Magnitude 6.3 AFGHANISTAN

Saturday, October 7, 2023 at 06:41:03 UTC

Latitude 34.610° N
Longitude 61.924° E
Depth 14 km

A magnitude 6.3 earthquake struck 36 km (24 miles) northwest of the region's largest city Herat in western Afghanistan, near the Iranian border. The earthquake occurred around 11:00 am locally at a depth of 14 km (8.7 miles) and was followed by eight aftershocks with magnitudes between 4.3 and 6.3.

Four villages in the Zenda Jan district in rural Herat province bore the brunt of the earthquake and aftershocks. Hundreds of houses have been damaged or destroyed. Hundreds of people are feared dead and over 1,000 are injured.

Image courtesy X user @nahafghan

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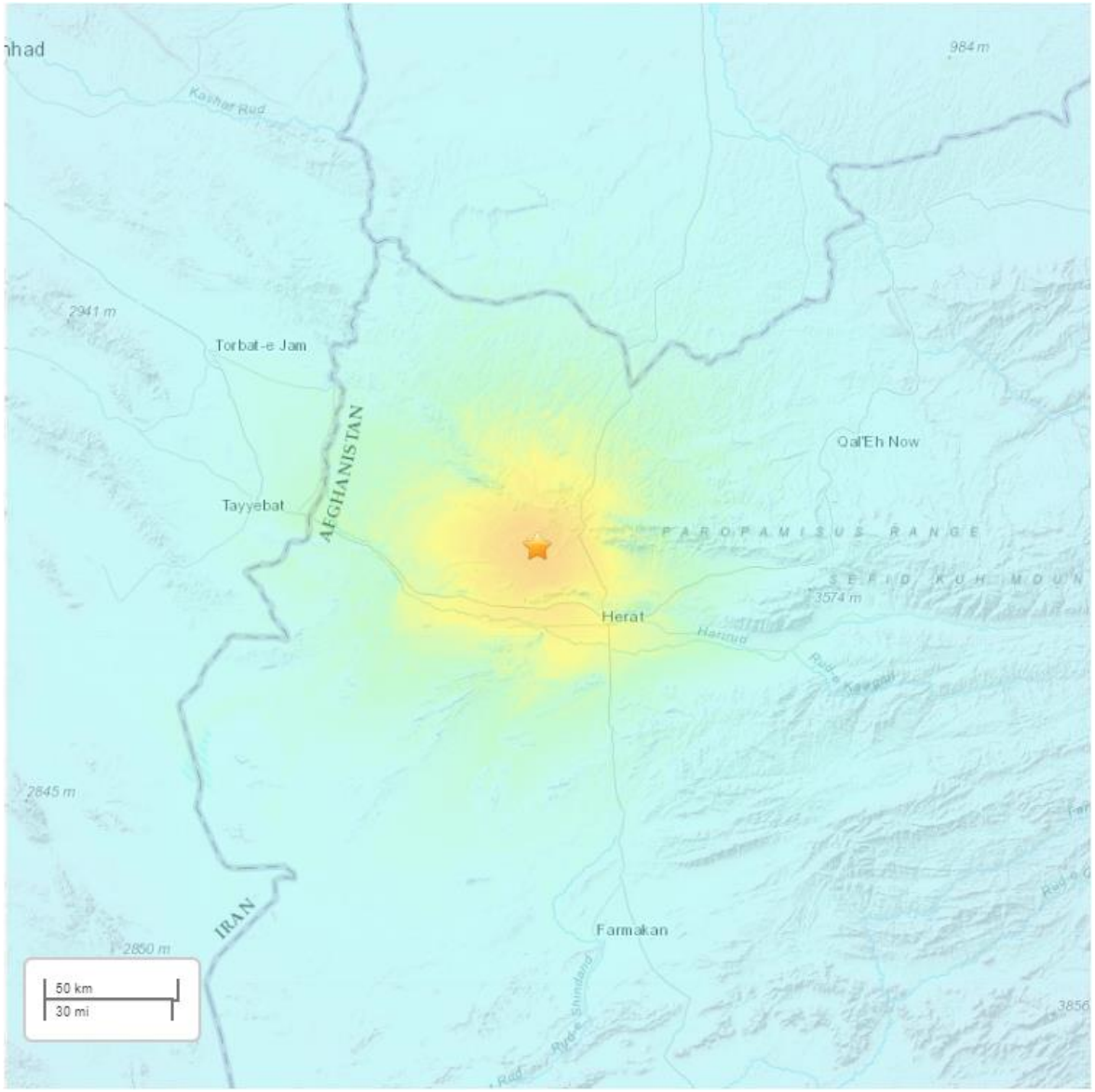
The Modified-Mercalli Intensity (MMI) scale is a ten-stage scale, from I to X, that indicates the severity of ground shaking. Intensity is based on observed effects and is variable over the area affected by an earthquake. Intensity is dependent on earthquake size, depth, distance, and local conditions.

