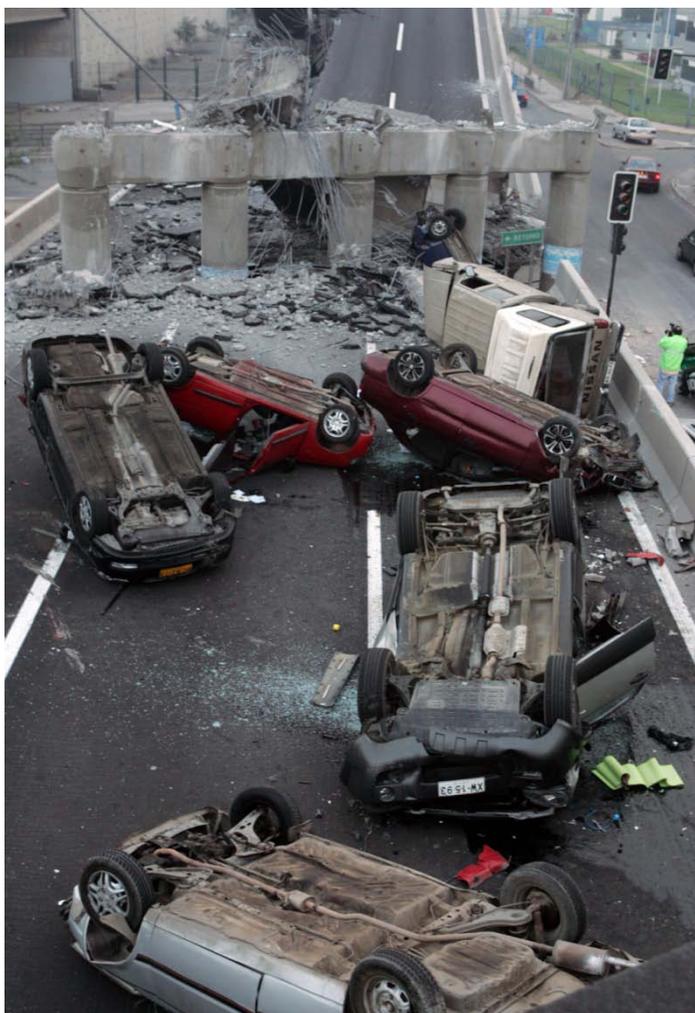


Magnitude 8.8 OFFSHORE MAULE, CHILE

Saturday, February 27, 2010 at 06:34:17 UTC

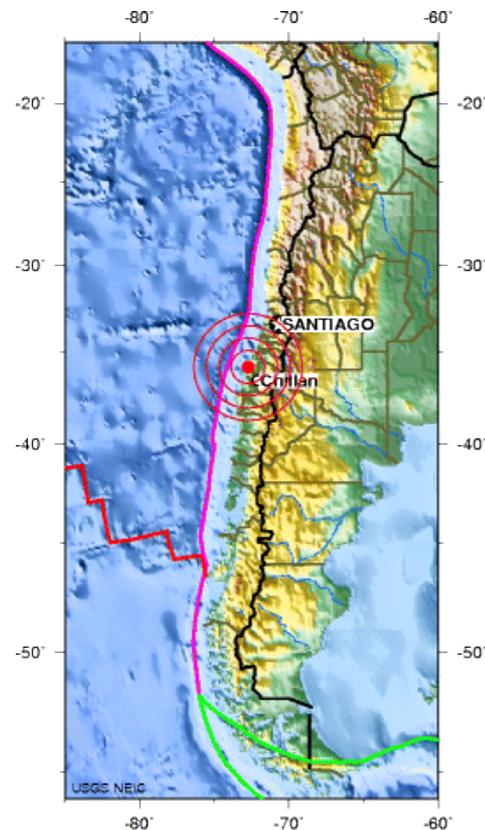
A great 8.8-magnitude struck central Chile early Saturday. The quake hit 200 miles (325 kilometers) southwest of the capital Santiago. The epicenter was just 70 miles (115 kilometers) from Concepcion, Chile's second-largest city.



USGS

Vehicles that were driving along a highway that collapsed during the earthquake near Santiago are seen overturned on the asphalt Saturday Feb. 27, 2010 after an 8.8-magnitude earthquake struck central Chile early Saturday.

AP Photo/David Lillo



OFFSHORE MAULE, CHILE

USGS

*Images courtesy of the
U.S. Geological Survey*

Magnitude 8.8 OFFSHORE MAULE, CHILE

Saturday, February 27, 2010 at 06:34:17 UTC

Interior Minister Edmundo Perez Yoma said this morning's quake was the most powerful tremor to hit his country in 50 years. At this time, 708 deaths have been reported and the number of dead and injured is likely to rise considerably as communications with the most heavily affected areas are restored.

In Santiago, the capital city with a population of nearly 5 million, it was reported that many, roads were destroyed and water, electricity, and phones lines were cut to many-making communication impossible.



Even closer to the epicenter, Chile's second-largest city, Concepcion with ~900,000 inhabitants in the area, experienced severe ground shaking and major damage.

This image provided by TVN shows a building in Concepcion totally engulfed in flames following the earthquake early Saturday Feb. 27, 2010

Magnitude 8.8 OFFSHORE MAULE, CHILE

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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 8 cm/yr.

