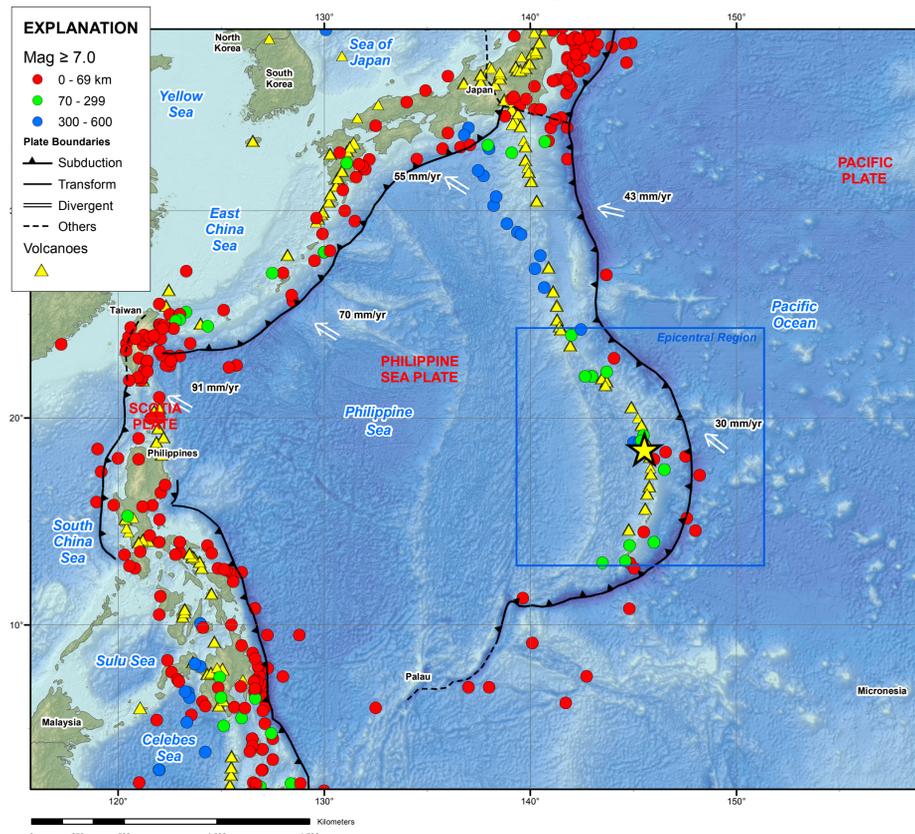


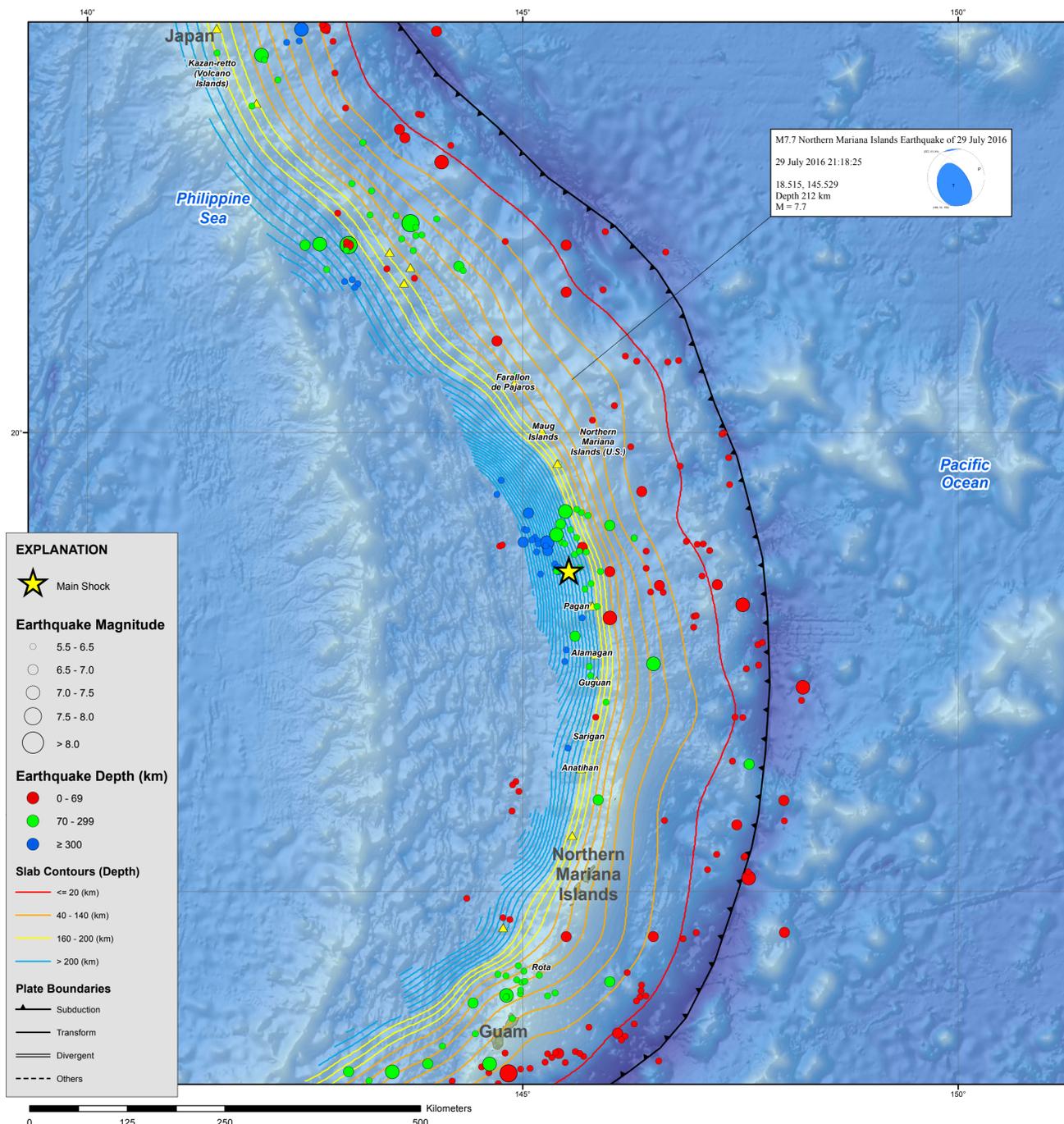
# M7.7 Northern Mariana Islands Earthquake of 29 July 