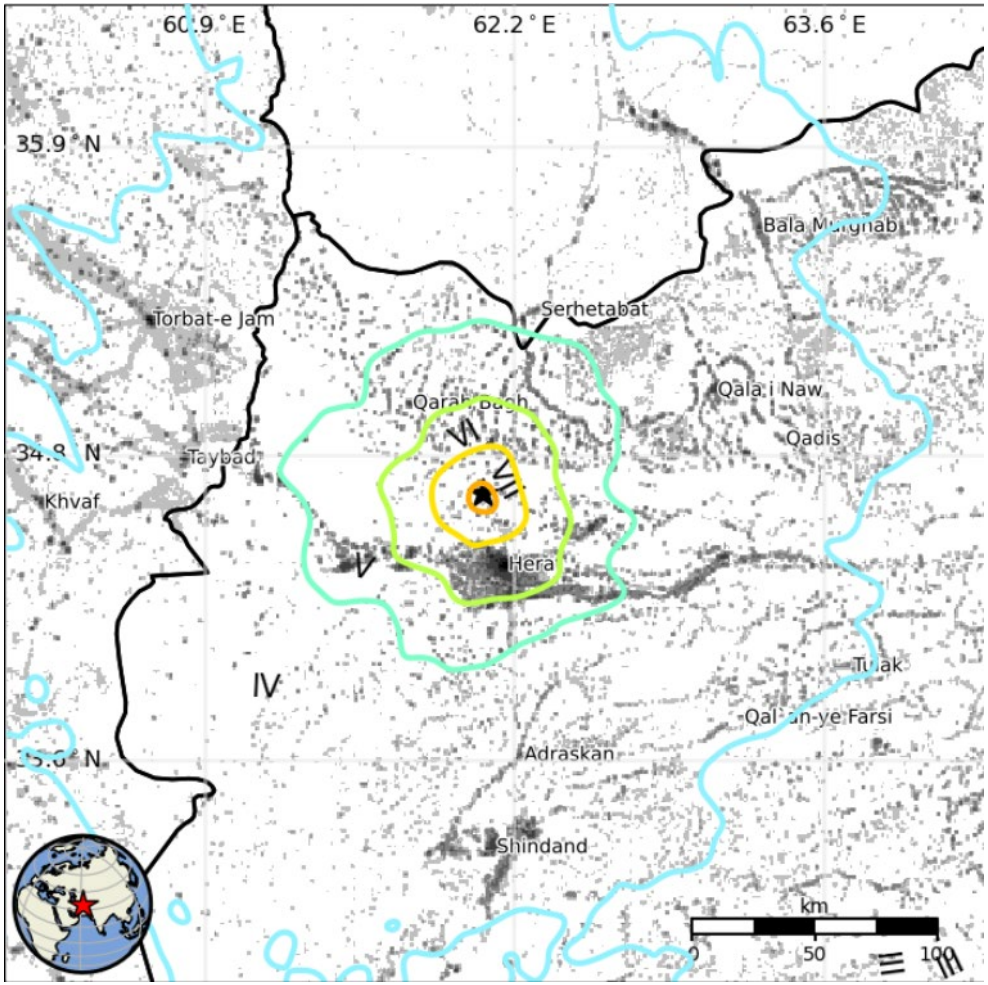
The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels. The USGS estimates that 3,000 people felt severe shaking from this M 6.3 earthquake.