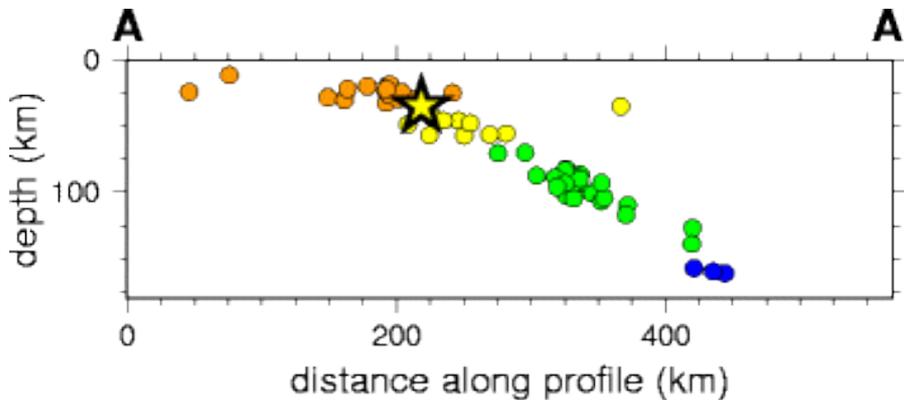


Magnitude 8.8 OFFSHORE MAULE, CHILE

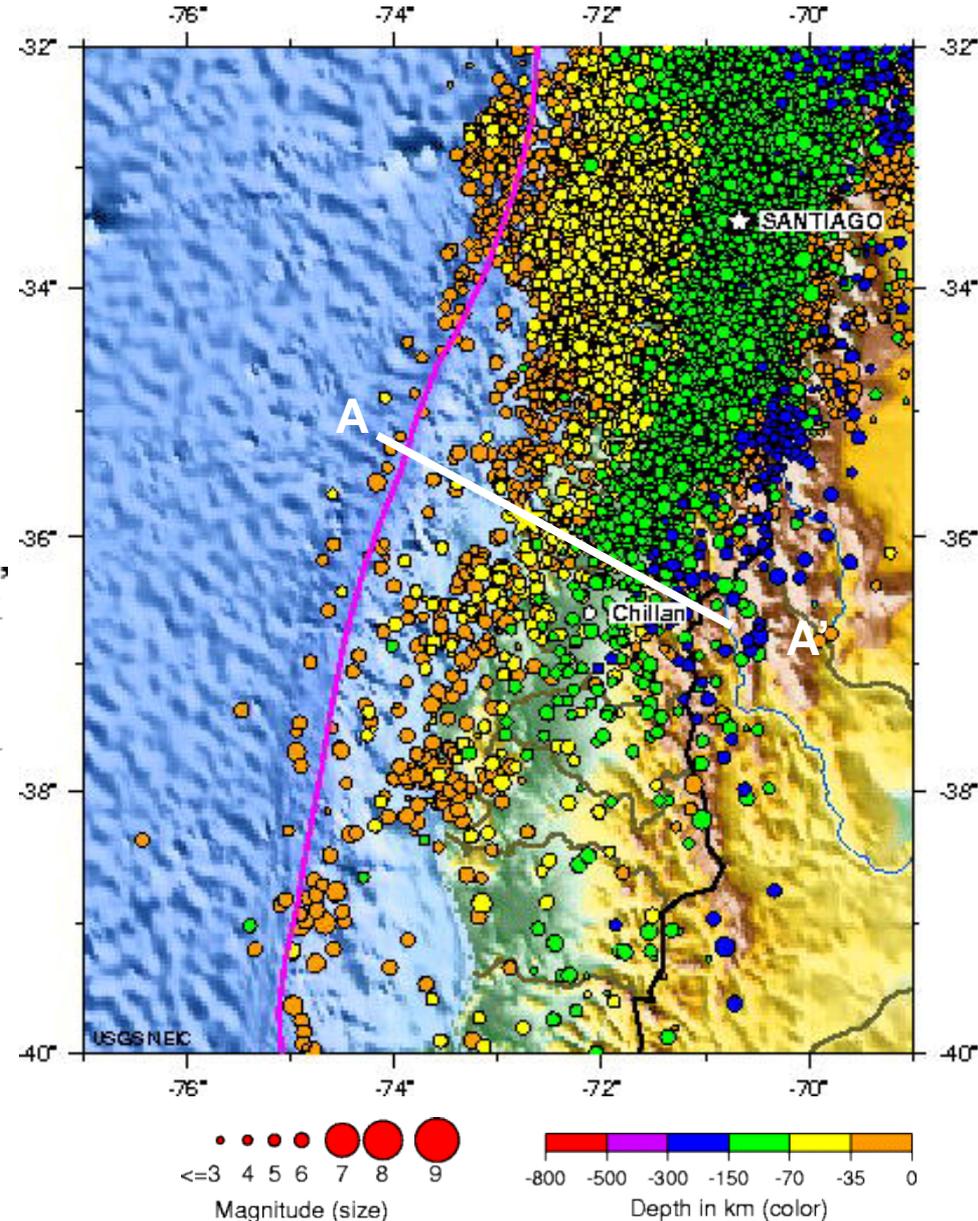
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The map on the right shows historic earthquake activity near the epicenter (star) from 1990 to present.

As shown on the cross section, earthquakes are shallow (orange dots) at the Peru - Chile Trench and increase to 300 km depth (blue dots) towards the east as the Nazca Plate dives deeper beneath the South American Plate.



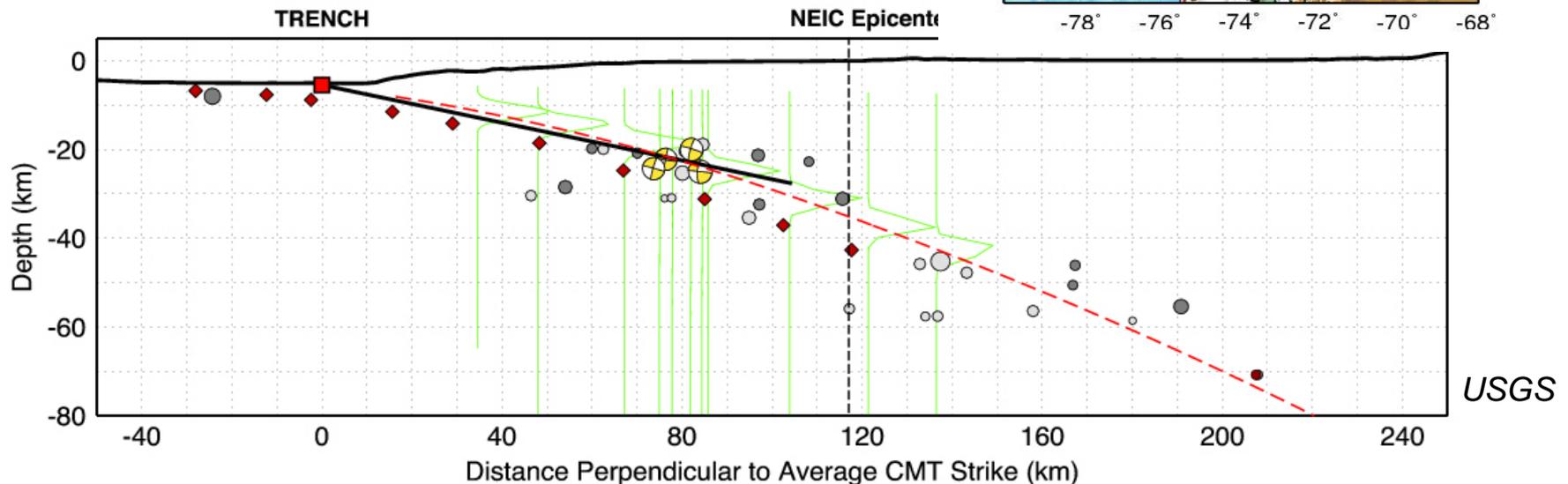
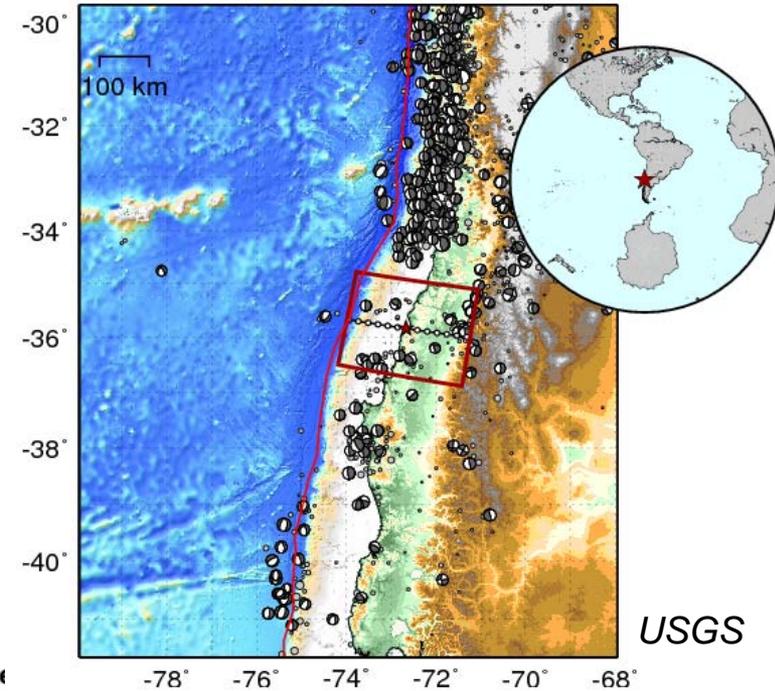
Seismicity Cross Section across the subduction zone showing the relationship between color and earthquake depth.



