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Chile Quake Is One of the Biggest in a Century

By Gautam Naik
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The 8.8 magnitude earthquake that struck off coastal Chile in the early hours of the morning is one of the biggest temblors anywhere in more than a century.

Data from the U.S. Geological Survey suggests that this morning's Chile quake tied in fifth place with an 8.8 quake that hit Ecuador and Bolivia in 1906. Only four quakes have been bigger since 1900. The largest was a 9.5 magnitude event that struck Chile in 1960, causing 1,655 fatalities, leaving 2 million homeless, and triggering a tsunami that killed people in Hawaii, Japan and the Philippines.

"This was a big one," said Harley Benz, scientist in charge of the USGS's National Earthquake Information Center in Golden, Colo., which monitors global quake activity in real time. "The Chile quake released 500 times more energy than the quake that hit Haiti."

That's because quake magnitudes are calculated on a logarithmic scale. Thus, a magnitude 8 quake releases 33 times the energy as a magnitude 7 quake, and a magnitude 9 quake releases 33 multiplied by 33 times the energy of a magnitude 7 event. The quake that hit Haiti on Jan. 12 was magnitude 7, and the Chile quake was magnitude 8.8 — which works out to about 500 times more energy.

Aftershocks are a big worry. After the initial quake, some 50 aftershocks have been recorded in Chile of magnitude 5 or larger, according the NEIC. The largest so far was a 6.9 magnitude aftershock. The Chile temblor's aftershock zone — the area where fault boundary ruptured — stretches for 600 kilometers, far larger than the 60-kilometer aftershock zone in Haiti.

The NEIC says it expects aftershocks to continue for several months. "There's a significant probability of having an aftershock in the magnitude 7 range," which could be potentially destructive, says Dr. Benz.

Scores of countries around the Pacific Ocean are bracing for a tsunami unleashed by the quake, and which is now speeding across the ocean at 550 miles per hour, or the speed of a jet plane.

"A tsunami has been generated that could cause damage along coastlines of all islands in the state of Hawaii," noted the U.S. government's tsunami warning center in Hawaii.

Tsunami-causing quakes usually occur where shards of the earth's crust — tectonic plates — meet. Magma rises from deep inside the earth, causing the plates to move. They slip-slide past each other, sometimes get stuck, then jerk forward again, producing a quake.

According to the USGS, the Chile 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, with the Nazca plate moving down and landward below the South American plate.

The last big earthquake at this particular location of the plate boundary — roughly 100 miles south of the capital city Santiago — occurred in 1835 and had an estimated 8.5 magnitude. Since then, the plates at this location have been trying to move past each other, but have been locked in place. Over the decades, the stresses and strains gradually built up.

The latest quake was triggered "when the deformation or strain exceeded the strength of the rocks in this fault zone, causing it to fail," said Brian Baptie, seismologist at the British Geological Survey in Edinburgh, U.K.

The quake caused a massive uplift of the sea floor, displacing a huge amount of water. That disruption acted like a giant wave machine, triggering tsunami waves. The resulting undulations aren't usually detectable by ships since the crests often measure less than three feet in height and are hundreds of miles apart. But the force of a tsunami becomes apparent in shallower water.

As it approaches the coast, a tsunami slows down to about 20 to 30 miles an hour. It is now at its most dangerous: All its energy gets compressed into much less depth, and the height of the wave can dramatically increase.

When a tsunami wave hits a coastline, its trough can temporarily expose the sea floor, though water quickly floods the area again. Such an event can trigger powerful and unpredictable currents along the shore, and debris picked up by the wave can boost its destructive power.

Because these events move such a large amount of water up and down, certain tsunamis — known as deep-water tsunamis — can traverse an entire ocean basin in less than 24 hours. The 2004 tsunami was in this category, and the latest one generated from the Chile earthquake appears to be, too. These waves hit a coast like a rapid, powerful tide. Most tsunamis strike in a group of three to 10 waves, separated by troughs.

The latest Chile quake has already generated tsunami waves estimated to be anywhere from 1 meter to 1.5 meters in height on the Chilean coastline. "But it's difficult to predict the wave amplitudes of the tsunami" as it approaches shallower waters of distant coastlines, said Dr. Baptie. He said that irregular coastlines and those with sudden drop-offs and changes in water depth were the most vulnerable to large, destructive waves.

Some 95% of the world's earthquakes occur in the Pacific Ocean; that's why the devastating earthquake-triggered tsunami that occurred in the Indian Ocean on Boxing Day 2004 took so many people by surprise. The Pacific Rim has long been ringed with early-warning systems intended to detect an imminent tsunami in time to allow people to flee to higher ground.

Coastal Chile has a history of massive earthquakes. Since 1973, there have been 13 events of magnitude 7.0 or greater, according to the USGS. The February 27 event originated about 230 km north of the source region of the magnitude 9.5 earthquake of May 1960 – the biggest temblor anywhere in at least 200 years. That quake spawned a tsunami that engulfed the Pacific Ocean, the USGS says.

The first signals of the Chile quake were picked up by 14 seismic ground stations in South America, Central America and Antarctica. About eight minutes after the quake, those signals showed up at the NEIC's Colorado headquarters. Two analysts on duty were immediately alerted when a warning chime sounded from their computers, signaling the occurrence of a big quake somewhere in the world.

The analysts quickly figured out the temblor's general location. Within 30 minutes of the quake occurring, they had fixed the exact location and magnitude, and generated a "shake map" which assessed the number of people and infrastructure exposed to the quake.

Those details were placed on the NEIC's Web site and also sent electronically to relief agencies, the United Nations and others. According to established protocol, an analyst at NEIC then picked up the phone and called the White House Situation Room, alerting them to the size and severity of the Chile quake.

Gautam Naik can be reached at gautam.naik@wsj.com