I	Not Felt	0 k*
II-III	Weak	535 k*
IV	Light	2,235 k
V	Moderate	633 k
VI	Strong	1,172 k
VII	Very Strong	53 k
VIII	Severe	3 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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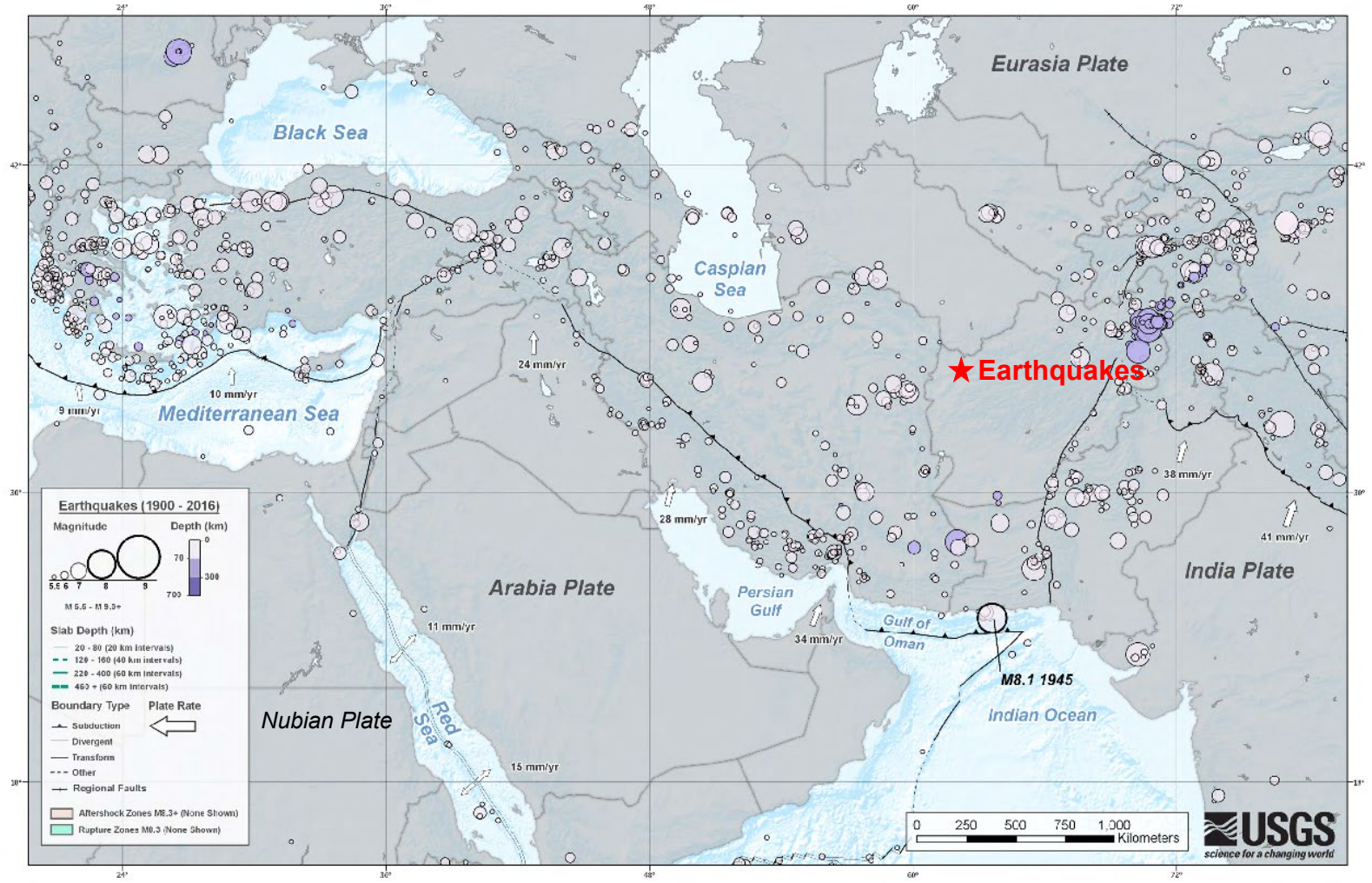
Middle East tectonics and earthquakes result from the interaction of the Eurasia, Arabia, India, and Nubian Plates. This regional tectonics map shows plate motions with respect to the Eurasian Plate. The location of the earthquakes is shown by the red star.