2016



## Tectonic Setting



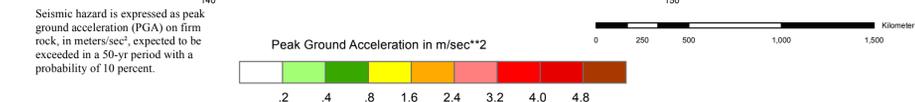
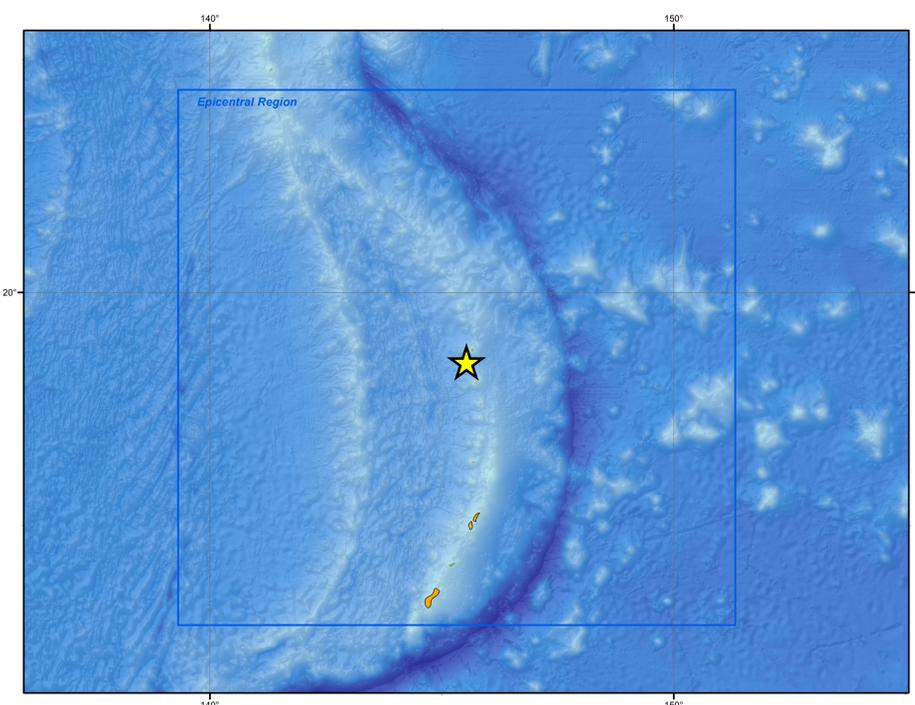
## Epicentral Region