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 6.3 Earthquake

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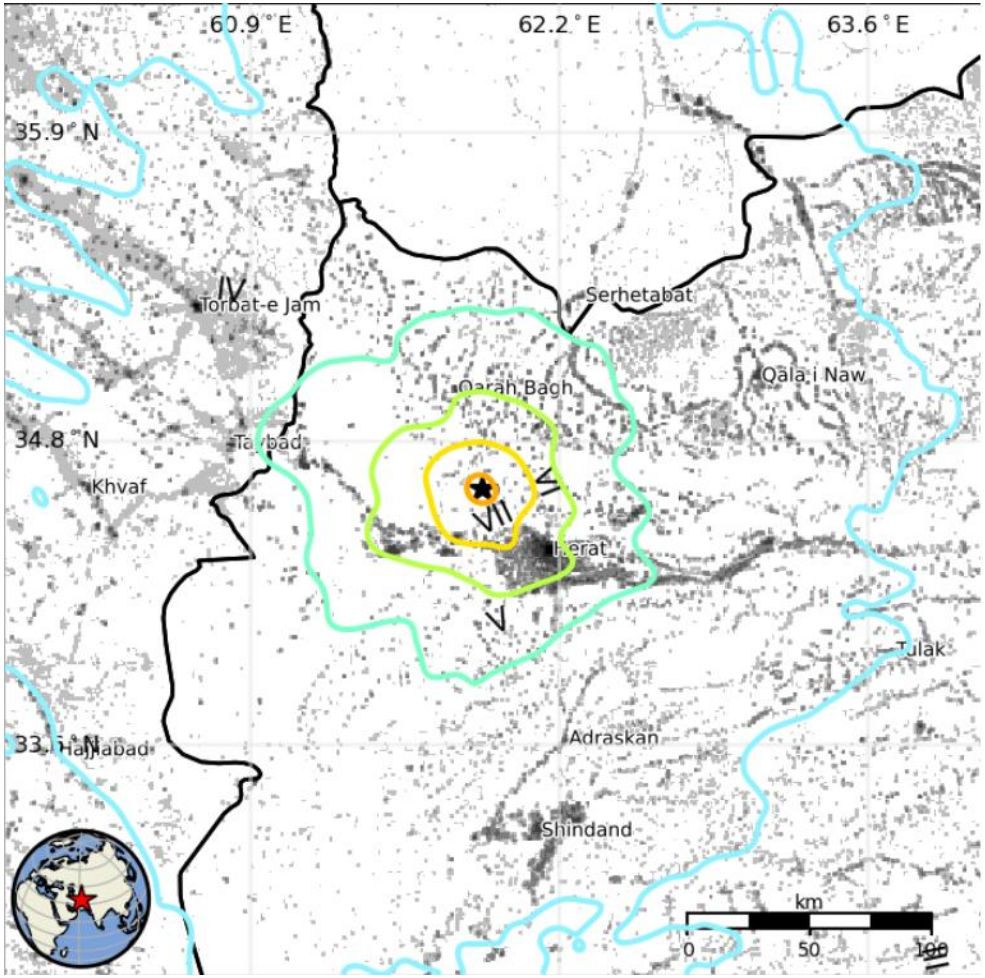
The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels. The USGS estimates that 44,000 people felt very strong shaking from the first M 6.3 earthquake and 2,000 felt severe shaking from the second M 6.3 earthquake.

I	Not Felt	0 k*
II-III	Weak	304 k*
IV	Light	2,459 k
V	Moderate	703 k
VI	Strong	1,172 k
VII	Very Strong	44 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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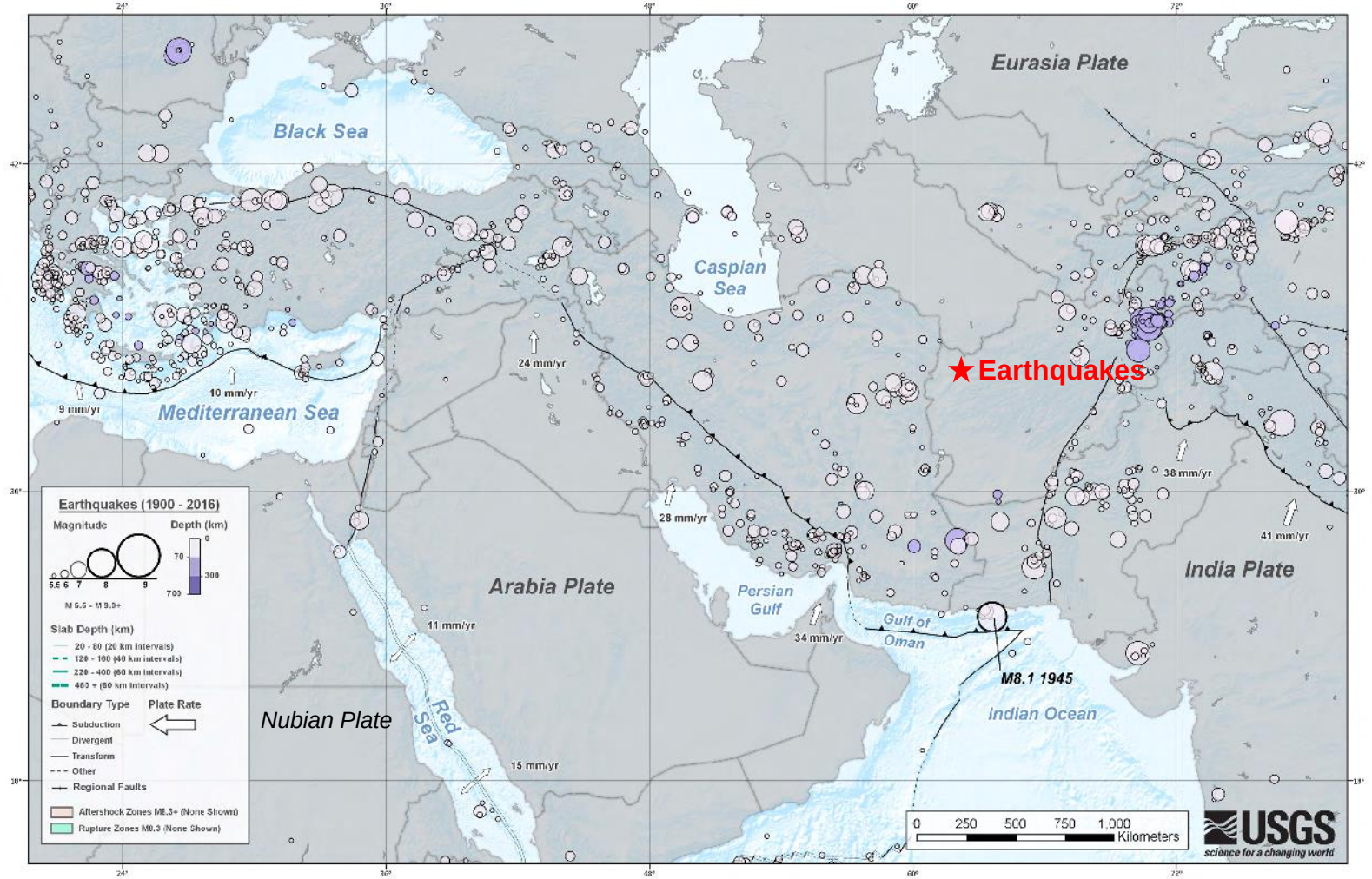
Middle East tectonics and earthquakes result from the interaction of the Eurasia, Arabia, India, and Nubian Plates. This regional tectonics map shows plate motions with respect to the Eurasian Plate. The location of the earthquakes is shown by the red star.