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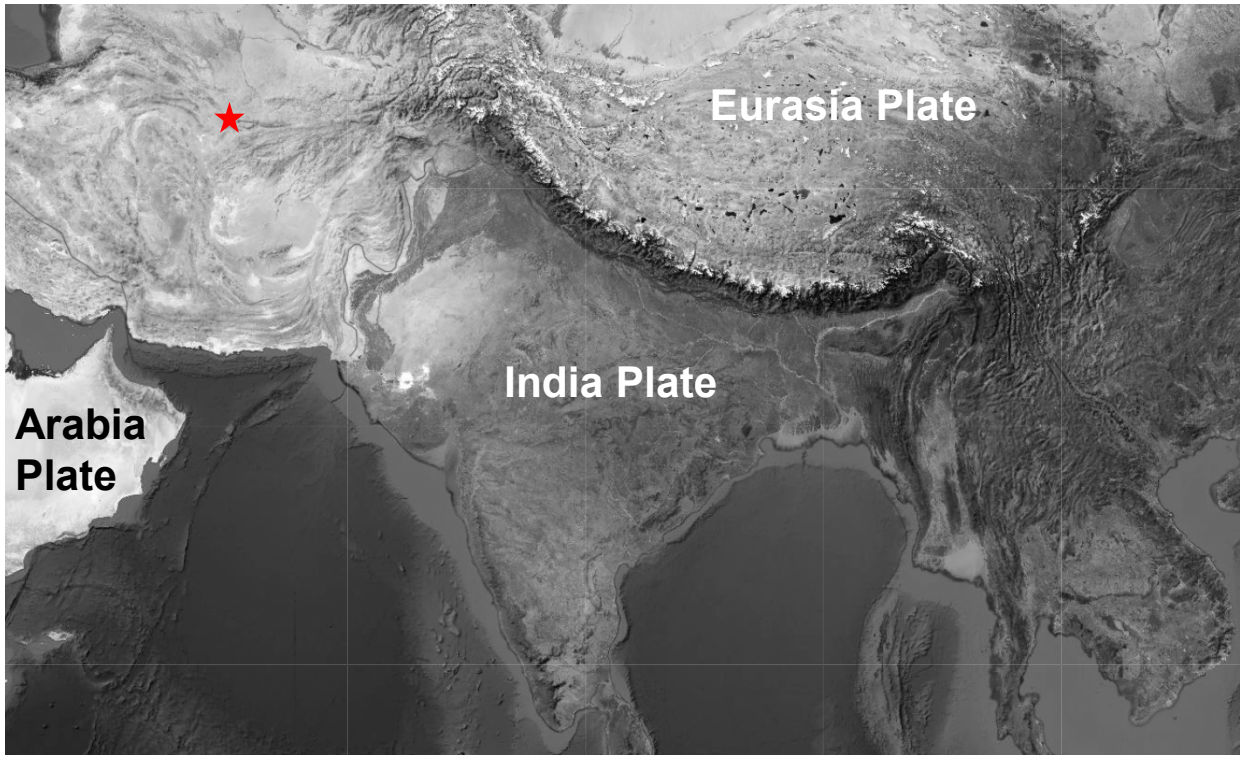
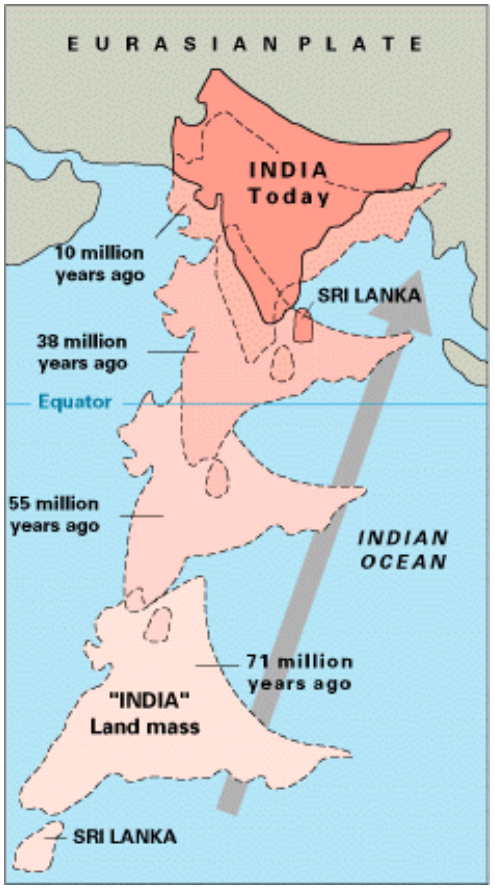
The northward-moving India plate is colliding with southern part of the Eurasian plate at a rate of about 1.7 in/yr (43 mm/yr). This collision has created the world's highest mountains and causes slips on major faults that generate large, often devastating earthquakes.

