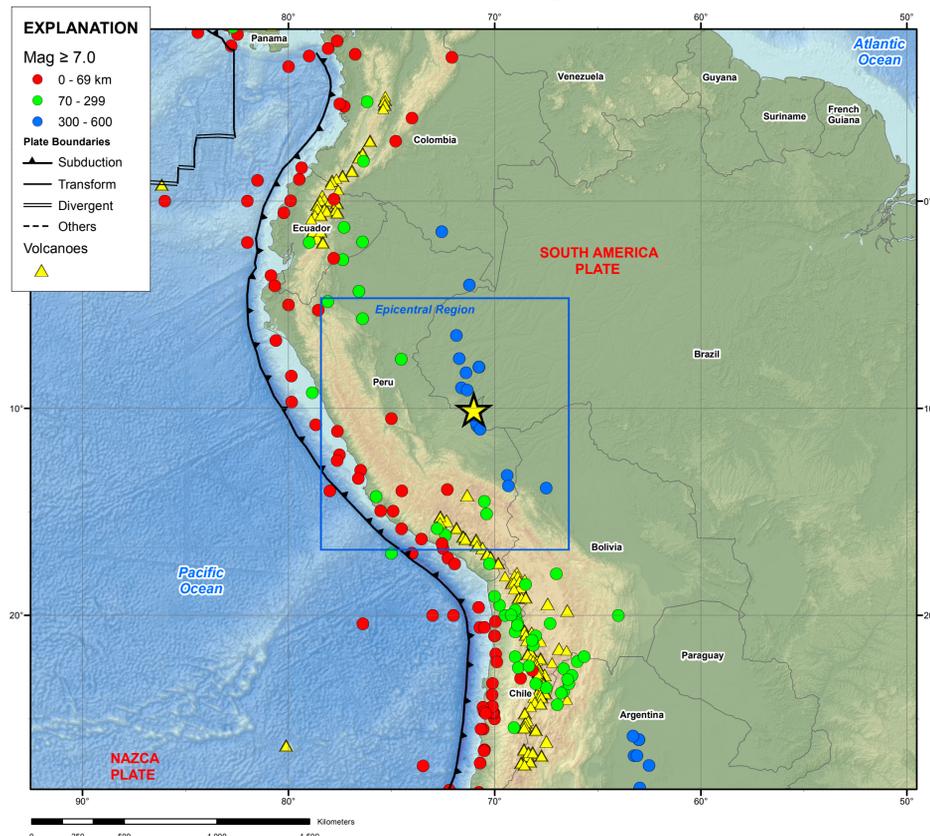


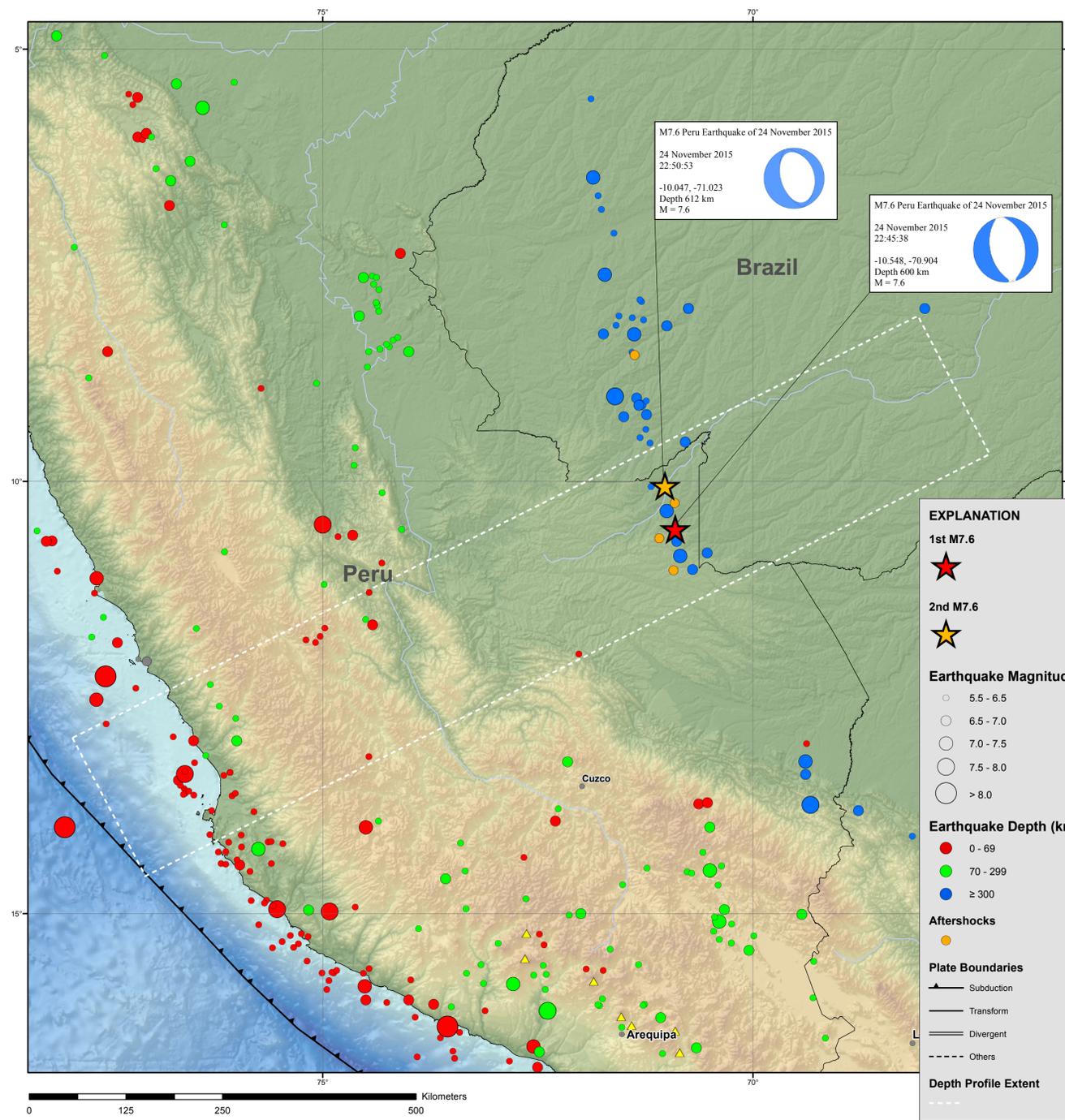
M7.6 Peru Earthquakes of 24 November 2015



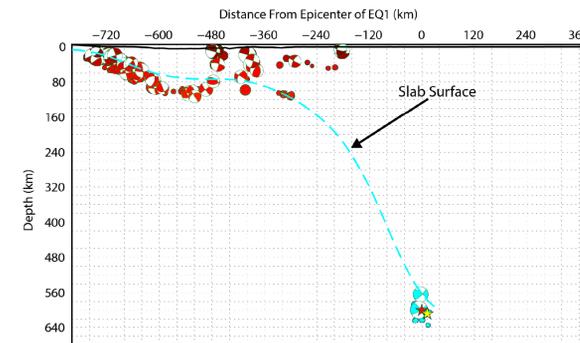
Tectonic Setting



Epicentral Region



Depth Profile



PAGER

USGS Earthquake Shaking **Green Alert**

M 7.6, CENTRAL PERU
Version 4
Origin Time: Tue 2015-11-24 22:50:53 UTC (17:50:53 local)
Location: 10.05°S 71.02°W Depth: 611 km

Estimated Fatalities

Estimated Economic Losses

Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (N = 10000)	I	II-III	IV	V	VI	VII	VIII	IX	X+
ESTIMATED MODIFIED MERCALLI INTENSITY									
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Heavy	V. Heavy	V. Heavy