Trench Geometry

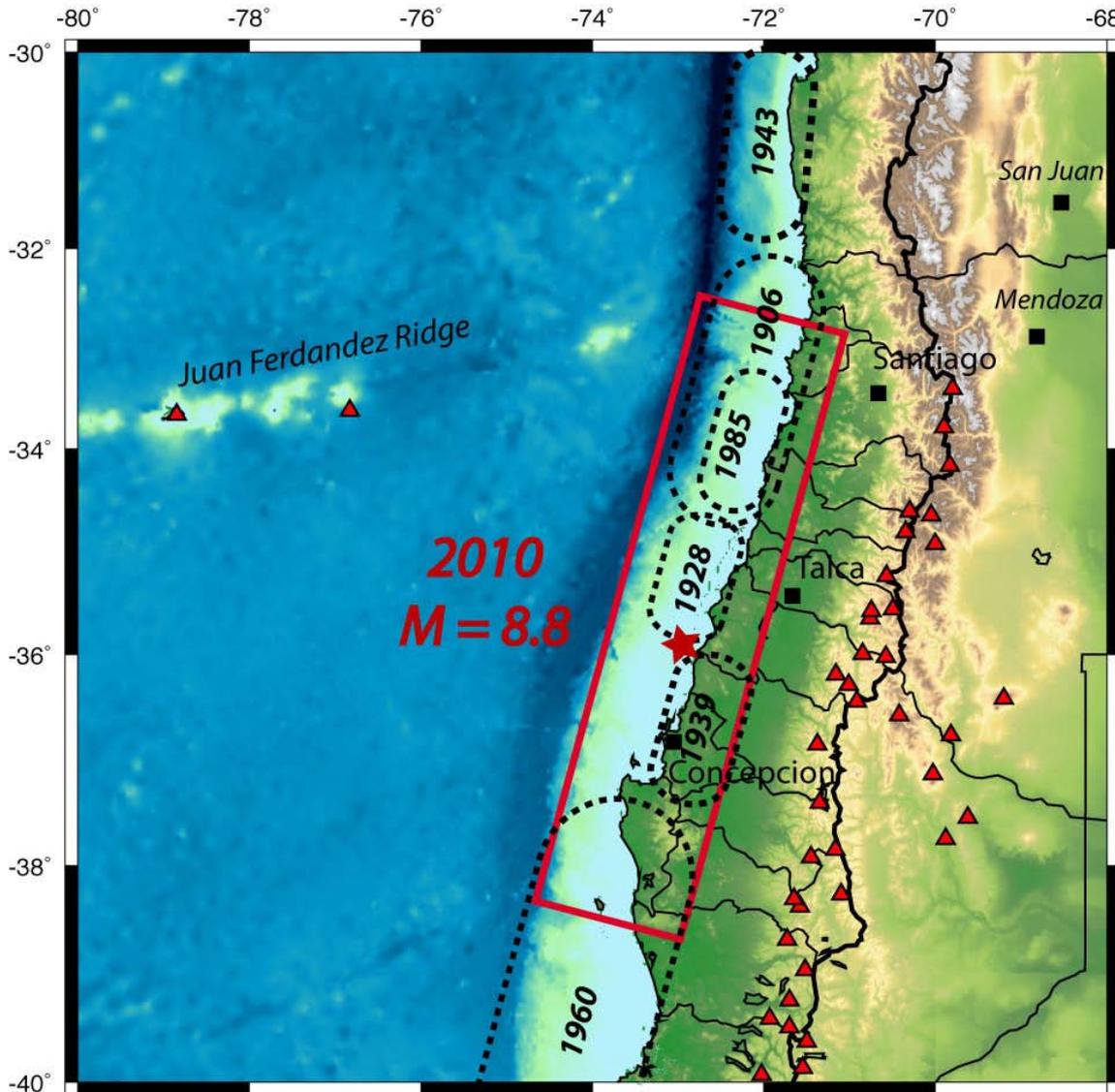
Basemap of subduction zone showing the area of the trench constrained in this example. Earthquake locations from the area are shown. Maroon rectangle indicates the area shown in cross section (c); all earthquakes within this area may be used to constrain trench geometry.

Cross-section of subduction zone. Probability density functions for EHB and NEIC locations are shown as green lines, scaled by a factor of x20 for display purposes. The black solid line describes the best fitting planar geometry; the red dashed line the best-fitting non-planar geometry.



Magnitude 8.8 OFFSHORE MAULE, CHILE

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Coastal Chile has a history of very large earthquakes. Since 1973, there have been 13 events of magnitude 7.0 or greater.

The February 27 shock originated about 230 km north of the source region of the magnitude 9.5 earthquake of May, 1960 – the largest earthquake worldwide in the last 200 years or more.

An outline of the approximate rupture from this Magnitude 8.8 earthquake and its relationship to the largest earthquakes along the coast of Chile this century.

Based on Beck et al., 1998

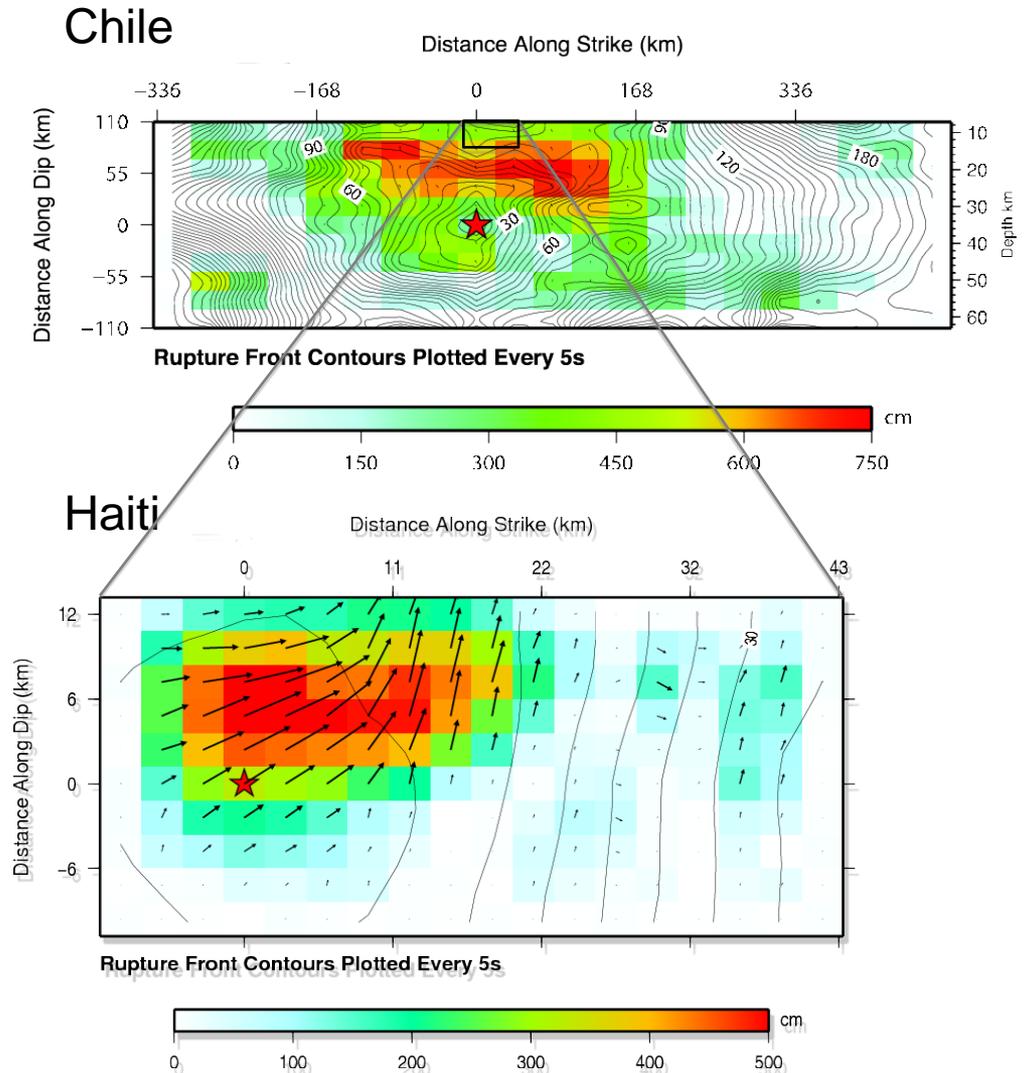
Magnitude 8.8 OFFSHORE MAULE, CHILE

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Although magnitude is still an important measure of the size of an earthquake, particularly for public consumption, **seismic moment** is a more physically meaningful measure of earthquake size.

Seismic moment is proportional to the product of the slip on the fault and the area of the fault that slips.

These “maps” of the slip on the fault surfaces of the January 12th M7.0 Haitian earthquake and the M8.8 Chilean earthquake show that, although the slip in Chile was only about 50% greater, the fault area was vastly larger. This accounts for the release of approximately 500 times more energy in the Chilean earthquake than in the Haiti earthquake.