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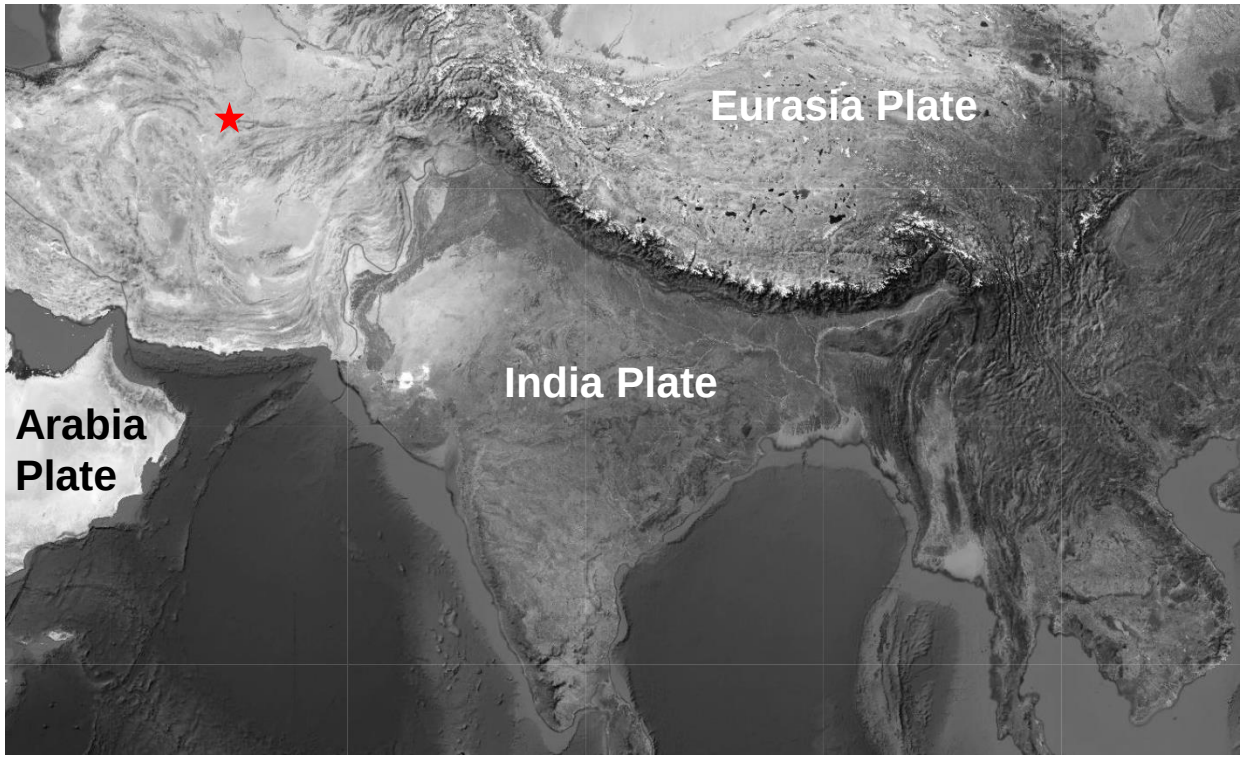
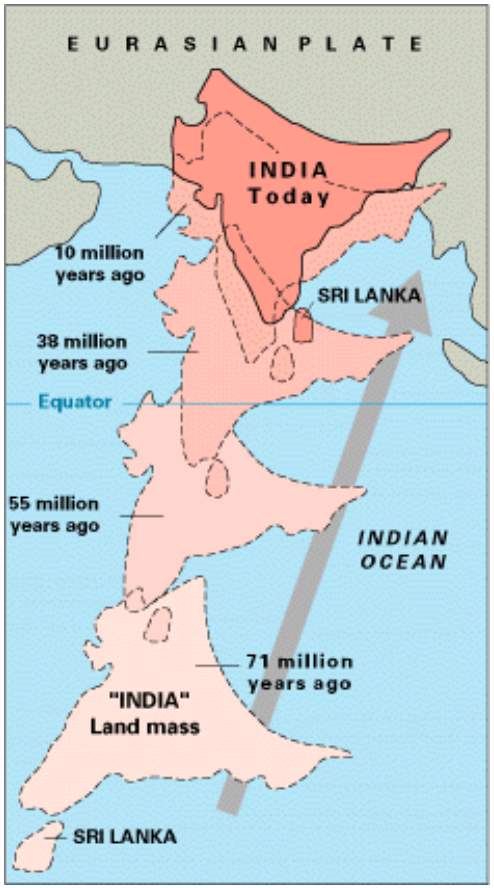
The northward-moving India plate is colliding with southern part of the Eurasian plate at a rate of about 1.7 in/yr (43 mm/yr). This collision has created the world's highest mountains and causes slips on major faults that generate large, often devastating earthquakes.