Earthquakes in Afghanistan are most abundant in and near the northeastern part of the country where the effects of the plate collision between India and Asia are most pronounced.





However, earthquakes in western and central Afghanistan are primarily influenced by the northward movement of the Arabia Plate relative to the Eurasia Plate.

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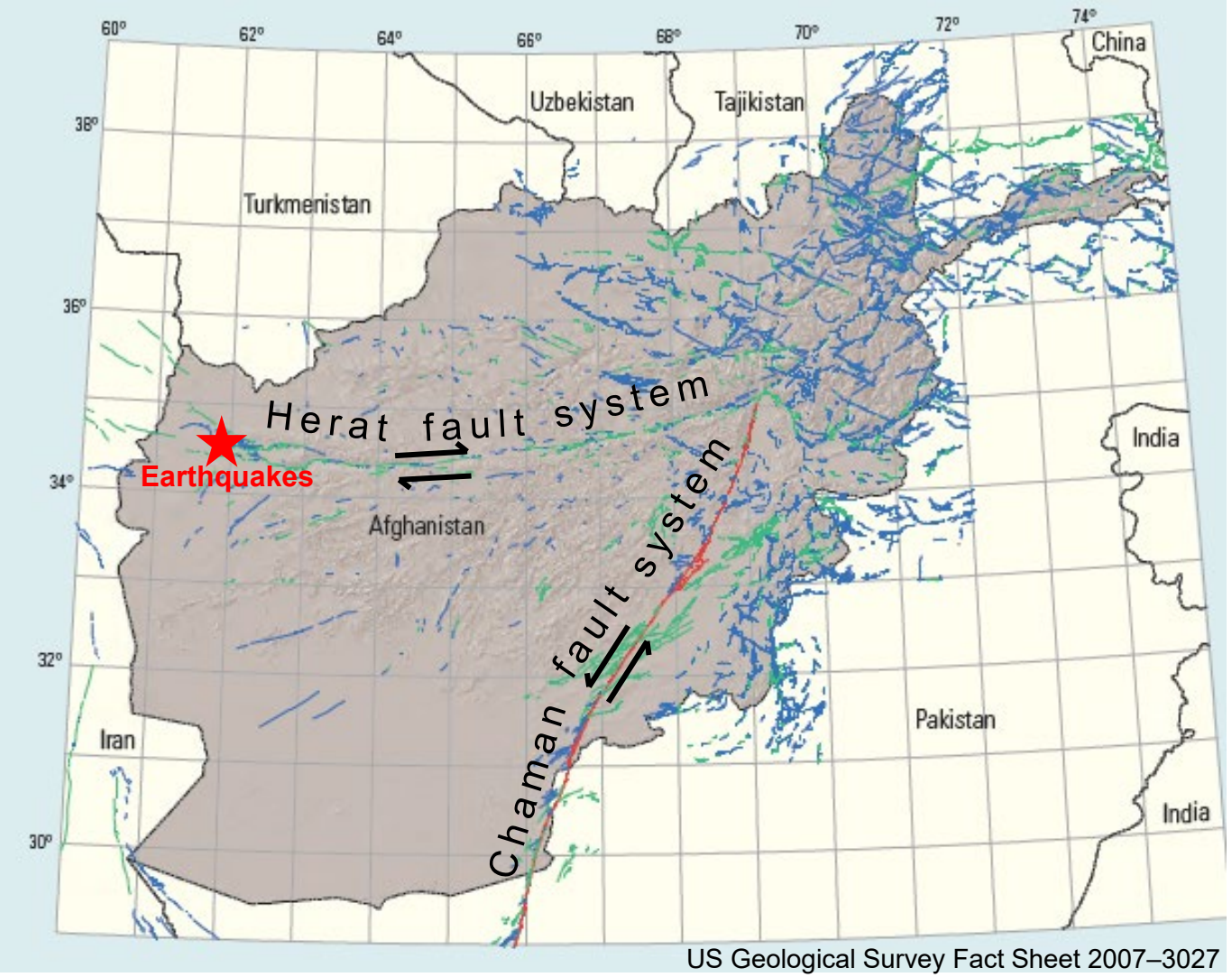
This map of Afghanistan shows locations of features thought to young crustal faults. The left-lateral strike-slip Chaman fault system, shown in red, is thought to be the most active and hazardous fault. The right-lateral strike-slip Herat fault system, shown in green, is thought to have lower slip rate and be less hazardous. Faults shown in blue are considered even less active.

