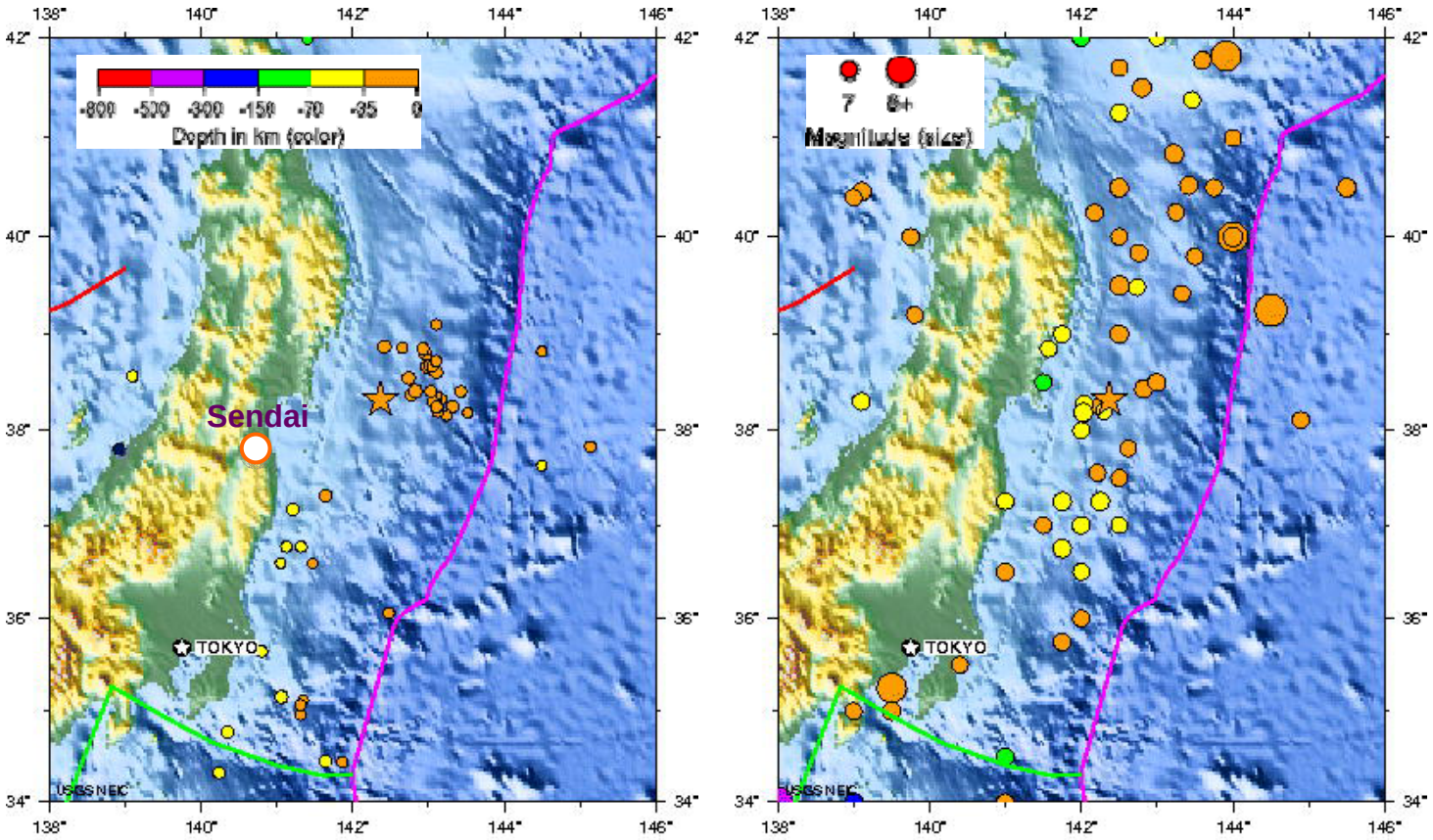
Magnitude 8.9 Great Earthquake Near East Coast of Honshu, Japan
Friday, March 11, 2011 at 05:46:23 UTC (March 10, 21:46:23 PST)
Epicenter: Latitude 38.322°N, 142.369°E. Depth: 24.4 kilometers.

Earthquake Summary:

A great earthquake occurred Friday afternoon at 2:46:23 local time off the east coast of Honshu about 130 kilometers (80 miles) east of Sendai, a city with population over one million that experienced very strong ground shaking. The star on left-side map below illustrates the epicenter of the M8.9 earthquake as determined by the US Geological Survey National Earthquake Information Center.

Also illustrated on the left-side map are epicenters of earthquakes that have occurred in this region during 2011. The set of orange circles to the east of the M8.9 earthquake epicenter are locations of the magnitude 7.2 earthquake that occurred on March 9 and its aftershocks. Given the close proximity of the M7.2 earthquake and its aftershocks to the M8.9 great earthquake, it is now apparent that these were “foreshocks” to the March 11 great earthquake. (Unfortunately, we do not yet know how to determine that a foreshock is a precursor to a larger earthquake until that larger event takes place. The designation of an earthquake as a foreshock is made with 20-20 hindsight. The analogy is that, when you bend a stick of wood, you often hear the cracking of a few wood fibers before the stick completely breaks through.)