Images courtesy of the U.S. Geological Survey

Magnitude 8.8 OFFSHORE MAULE, CHILE

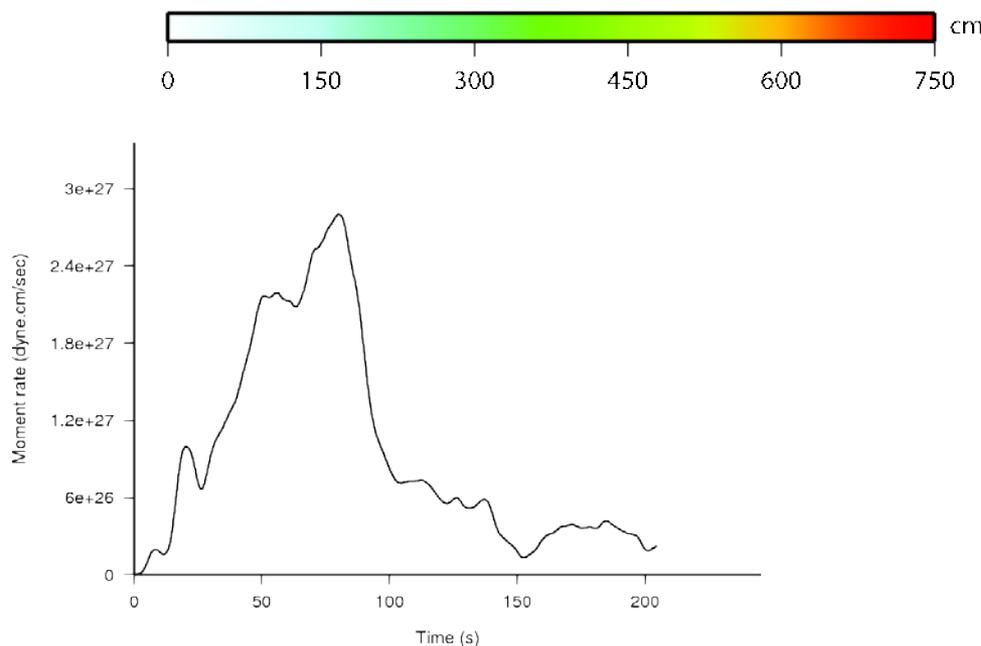
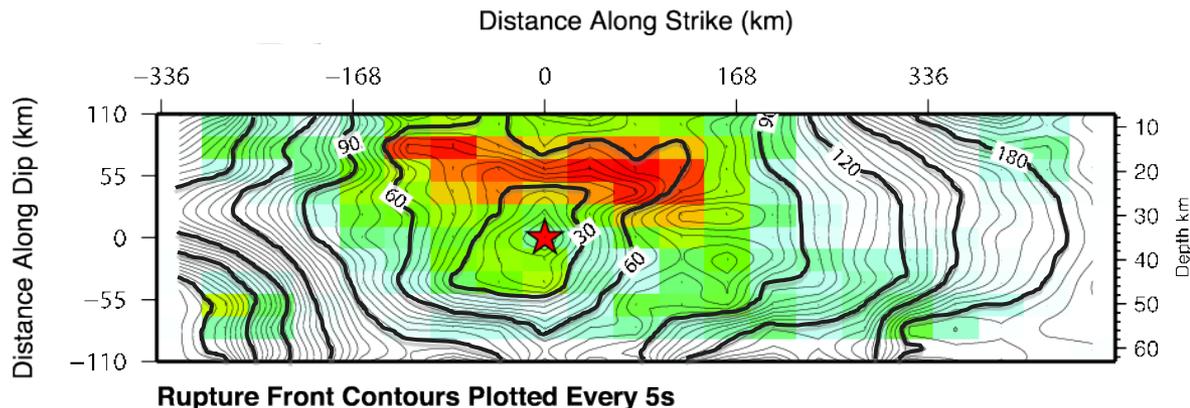
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Large earthquakes involve slip on a fault surface that is progressive in both space and time.

This “map” of the slip on the fault surface of the M8.8 Chilean earthquake shows how fault displacement propagated outward from an initial point (or focus) about 35 km beneath the Earth’s surface.

The rupture extended over 500 km along the length of the fault, and from the Earth’s surface to depths of over 50 km.

The largest amounts of rupture occurred in the first 60 seconds but smaller displacements continued for up to 200 seconds after the start of the earthquake.

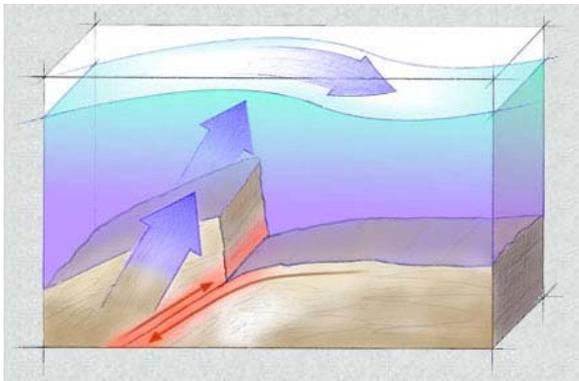


2010 Feb 27 04:47:49 Moment_rate_Function

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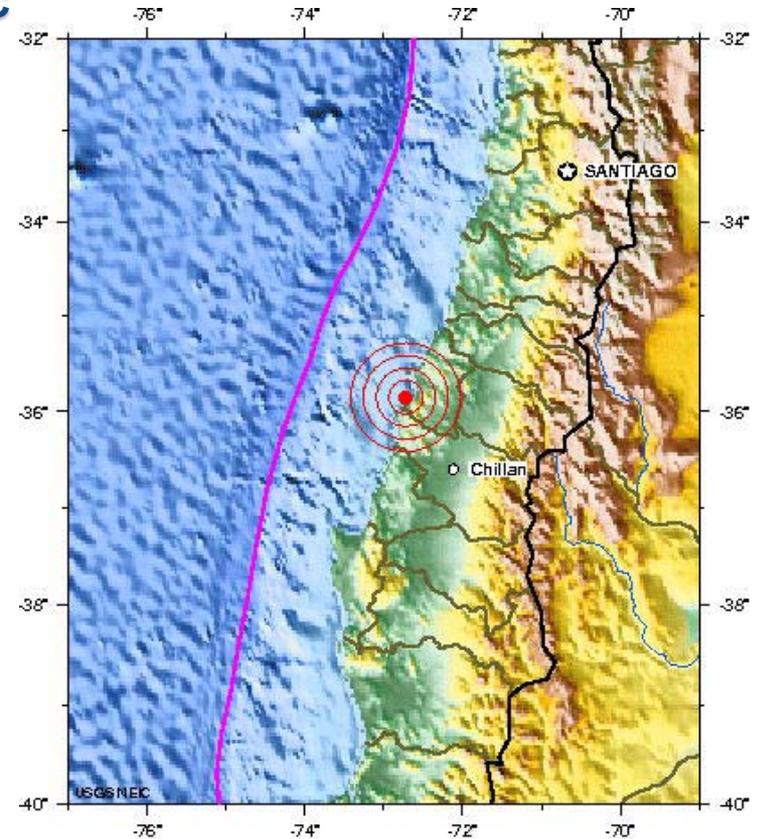
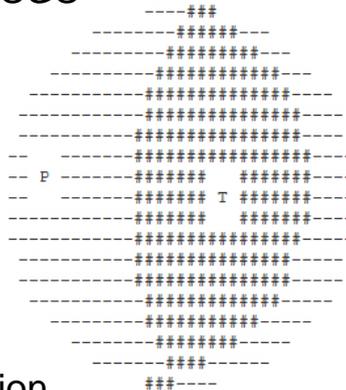
This earthquake occurred at the boundary between the Nazca and South American tectonic plates. The two plates are converging at a rate of 80 mm per year. The earthquake occurred as thrust-faulting on the interface between the two plates, with the Nazca plate moving down and landward below the South American plate.



