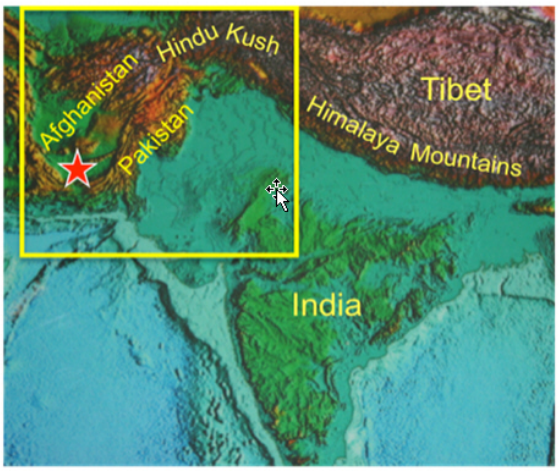
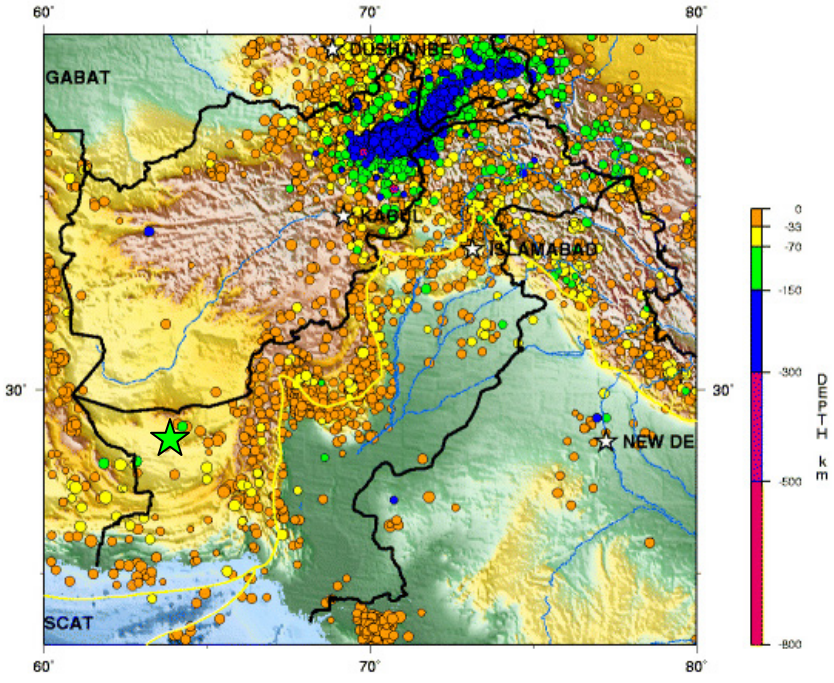
Magnitude 7.2 Earthquake in Southwestern Pakistan
Tuesday, January 18, 2011 at 20:23:26 UTC (12:23:26 PST)
Wednesday, January 19, 2011 at 1:23:26 AM at Epicenter
Epicenter: Latitude 28.838 °N, Longitude 63.947 °E Depth: 84 km

Earthquake Summary:

A magnitude 7.2 earthquake occurred in southwestern Pakistan on Tuesday January 18, 2011 at 20:23:26 Coordinated Universal Time (UTC). As determined by the US Geological Survey National Earthquake Information Center (NEIC), the epicenter of this major earthquake was located 45 kilometers (28 miles) west of Dalbandin and 1,020 kilometers (633 miles) west-southwest of Islamabad, Pakistan. The map on the left below shows historic earthquakes from 1990 to present with the January 18, 2011 earthquake shown by the green star. The depth of this earthquake was 84 km so fortunately the violence of ground shaking was strong but not as severe as it would have been for a shallower earthquake of the same magnitude. For example, the ground shaking expected at the epicenter of the January 18, 2011 earthquake was about one-fourth as violent as the ground shaking produced by the smaller M7.0 Haiti earthquake that had a depth of 13 km. Because southwestern Pakistan is sparsely populated (Dalbandin has a population of about 15,000), it is thought that there will be few injuries or fatalities. However, communications with the affected area are limited and the impact of this earthquake is uncertain.



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 a earthquakes that have thrust (compressional), strike-slip (shearing), and occassionally normal (extensional) faulting mechanisms.



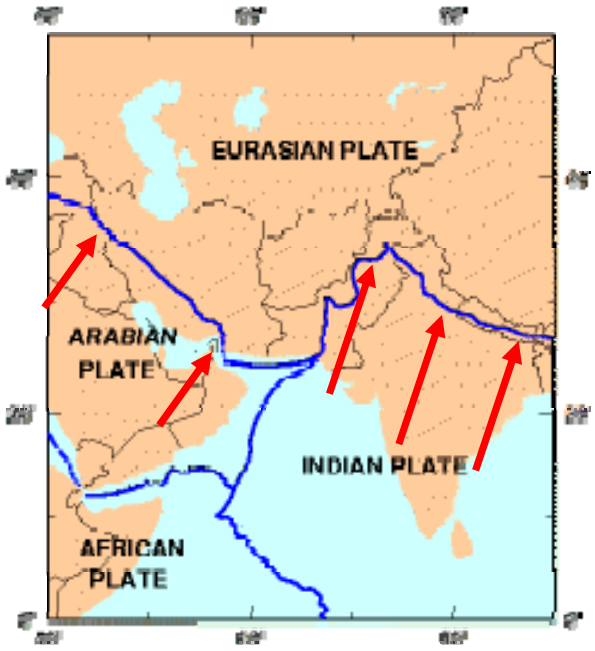


Image courtesy of the US Geological Survey

Seismogram Description:

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

Body waves travel through Earth's mantle from the earthquake to a distant station along paths that curve upwards because the velocity of seismic waves generally increases with depth in the mantle. However, direct P and S waves cannot travel to stations more than epicentral distance $\Delta > 103°$ because of the large decrease in wave velocities across the boundary between the mantle and the liquid outer core. (Epicentral distance, Δ, 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.) There is a "shadow zone" for direct P waves in the range $103° < \Delta < 143°$. The S-wave shadow zone exists for $\Delta > 103°$ because the liquid outer core blocks S waves that cannot travel through liquids. The first arrival to Portland is a diffracted P wave, which travels through the mantle and is diffracted off the mantle – core boundary. It is recorded in Portland about 14 minutes after the earthquake. The second clear arrival on the seismogram below is actually two waves arriving to the station at the same time. The PP arrival is a compressive wave that traveled through Earth's mantle and bounced midway between the epicenter and Portland; PKiKP is a wave that travels a path ultimately bouncing off the outer core – inner core boundary before traveling back out to the station. These waves both arrive to the station about 18 minutes 24 seconds after the earthquake.

Aligned with the travel time curve, the next expected arrival at this distance is an Sdiff, an S wave that diffracted off the mantle – core boundary following the same path as the Pdiff wave. This wave arrives to the station about 25 minutes 50 seconds after the earthquake. Following the Sdiff, the large amplitude arrival is both PS and SP. The path of these waves is the same as a PP, bouncing midway between the epicenter and Portland. However, the difference is that each wave travels half the distance as an S wave, and the other half as a P wave. These waves arrive in Portland about 27 minutes 32 seconds after the earthquake.

The (Love and Rayleigh) surface waves traveled from the earthquake to Portland around the perimeter of the Earth. Because the distance around the perimeter is longer than the distance through Earth's mantle and the speed of surface waves is slower than body waves, surface waves did not arrive in Portland until about 44 minutes after the earthquake occurred.