Magnitude 8.3 OFFSHORE COQUIMBO, CHILE
Wednesday, September 16, 2015 at 22:54:33 UTC

USGS

A great 8.3 magnitude earthquake struck offshore Chile late Wednesday. The earthquake occurred 229km (142mi) north-northwest of the capital Santiago. The earthquake shook buildings in Santiago and generated a tsunami that caused flooding in some coastal areas. The coastal town of Coquimbo was hit by waves of up to 4.5 meters (15 feet) high after the earthquake.

Tsunami advisories were issued for parts of South America and as far away as Hawaii, California and French Polynesia.

Police patrol a debris strewn street in Valparaiso, Chile, after a tsunami, caused by an earthquake in the area, Wednesday, Sept. 16, 2015. A magnitude-8.3 earthquake hit off Chile's central coast, causing buildings to sway in Santiago and other cities and sending people running into the streets. Authorities reported one death in a town north of the capital.

(Pablo Ovalle Isasmendi / AP)

Teachable Moments

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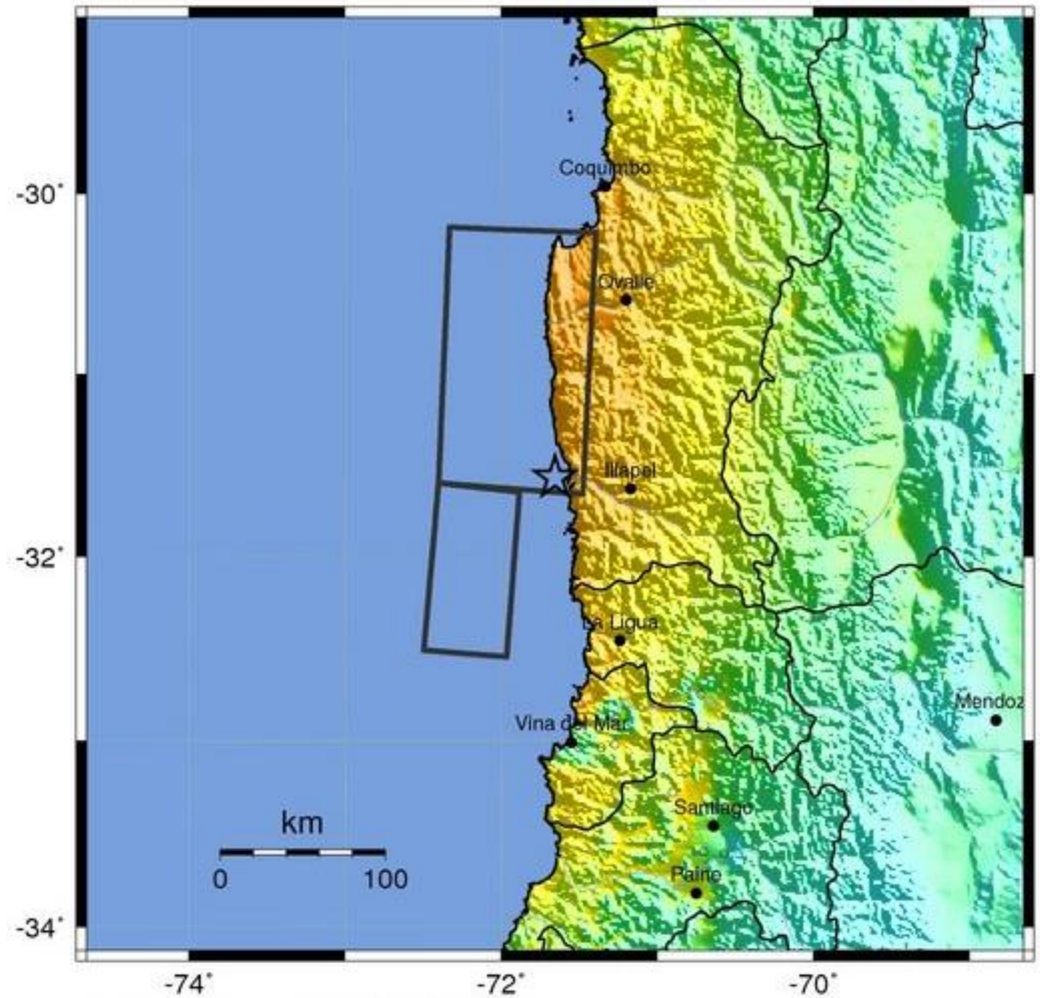
The Modified-Mercalli Intensity scale is a twelve-stage scale, from I to XII, that indicates the severity of ground shaking.

The coastline nearest the earthquake experienced severe shaking.

Modified Mercalli Intensity	Perceived Shaking
X	Extreme
IX	Violent
VIII	Severe
VII	Very Strong
VI	Strong
V	Moderate
IV	Light
II-III	Weak
I	Not Felt

Image courtesy of the US Geological Survey



USGS Estimated shaking Intensity from M 8.3 Earthquake

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USGS PAGER
Population Exposed to Earthquake Shaking

The USGS PAGER map shows the population exposed to different Modified Mercalli Intensity (MMI) levels.

27,000 people were exposed to severe shaking from this earthquake.

MMI	Shaking	Pop.
I	Not Felt	--*
II-III	Weak	--*
IV	Light	650k*
V	Moderate	7,870k*
VI	Strong	1,727k
VII	Very Strong	748k
VIII	Severe	27k

The color coded contour lines outline regions of MMI intensity. The total population exposure to a given MMI value is obtained by summing the population between the contour lines. The estimated population exposure to each MMI Intensity is shown in the table.

