Magnitude 5.7 earthquake strikes in a long-lived gap in great earthquakes

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Spanish version

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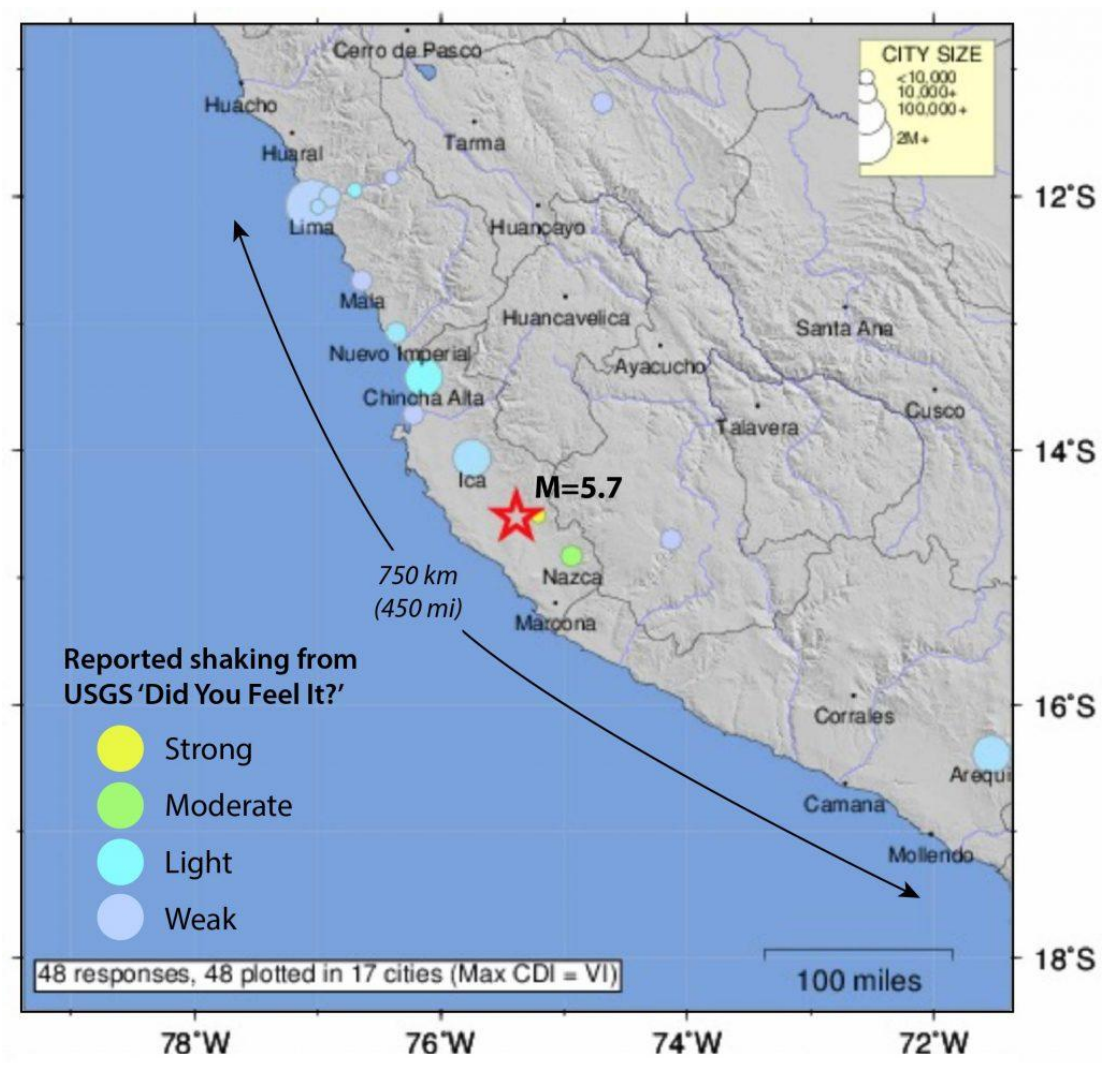
Widely Felt

