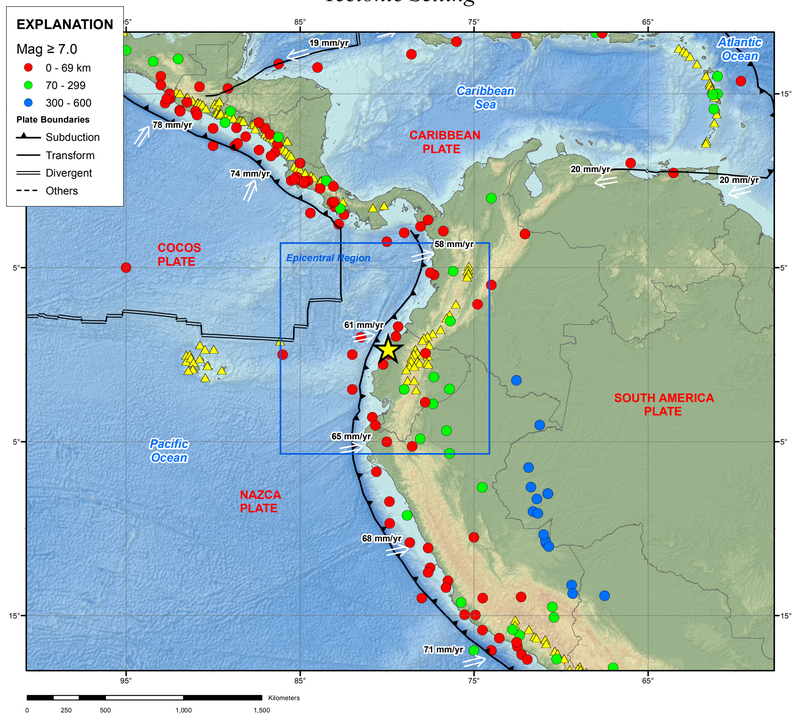
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

EARTHQUAKE SUMMARY MAP

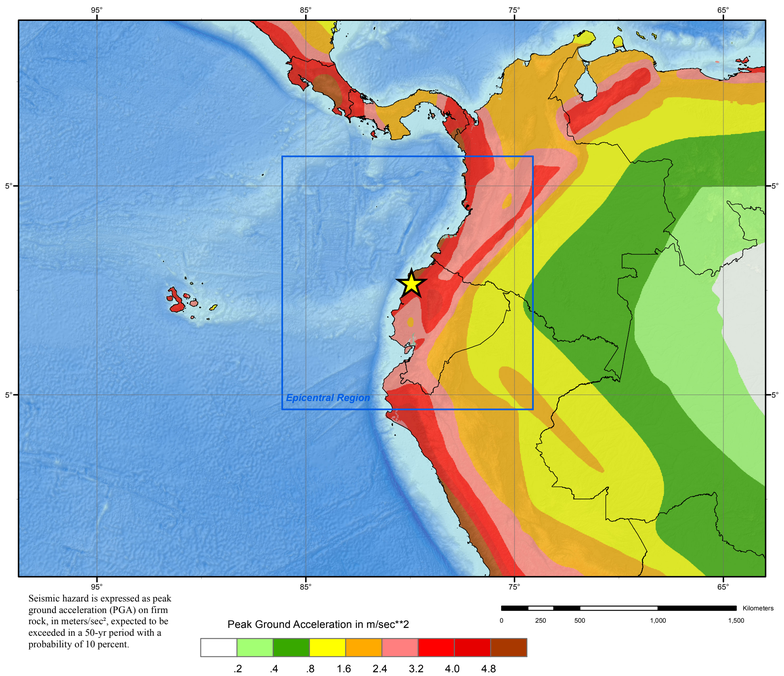
Prepared in cooperation with the Global Seismographic Network