Image courtesy of the US Geological Survey

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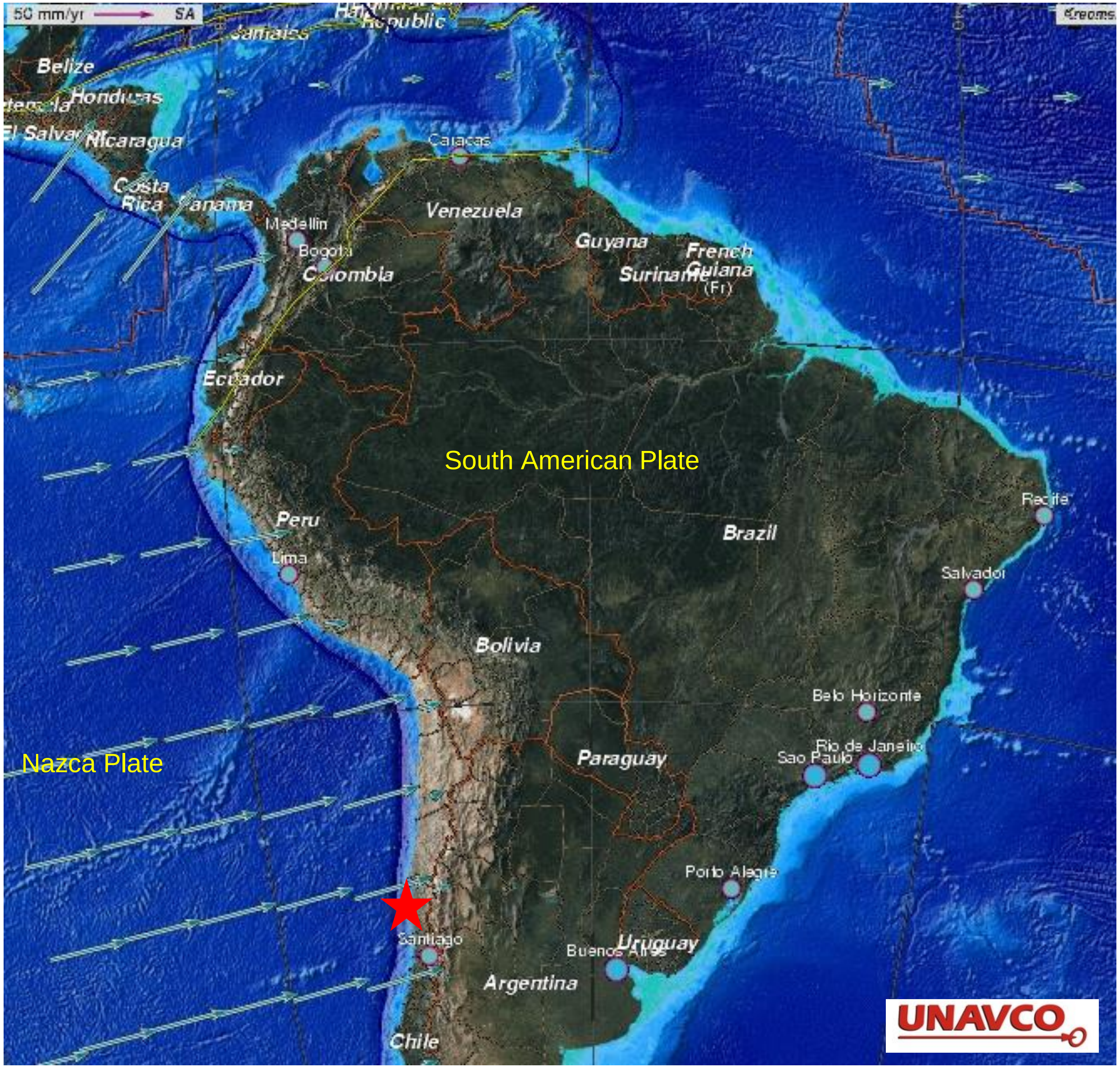
This earthquake occurred on the subduction zone plate boundary at the Peru – Chile Trench where the oceanic Nazca Plate subducts beneath the continental South American Plate.

The red star on the 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 6.3 cm/yr.



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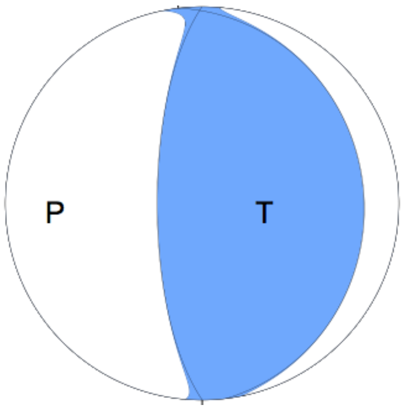
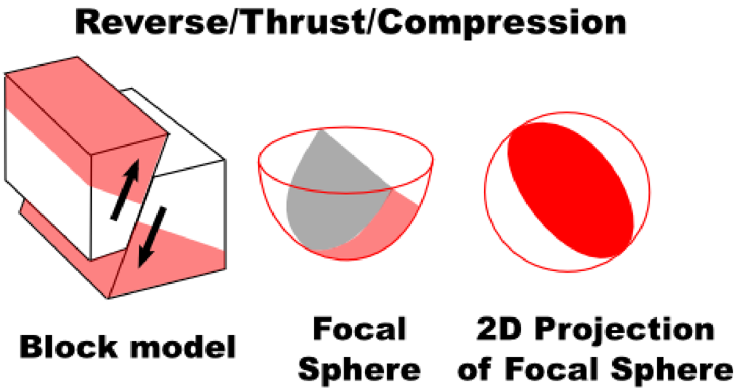
This magnitude 8.3 earthquake has a focal mechanism that indicates thrust faulting. This mechanism is consistent with displacement along the megathrust boundary between the Nazca and South America Plates. The two plates are converging at a rate of 63 mm per year. The earthquake occurred as thrust-faulting on the interface between the two plates, with the Nazca plate moving down and landward below the South American Plate.

In theory, either the nodal plane dipping ~70° to the west or the nodal plane dipping ~20° to the east could be the fault plane. Given the location of the earthquake on or near the megathrust plate boundary, the shallow east-dipping nodal plane is almost certainly the fault plane.



USGS Centroid Moment Tensor Solution



Shaded areas show quadrants of the focal sphere in which the P-wave first-motions are away from the source, and unshaded areas show quadrants in which the P-wave first-motions are toward the source. The letters represent the axis of maximum compressional strain (P) and the axis of maximum extensional strain (T) resulting from the earthquake.

