Magnitude 7.7 PAKISTAN

Tuesday, September 24, 2013 at 11:29:48 UTC

A powerful earthquake has killed at least 208 people in Pakistan's remote south-west province. Many houses were flattened and thousands of people have spent the night in the open.

The earthquake was felt across Pakistan. Residents rushed into the streets as tall buildings swayed in Karachi, the country's most densely populated city (11.6 million), 270 km south of the epicenter.

Pakistani villagers look for belongings amid the rubble of their destroyed homes following an earthquake in the remote district of Awaran, Baluchistan province, Pakistan.

Rescuers struggled Wednesday to help thousands of people injured and left homeless after their houses collapsed in a massive earthquake in southwestern Pakistan Tuesday, as the death toll rose to hundreds.

(AP Photo/Arshad Butt)

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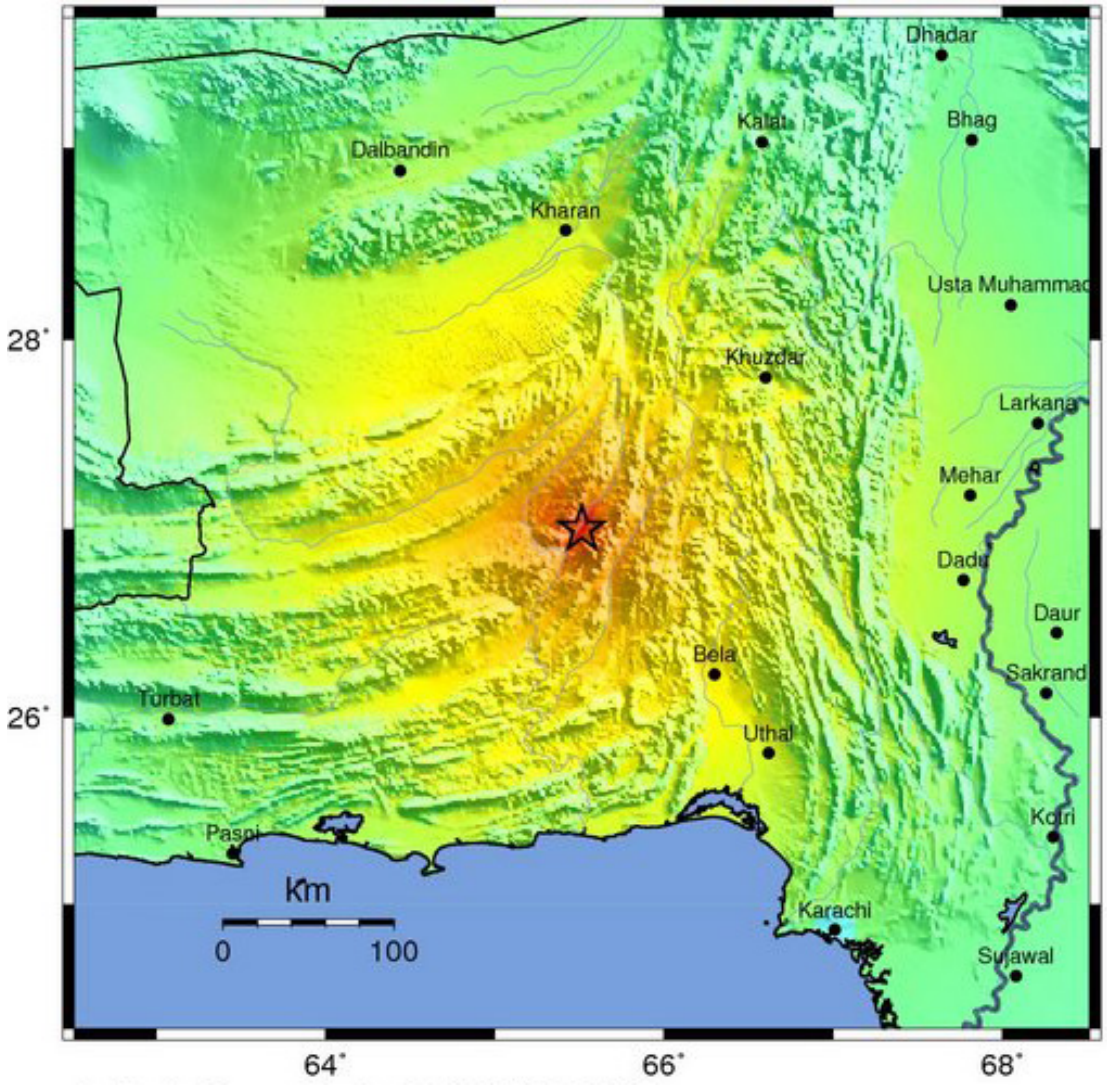
Shaking Intensity

