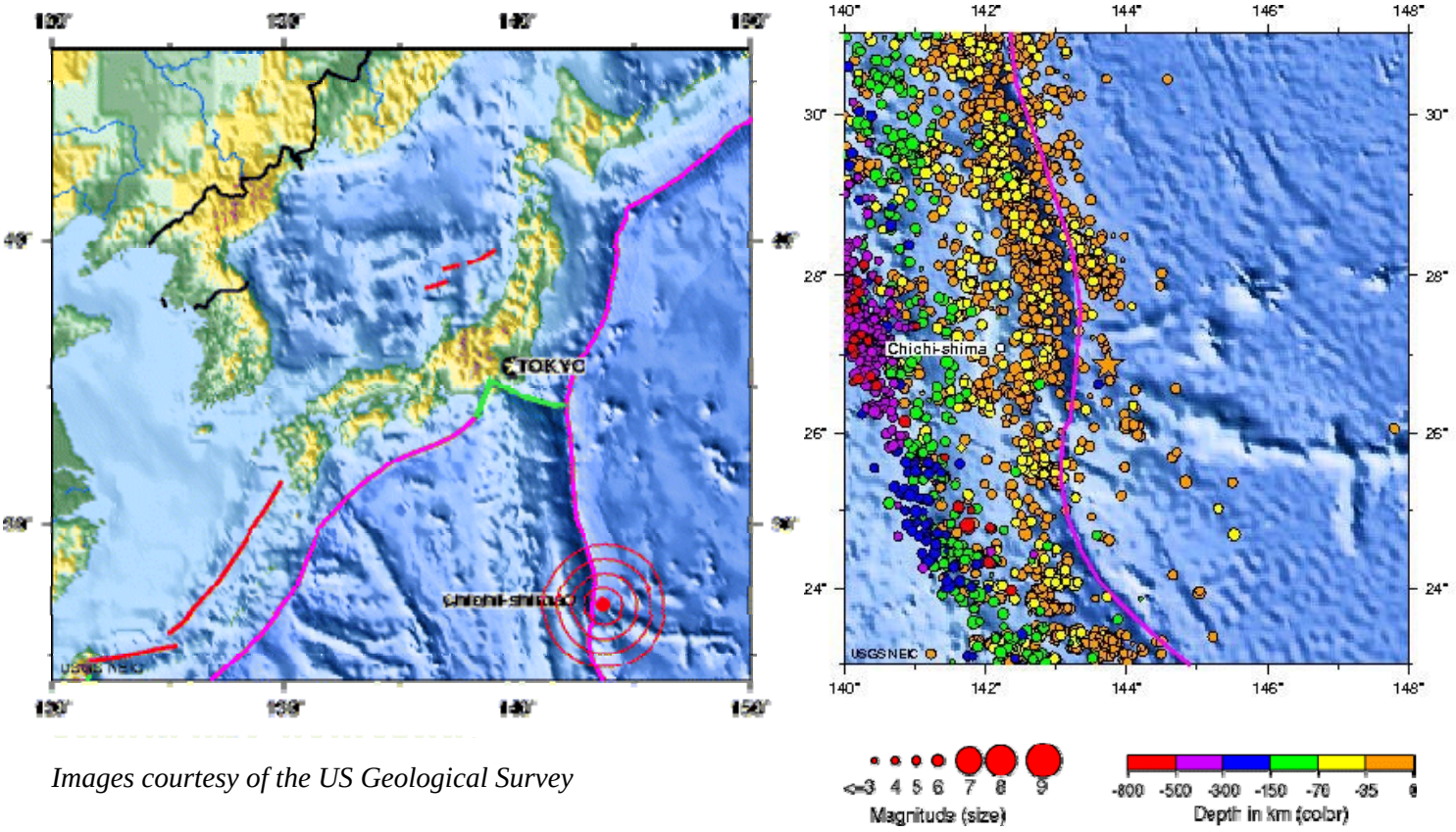
Major 7.4 Earthquake in Bonin Islands Region, Japan
Tuesday, December 21, 2010 at 17:19:41 UTC (09:19:40 AM PST)
Wednesday, December 22, 2010 at 03:19:40 AM at epicenter
Epicenter: Latitude 26.866°N, 143.739°E. Depth: 14.9 kilometers.

Earthquake Summary:

A major earthquake occurred Wednesday morning Portland time in the Bonin Islands region, about 210 miles northeast of Iwo Jima and 650 miles south-southeast of Tokyo. The circle with surrounding rings on left-side map below illustrates the epicenter of this earthquake as determined by the US Geological Survey. The map on the right below shows historic earthquake activity near the epicenter (star) from 1990 to present.

This earthquake occurred just east of the Japan Trench where the Pacific Plate subducts beneath the Philippine Plate. Historic earthquakes on this subduction zone are shallow at the Japan Trench and increase to >500 km depth (red dots) towards the west as the Pacific Plate dives deeper beneath the Philippine Plate. Because the epicenter of the December 21 event was remote from population centers, there were no reports of significant damage or injuries produced by this earthquake. A tsunami warning was issued and a small tsunami was generated but the largest reported wave heights were less than 6 inches.