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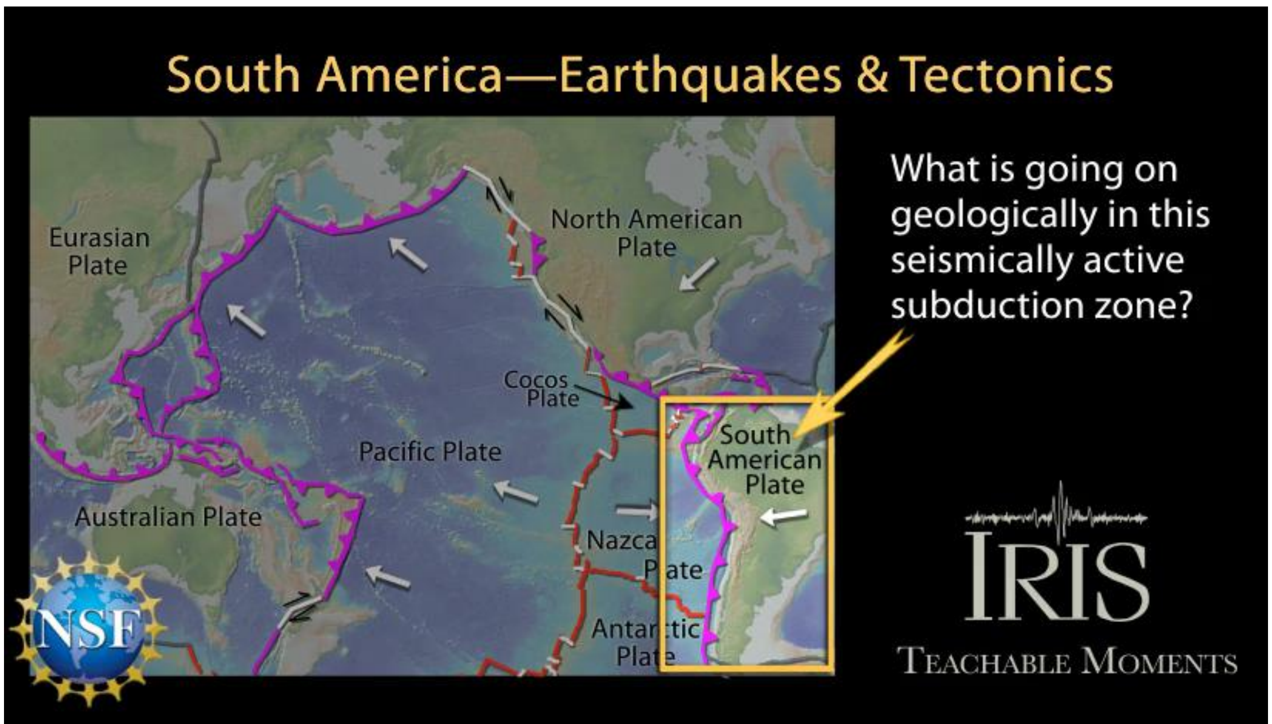
This magnitude 8.3 earthquake is typical of great subduction zone earthquakes on the shallow portion of the Nazca – South America plate boundary. Earthquakes also occur within the shallow portions of both plates near the boundary; within the top portion of the Nazca Plate as it bends to descend into the deeper mantle; and at depths greater than 100 km within the subducting Nazca Plate.



Animation exploring plate tectonics and earthquakes of the Nazca – South America plate boundary region.

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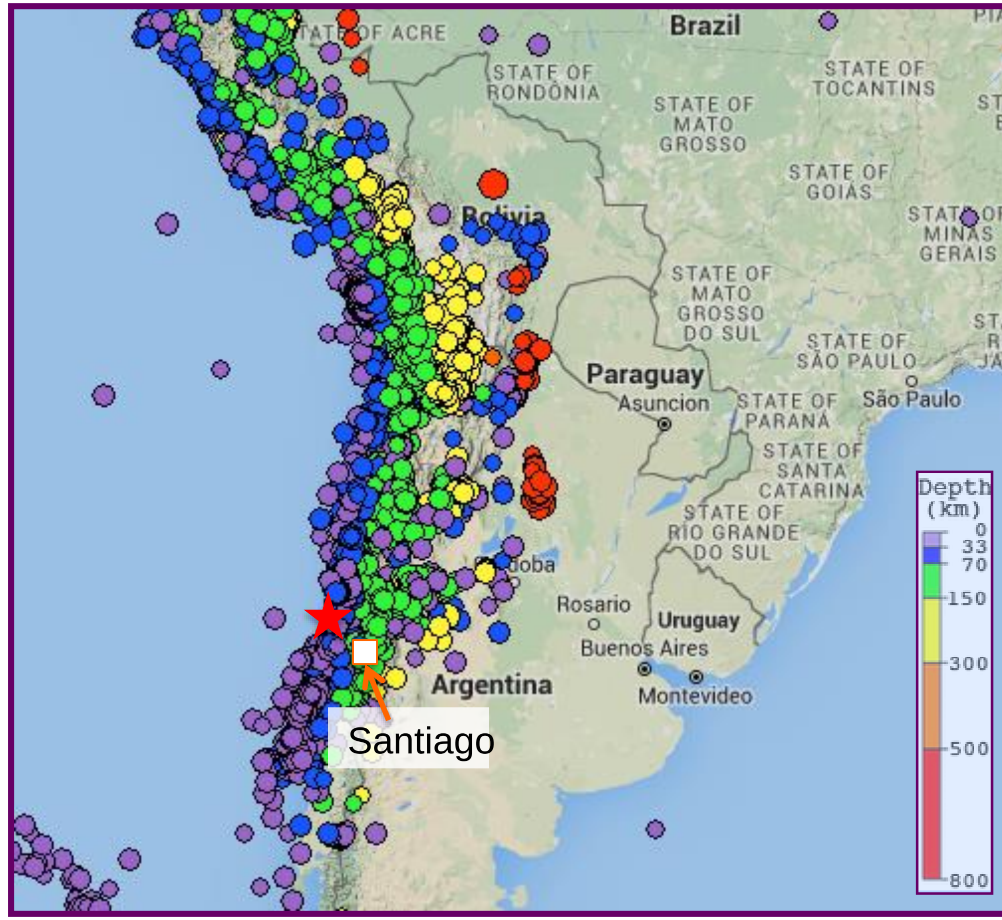
This map shows seismicity along the west coast of South America from southern Chile into Peru. Earthquakes are color-coded by depth as shown by the legend in the lower right corner. Depths of earthquakes increase from west to east across the subduction zone.

