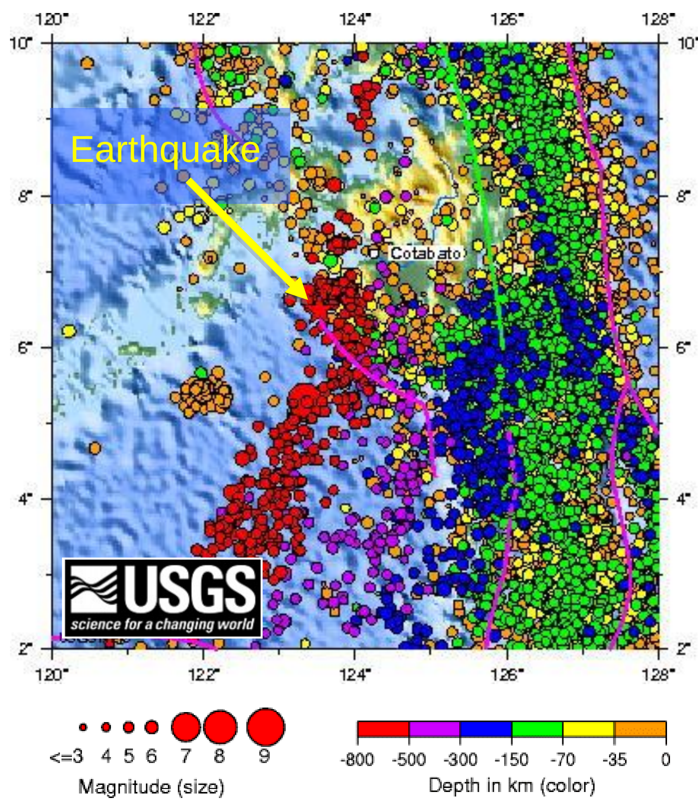
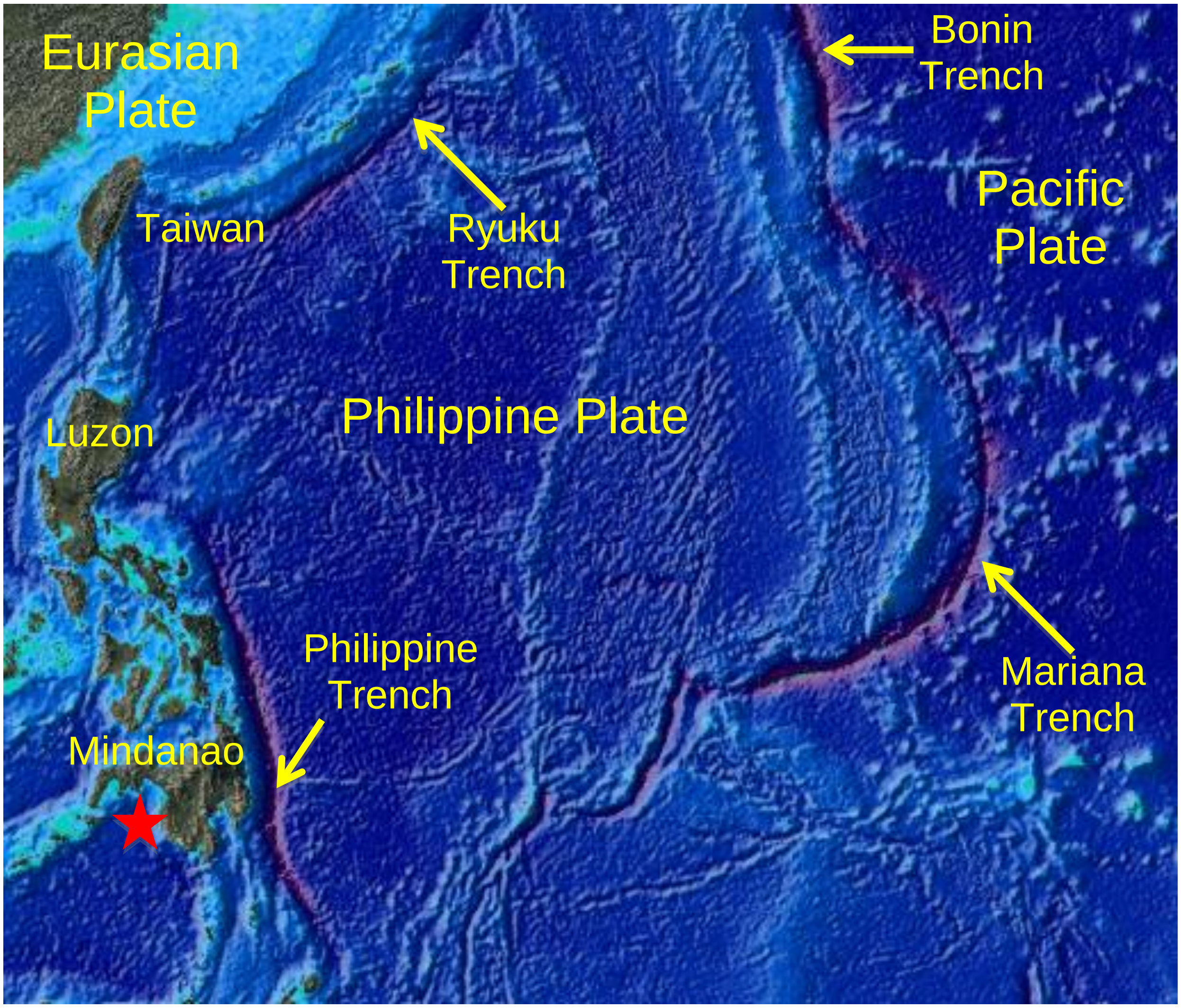
Magnitude 7.6 Earthquake Moro Gulf, Mindanao, Philippines
Friday, July 23, 2010 at 22:51:11 UTC
Epicenter: Latitude 6.494°N, 123.533°E. Depth: 576.3 kilometers.

