Major Magnitude 7.2 Earthquake South of Papua, Indonesia

Wednesday, September 29, 2010 at 17:11:24 UTC (10:11:24 AM PDT, Thursday 02:11:24 AM Local Time)
Epicenter: Latitude 4.920°S, 133.783°E. Depth: 12.3 kilometers.

As determined by the US Geological Survey National Earthquake Information Center (NEIC), a magnitude 7.2 earthquake occurred Wednesday in the Aru Basin south of Papua New Guinea. The epicenter is indicated by the red star on the left-side map below while the map on the right shows historic earthquake activity near the epicenter (yellow star) from 1990 to present. Just 33 seconds before the magnitude 7.2 main shock, a magnitude 6.2 foreshock occurred in the same location. The magnitude 7.2 earthquake was sufficiently far from populated areas on land that no reports of damage or deaths have been received. No tsunami watch or warning was issued because earthquakes of this magnitude are generally too small to generate a damaging tsunami.

Plate Tectonic Setting

On a broad scale, the Pacific, Philippine, and India-Australia plates in this region meet in a complex arrangement of subduction zones in the western Pacific Ocean. The Pacific Plate subducts beneath the Papua – New Guinea area at the northern fringe of the India-Australia Plate. In detail, there are numerous microplates (fragments of larger plates) with convergent and transform (strike-slip) boundaries between them. A more complete description of the plate tectonics in the New Guinea region can be found on the NEIC web site at: http://earthquake.usgs.gov/earthquakes/recenteqsww/Quakes/us2010ywbr.php#summary

Foreshocks

When a major earthquake is preceded by a smaller earthquake that occurs second, minutes, hours, or even days before, the preceding smaller earthquake is called a “foreshock” of the larger “main shock”. In this case, the magnitude 6.2 earthquake was a foreshock of the magnitude 7.2 earthquake that occurred just 33 seconds later. The foreshock – main shock relationship is analogous to what often happens when you bend and break a wood stick. You often hear small “crackling” sounds just before the wood stick breaks. Those crackling sounds are a few wood fibers breaking before the whole stick breaks in half. With earthquakes, a foreshock is a small patch of a fault rupturing before a larger patch on the same or a nearby fault ruptures to produce the larger main shock. An unsolved problem is: How can we tell if a particular earthquake is a foreshock to a larger earthquake before that larger earthquake occurs? If we could recognize foreshocks as warnings of impending larger earthquakes, this could be very useful for short-term earthquake forecasting and could be a breakthrough in earthquake mitigation. Seismologists are currently studying earthquake sequences with hopes of understanding foreshock – main shock relationships.