The Modified Mercalli Intensity (MMI) scale depicts shaking severity. The area nearest the earthquake experienced violent shaking.

Modified Mercalli Intensity	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 US Geological Survey



USGS Estimated shaking Intensity from M 7.7 Earthquake

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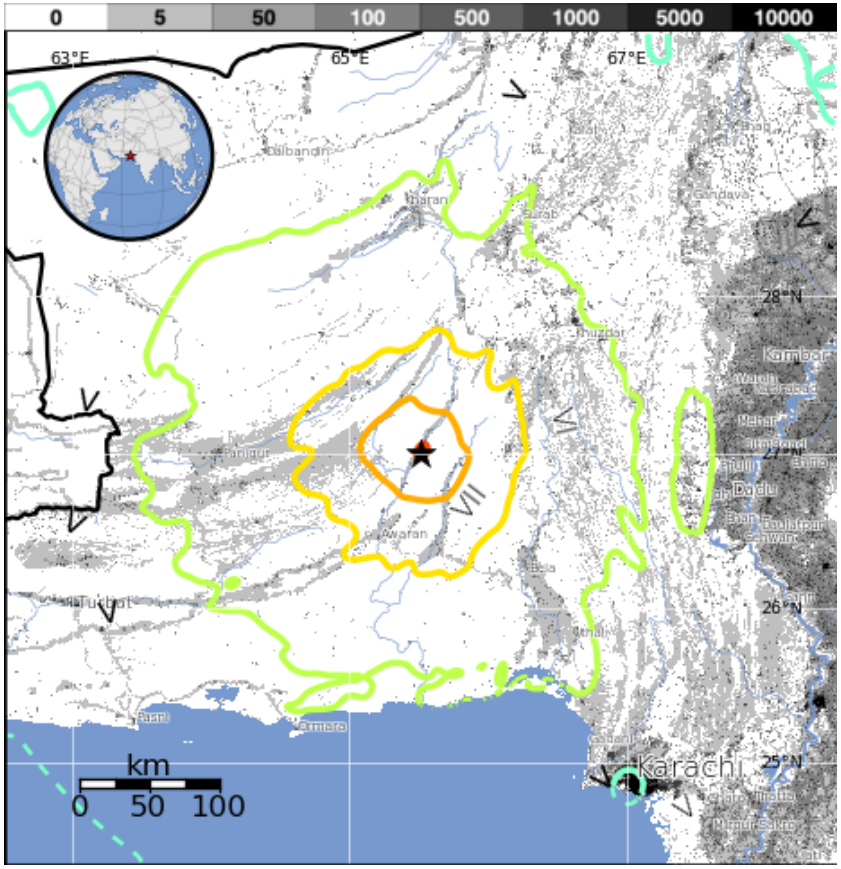
USGS PAGER

Population Exposed to Earthquake Shaking

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

The USGS is estimating that 18,000 people were exposed to violent shaking, and 30,000 exposed to severe shaking during this earthquake.



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 below.

Image courtesy of the US Geological Survey

Estimated Modified Mercalli Intensity	I	II-III	IV	V	VI	VII	VIII	IX	X
Est. Population Exposure	--*	--*	9,642k*	20,769k*	1,203k	181k	30k	18k	0k
Perceived Shaking	Not Felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme

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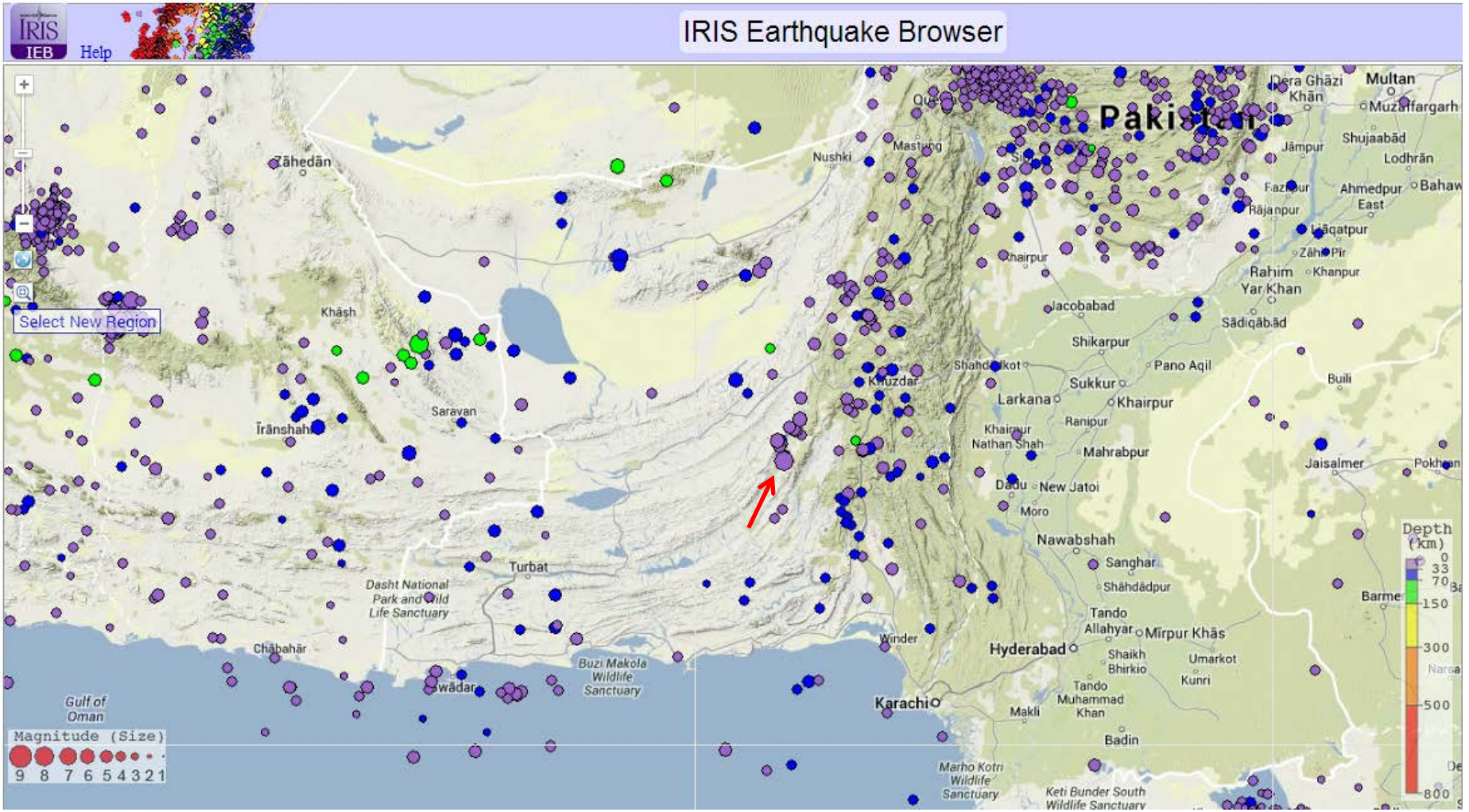
This earthquake epicenter is plotted on the map with regional seismicity since 1990.