Simplified diagram of thrust faulting during a subduction zone earthquake. The sudden motion along the fault displaces massive volumes of seawater creating a tsunami. (© 1999 Zeke Smith)

USGS Centroid Moment Tensor Solution

USGS



OFFSHORE MAULE, CHILE

2010 02 27 06:34:14 UTC 35.85S 72.72W Depth: 35.0 km, Magnitude: 8.8

Earthquake Location

The tension axis (T) reflects the minimum compressive stress direction. The pressure axis (P) reflects the maximum compressive stress direction.

Images courtesy of the U.S. Geological Survey

Magnitude 8.8 OFFSHORE MAULE, CHILE

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Large shallow earthquakes in subduction zones can produce tsunamis because these events can displace a large area of ocean floor by several meters. Along the coast of Chile, tsunami wave heights up to 2.3 meters (7.7 ft) were recorded. Tsunamis can have wavelengths greater than 100 km and periods of tens of minutes. Because the wavelength is more than 20 times the 4 km average depth of the oceans, a tsunami travels as a “shallow water” wave than can propagate across an entire ocean basin with minimal loss of energy.

Reuters reported that a tsunami caused by the quake caused "serious damage" to Chile's sparsely populated Juan Fernández Islands, where Scottish sailor Alexander Selkirk was marooned in the 18th Century inspiring the novel Robinson Crusoe. (NBC)

Tsunami waves travel very fast on the open ocean, but their destructive power comes from the towering heights they attain as they approach the coast.

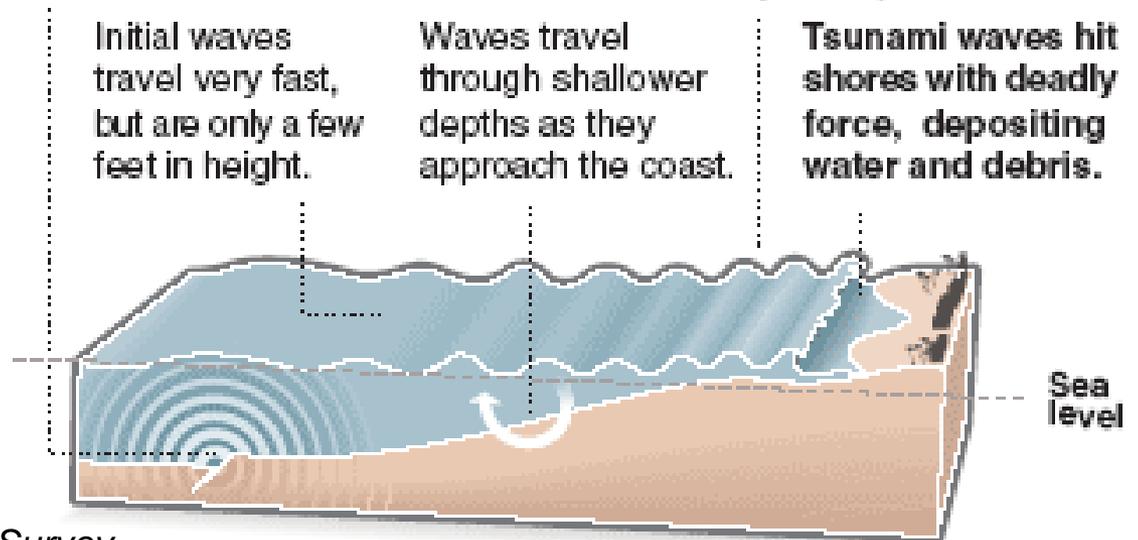
Seismic event or displacement sends shock waves outward.

As they approach land, the waves decrease in speed while increasing in height.

Initial waves travel very fast, but are only a few feet in height.

Waves travel through shallower depths as they approach the coast.

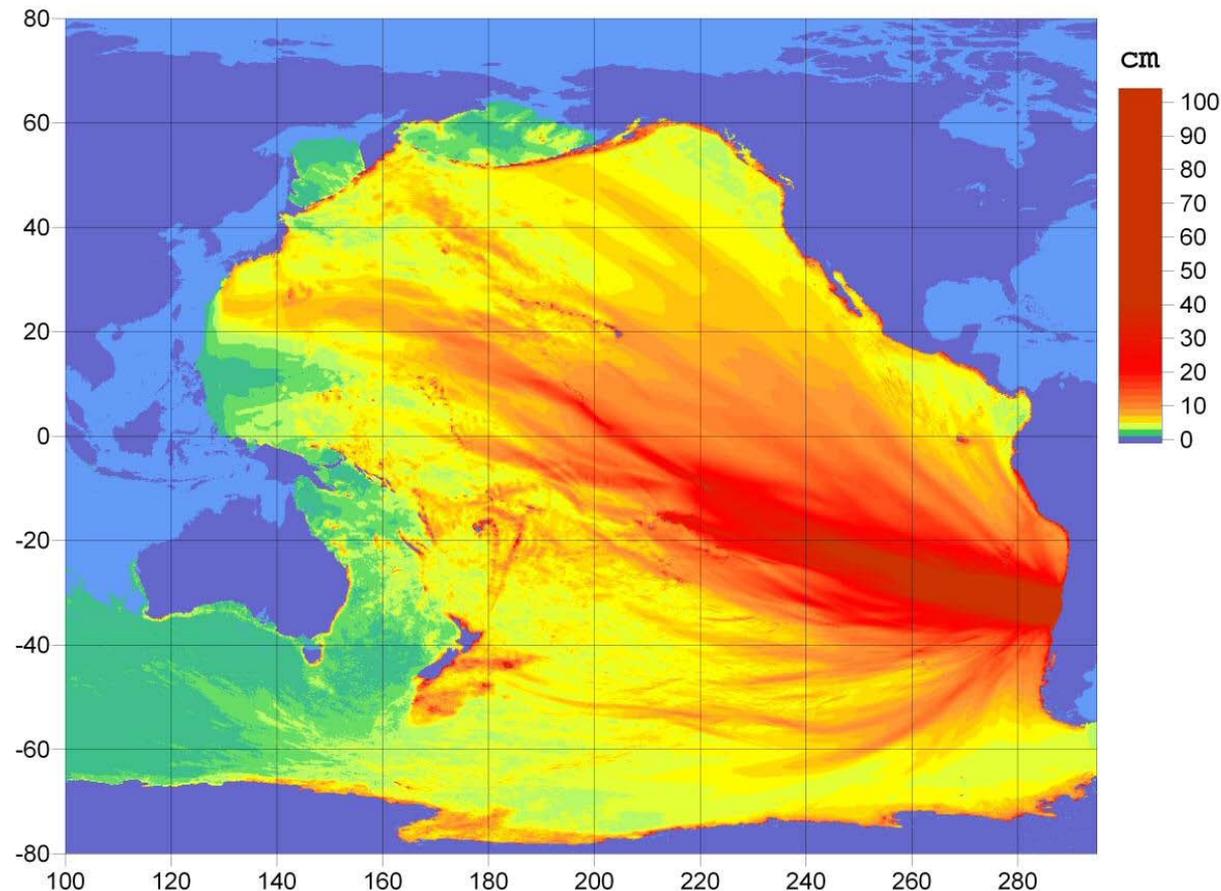
Tsunami waves hit shores with deadly force, depositing water and debris.



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.

Preliminary Forecast Model Energy Map

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 M8.8 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.