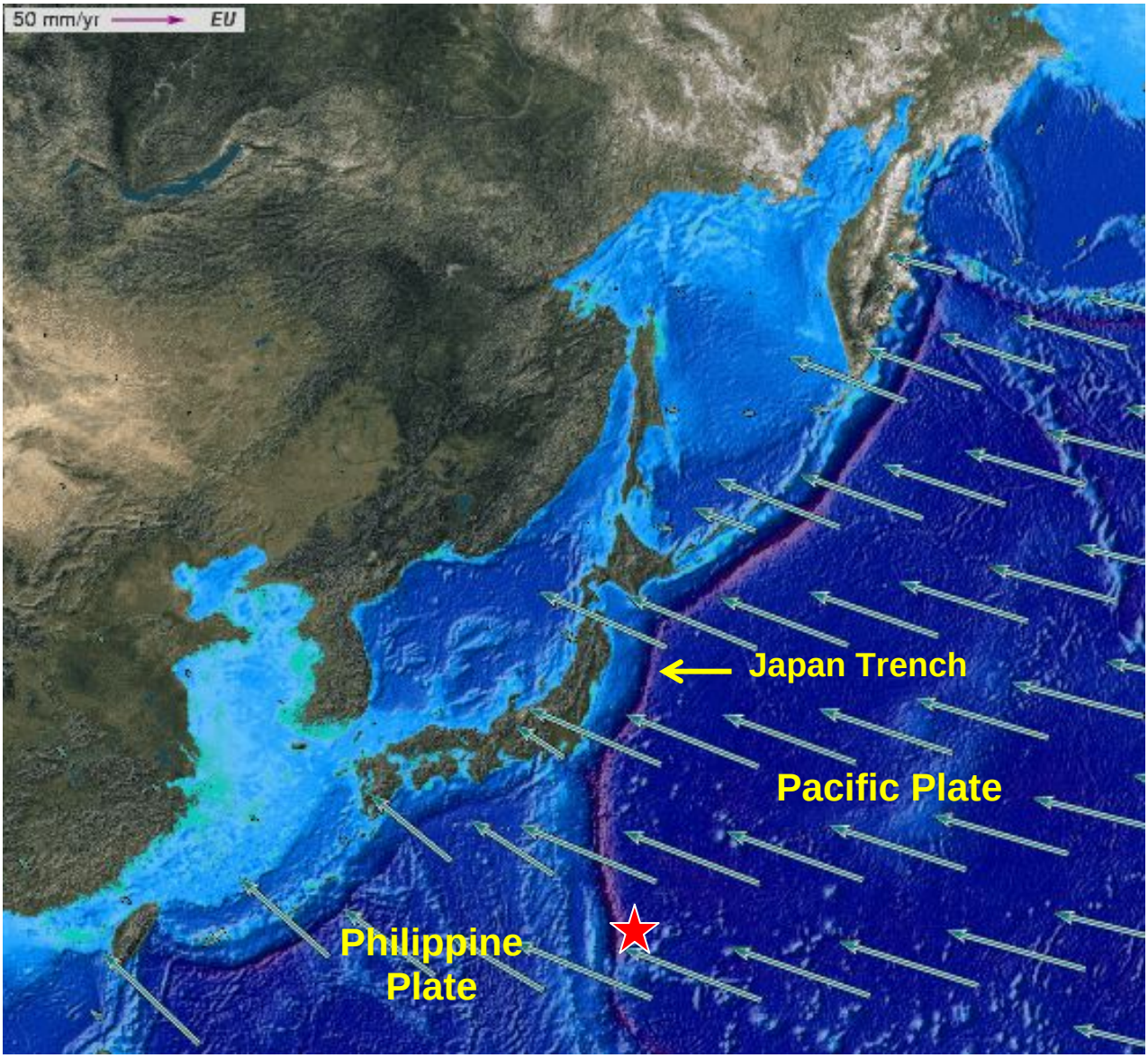


Images courtesy of the US Geological Survey

Plate Tectonic Setting:

The epicenter of the earthquake that occurred December 21, 2010 is indicated by the red star on the map below. This map also shows the rate and direction of motion of the Pacific Plate with respect to the Philippine Plate near the Japan Trench. The rate of convergence at this plate boundary is about 100 mm/yr (10 cm/year). This is a fairly high convergence rate and this subduction zone is very seismically active. For comparison, the convergence rate of the Juan de Fuca Plate beneath the North American Plate at the Cascadia subduction zone is about 35 mm/yr (3.5 cm/year).

It is noteworthy that the epicenter is east of the Japan Trench so this earthquake was not on the interface between the Pacific and Philippine Plates along the subduction zone boundary. Outboard of trenches where oceanic plates subduct, the plate must bend to start its descent into the trench. This bending results in extensional stress within the upper part of the oceanic plate. Indeed, the mechanism of the December 21 earthquake was dominantly normal faulting indicating that extensional forces were responsible for this earthquake that occurred within the upper part of the Pacific Plate.



Seismogram Description:

The record of the M7.4 Bonin Islands, Japan on the University of Portland seismometer (UPOR) is illustrated below. Portland is about 8177 km (5081 miles, 73.67°) from the location of this earthquake. Following the earthquake, it took 11 minutes and 33 seconds (693 seconds) for the compressional P waves to travel a curved path through the mantle from the Bonin Islands to Portland. PP waves are compressional waves that bounced off the Earth's surface halfway between the earthquake and the station. PP energy arrived 14 minutes and 17 seconds (857 seconds) after the earthquake. S waves are shear waves that follow the same path through the mantle as P waves. The S waves arrived 21 minutes and 3 seconds (1263 seconds) after the earthquake. Surface wave energy required approximately 31 minutes and 9 seconds (1869 seconds) to travel the 8177 km (5081 miles) around the perimeter of the Earth from the Bonin Islands to Portland, Oregon.