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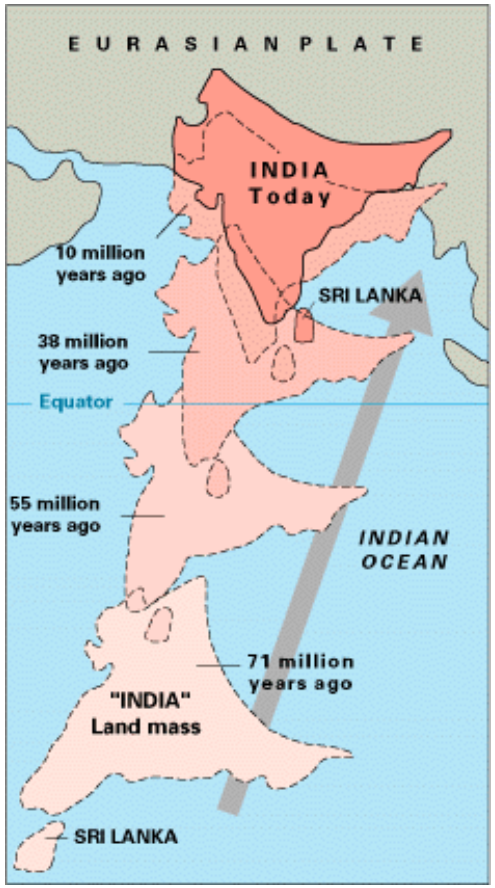
The earthquake activity in Pakistan is related to the ongoing continent-continent collision between India and Asia. That collision has produced the Himalaya Mountains and the Tibetan Plateau. The collision zone wraps around the northwest promontory of the Indian continent in the Hindu Kush region of Tajikistan and Afghanistan then extends to the southwest through Pakistan.



Whereas the motion of India into Asia is essentially perpendicular to the Himalaya Mountains, the motion in Pakistan is “oblique convergence”. This region is quite complex with earthquakes that have thrust (compressional), strike-slip (shearing), and occasionally normal (extensional) faulting mechanisms.

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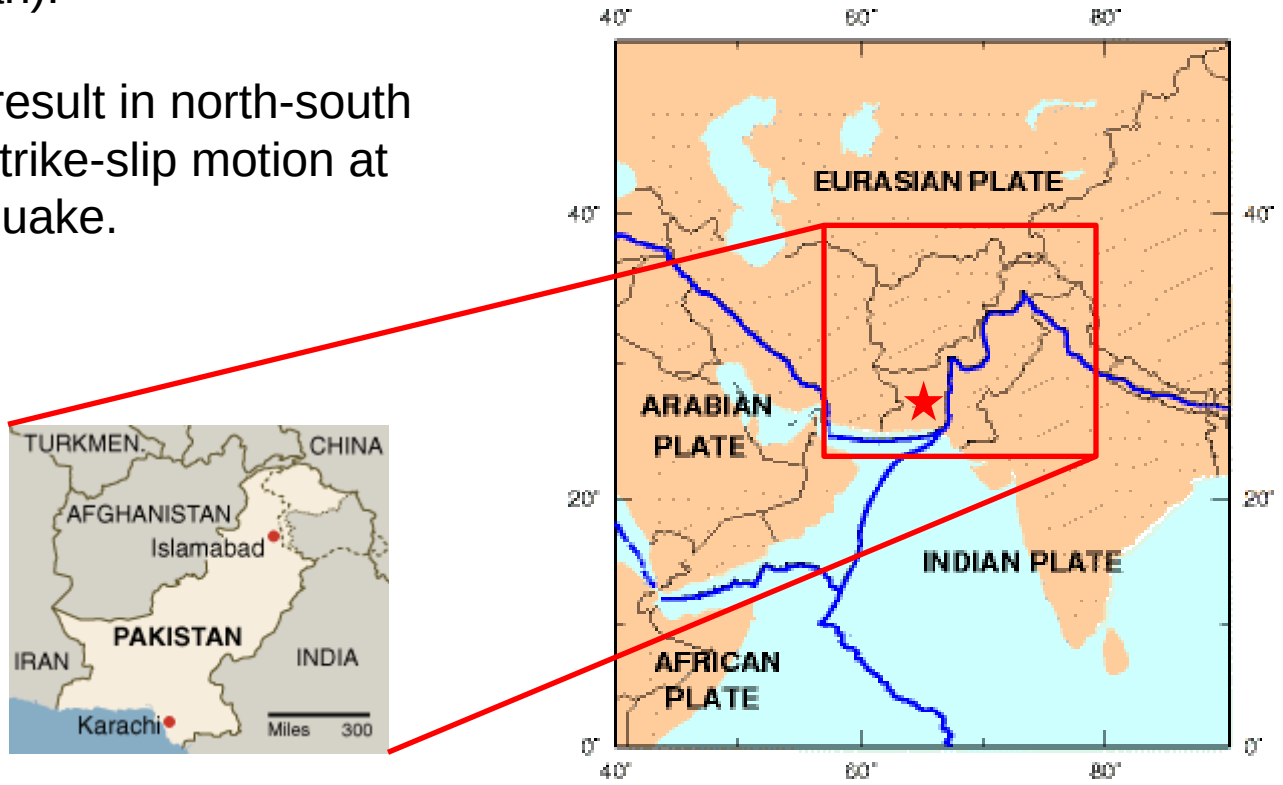
This earthquake occurred near the plate boundaries of the Eurasian, Arabian, and Indian Plates.