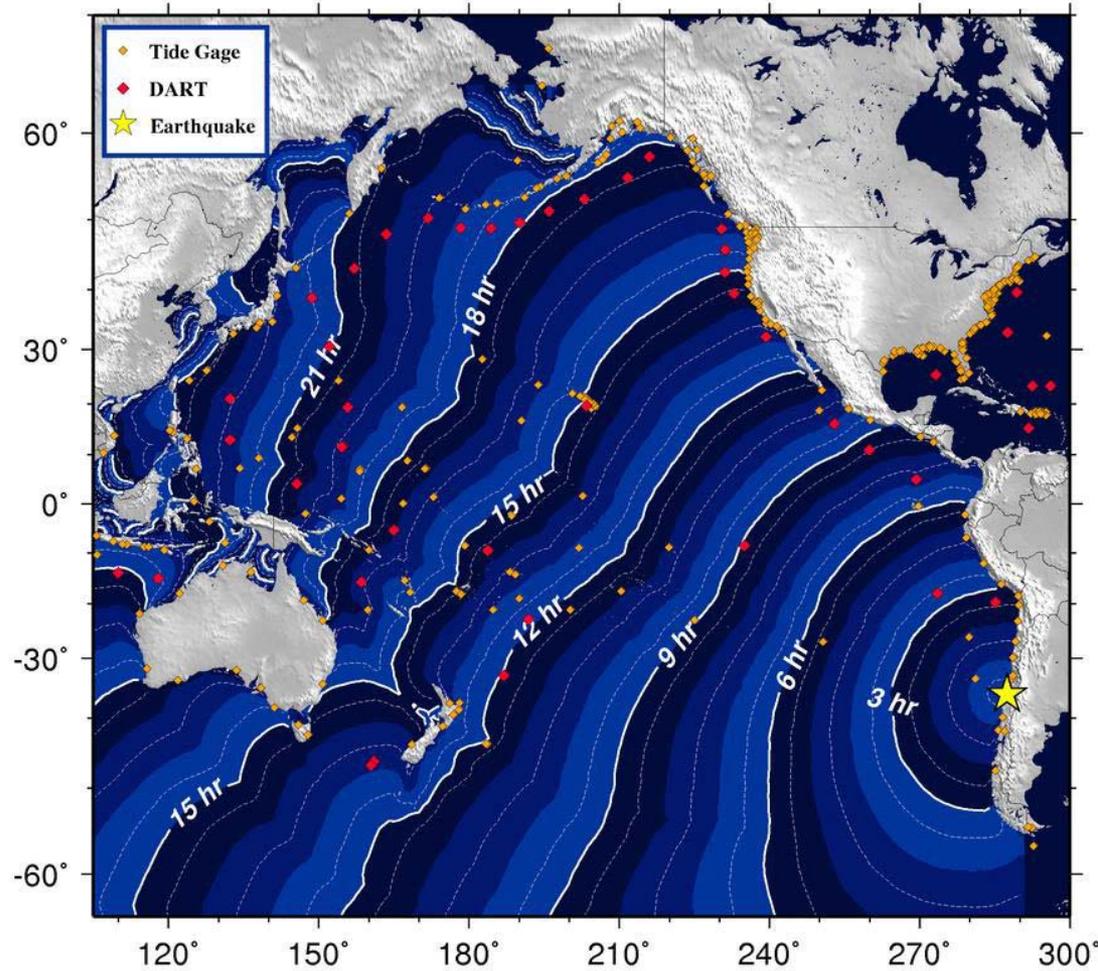
Magnitude 8.8 OFFSHORE MAULE, CHILE

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In Hawaii, the state Department of Transportation is urging all shipping agents and shipping companies to get their ships out of port this morning. Hawaii has been put on alert to expect its largest waves since 1964.

In Hawaii, the tsunami warning alarms sounded at 6 am, giving residents 5 hours to evacuate to higher ground by the expected ~11 am arrival of tsunami waves.

Tsunami waves are likely to hit Asian, New Zealand, and Australian shores in the next 24 hours. Alaska and the U.S. West Coast, including California, are also under warning. The warning means there may be strong currents, but that widespread inundation is not expected to occur.



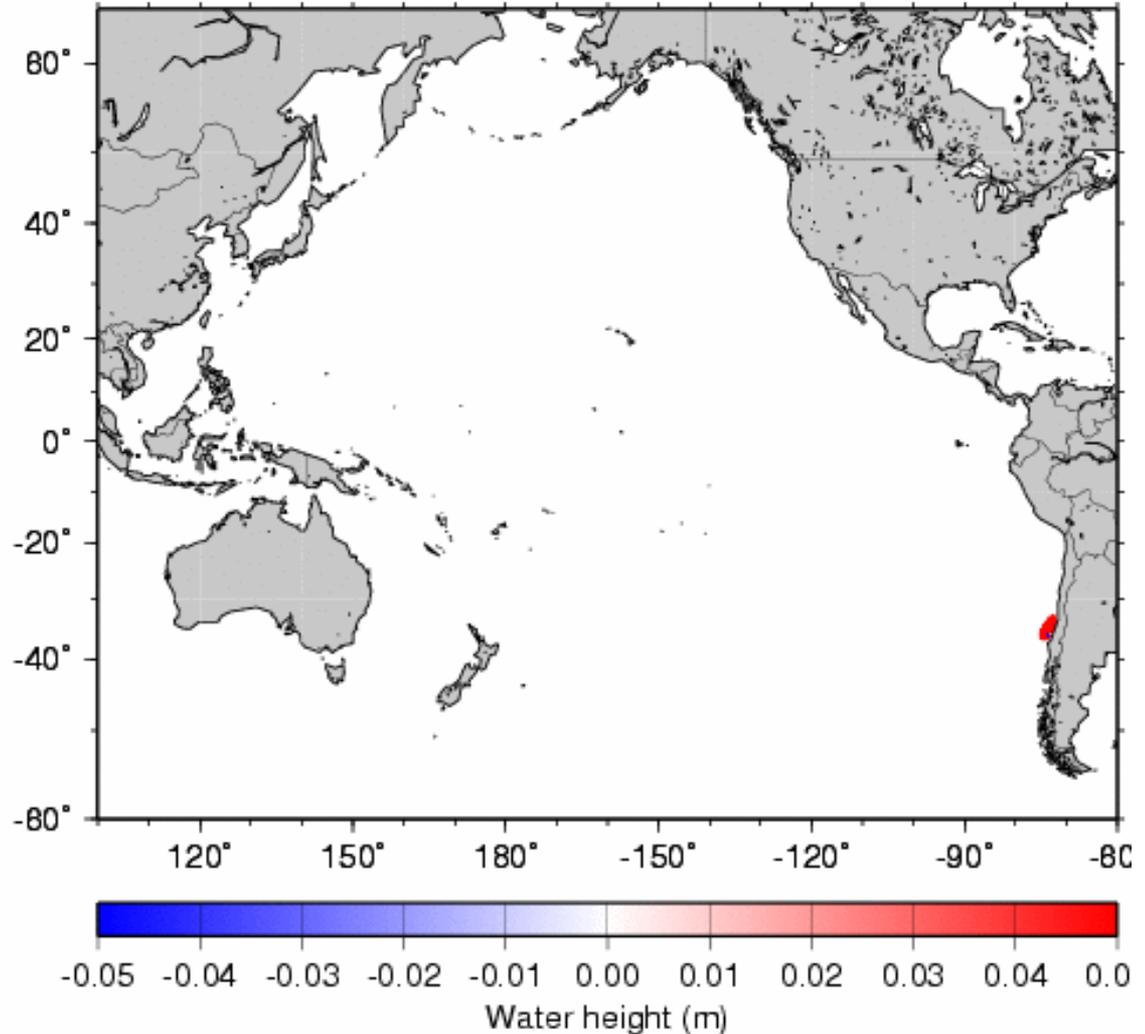
Tsunami Model for Chilean earthquake - Earthquake Research Institute, Tokyo

Animation model of the Tsunami propagation across the Pacific.

Tsunamis generated in Chile are a concern in the Pacific.

This earthquake originated about 230 km north of the source region of the magnitude 9.5 earthquake of May, 1960 the largest instrumentally recorded earthquake in the world.