Population Exposure

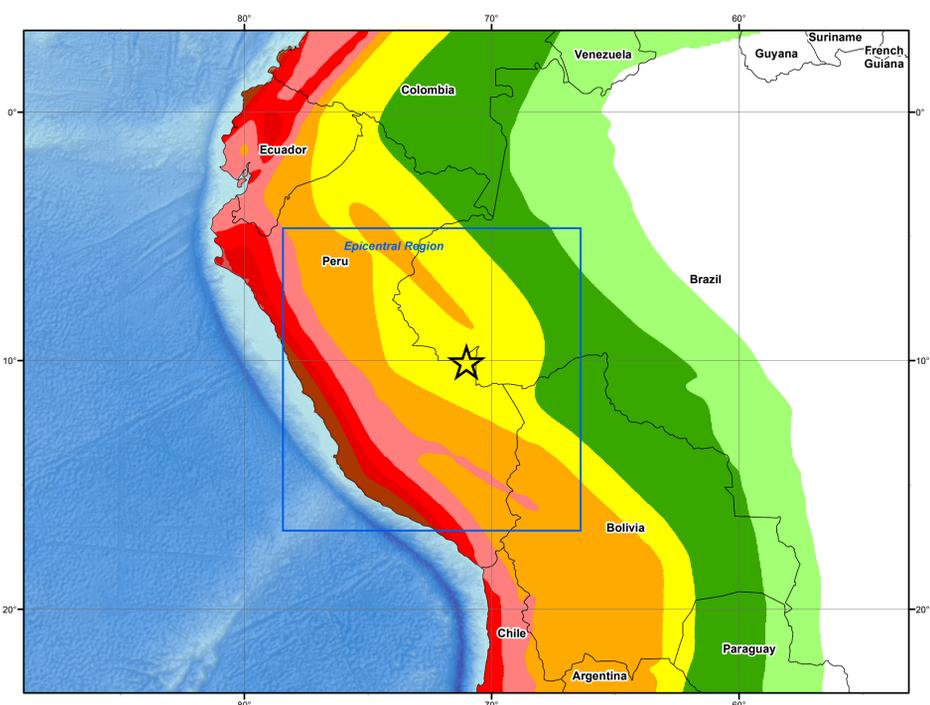
Historical Earthquakes (with MMI levels):

Date (UTC)	Dist (km)	Mag	Max Shaking (MMI)	Deaths
1568-23-19	306	6.1	VI	0
1682-11-10	306	6.6	VII	0
1789-04-05	374	6.2	VII	16

Selected City Exposure

MMI City	Population
III Arequipa	13k
III Cuzco	14k
III San Lorenzo	14k
III Puerto Walter	2k
III Manosel Urbano	4k
III Beria	4k
III Tarauaca	17k
III Inapari	< 1k
III Breu	< 1k

Seismic Hazard



TECTONIC SUMMARY

The November 24, 2015 22:45 UTC M 7.6 earthquake was the first of two similarly sized events near the Peru-Brazil border in southeast Peru. Both earthquakes occurred as the result of normal faulting at a depth of approximately 600 km, almost 1000 kilometers east of the Peru-Chile Trench within the subducted oceanic lithosphere of the Nazca plate. Focal mechanisms indicate rupture occurred on either a north or south-southeast striking, moderately dipping normal fault. At the location of the earthquakes, the Nazca plate subducts to the east under the South America plate at a velocity of about 69 mm/yr.

The 22:50 UTC event followed another M 7.6 earthquake (22:45 UTC) by 5 minutes; the events were separated by approximately 50 km horizontally – slightly more than typical location uncertainties of global earthquakes – and just 6 km vertically. The two events also had approximately the same focal mechanism. The latter earthquake was almost certainly triggered by the earlier event. Seismologists sometimes refer to a pair of similarly sized earthquakes that occur at nearly the same time and location as an earthquake "doublet."