The tectonics of southern and central Pakistan reflect a complex plate boundary where the India Plate slides northward relative to the Eurasian Plate in the east, and the Arabian Plate subducts northward beneath the Eurasian Plate in the Makran (western Pakistan).

These motions typically result in north-south to northeast-southwest strike-slip motion at the latitude of this earthquake.



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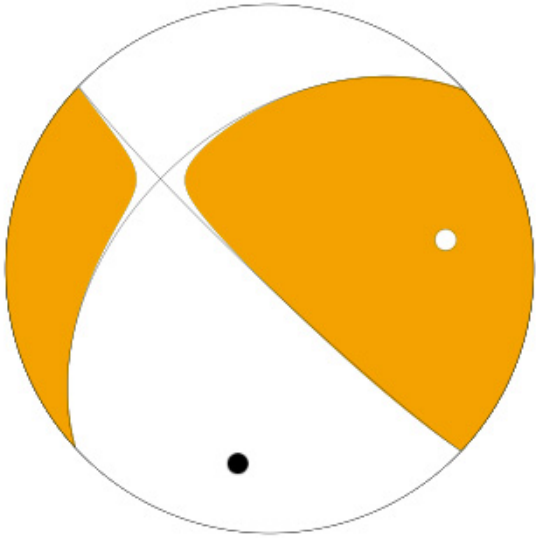
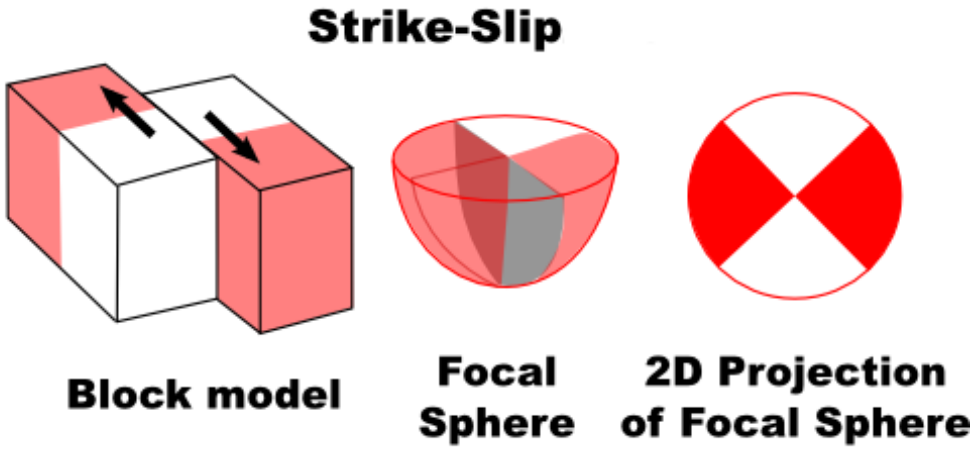
This earthquake occurred as the result of left-lateral oblique-strike-slip motion at shallow crustal depths. The location and mechanism of the earthquake are consistent with rupture within the Eurasian Plate above the Makran subduction zone where the Arabian Plate is subducting beneath the Eurasian Plate.