These earthquakes, indicated by the red star, occurred along or near the western end of the 1100-km-long Herat fault system. In this area, the Herat fault system splits into smaller faults with vertical displacements that formed the Herat basin. Indeed, the focal mechanisms of these earthquakes indicate that they were produced by thrust faulting.



US Geological Survey Fact Sheet 2007–3027

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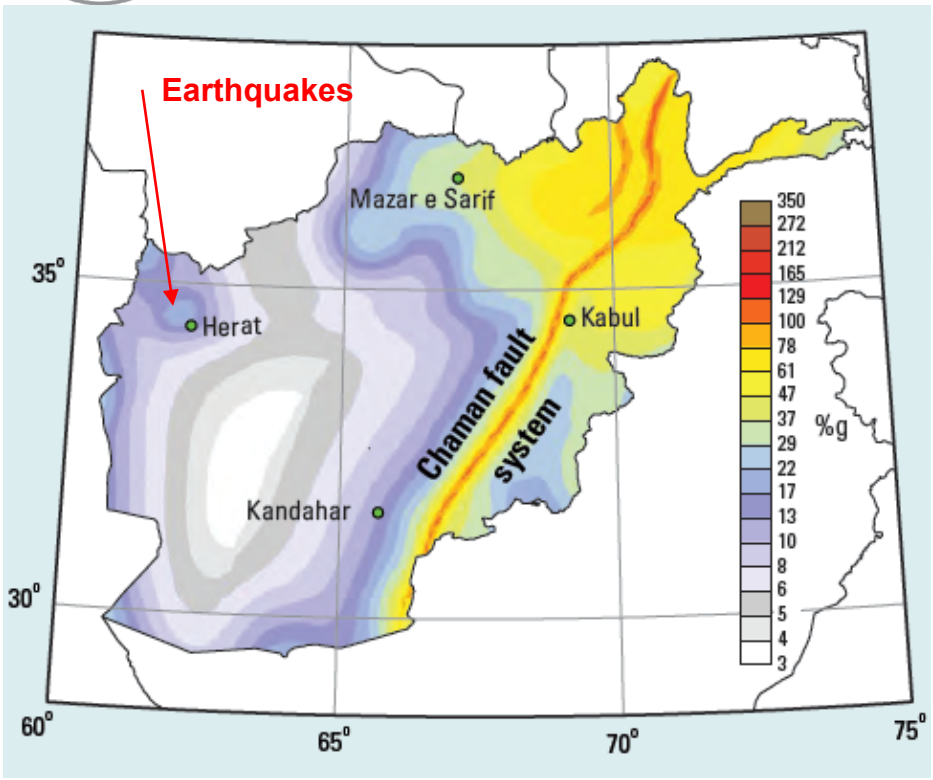