Google Earth™ mapping service

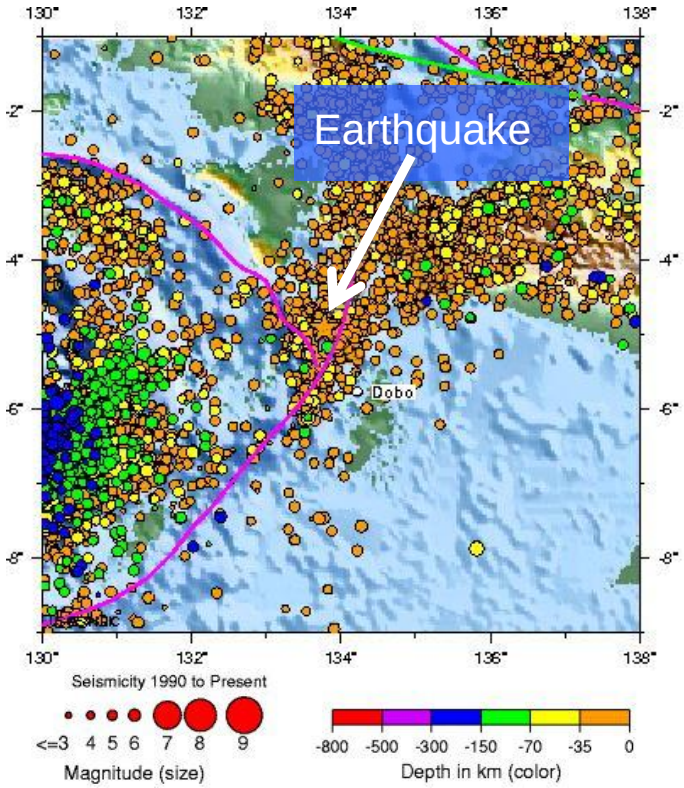


Image courtesy of the US Geological Survey

Seismogram Description

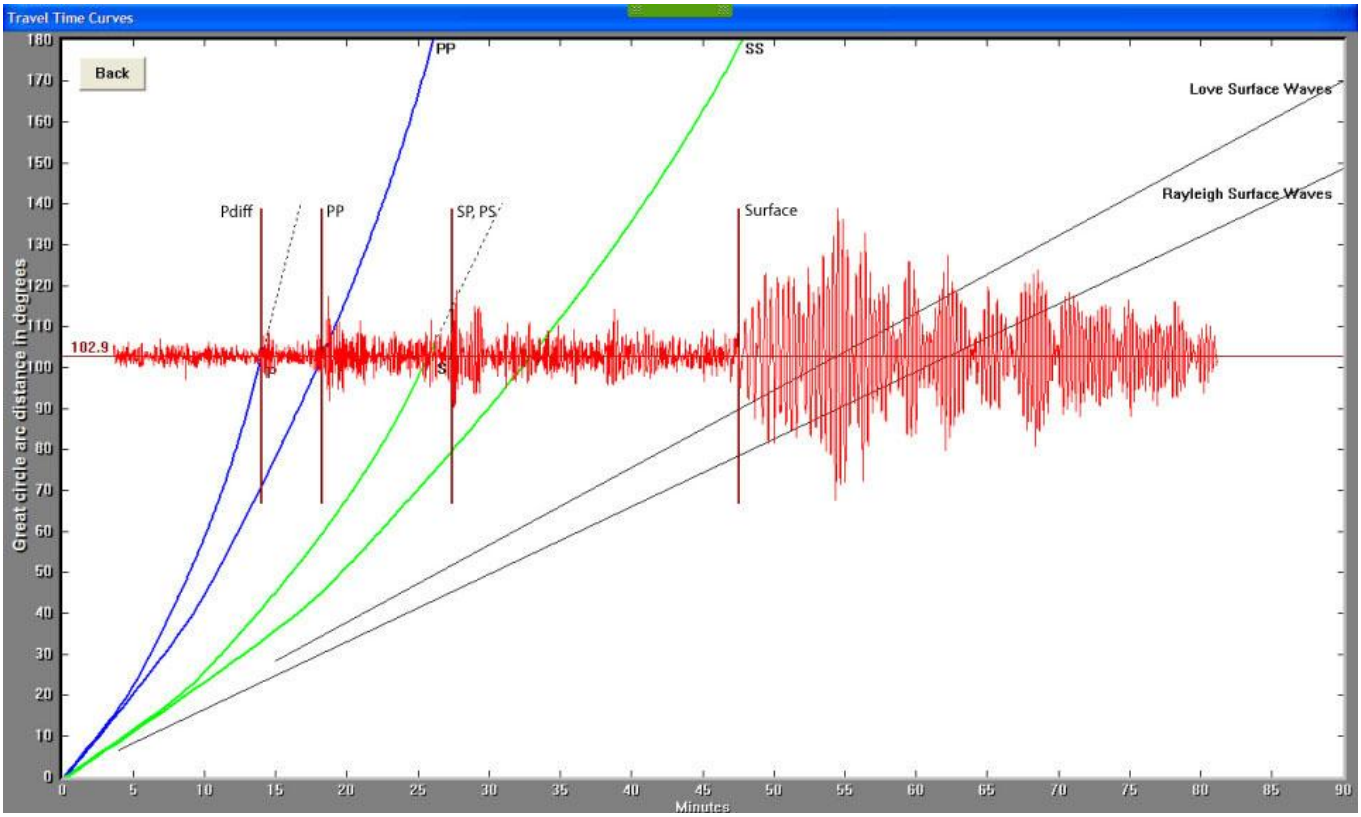
The record of the magnitude 7.2 Papua, Indonesia earthquake on the University of Portland seismometer is illustrated below. Portland is about 11,427 km (~7100 miles, 102.95 degrees) from the location of this earthquake. This record is complicated because just 33 seconds before the magnitude 7.2, a magnitude 6.2 foreshock occurred. Each phase arrival from the magnitude 7.2 described below is preceded by the arrivals from the magnitude 6.2 just 33 seconds earlier.

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.) This earthquake occurred at the edge of the shadow zone, and the first arrival to Portland appears to be a diffracted P wave, which travels through the mantle and is diffracted off the mantle - core boundary. It is recorded in Portland about 13 minutes 57 seconds after the earthquake. It is the first arrival marked on the seismogram below.

The second arrival marked 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. The PP wave arrives to the station about 18 minutes 12 seconds after the earthquake, with the PKiKP arriving 6 seconds later.

The third marked 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 to Portland about 27 minutes 19 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.



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