USGS Centroid 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 dots represent the axis of maximum compressional strain (in black, called the "P-axis") and the axis of maximum extensional strain (in white, called the "T-axis") resulting from the earthquake. An introduction to focal mechanisms can be found in the animation at following URL: http://www.iris.edu/hq/programs/education_and_outreach/animations/25

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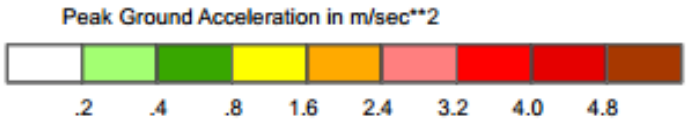
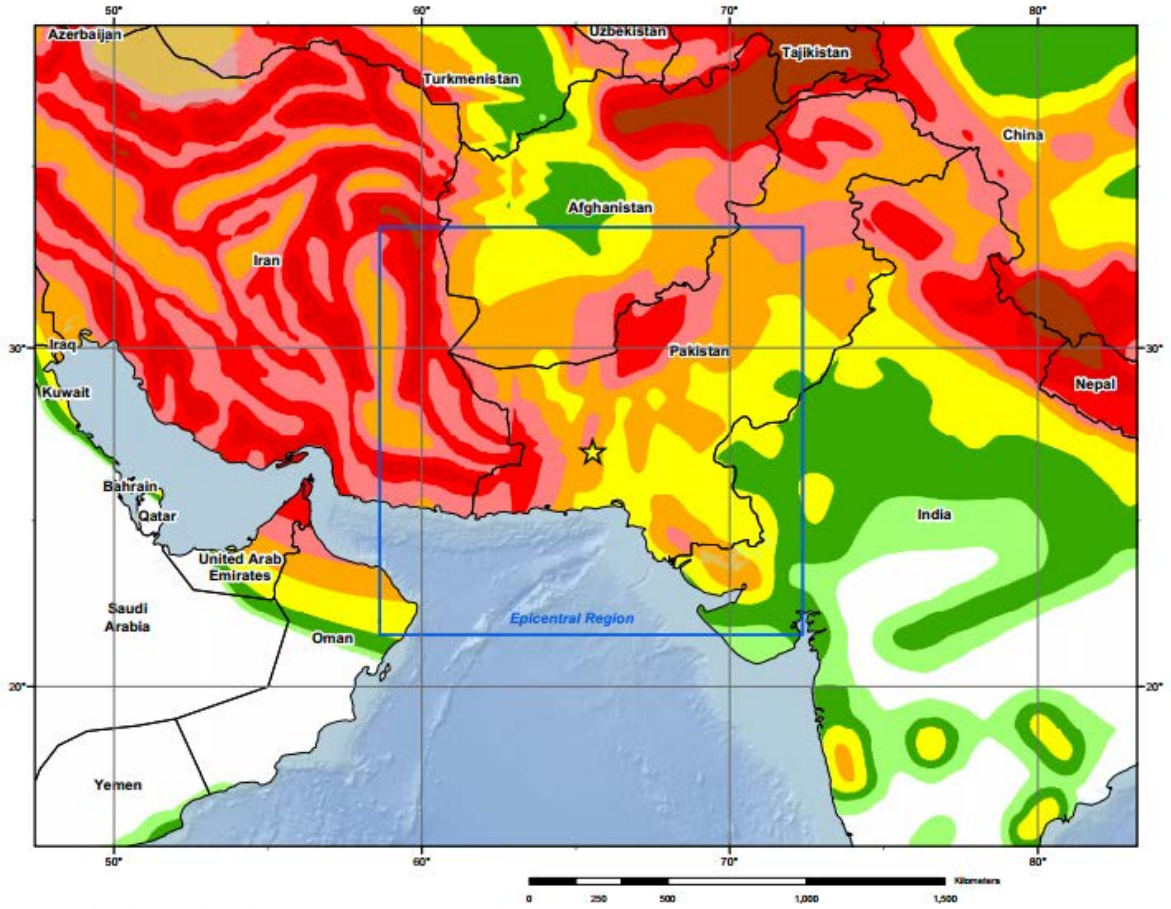
In the past 40 years, only one significant event (M6.1 July, 1990), which killed 6, has occurred within 200km of this earthquake. Although many areas through the Middle East and Himalaya are very seismically active, southern and southeastern Pakistan have a lower seismic hazard than northern and northeastern Pakistan.



