Magnitude 7.0 Major Earthquake Beneath Argentina
Saturday, January 1, 2011 at 09:56:59 UTC (01:56:59 AM PST)
06:56:59 AM Local time in Argentina
Epicenter: Latitude 6.758 °S, Longitude 63.103 °W Depth: 584 km

Earthquake Summary:

A major earthquake occurred beneath northern Argentina at 6:56:59 AM local time Saturday January 1. The red star on the left-hand map below shows the epicenter of the earthquake while the arrows show the direction of motion of the Nazca Plate toward the South American Plate. At the location of this earthquake, the two plates are converging at a rate of about 8 cm/yr. The map on the right shows historic earthquake activity near the epicenter (star) from 1990 to present. The legend at the bottom of the right-side map shows the color code used to indicate earthquake depth. Blue circles on the western side of this map are earthquakes with depths in the 150 - 300 km range. The line of red circles containing the January 1, 2011 event indicates earthquakes with depths in the 500 – 800 km range. The South American Plate is about 150 km thick so earthquakes on the interface between the Nazca and South American plates have maximum depth of about 150 km. This January 1, 2011 deep earthquake occurred within the Nazca Plate where it subducts towards the east-northeast into the mantle beneath the South American Plate. To produce earthquakes, rocks must be brittle so they can accumulate elastic energy as they bend then rapidly release that energy during earthquake rupture. Rocks are brittle at low temperatures but become viscoelastic when they reach temperatures of about 600 °C. With the exception of subducting oceanic plates, all rocks in Earth's mantle below about 100 km depth are viscoelastic and cannot rupture to produce earthquakes. Rocks within subducting oceanic plates are immersed in hotter mantle rocks and warm up as they descend deeper into the mantle. Rapidly subducting oceanic plates can reach depths up to about 700 km into the mantle before they become too warm to produce earthquakes. The January 1, 2011 earthquake below Argentina is an example of a deep earthquake within one of the many subduction zones around the Pacific Ring of Fire.