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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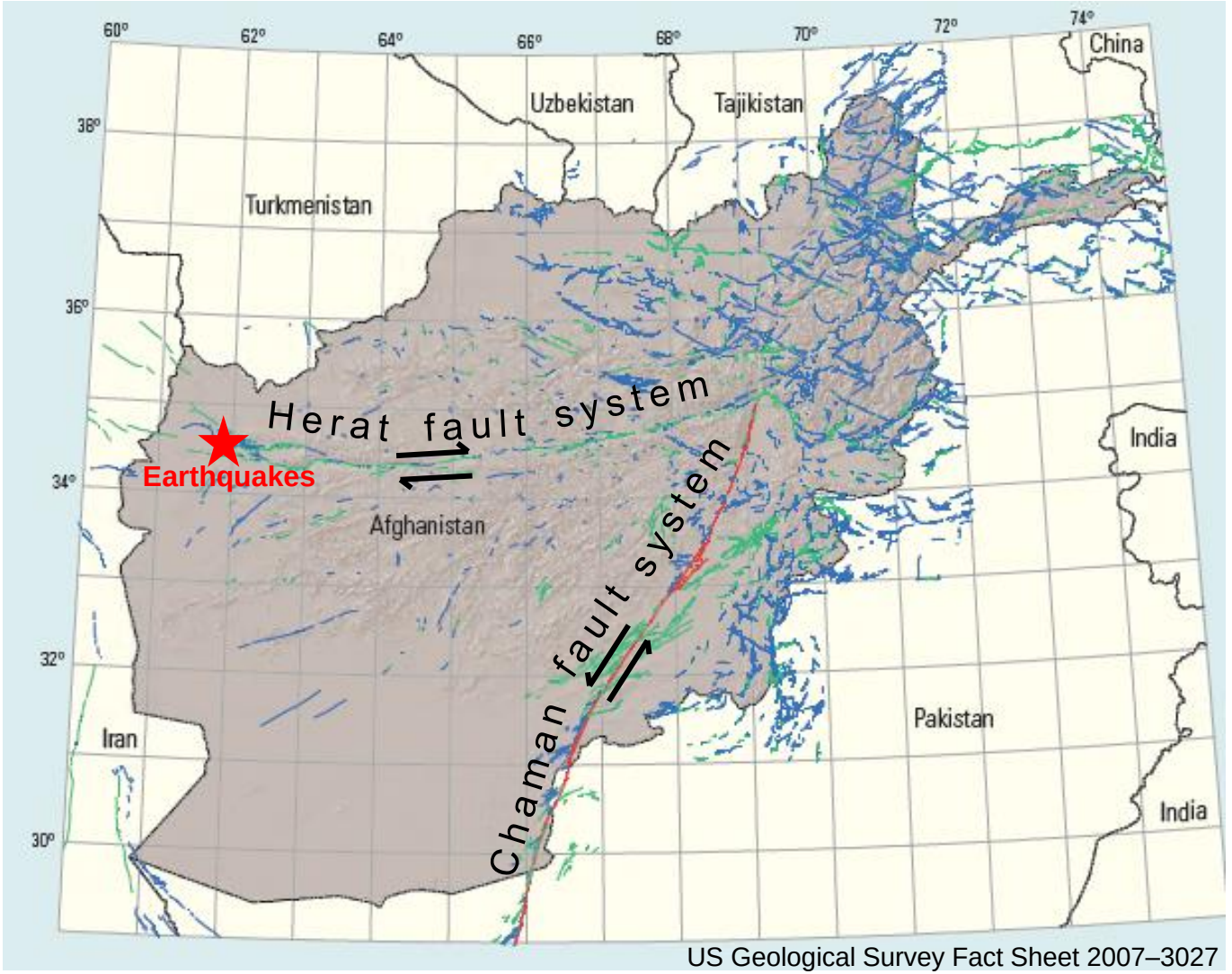
This map of Afghanistan shows locations of features thought to young crustal faults. The left-lateral strike-slip Chaman fault system, shown in red, is thought to be the most active and hazardous fault. The right-lateral strike-slip Herat fault system, shown in green, is thought to have lower slip rate 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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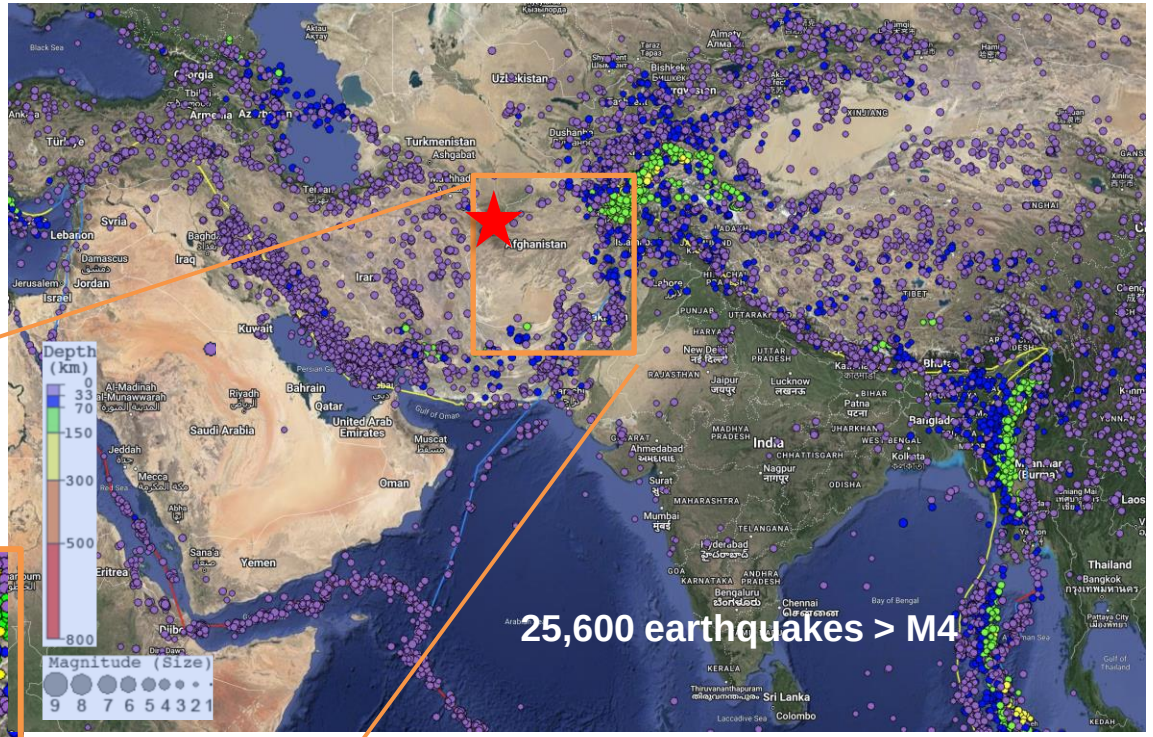
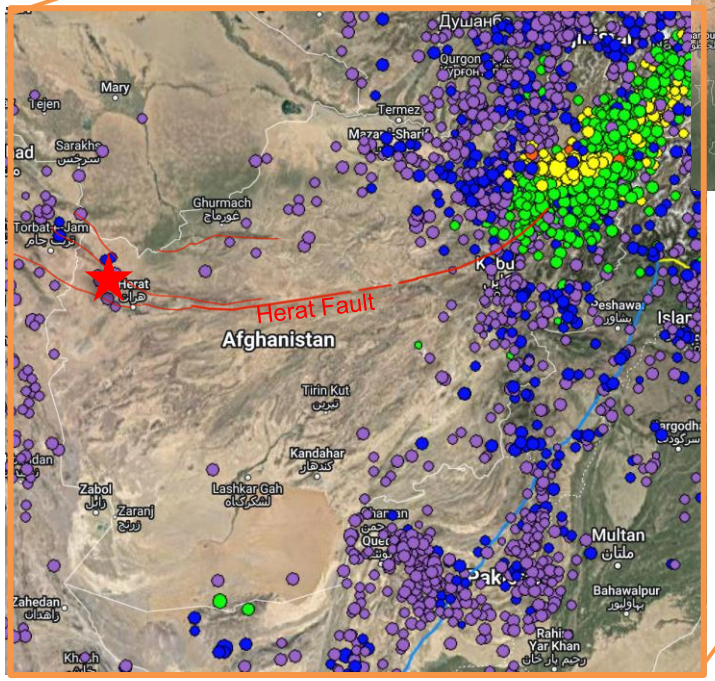
Regional historic seismicity >M4 between 2000-2023. Earthquakes are color coded by depth.