As reported by the US Geological Survey National Earthquake Information Center, a major earthquake of magnitude 7.6 occurred Friday afternoon Portland time deep beneath the Moro Gulf, Mindanao, Philippines. The epicenter of the M7.6 earthquake is indicated by the red star on left-side map below. On the right-side map below, earthquakes from 1990 to present are illustrated with the epicenter of the July 23 event shown by the red star.

The map on the next page shows the configuration of tectonic plates and trenches in the western Pacific Ocean. The M7.6 earthquake occurred at 576 km depth within the Philippine Plate where it subducts towards the west beneath the Eurasian Plate. Just 43 minutes prior to the M7.6 earthquake, a M7.3 event occurred in the same region but ~30 km deeper within the Philippine Plate. Yet another earthquake of M7.4 in the same region occurred just 24 minutes after the M7.6 event but 40 km deeper within the Philippine Plate. This unusual sequence of three earthquakes between magnitude 7.3 and 7.6 occurred in a cluster about 600 km deep inside the Philippine Plate within an interval of 67 minutes. The initial M7.3 event is thus a foreshock of the M7.6 earthquake while the M7.4 event is an aftershock of the M7.6 earthquake.





The earthquakes were too deep to cause a tsunami. Additionally, because of the depth, they were reported to be hardly felt, and no damage has been reported.

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, Δ, of 103° because of the large decrease in seismic velocities across the boundary between the lower 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 Earth's center.) There is a "shadow zone" for direct P waves in the range 103° < Δ < 143°. The S-wave shadow zone exists for Δ > 103° because the liquid outer core blocks S waves that cannot travel through liquids.

The record of the M7.6 Moro Gulf earthquake on the University of Portland seismometer is illustrated below. Portland is about 11,279 km from the location of this earthquake and is at the edge of the shadow zone. The first arrival is small amplitude, and has a gradual onset, characteristics of a diffracted P wave arrival (Pdiff). This Pdiff is the first wave to arrive at Portland 771 seconds (12 minutes 51 seconds) after the earthquake. The second labeled arrival is pPdiff, a depth phase unique to deep earthquakes. This wave leaves the earthquake traveling towards the Earth's surface where it is reflected back into the mantle to travel approximately the same path as the Pdiff to the seismic station. The pPdiff arrives to Portland 897 seconds (14 minutes 57 seconds) after the earthquake, and the time difference between these two arrivals provides information about the depth of the earthquake. The next marked arrival on the record is a combination of a PP wave and a PKiKP wave which arrive simultaneously to Portland 1031 seconds (17 minutes 11 seconds) after the earthquake. PP is a compressive wave that traveled through Earth's mantle and bounced midway between the epicenter and Portland. PKiKP is a P wave that traveled a path from the earthquake through the mantle, outer core, inner core, outer core, and finally upwards through the mantle to the seismic station. The final labeled phase on this record is an SKS arrival. Since the distance to the earthquake puts Portland in the shadow zone for this earthquake, a direct S arrival is not expected. However the SKS is clear 1354 seconds (22 minutes 34 seconds) after the earthquake. SKS is a wave that leaves the earthquake as an S phase, converts to a P wave on the mantle – outer core boundary, travels through the outer core as a P wave, then converts back to an S wave as it travels upward through mantle – outer core boundary, arriving to the station as an S wave.