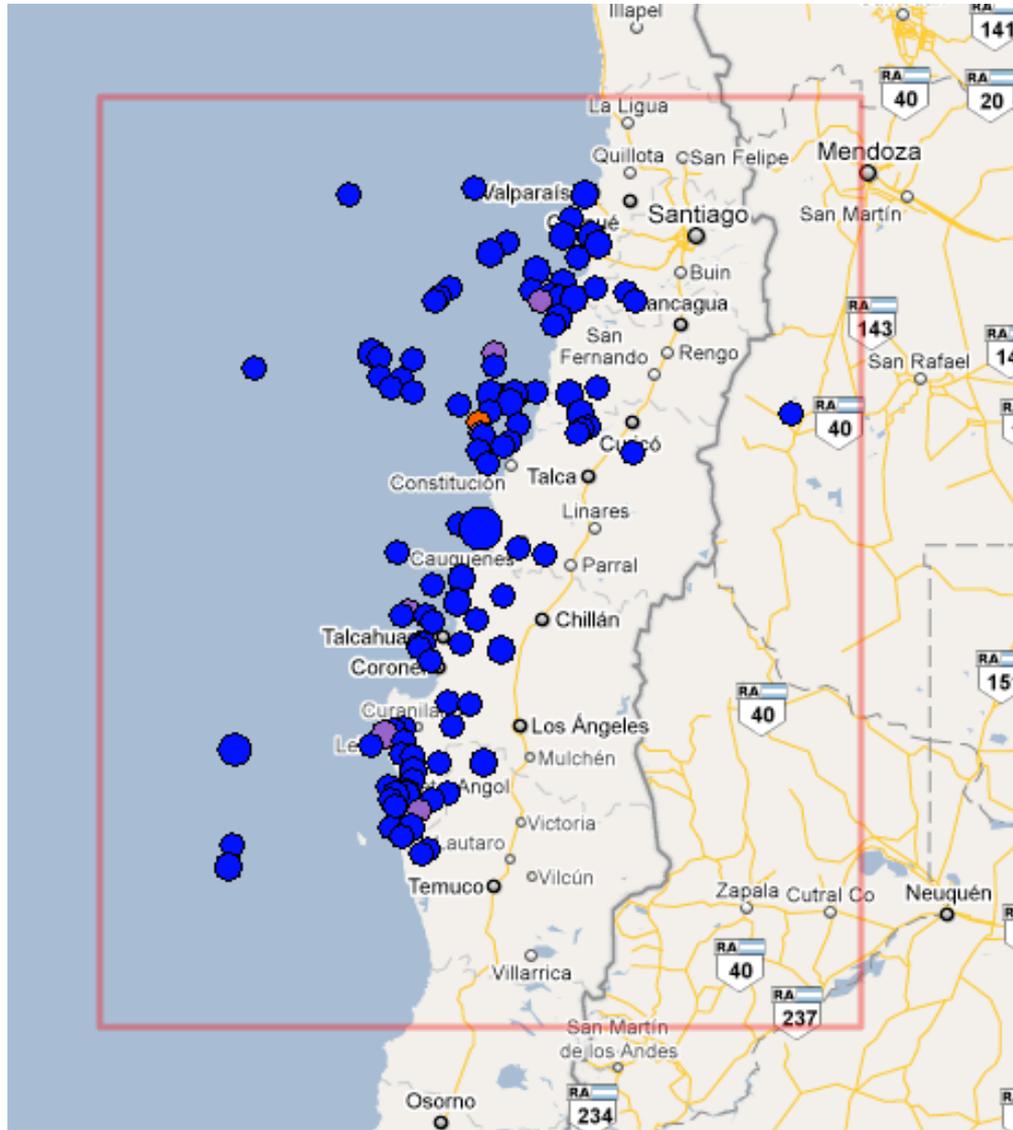
This magnitude 9.5 earthquake killed 1655 people in southern Chile and unleashed a tsunami that crossed the Pacific, killing 61 people in Hawaii, Japan, and the Philippines.



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A large vigorous aftershock sequence can be expected from this earthquake.



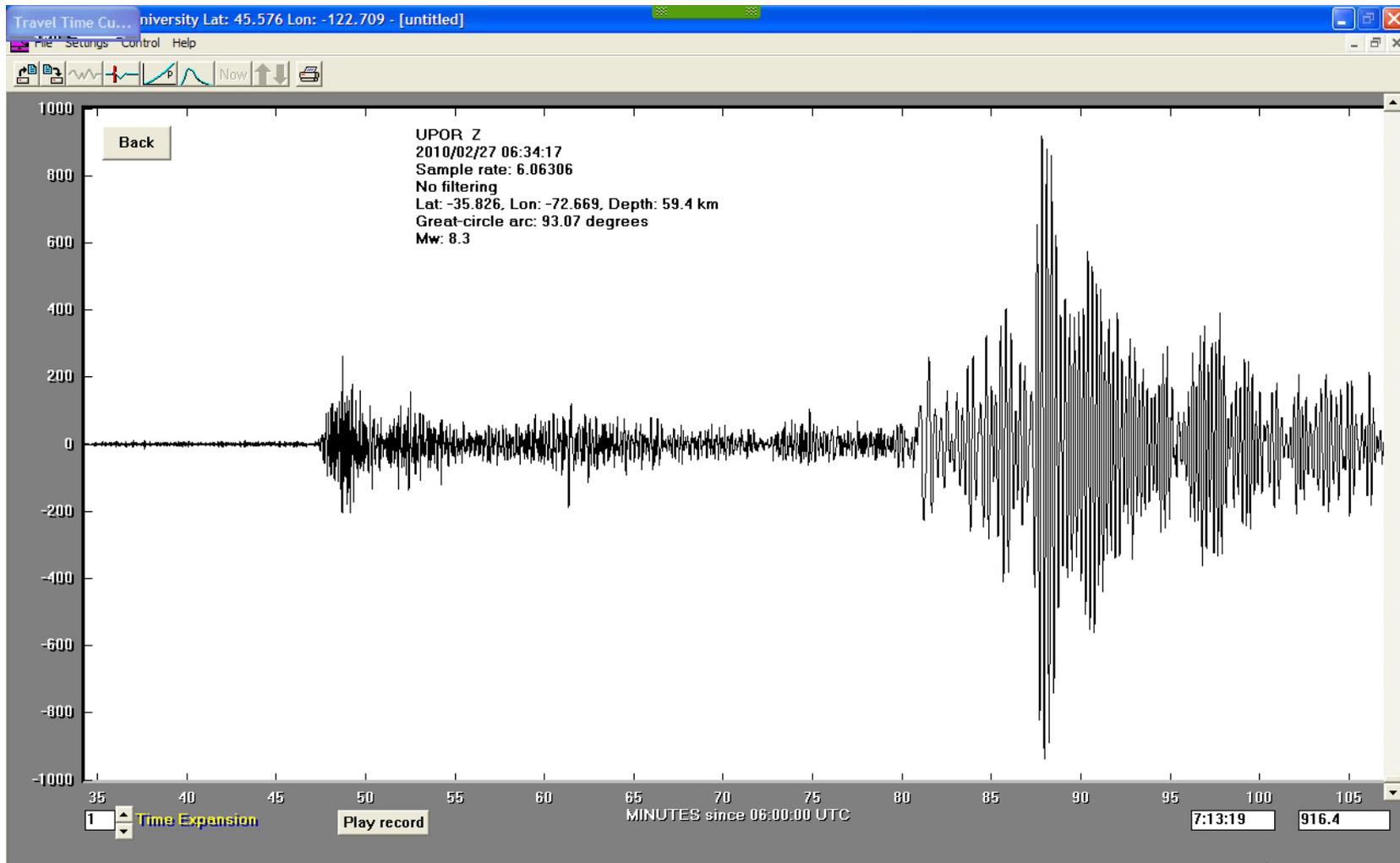
An earthquake large enough to cause damage will probably be followed by several felt aftershocks within the first hour. The rate of aftershocks decreases quickly - the decrease is proportional to the inverse of time since the main shock. This means the second day has about 1/2 the number of aftershocks 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.