Red star indicates the epicenter of these earthquakes.





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

Left: Closeup view of the region shows 5,600 earthquakes > M4, with few occurring in central and western Afghanistan. This earthquake occurred on the western end of the Herat Fault, a structure that shows little activity compared to earthquakes along the Pakistan border region.

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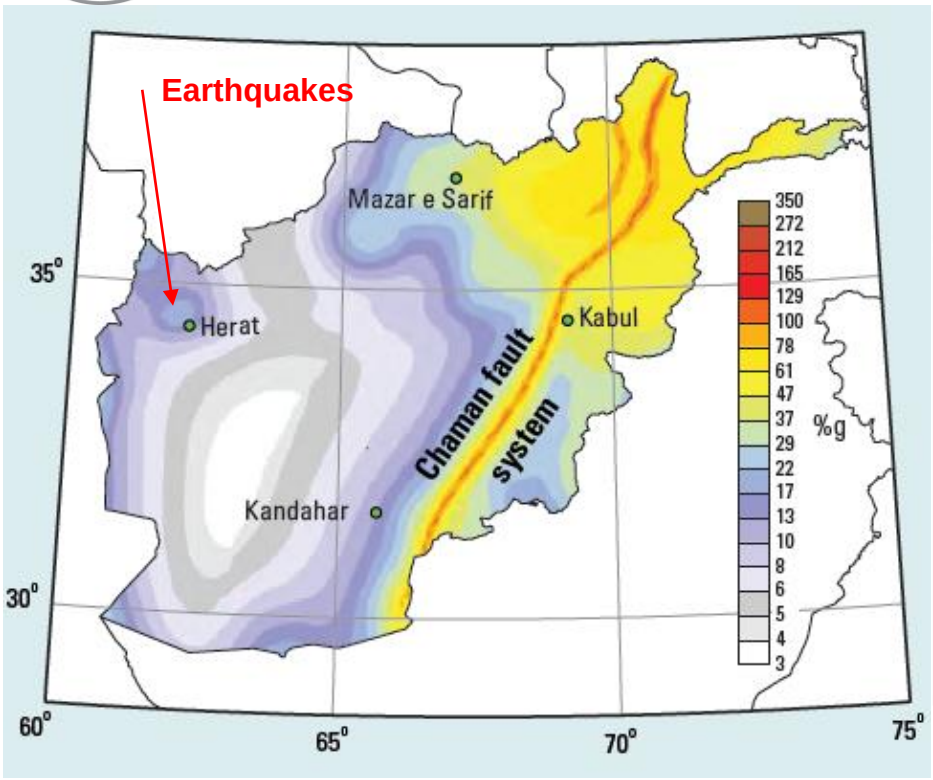