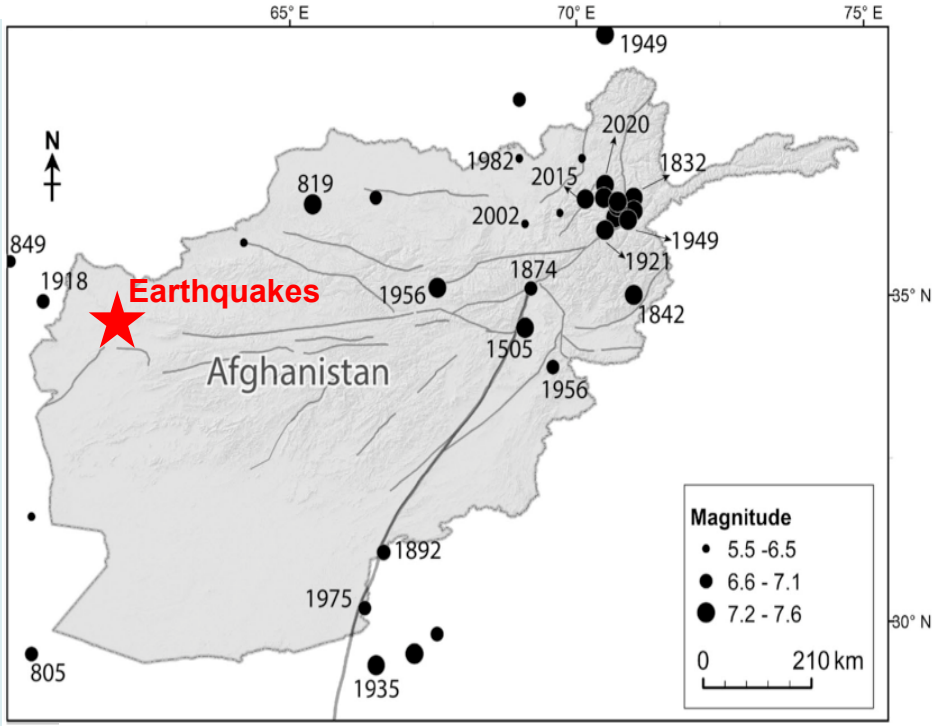

From: Z. Shnizai, Journal of Seismology, v. 24, p. 1131–1157, 2020

US Geological Survey Fact Sheet 2007–3027

A generalized seismic-hazard map of Afghanistan is shown on the left with hot colors indicating highest hazard and cooler colors indicating lower hazard. A map of damaging historic earthquakes is shown on the right. Eastern and particularly northeastern Afghanistan are the regions of highest seismic hazard and most frequent occurrence of damaging historic earthquakes. These earthquakes, shown by the red star, occurred in western Afghanistan where seismic hazard is thought to be lower and damaging earthquakes have occurred less often. These observations demonstrate that infrequent but shallow strong ($6.0 \leq M \leq 7.0$) earthquakes in areas of structures vulnerable to earthquake ground shaking can result in considerable damage, injuries, and fatalities.