M7.8 Coastal Ecuador Earthquake of 16 April 2016

Tectonic Setting

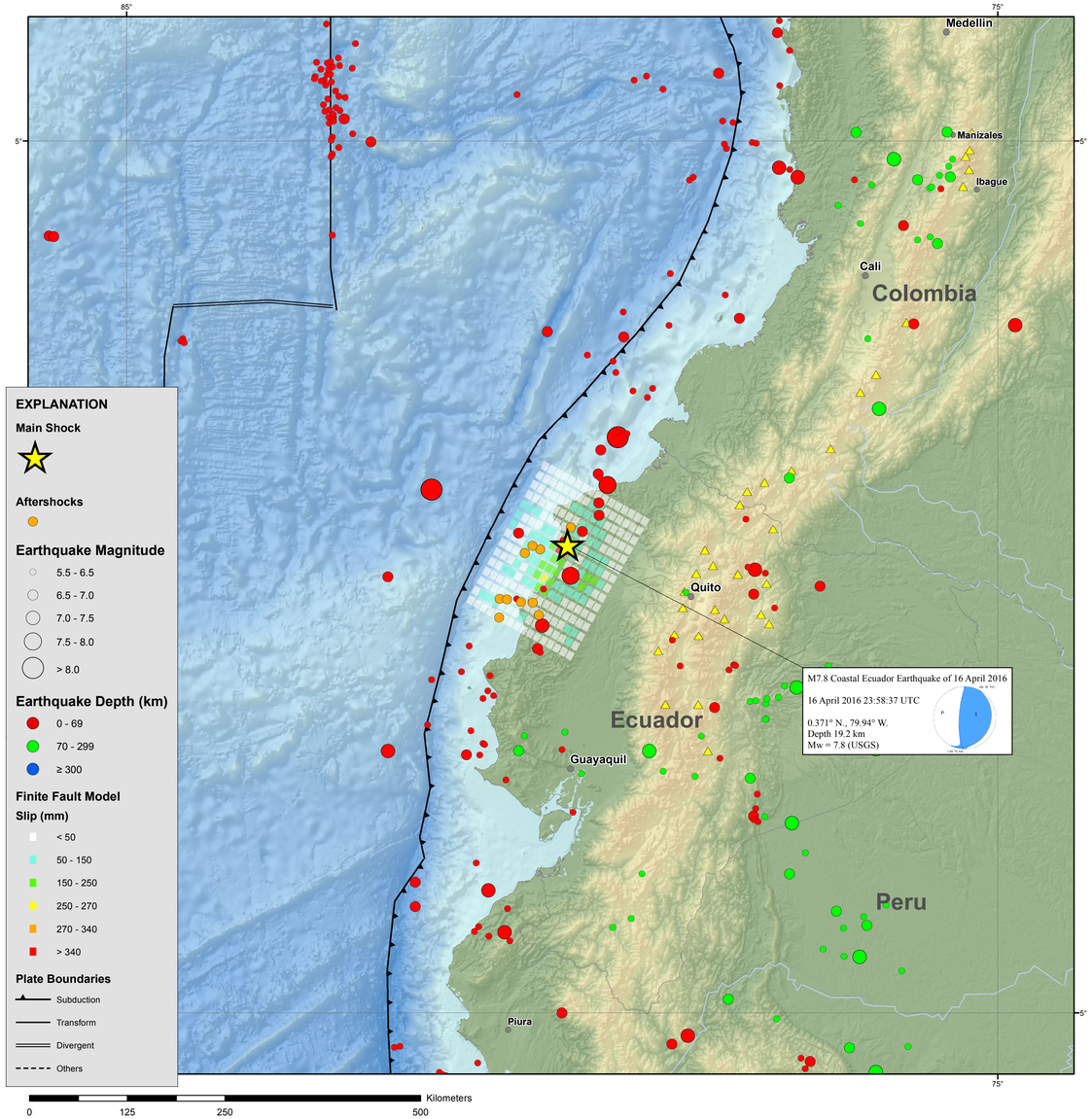


Seismic Hazard

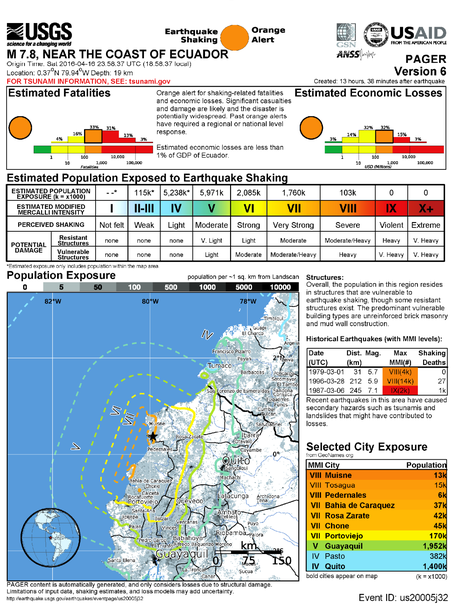


Seismic hazard is expressed as peak ground acceleration (PGA) on firm rock, in meters/sec^2, expected to be exceeded in a 50-yr period with a probability of 10 percent.

Epicentral Region



PAGER



USGS science for a changing world

M 7.8, NEAR THE COAST OF ECUADOR

Origin Time: Sat 2016-04-16 23:58:37 UTC (18:58:37 local)
Location: 0.37°N 79.94°W Depth: 19 km
FOR TSUNAMI INFORMATION, SEE: tsunami.gov

Earthquake Shaking: Orange Alert

PAGER Version 6
Created: 13 hours, 38 minutes after earthquake

Estimated Fatalities

Orange alert for shaking-related fatalities and economic losses. Significant casualties and damage are likely and the disaster is potentially widespread. Past orange alerts have required a regional or national level response.

Estimated Economic Losses

Estimated economic losses are less than 1% of GDP of Ecuador.

Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)		- -*	115k*	5,238k*	5,971k	2,085k	1,760k	103k	0	0
ESTIMATED MODIFIED MERCALLI INTENSITY		I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING		Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

*Estimated exposure only includes population within the map area

Population Exposure

population per ~1 sq. km from Landscan

Structures:
Overall, the population in this region resides in structures that are vulnerable to earthquake shaking, though some resistant structures exist. The predominant vulnerable building types are unreinforced brick masonry and mud wall construction.

Historical Earthquakes (with MMI levels):

Date (UTC)	Dist. (km)	Mag.	Max MMI(#)	Shaking Deaths
1979-03-01	31	5.7	VIII(4k)	0
1996-03-28	212	5.9	VIII(14k)	27
1987-03-06	245	7.1	IX(2k)	1k

Recent earthquakes in this area have caused secondary hazards such as tsunamis and landslides that might have contributed to losses.

Selected City Exposure
from GeoNames.org

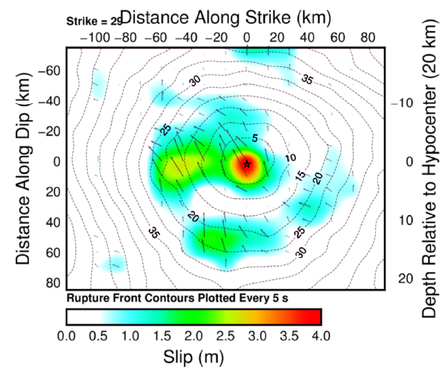
MMI	City	Population
VIII	Muisne	13k
VIII	Tosagua	15k
VIII	Pedernales	6k
VII	Bahia de Caraquez	37k
VII	Rosa Zarate	42k
VII	Chone	45k
VII	Portoviejo	170k
V	Guayaquil	1,952k
IV	Pasto	382k
IV	Quito	1,400k

bold cities appear on map (k = x1000)

PAGER content is automatically generated, and only considers losses due to structural damage. Limitations of input data, shaking estimates, and loss models may add uncertainty.
http://earthquake.usgs.gov/earthquakes/eventpage/us20005j32

Event ID: us20005j32

Finite Fault Model



Distribution of the amplitude and direction of slip for subfault elements of the fault rupture model are determined from the inversion of teleseismic body waveforms and long period surface waves. Arrows indicate the amplitude and direction of slip (of the hanging wall with respect to the foot wall); the slip is also colored by magnitude. The view of the rupture plane is from above. The strike of the fault rupture plane is 29° and the dip is 15°ESE. The dimensions of the subfault elements are 14 km in the strike direction and 10 km in the dip direction. The rupture surface is approximately 70 km along strike and 20 km along downdip. The seismic moment release based upon this plane is 7.1e+27 dyne.cm.

TECTONIC SUMMARY

The April 16, 2016 M 7.8 earthquake, offshore of the west coast of northern Ecuador, occurred as the result of shallow thrust faulting on or near the plate boundary between the Nazca and Pacific plates. At the location of the earthquake, the Nazca plate subducts eastward beneath the South America plate at a velocity of 61 mm/yr. The location and mechanism of the earthquake are consistent with slip on the primary plate boundary interface, or megathrust, between these two major plates. Subduction along the Ecuador Trench to the west of Ecuador, and the Peru-Chile Trench further south, has led to uplift of the Andes mountain range and has produced some of the largest earthquakes in the world, including the largest earthquake on record, the 1960 M 9.5 earthquake in southern Chile.

While commonly plotted as points on maps, earthquakes of this size are more appropriately described as slip over a larger fault area. Events of the size of the April 16, 2016 earthquake are typically about 160x60 km in size (length x width).

Ecuador has a history of large subduction zone related earthquakes. Seven magnitude 7 or greater earthquakes have occurred within 250 km of this event since 1900. On May 14th, 1942, a M 7.8 earthquake occurred 43 km south of this April 16th, 2016 event. On January 31st, 1906 a M 8.3 earthquake (reportedly as large as M 8.8 in some sources) nucleated on the subduction zone interface 90 km to the northeast of the April 2016 event, and ruptured over a length of approximately 400-500 km, resulting in a damaging tsunami that caused in the region of 500-1,500 fatalities. The April 2016 earthquake is at the southern end of the approximate rupture area of the 1906 event. A shallow, upper crustal M 7.2 earthquake 240 km east of the April 2016 event on March 6th, 1987 resulted in approximately 1,000 fatalities.

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)
HDF (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. Helmberger, 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: Geochem. Geophys. Geosyst., v. 4, no. 3, pp. 1027-80.

Engdahl, E.R., and Villasenor, 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 signifiance.

Map updated by U.S. Geological Survey National Earthquake Information Center
18 April 2016
http://earthquake.usgs.gov/
Map not approved for release by Director USGS