Earthquakes deeper than 100 km occur within the subducting Nazca Plate. The epicenter of the September 16, 2015 earthquake is shown by the red star and is located 229 km (142 miles) NNW of Santiago.



Created using the IRIS Earthquake Browser (IEB).

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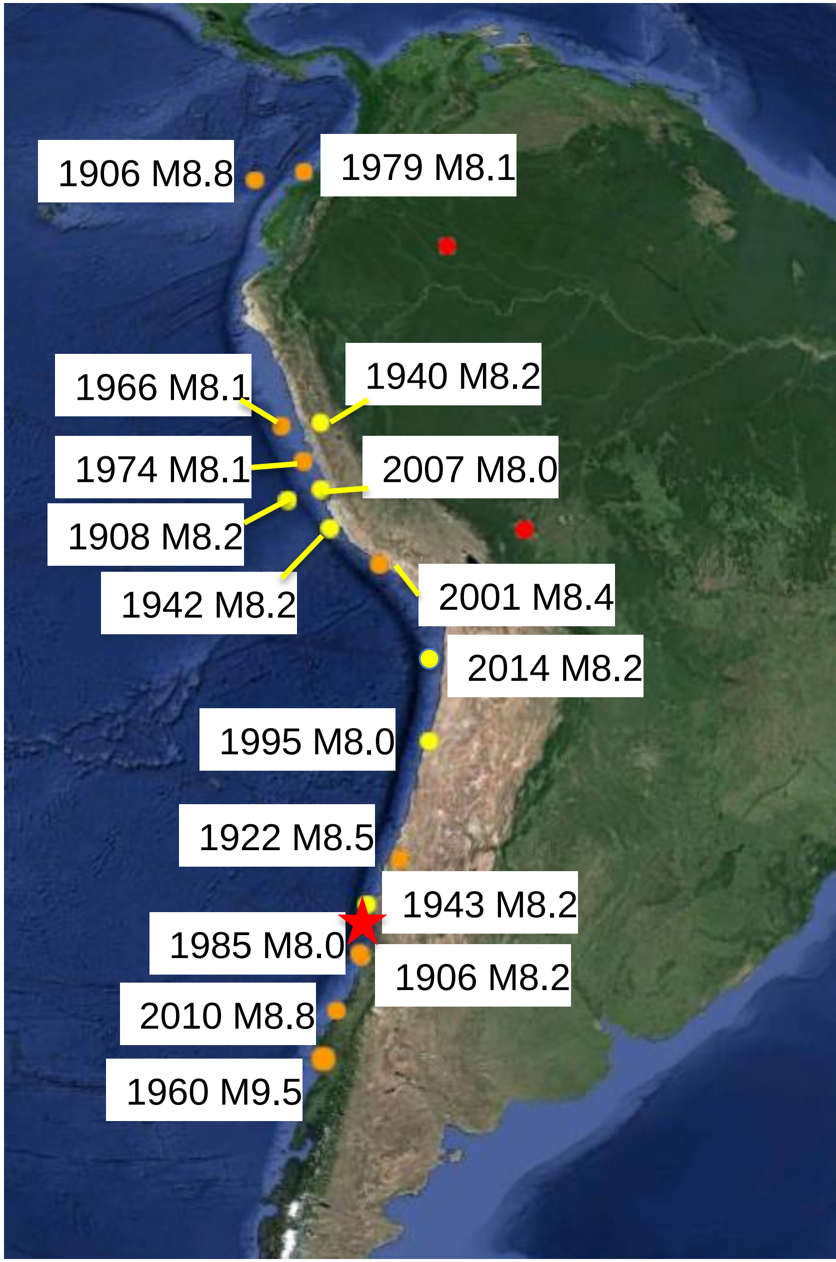
Earthquakes with magnitude ≥ 8.0 are designated as “great” earthquakes. The US Geological Survey National Earthquake Information Center has published a list of great earthquakes that have occurred since 1900.

Including the September 16, 2015 magnitude 8.3 earthquake,18 great earthquakes have locations and depths consistent with hypocenters on the Nazca – South America plate boundary.

The epicenter of the September 16 earthquake is shown by the red star on the map. This epicenter is located between those of the 1943 M8.2 Coquimbo earthquake and the 1985 M8.0 Valaparaiso earthquake.