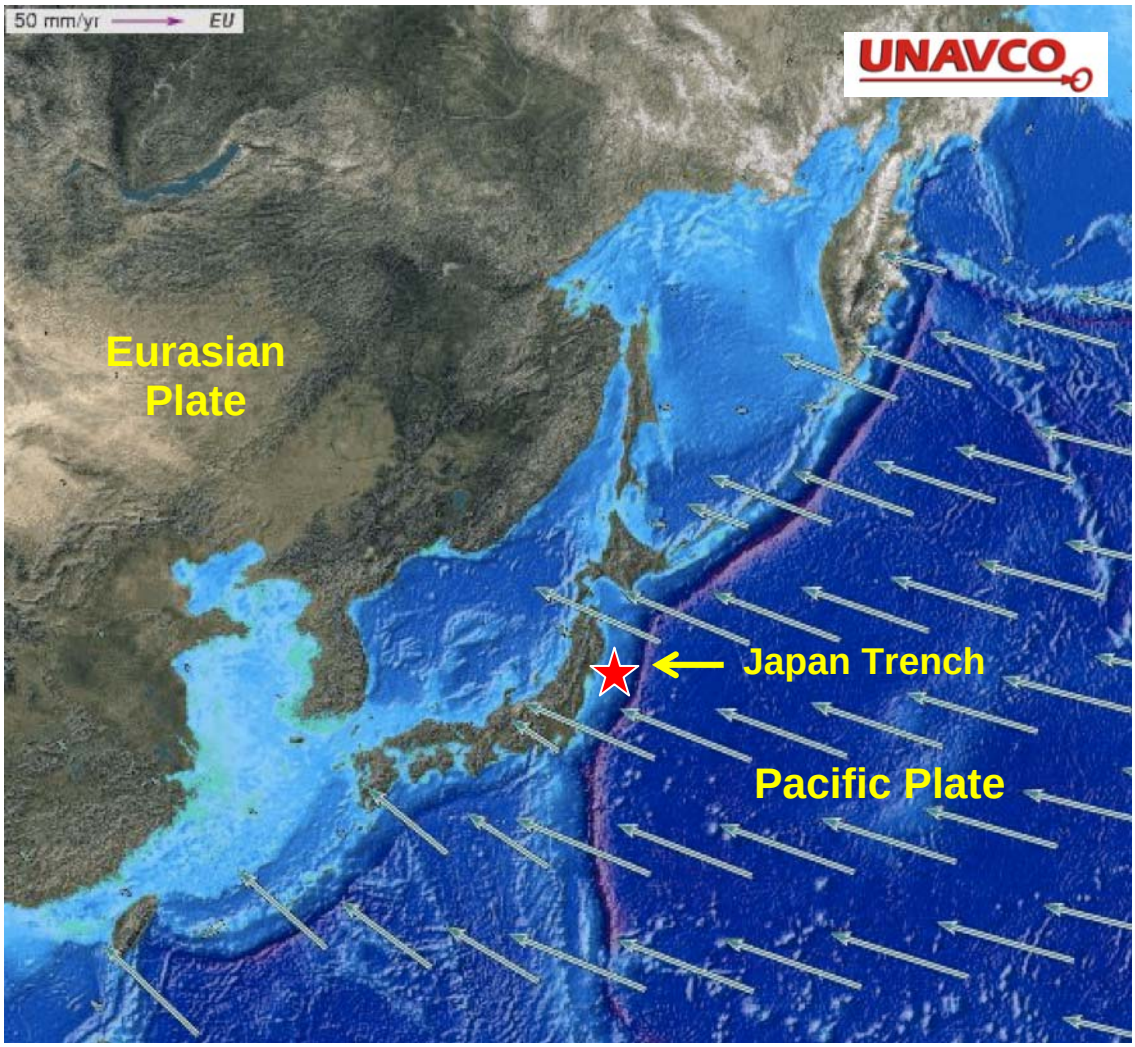
The map on the right below shows magnitude 7 and larger earthquakes in this region since 1900. Including the March 11 great earthquake, there have been five great (M8 or larger) earthquakes in this region over the past 111 years. So great earthquakes are not uncommon in this region, at least when viewed over centuries time scales.



Images courtesy of the US Geological Survey

Regional Tectonics:

The epicenter of the great earthquake that occurred March 11, 2011 is indicated by the red star on the map below. This earthquake was the result of thrust faulting along or near the convergent plate boundary where the Pacific Plate subducts beneath Japan. This map also shows the rate and direction of motion of the Pacific Plate with respect to the Eurasian 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).



Hazards:

Great earthquakes at shallow depth beneath the ocean pose a major tsunami threat. Indeed a 4-meter (13-feet) high tsunami did arrive along the Japanese coast nearest the epicenter. In various locations along Japan's coast, severe flooding has occurred with dozens of cars, boats, and buildings carried along by waters. Reports of damage, injuries, and possible fatalities are preliminary at this time, but the damage appears to be extensive. The Pacific Tsunami Warning Center in Hawaii quickly issued a tsunami warning for the state of Hawaii, and later extended the warning to the entire Pacific region.

Seismogram Description:

The record of the M8.9 earthquake that occurred near the east coast of Honshu, Japan on the University of Portland seismometer (UPOR) is illustrated below. Portland is about 7427 km (4615 miles, 66.91°) from the location of this earthquake. Following the earthquake, it took 10 minutes and 50 seconds (650 seconds) for the compressional P waves to travel a curved path through the mantle from Japan to Portland. PP waves are compressional waves that bounce off the Earth's surface halfway between the earthquake and the station. PP energy arrived 13 minutes and 17 seconds (797 seconds) after the earthquake. S and SS are shear waves that follow the same path through the mantle as P and PP waves, respectively. The S waves arrived 19 minutes and 42 seconds (1182 seconds) and SS waves arrived 24 minutes and 2 seconds (1442 seconds) after the earthquake. Surface wave energy required approximately 28 minutes and 18 seconds (1698 seconds) to travel the 7427 km (4615 miles) around the perimeter of the Earth from Japan to Portland, Oregon.