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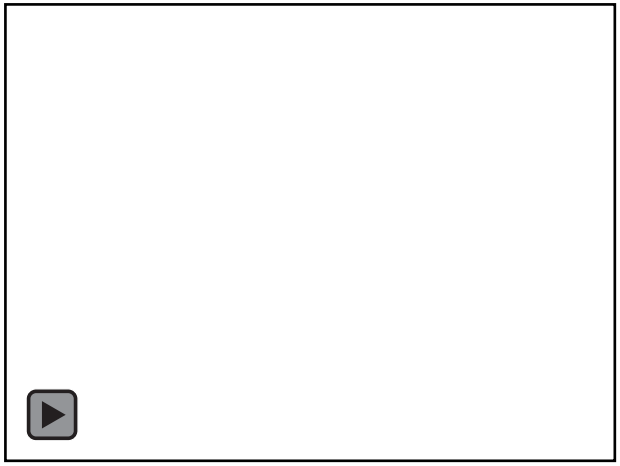
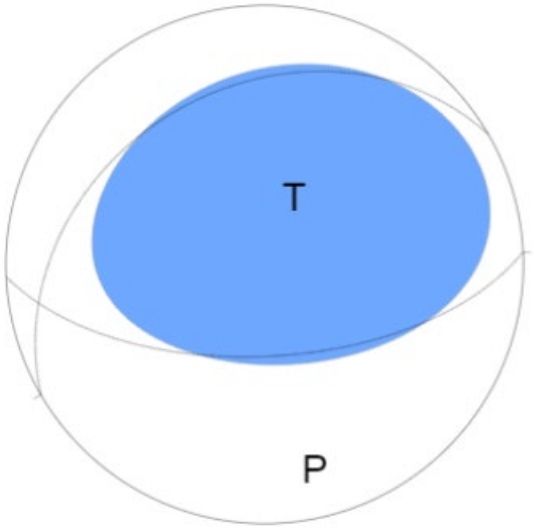
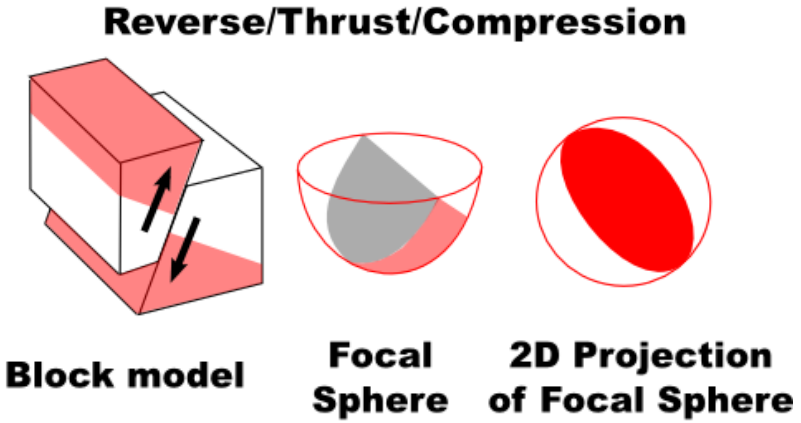
The focal mechanism of this earthquake is consistent with the previous earthquakes in this sequence. The location, depth and focal mechanism indicate rupture occurred as the result of thrust faulting at shallow depths near the far western terminus of the Hindu Kush mountain range.





USGS W-phase Moment Tensor Solution



Shaded areas show quadrants of the focal sphere in which the P-wave first-motions are away from the source, and unshaded areas show quadrants in which the P-wave first-motions are toward the source. The letters represent the axis of maximum compressional strain (P) and the axis of maximum extensional strain (T) resulting from the earthquake.