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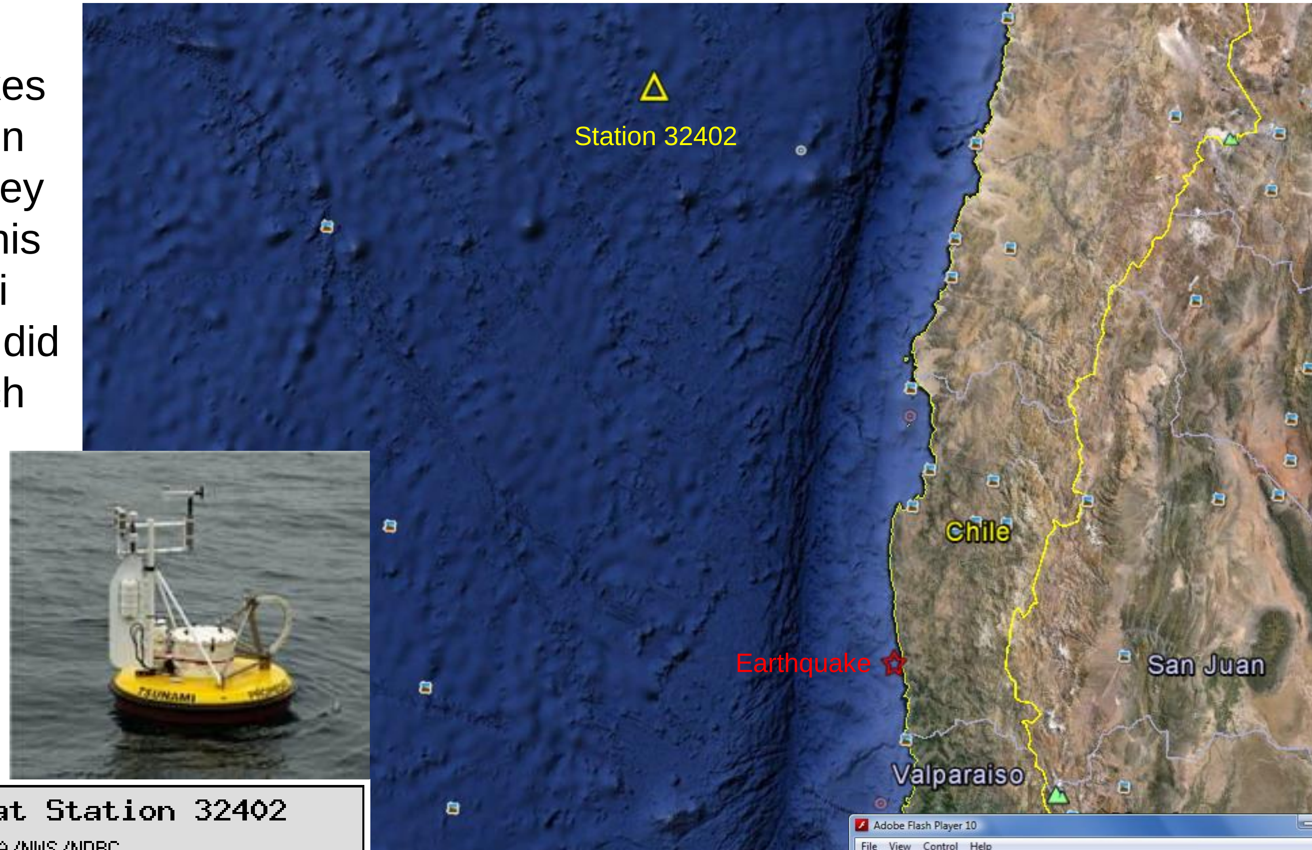
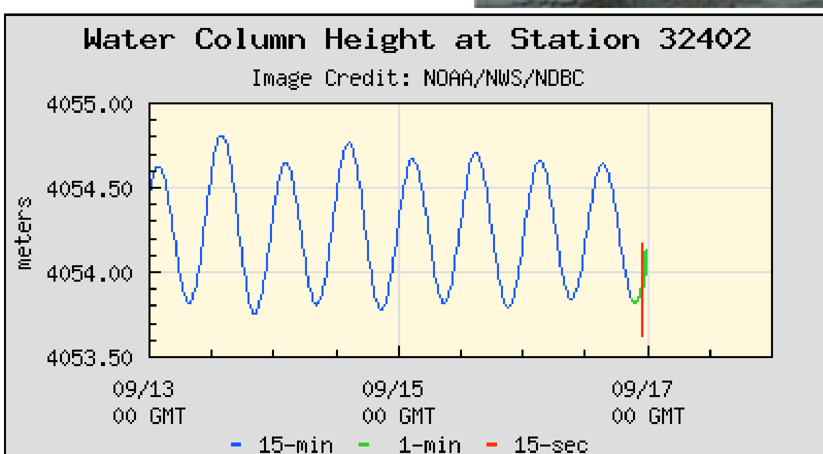
Shallow great earthquakes in subduction zones often cause tsunamis when they offset the ocean floor. This offset generates tsunami waves. This earthquake did produce a tsunami, which was measured on a nearby buoy and triggered the warning system.





The water column height change that triggered the system.

Flash animation of how the DART system detects ocean waves

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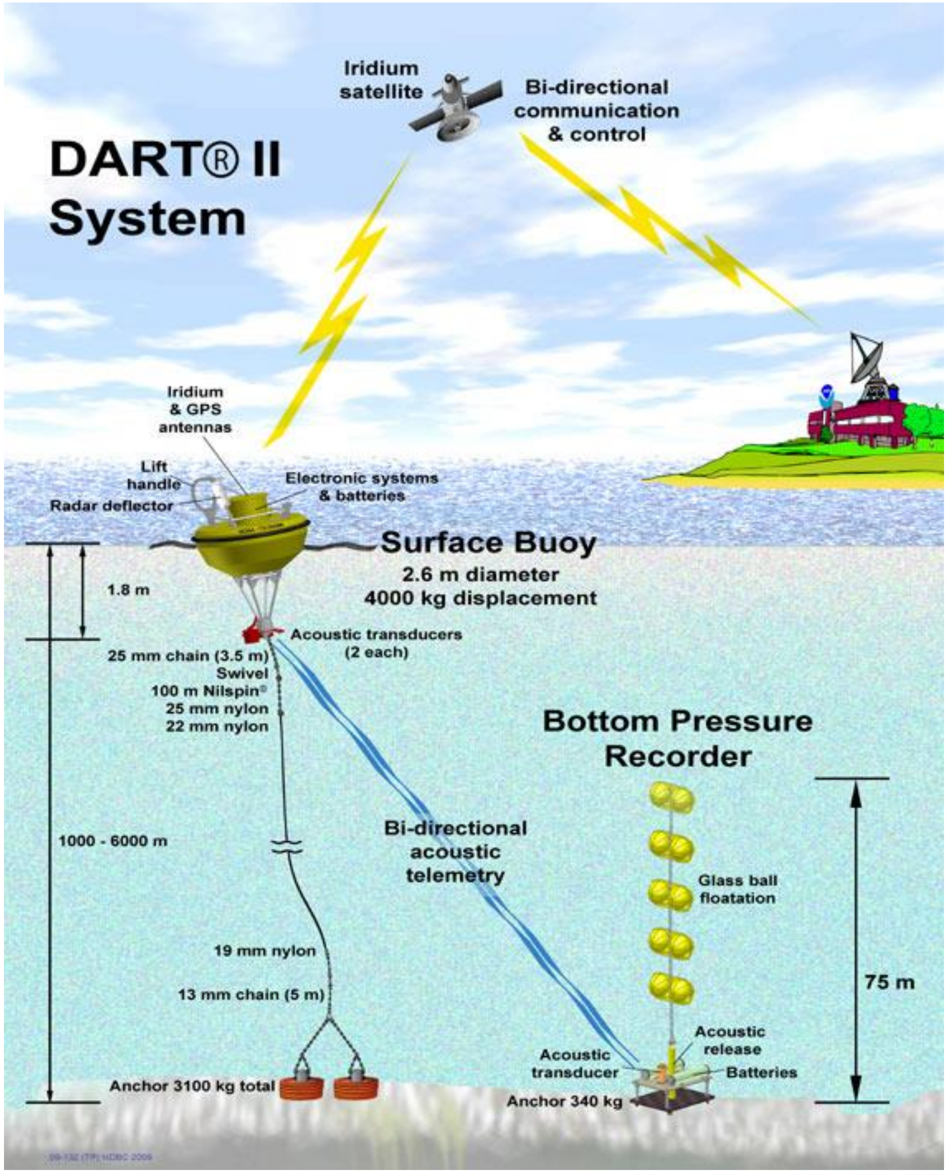