At this time, ~ 90 aftershocks > M 5 have been recorded, including a M 6.9. 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). [Use the IEB to explore the aftershock sequence!](#)

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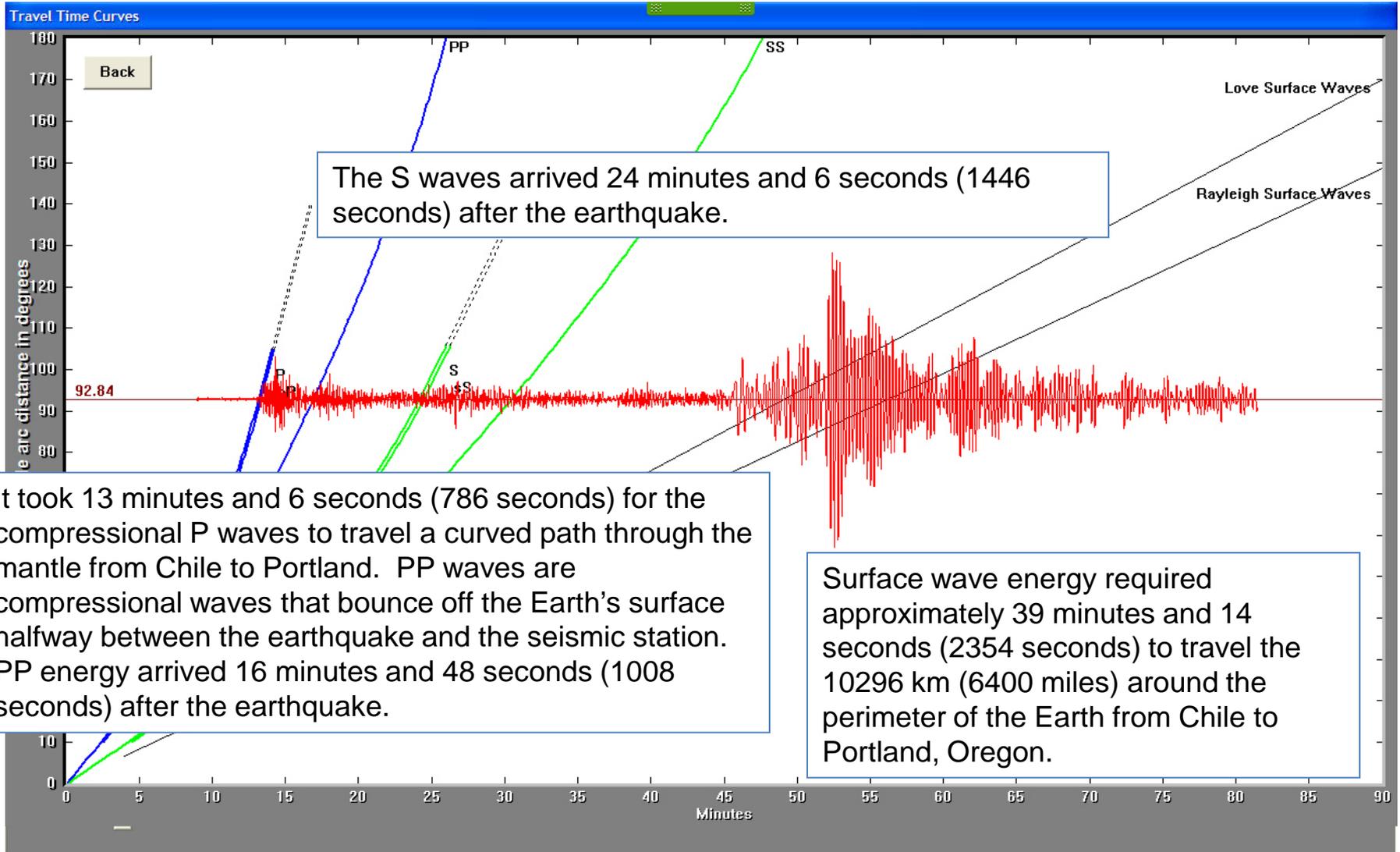
The record of the M8.3 Offshore Maule, Chile earthquake on the University of Portland seismometer (UPOR) is illustrated below.



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Portland is about 10296 km (6400 miles, 92.76°) from the location of this earthquake.



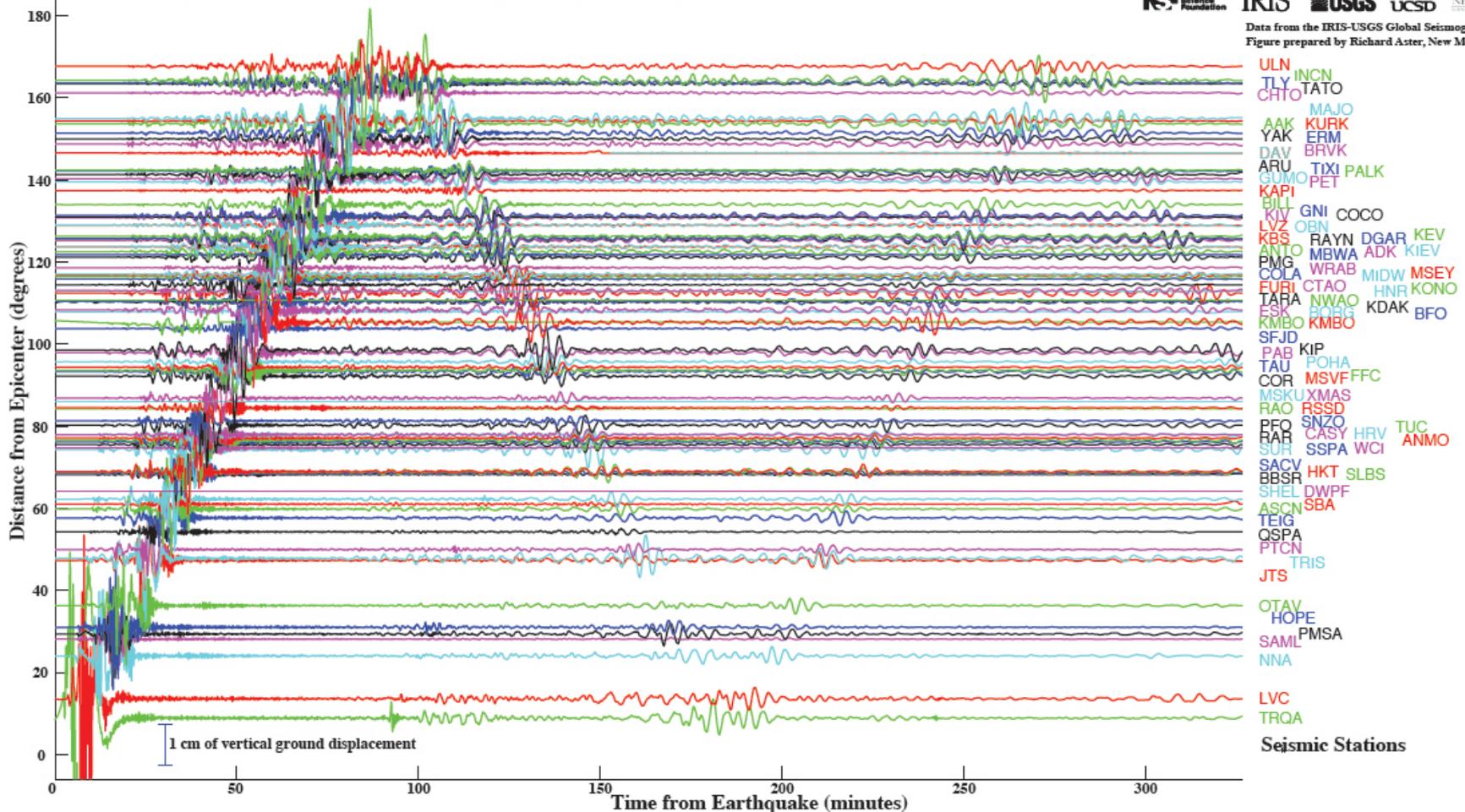
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February 27, 2010 Chile Earthquake (M=8.8) Global Displacement Wavefield



Data from the IRIS-USGS Global Seismographic Network
Figure prepared by Richard Aster, New Mexico Tech



Global record section

The global surface wave displacements around the globe are shown. The closest shown station is in Argentina and the most distant one is in Mongolia. A 6.9 aftershock is visible for comparative scale near 90 minutes after the mainshock.