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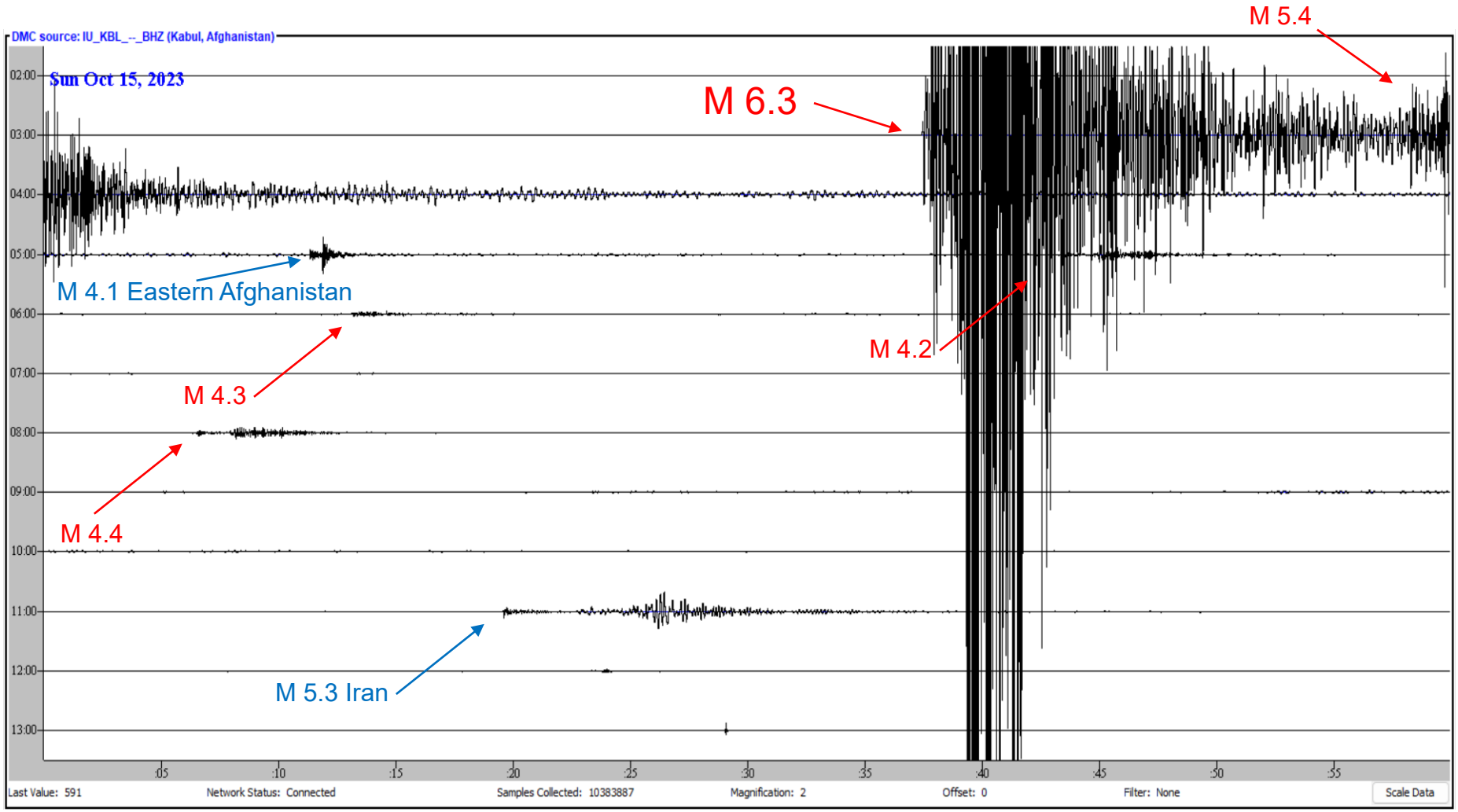
The recording of this earthquake is seen below on the helicorder screen from jAmaSeis in Kabul, Afghanistan (KBL). Kabul is 633 km (393 miles, 5.71°) from the location of this earthquake. Aftershocks and two additional regional earthquakes that occurred on October 15 are also labeled.



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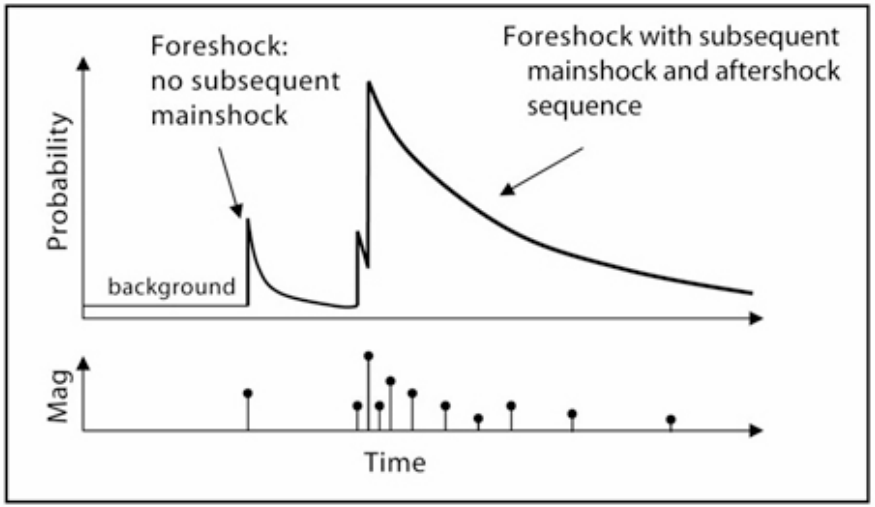
A **foreshock** is a smaller magnitude earthquake that precedes the mainshock. There are no special characteristics of a foreshock that let us know it is a foreshock until the mainshock occurs.

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.

The M 6.3 October 15 earthquake is within the cluster of aftershocks of the three previous M 6.3 earthquakes. On that basis, the M 6.3 October 15 would be considered an aftershock. However, it is an unusual aftershock in having a magnitude equal to the mainshock.



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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