This earthquake hazard map illustrates the peak ground acceleration expected to be exceeded with 10% probability during a 50-year period. The dark red zones indicate zones with accelerations of about 0.5g where g=acceleration of gravity.

USGS Seismic Hazard Map



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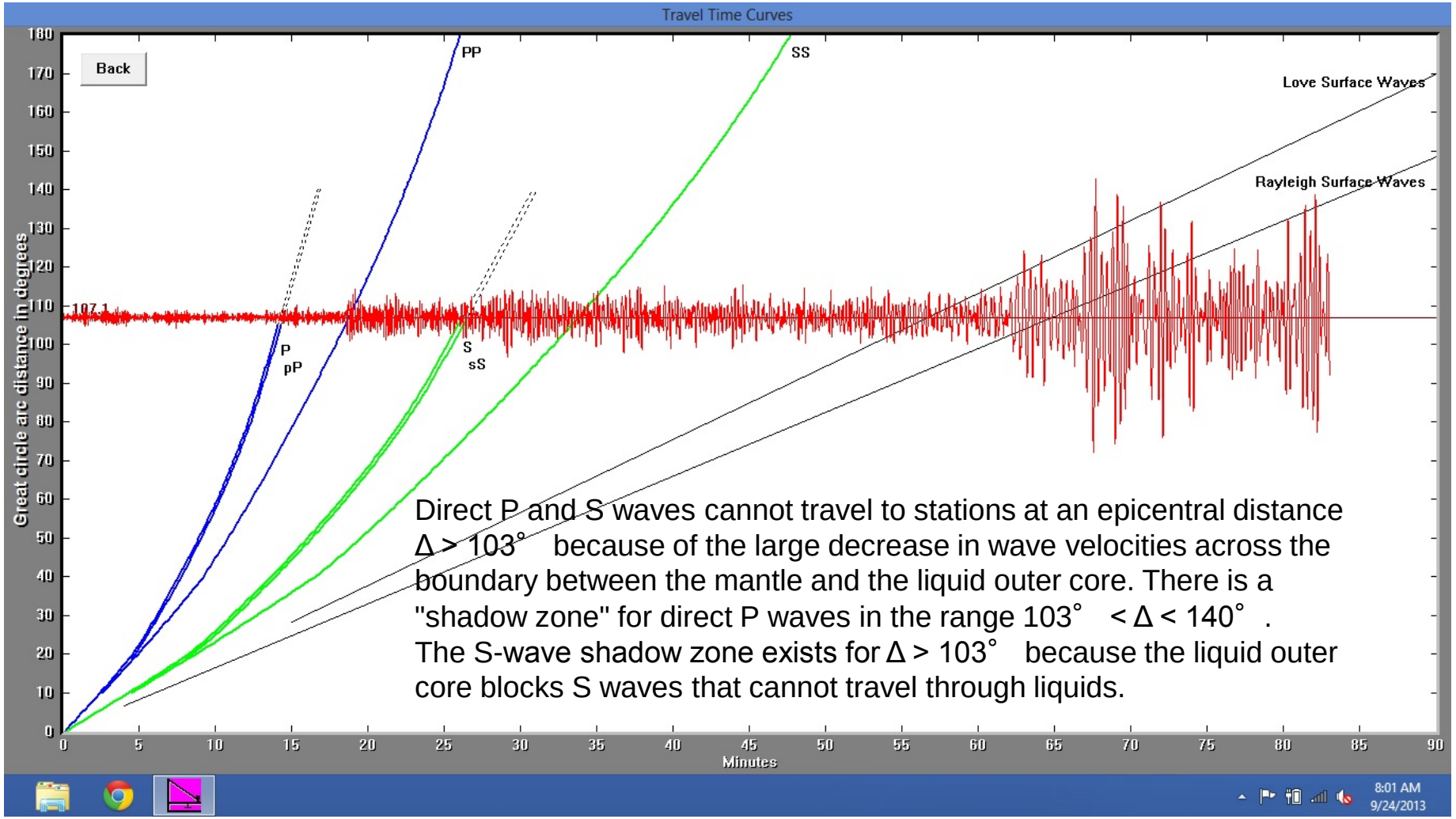
The record of the earthquake on the University of Portland seismometer (UPOR) is illustrated below. Portland is about 11,733 km (~7290 miles, 105.7 degrees) from the location of this earthquake.