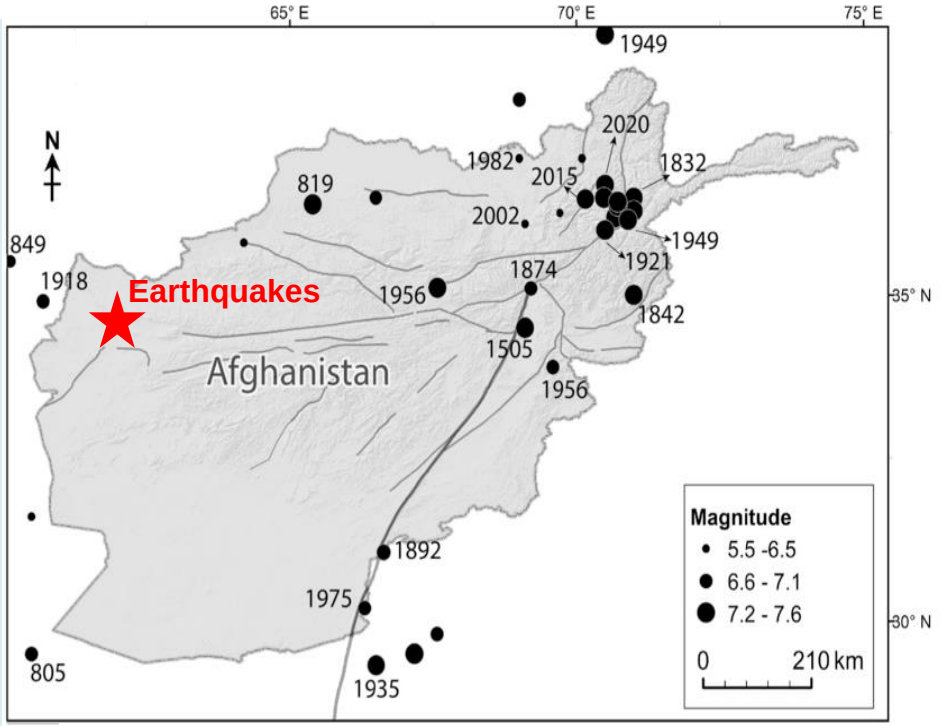

From: Z. Shnizai, Journal of Seismology, v. 24, p. 1131–1157, 2020

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. Interestingly, the October 7 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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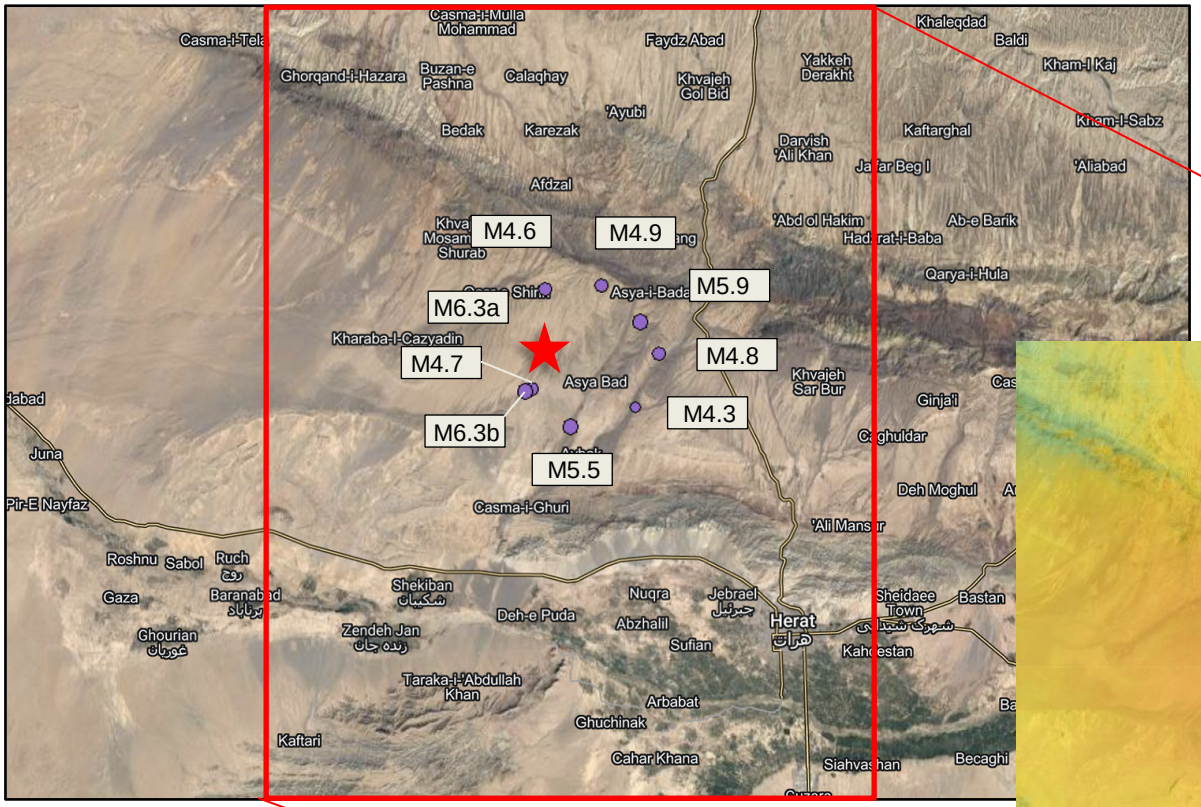
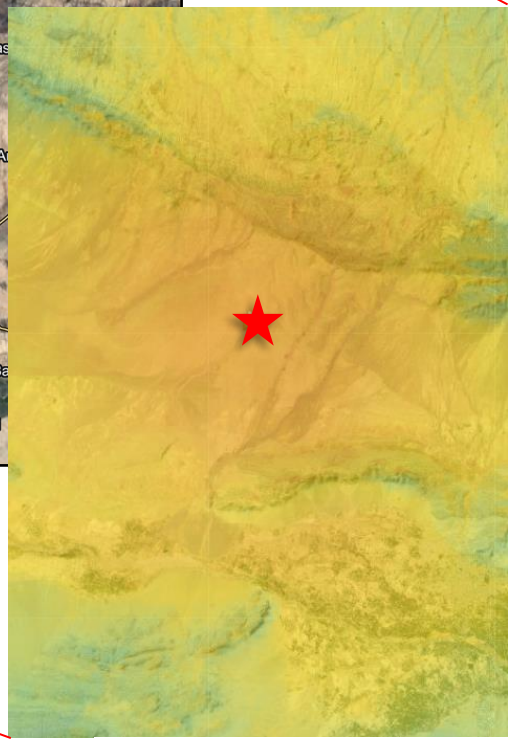
Map of the main shock (red star) and aftershocks of the October 7th event.

All were shallow crustal earthquakes that caused strong shaking in the valley (far right).

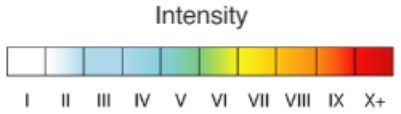




Map generated from the Interactive Earthquake Browser (www.iris.edu/ieb)

Mag	Depth km	Day	Time UTC	Lat	Lon	Dist km
6.3	14	2023-10-07	06:41:03.428Z	34.61	61.92	0
4.7	10	2023-10-07	07:10:34.212Z	34.58	61.91	3