The DART II® system consists of a seafloor bottom pressure recording (BPR) system capable of detecting tsunamis as small as 1 cm, and a moored surface buoy for real-time communications.

DART II has two-way communications between the BPR and the Tsunami Warning Center (TWC) using the Iridium commercial satellite communications system. The two-way communications allow the TWCs to set stations in event mode in anticipation of possible tsunamis or retrieve the high-resolution (15-s intervals) data in one-hour blocks for detailed analysis.

DART II systems transmit standard mode data, containing twenty-four estimated sea-level height observations at 15-minute intervals, once every six hours.

NOAA

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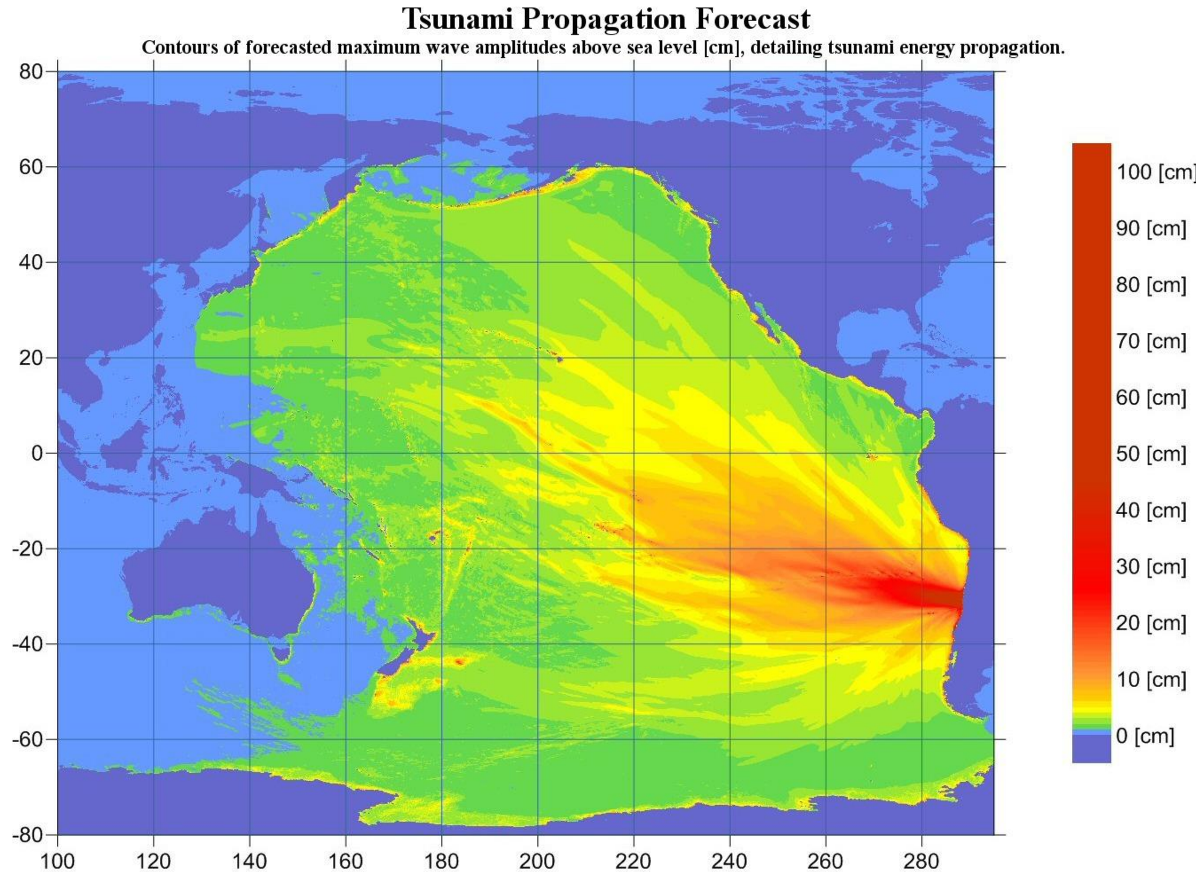
In the open ocean, a tsunami travels at a speed of over 700 km/hr (~440 mph) and the wave moves the ocean water all the way to the sea floor. This "shallow water" behavior means that the velocity and projected wave heights of a tsunami can be calculated using a map of ocean depth.

The map on the right is from NOAA's West Coast and Alaskan Tsunami Warning Center. This map shows the predicted amplitudes of the tsunami produced by the M8.3 Chilean earthquake. Since tsunamis have such large wavelengths, they "experience" the ocean as shallow water. This makes tsunamis nondispersive and allows them to propagate without dispersion or significant loss of energy across entire ocean basins.