**EXPLANATION**

- ★ Main Shock
- Earthquake Magnitude
  - 5.5 - 6.5
  - 6.5 - 7.0
  - 7.0 - 7.5
  - 7.5 - 8.0
  - > 8.0
- Earthquake Depth (km)
  - 0 - 69
  - 70 - 299
  - ≥ 300
- Slab Contours (Depth)
  - ≤ 20 (km)
  - 40 - 140 (km)
  - 160 - 200 (km)
  - > 200 (km)
- Plate Boundaries
  - ▲ Subduction
  - Transform
  - Divergent
  - Others

## Seismic Hazard



## TECTONIC SUMMARY

The July 29, 2016 M 7.7 earthquake in the Northern Mariana Islands region occurred as the result of oblique reverse faulting at an intermediate depth, approximately 210 km beneath the Pacific Ocean and 200 km west of the Mariana Trench, which marks where the Pacific plate begins its subduction beneath the overriding Philippine Sea plate. Focal mechanism solutions indicate oblique rupture occurred on either a south-southwest or northwest striking reverse fault. Slip on a fault of either orientation is consistent with the intraplate compressional tectonics implied by the faulting mechanism and earthquake depth. At the location of the earthquake, the Pacific plate moves to the west relative to the Philippine Sea plate with a velocity of about 40 mm/yr, and at about 60 mm/yr relative to the Mariana microplate. The earthquake likely represents the release of stress resulting from the distortion of the Pacific plate at depth.

Earthquakes like this event, with focal depths between 70 and 300 km, are commonly termed "intermediate-depth" earthquakes. Intermediate-depth earthquakes represent deformation within subducted slabs rather than at the shallow plate interface between subducting and overriding tectonic plates. They typically cause less damage on the ground surface above their foci than is the case with similar magnitude shallow-focus earthquakes, but large intermediate-depth earthquakes may be felt at great distance from their epicenters. "Deep-focus" earthquakes, those with focal depths greater than 300 km, also occur in the subducted Pacific plate beneath the Mariana island arc. Earthquakes have been reliably located to depths of about 630 km beneath the Mariana arc.

While commonly plotted as points on maps, earthquakes of this size are more appropriately described as slip over a larger fault area. Reverse faulting events of the size of the July 29, 2016 earthquake are typically about 110x40 km in size (length x width).

The Mariana Arc hosts frequent moderate-to-large earthquakes, and four other events over M 7 have occurred within 250 km of the July 29th earthquake in the preceding century. These include a deep (595 km) M 7.1 event in August 1995, approximately 70 km to the northwest, and a M 7.2 in October 2007, also at an intermediate depth (207 km), and 60 km to the north-northwest of the July 29th, 2016 earthquake. The remote location of all of these earthquakes makes them minimally disruptive.

## PAGER

**USGS Earthquake Shaking Green Alert**

**M 7.7 PAGAN REGION, NORTHERN MARIANA ISLANDS**  
Origin Time: Fri 2016-07-29 21:18:25 UTC (21:18:25 local)  
Location: 18.52°N 145.53°E Depth: 212 km

Estimated Fatalities: 22 minutes, 35 seconds to earthquake  
Estimated Economic Losses: 2% of GDP

**Estimated Population Exposed to Earthquake Shaking**

ESTIMATED POPULATION EXPOSURE (N = 21000)	Intensity I	Intensity II-III	Intensity IV	Intensity V	Intensity VI	Intensity VII	Intensity VIII	Intensity IX	Intensity X+
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures: none	Resistant Structures: none	Resistant Structures: none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures: none	Vulnerable Structures: none	Vulnerable Structures: none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

**Population Exposure**

Estimated population city, census population within the map area

**Selected City Exposure**

City	Population
NMI City	

Event ID: us100068j

## DYFI?

**USGS Community Internet Intensity Map**  
PAGAN REGION, NORTHERN MARIANA ISLANDS  
Jul 30 2016 07:18:25 AM local 18.5153N 145.5293E M7.7 Depth: 212 km ID:us100068j

34 responses in 7 ZIP codes and 1 city (Max CDI = IV)

SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Processed: Fri Jul 29 21:43:28 2016 vmdyfi1

## 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 Villasenor, 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 ESRJ, 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. 72, 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  
29 July 2016  
http://earthquake.usgs.gov/  
Map not approved for release by Director USGS