6.3	10	2023-10-07	07:12:50.042Z	34.57	61.9	4
4.6	10	2023-10-07	08:06:37.093Z	34.67	61.93	6
5.5	11.438	2023-10-07	06:49:41.577Z	34.54	61.95	8
4.9	9.302	2023-10-07	09:40:31.097Z	34.67	61.99	9
5.9	7.726	2023-10-07	07:40:29.417Z	34.64	62.03	10
4.3	10.877	2023-10-07	11:27:42.535Z	34.56	62.03	10
4.8	10.233	2023-10-07	09:27:19.125Z	34.61	62.05	11

Table of the main shock at 6:41 UTC and aftershocks with depth, time, and distance from main shock.



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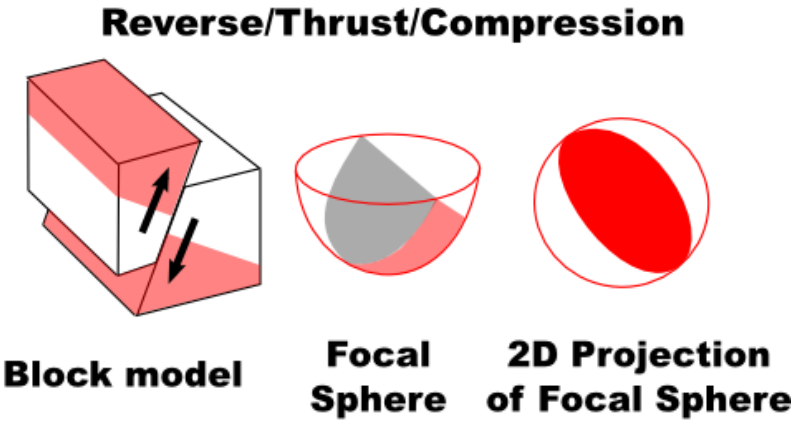
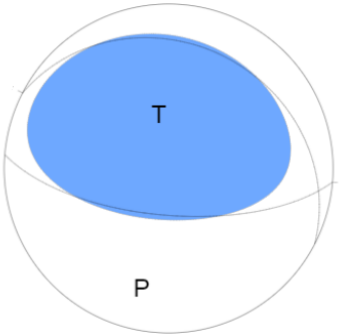
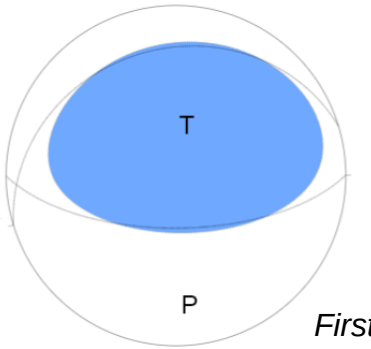
The preliminary location, depth and focal mechanism of both events indicate rupture occurred as the result of thrust faulting at shallow depths near the far western terminus of the Hindu Kush mountain range.