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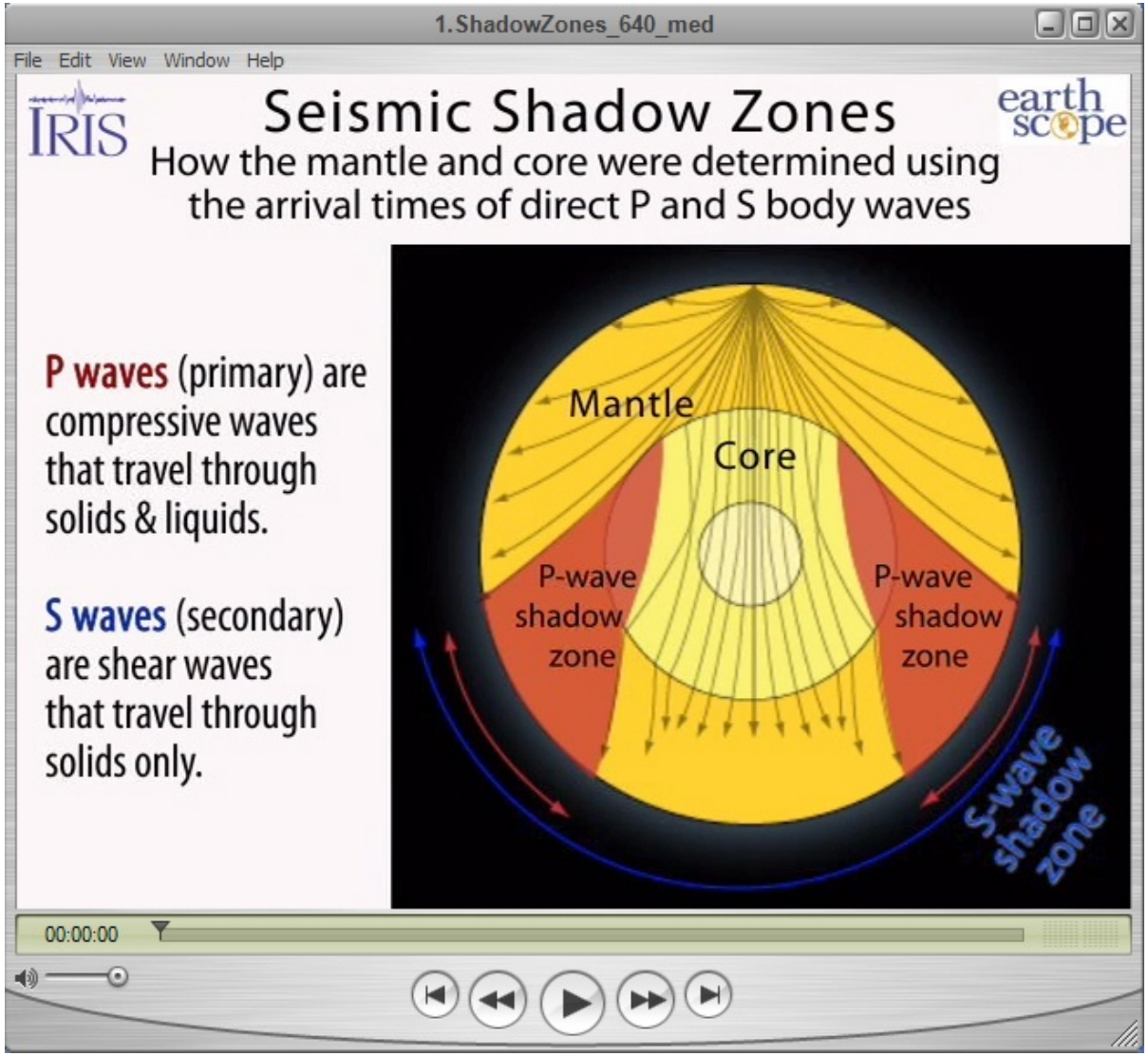
Animation explaining the seismic shadow zone.

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 seen 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°.



http://www.iris.edu/hq/programs/education_and_outreach/animations/18

Jenda Johnson

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The University of Portland