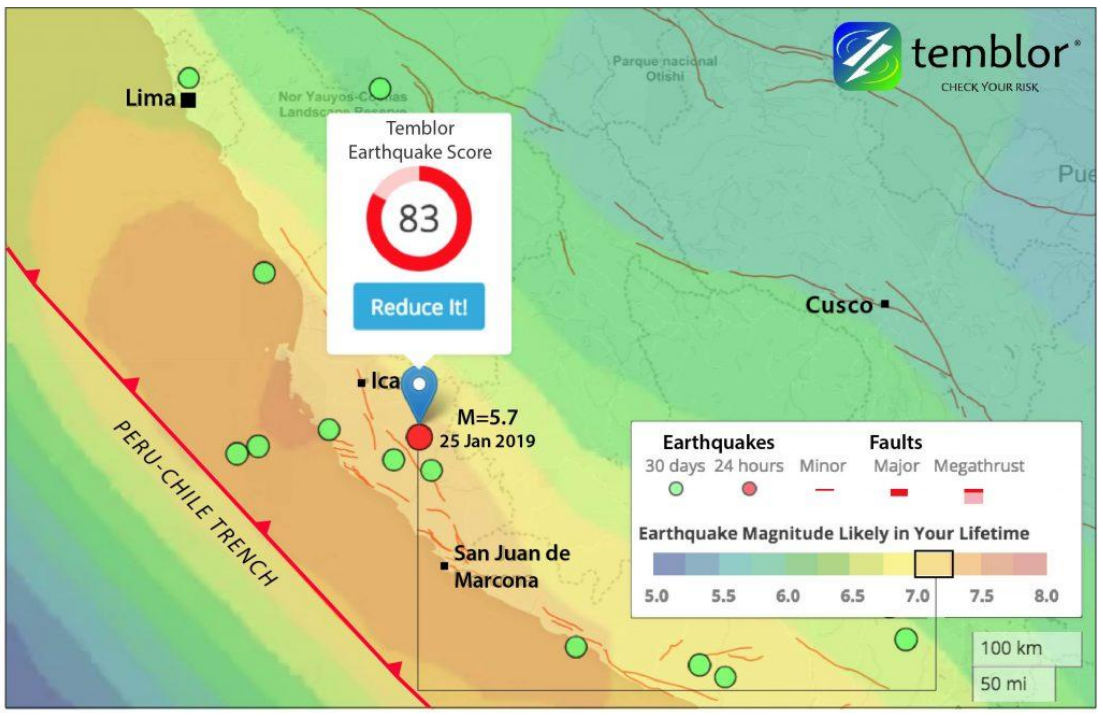
The moderate earthquake struck at 11:45 pm local time on 25 January 2019 in Peru, and was felt from Lima to Arequipa. The widespread shaking is probably a result of its depth of about 65 km (40 mi), which places it within the subducting Nazca slab, rather than on the megathrust, on which the largest quakes strike. The quake is tensional in nature, perhaps associated with the downward bending of the slab.



USGS 'Did You Feel It?' responses reveal the extraordinary extent of shaking felt by citizens from today's quake.