Both earthquakes, the initial M 6.3 and the M 6.3 earthquake that occurred approximately 30 minutes later occurred on east-west striking fault planes that dip to either the north or south.





Second M 6.3



First M 6.3

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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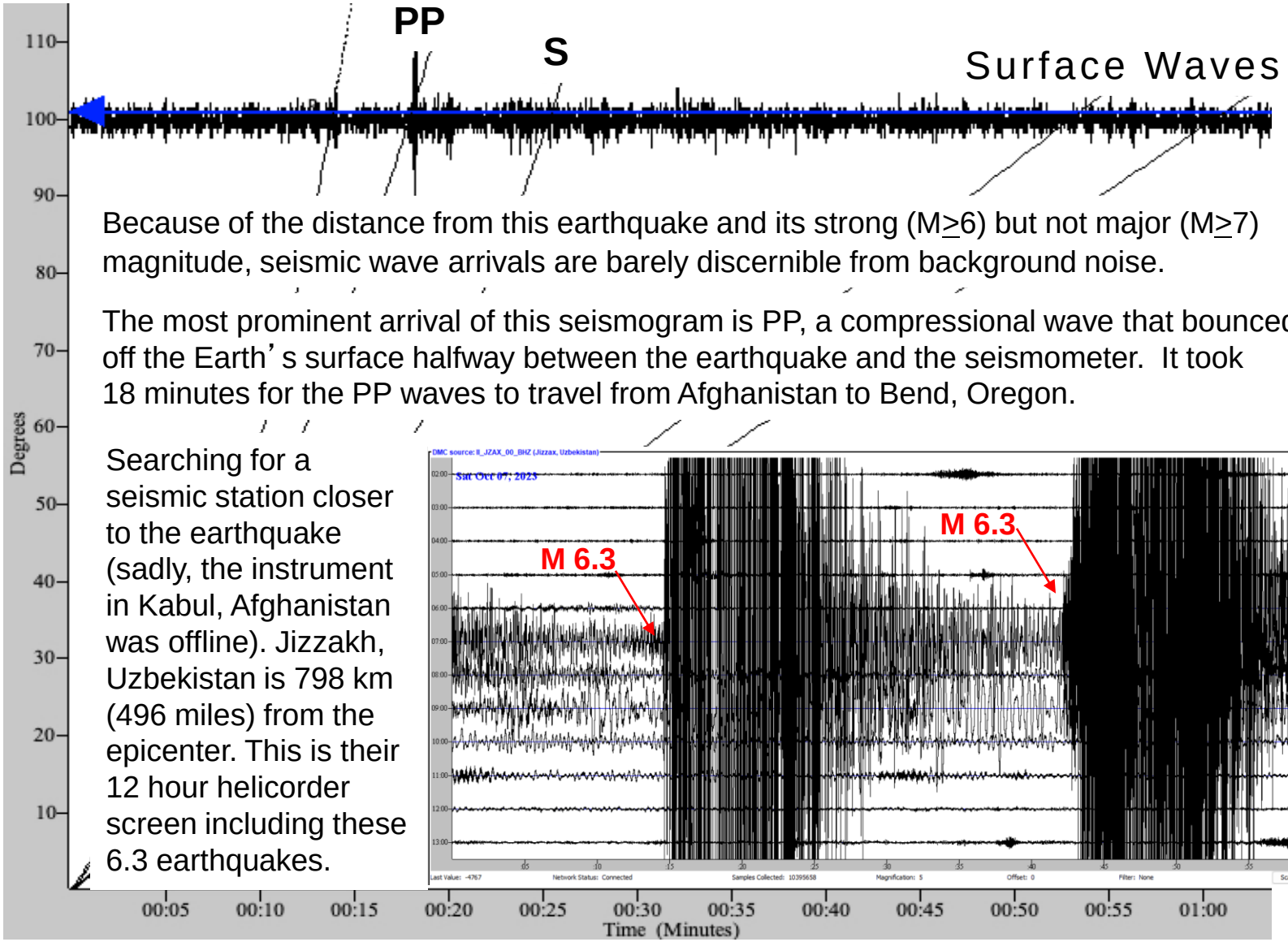
The record of the second Afghanistan M6.3 earthquake in Bend, Oregon (BNOR) is illustrated below. Bend is 11,271 km (7.004 miles, 101.5˚) from the location of this earthquake.



Because of the distance from this earthquake and its strong (M≥6) but not major (M≥7) magnitude, seismic wave arrivals are barely discernible from background noise.

The most prominent arrival of this seismogram is PP, a compressional wave that bounced off the Earth's surface halfway between the earthquake and the seismometer. It took 18 minutes for the PP waves to travel from Afghanistan to Bend, Oregon.

Searching for a seismic station closer to the earthquake (sadly, the instrument in Kabul, Afghanistan was offline). Jizzakh, Uzbekistan is 798 km (496 miles) from the epicenter. This is their 12 hour helicorder screen including these 6.3 earthquakes.

Teachable Moments are a service of

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