NOAA

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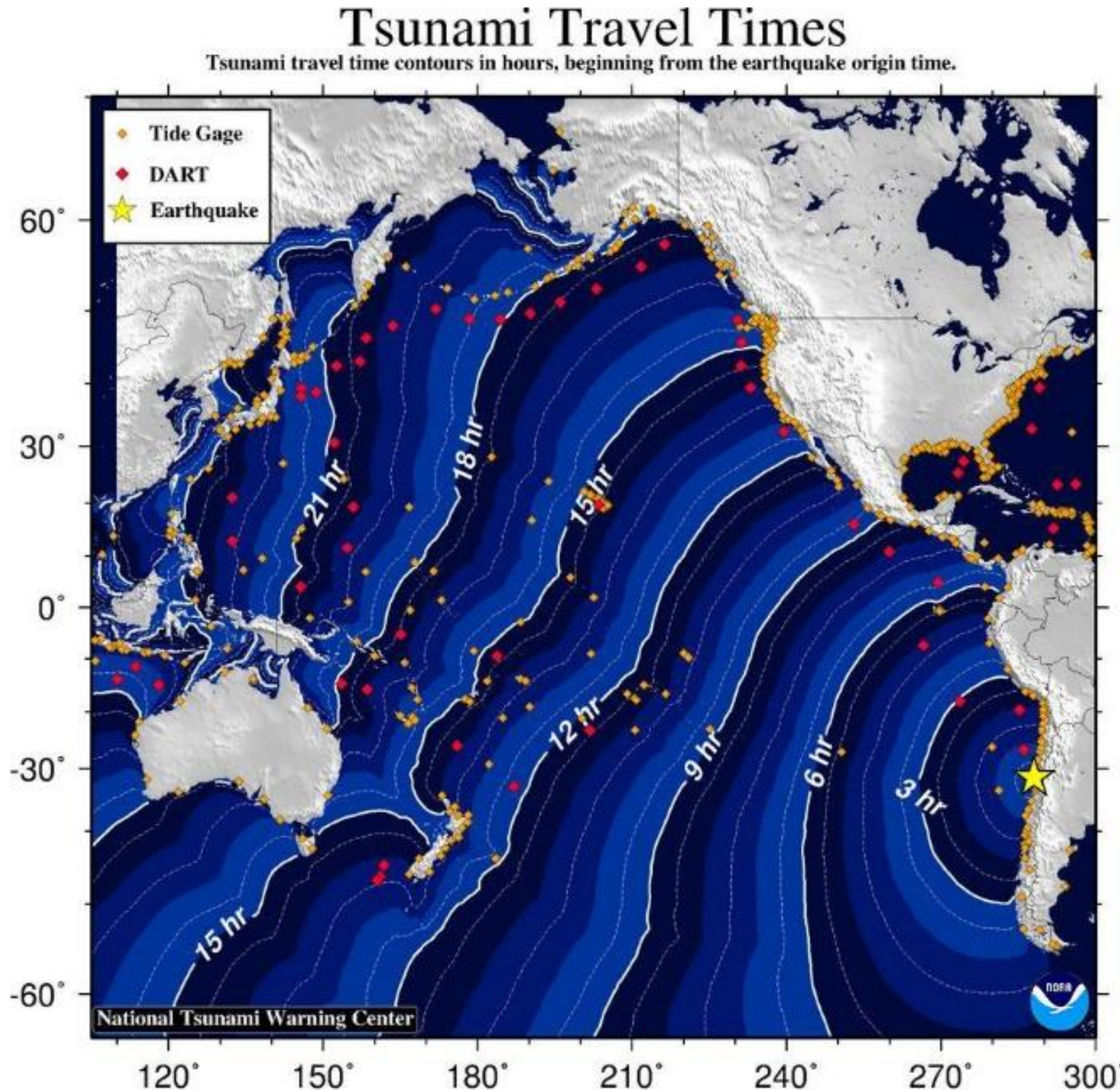
Projected travel times for the arrival of the tsunami waves across the Pacific.

Nearby the earthquake there are only minutes to evacuate. However, in many other regions there is advance warning.



A tsunami map shows projected travel times for the Pacific Ocean. This map indicates forecasted times only, not that a wave traveling those distances has actually been observed.

NOAA

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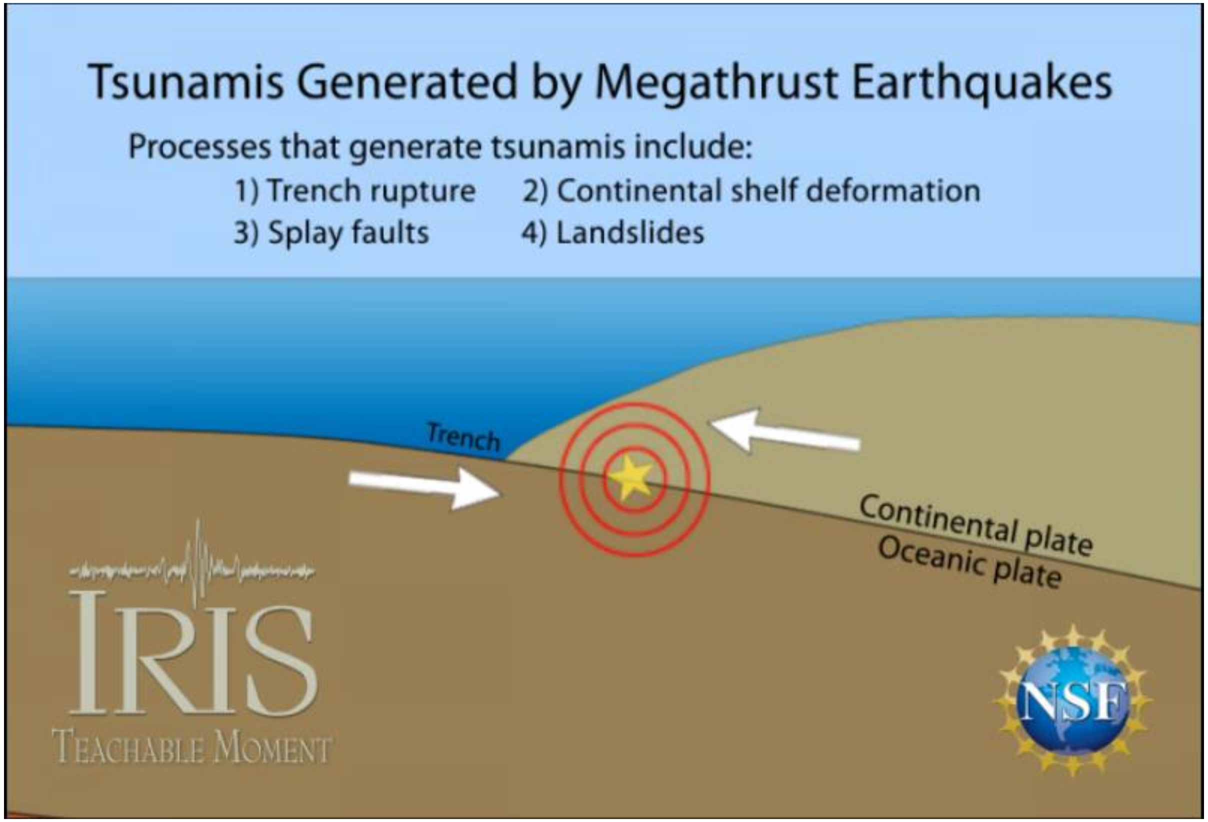
Subduction-zone mega-thrust earthquakes, the most powerful earthquakes in the world, can produce tsunamis through a variety of structures. These include fault boundary rupture, deformation of overlying plate, splay faults, and landslides during earthquakes. In this animation we explore different tsunami-producing mechanisms by examining three famous earthquakes: Japan 2011, Chile 2010, and Alaska 1964. From a hazards viewpoint, it is critical to remember that tsunamis are multiple waves that often arrive on shore for many hours after the initial wave.