As it descends eastwards from the Peru-Chile Trench off the west coast of Peru, the Nazca plate is seismically active down to depths of about 200 km. Between depths of 200 km and 500 km, where the Nazca plate subducts beneath eastern Peru, very few earthquakes are produced. Beneath Peru and Brazil in the border region near the November 24th earthquake, the subducted Nazca plate is again seismically active between depths of about 500 km and 650 km. The deep part of the Nazca plate, in which the November 24th earthquakes occurred, took 10 million years or more to descend from the point at which it initially thrust under the South America plate.

Earthquakes that have focal depths greater than 300 km are commonly termed "deep-focus" earthquakes. Deep-focus earthquakes cause less damage on the ground surface above their foci than similar magnitude shallow-focus earthquakes, but large deep-focus earthquakes may be felt at great distance from their epicenters. The largest recorded deep-focus earthquake to date was the M 8.3 event that occurred at a depth of 600 km within the subducted Pacific plate beneath the Sea of Okhotsk offshore northeastern Russia in 2013. The M 8.3 Okhotsk earthquake was felt all over Asia, as far away as Moscow, and across the Pacific along the western seaboard of the United States. Prior to 2013, the largest recorded deep-focus earthquake was a M 8.2 event that occurred at a depth of 630 km within the subducted Nazca plate near the northern Bolivian border in 1994, approximately 500 km southeast of the November 24, 2015 events. The Bolivia earthquake was also broadly felt across the United States.

Over the past century, 91 earthquakes with a magnitude of M 7 or more have occurred at depths greater than 300 km globally; 13 of these were located in the same region as the November 24, 2015 events. The largest nearby event at these depths was the aforementioned M 8.2 Bolivia earthquake. The most recent large event in the immediate vicinity of the November 24, 2015 events was a M 7.0 earthquake in October 1990, 15 km to the southeast.

DATA SOURCES

EARTHQUAKES AND SEISMIC HAZARD
USGS, National Earthquake Information Center
NOAA, National Geophysical Data Center
IASPEI, Centennial Catalog (1900 - 1999) and extensions (Engdahl and Villaseñor, 2002)
EHB catalog (Engdahl et al., 1998)
IHF (unpublished earthquake catalog, Engdahl, 2003)
Global Seismic Hazard Assessment Program
Volcanoes of the World (Siebert and Simkin, 2002)

PLATE TECTONICS AND FAULT MODEL
PB2002 (Bird, 2003)
Ji, C., D.J. Wald, and D.V. Helwegger. Source description of the 1999 Hector Mine, California earthquake. Part I: Wavelet domain inversion theory and resolution analysis. Bull. Seism. Soc. Am., Vol 92, No. 4, pp. 1192-1207, 2002.
DeMets, C., Gordon, R.G., Argus, D.F., 2010. Geologically current plate motions. Geophys. J. Int. 181, 1-80.

BASE MAP
NIMA and ESRI, Digital Chart of the World
USGS, EROS Data Center
NOAA GEBCO and GLOBE Elevation Models

REFERENCES

Bird, P., 2003. An updated digital model of plate boundaries. Geochim. Geophys. Geosyst., v. 4, no. 3, pp. 1027-80.

Engdahl, E.R., and Villaseñor, A., 2002. Global Seismicity: 1900-1999, chap. 41 of Lee, W.H.K., and others, eds., International Earthquake and Engineering Seismology, Part A: New York, N.Y., Elsevier Academic Press, 932 p.

Engdahl, E.R., Van der Hilst, R.D., and Buland, R.P., 1998. Global teleseismic earthquake relocation with improved travel times and procedures for depth determination. Bull. Seism. Soc. Amer., v. 88, p. 722-743.

DISCLAIMER
Base map data, such as place names and political boundaries, are the best available but may not be current or may contain inaccuracies and therefore should not be regarded as having official significance.
Map updated by U.S. Geological Survey National Earthquake Information Center
25 November 2015
http://earthquake.usgs.gov/
Map not approved for release by Director USGS