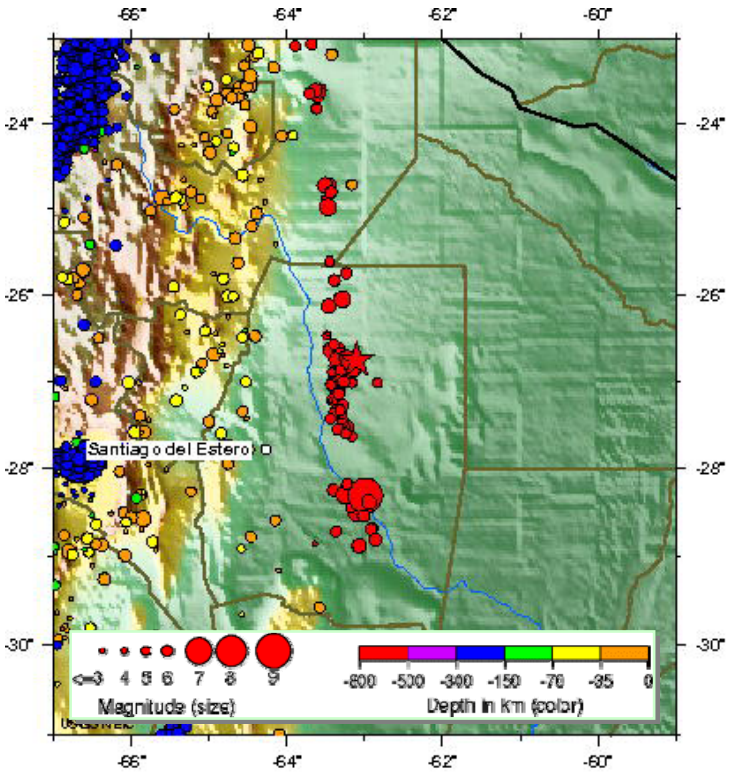
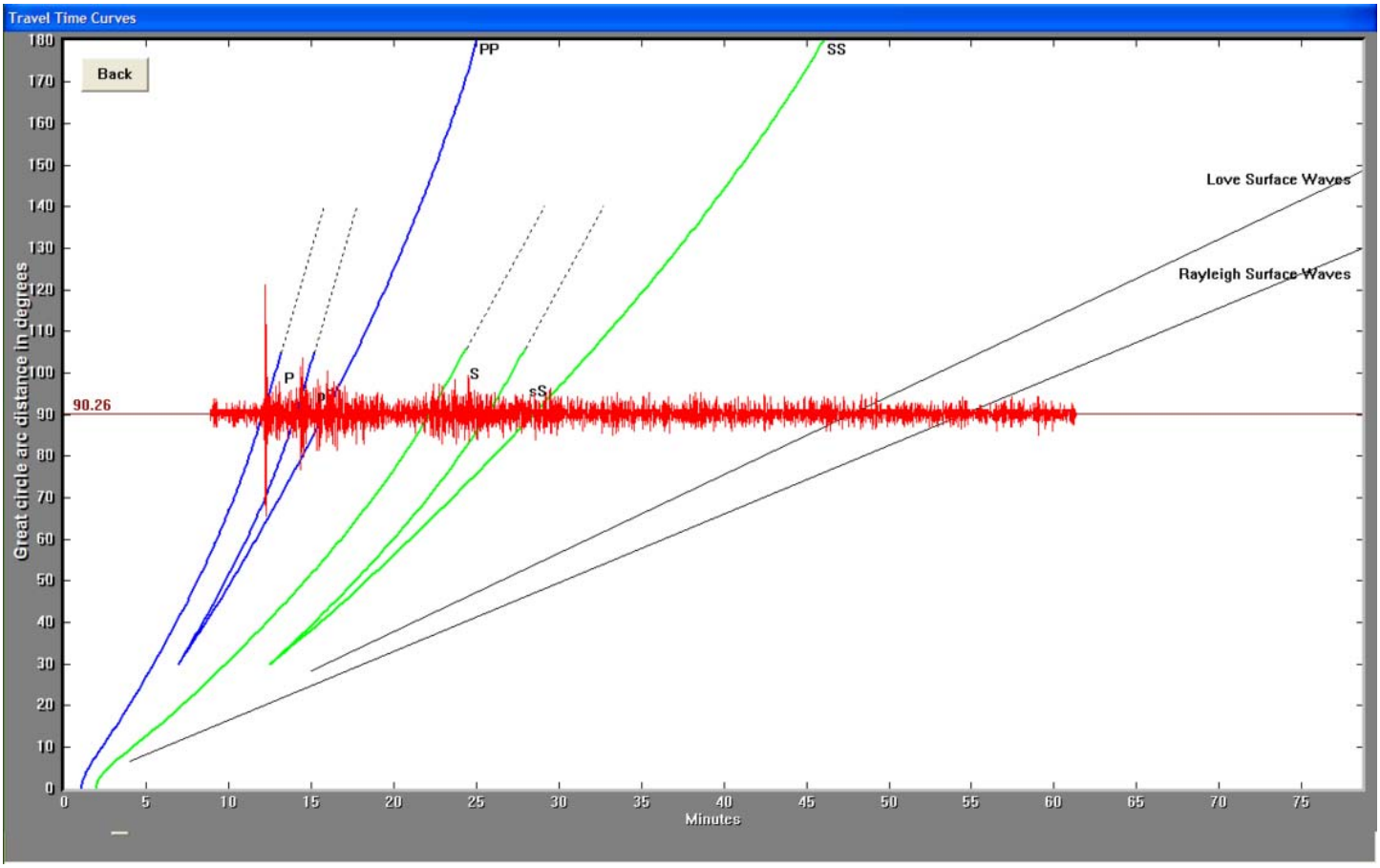


Image courtesy of the US Geological Survey

Seismogram Description:

The record of the M7.0 Argentina earthquake on the University of Portland seismometer in Portland, Oregon is illustrated below. Portland is about 9990 km (90°) from the location of this very deep earthquake (approximately 584 km deep). Following the earthquake, it took 11 minutes and 58 seconds for the P waves to travel from the Argentina earthquake to Portland, Oregon. P waves are body waves, compressional waves that travel through the Earth's mantle. The second arrival is pP, a depth phase unique to deep earthquakes. This wave leaves the earthquake traveling up towards the Earth's surface where it is reflected back into the mantle to travel approximately the same path as the P waves to the seismic station. The pP arrived in Portland 14 minutes 4 seconds after the earthquake, and the time difference between the P and pP arrivals provides information about the depth of the earthquake. PP waves are P waves that bounce once off the Earth's surface between the epicenter and the recording seismometer. PP waves from the January 1, 2011 earthquake arrived 15 minutes 42 seconds after the earthquake. The S waves started arriving 22 minutes 2 seconds after the earthquake occurred. S waves are also body waves, but they travel as shear waves through Earth's mantle. Following the S wave arrival, sS and SS wave arrivals can be seen on the record. Deep earthquakes often do not generate surface waves because Earth's surface is very far from the earthquake and therefore experiences a very small displacement. In addition to the time difference between the P and pP waves, the lack of surface waves is another clue that this was a very deep earthquake.



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