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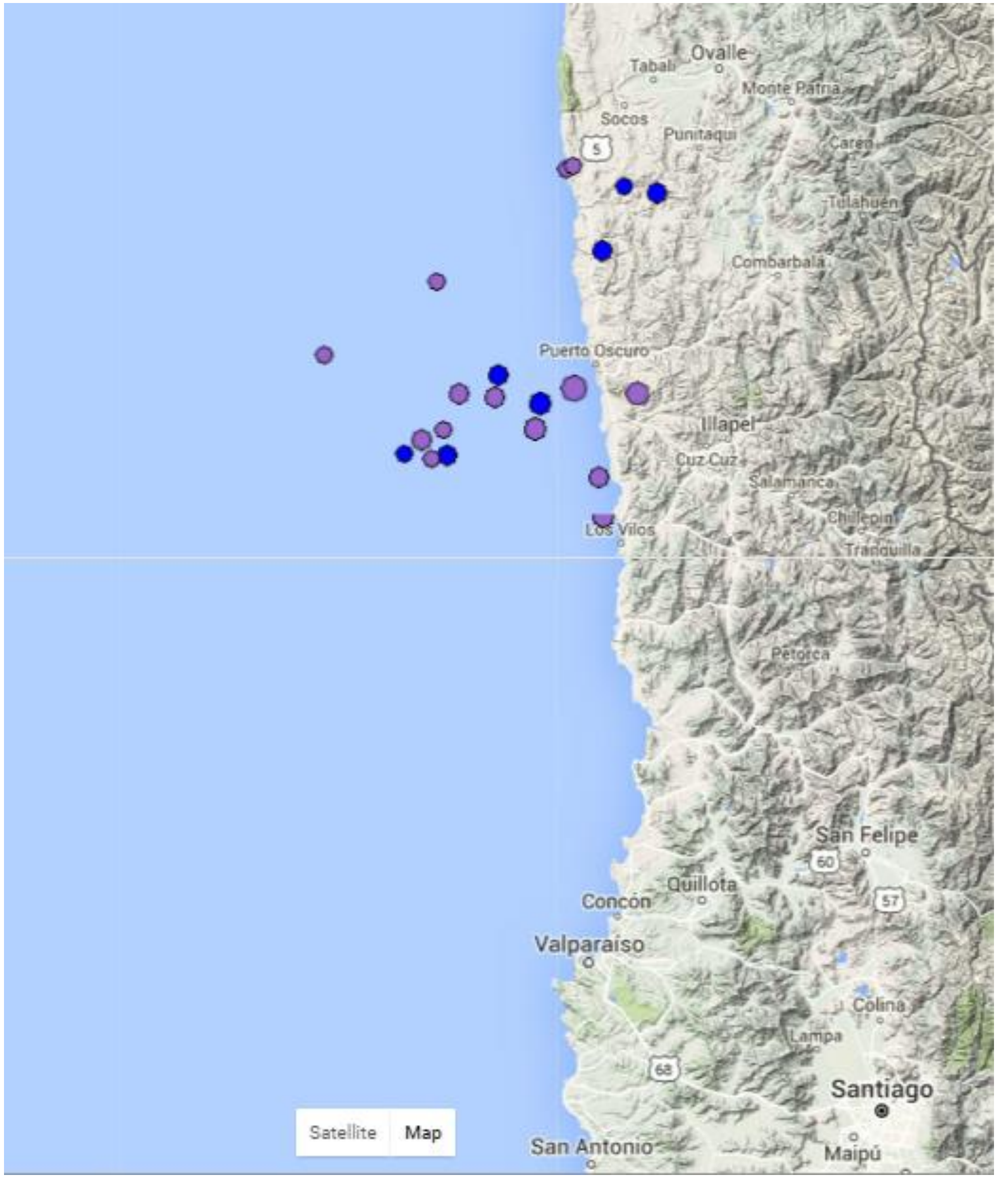

An earthquake large enough to cause damage will probably be followed by several felt aftershocks within the first hour. The rate of aftershocks decreases quickly - the decrease is proportional to the inverse of time since the main shock. This means the second day has about 1/2 the number of aftershocks of the first day and the tenth has about 1/10 the number of the first day. These patterns describe only the overall behavior of aftershocks; the actual times, numbers and locations of the aftershocks are random.

In the first 5 hours after the M 8.3 earthquake there have been 17 aftershocks including a M 7.0. Aftershocks typically follow earthquakes, as motion of the crust in one location puts pressure on weak spots along earthquake fault lines, triggering further motion. This figure was created with the IRIS Earthquake Browser (IEB).

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