Major 7.6 Earthquake in Southern Sumatra, Indonesia
Wednesday, September 30, 2009 at 10:16:09 UTC
03:16:09 Pacific Standard Time
Epicenter: Latitude 0.725°S, 99.856°E. Depth: 81 kilometers.

As determined by the US Geological Survey National Earthquake Information Center (NEIC), a major earthquake occurred Wednesday morning Portland time 60 km (35 miles) west-northwest of Padang, Sumatra, Indonesia. The epicenter of the earthquake is indicated by the red star on left-side map below while the orange line shows the surface trace of the boundary between the Australia – Indian Plate and the Eurasian Plate. The map on the right below shows historic earthquake activity near the epicenter (green star) from 1990 to present. As the Australia – Indian Plate subducts below the Eurasian Plate at a velocity of about 60 mm/yr (6 cm/yr), earthquake depths increase from southwest to northeast across this plate boundary. The earthquake of September 30, 2009 nicely fits the pattern of depths for earthquakes that occur on the subsurface interface between the Australia – Indian and Eurasian plates. This earthquake did not produce a tsunami because it occurred at a depth of 81 km, far below the seafloor. The latest information indicates that at least 1100 people were killed and 2181 were injured as more than 2650 buildings have been damaged in the Padang area and landslides have disrupted power and communications. Thousands of people are still unaccounted for in the area and it is feared the death toll will rise as rescue and recovery crews search for survivors and victims in the many collapse buildings.

NEIC notes that: “Approximately 350 km to the south, a 250 km section of the plate boundary slipped during an M8.4 earthquake in September 2007, while approximately 300 km to the north, a 350 km section slipped during the M8.7 earthquake of March 2005.” It is also important to remember that the subduction zone boundary between the Australia – Indian and the Eurasian plates ruptured for ~1200 km north from the northern tip of Sumatra in the great magnitude 9.2 earthquake of December 26, 2004. That great earthquake produced a tsunami that killed 250,000 people in countries around the Indian Ocean.
The record of the September 30, 2008 Sumatra earthquake on the University of Portland seismometer is illustrated below. Portland is about 13,500 km (~8500 miles) 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 increase with depth in the mantle. However, direct P and S waves cannot travel to stations more than epicentral distance $\Delta > 103^\circ$ because of the large decrease in wave velocities across the boundary between the mantle and the liquid outer core. (Epicentral distance, $\Delta$, 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 $103^\circ < \Delta < 143^\circ$. The S-wave shadow zone exists for $\Delta > 103^\circ$ because the liquid outer core blocks S waves that cannot travel through liquids. The wave labeled PP is a pressure wave that traveled through Earth’s mantle and bounced midway between the epicenter and Portland; SS is a shear wave that also bounced midway between the epicenter and Portland. It took about 20 minutes for the PP waves and 37 minutes for the SS waves to travel from the earthquake to Portland. 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 almost 52 minutes after the earthquake occurred beneath Sumatra. For an earthquake of this magnitude, the surface waves for this event are of modest amplitude. Because the earthquake occurred at 81 km depth, most of the seismic energy traveled away from the earthquake as P and S waves rather than as surface waves.