Highly Active Zone

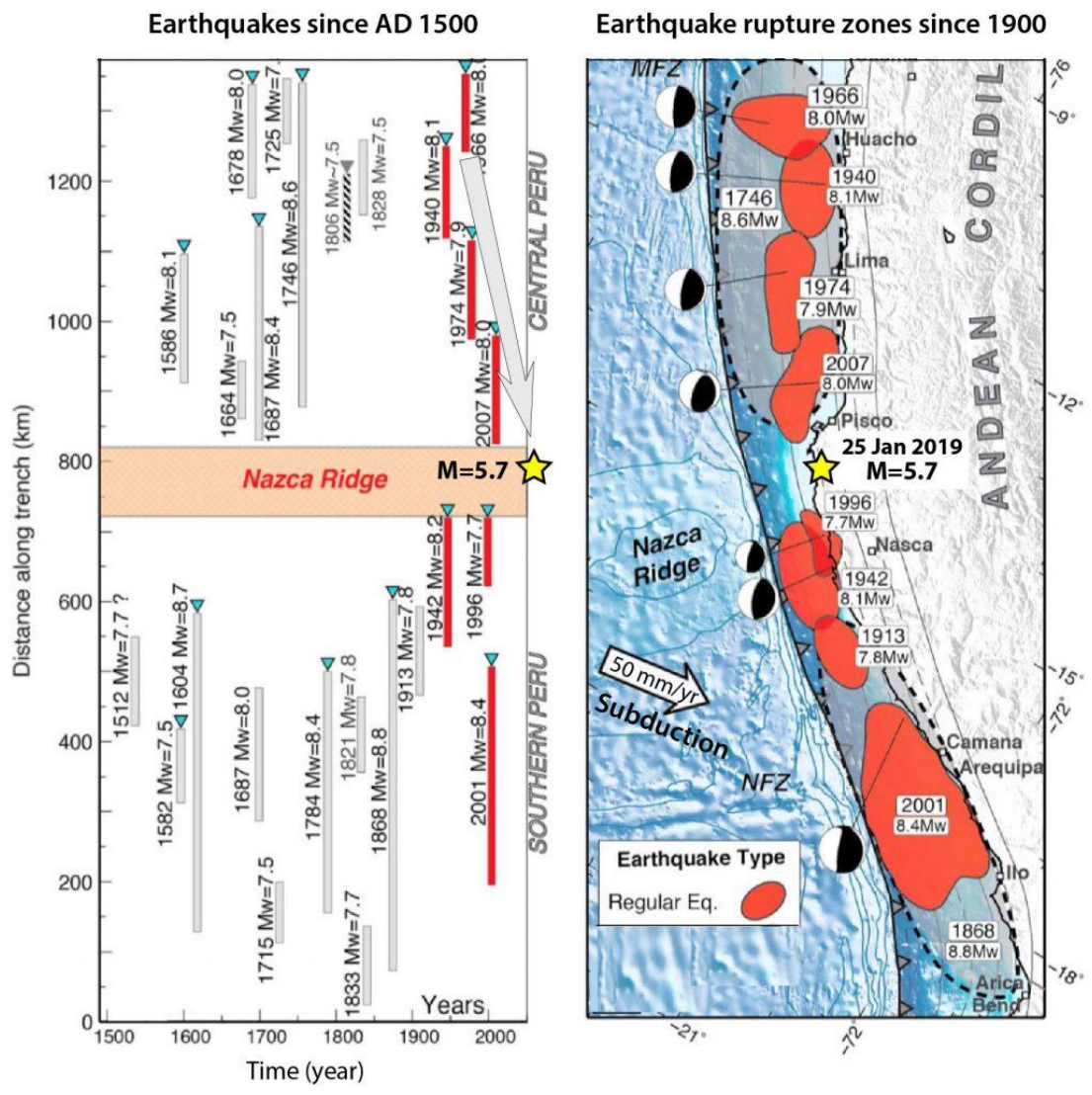
The earthquake lies in zone with one of the highest rates of great earthquakes anywhere on Earth, slightly higher than the quake rate at Lima. The earthquakes are a byproduct of the subduction of the Nazca tectonic plat beneath the Andean Cordillera at a rate of about 50 mm/yr (2 in/yr). Here we show the quake relative to the Global Earthquake Activity Rate (GEAR) model, whose color bands indicate that in the region where today's quake struck, a M=7.0-7.25 event would be expected in a normal human lifetime. Such a quake is about 60 times larger than the M=5.7 event, and so vastly more damaging.



The Earthquake Score for this location is very high, a result of a high seismic hazard coupled with weak buildings. The GEAR model forecasts a 1% chance per year of M=7.0-7.25 quake at today's location, which corresponds to a 57% chance in an 85-year lifetime.

Surrounded by Past Great Quakes

The earthquake lies between the sites of recent great earthquakes, with a M=8.0 earthquake to the north in 2007, and a M=7.7 earthquake to the south in 1996. Each of these earthquakes generated large, deadly local tsunami. On a much larger and longer scale, the M=5.7 lies north of the 1868 M~8.8 and south of the 1746 M~8.6 earthquakes. The event also lies atop the subducting Nazca Ridge. Seafloor ridges are typically the product of seamounts or fractures that are more buoyant than the surrounding oceanic crust, and as a result, resist subduction. Villegas-Lanza et al. (2016) suggest in their figure below that the ridge marks an aseismic region, one that has not locally produced a great quake in the past five centuries. This is supported by independent analysis of the megathrust coupling by Perfettini et al (2010), that indicates aseismic slip in this region. However, great earthquakes sometimes rupture through what were previously interpreted to be barriers to rupture.



The time history of great earthquakes is shown in the left panel, whereas the right panel shows the rupture areas of the past 100 years of earthquakes. Notice the apparent migration of large quakes toward the M=5.7 over the past 80 years (grey arrow in left panel); this could be a random artifact, or it could be caused by Coulomb stress transfer (Lin and Stein, 2004). Today's quake struck in a gap in historical rupture zones; this gap could be permanent, but that is not assured. The figure annotated from Villegas-Lanza et al. (2016).

What next?

Most likely, the Nazca Ridge prevents great earthquakes from rupturing within about 50-100 km (30-60 mi) of today's quake, which would, of course, be welcome news.

But an alternative hypothesis, which is perhaps more consistent with the GEAR model and the apparent 80-year migration of great quakes toward today's epicenter, is that this could be the next section of the megathrust to rupture. While we hope this is not the case, its possibility should dictate preparation and mitigation efforts.

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