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

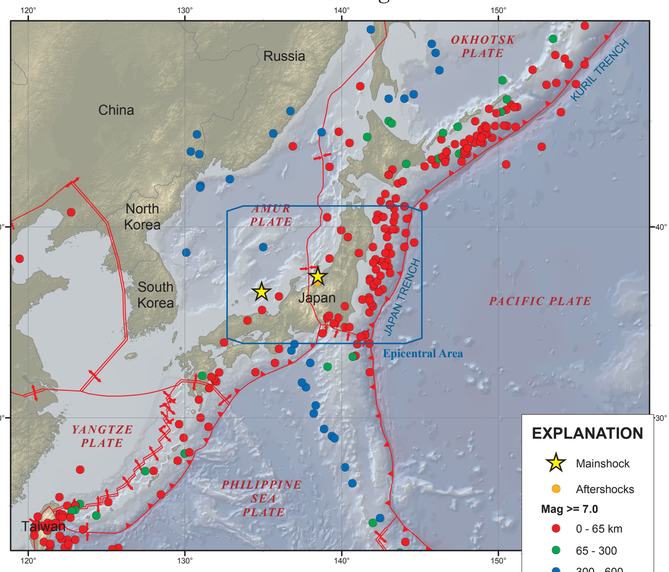
EARTHQUAKE SUMMARY MAP XXX

Prepared in cooperation with the Global Seismographic Network

GSN

M6.6 and 6.8 Honshu, Japan, Earthquakes of 16 July 2007

Tectonic Setting



RELATIVE PLATE MOTIONS

The broad red vectors represent the motion of the Australia Plate relative to the other plates in the region. The motion of the Australia Plate is generally northward with respect to the Pacific Plate, and many micro-plates are caught between them.

SCALE 1:20,000,000 at the Equator

0 200 400 800 1,200 1,600 Kilometers

EXPLANATION

- Mainshock
- Aftershocks

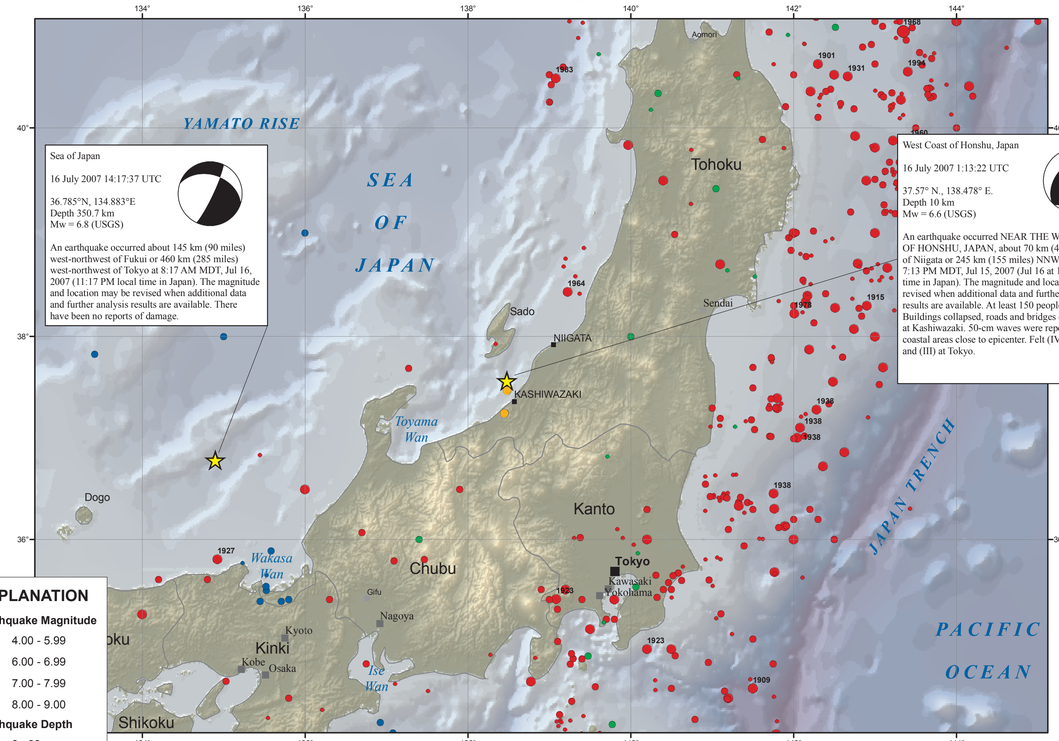
Mag >= 7.0

- 0 - 65 km
- 65 - 300
- 300 - 600

Plate Boundary

- Subduction
- Transform
- Divergent
- Convergent

Epicentral Region



Sea of Japan

16 July 2007 14:17:37 UTC

36.785°N, 134.883°E
Depth 350.7 km
Mw = 6.8 (USGS)

An earthquake occurred about 145 km (90 miles) west-northwest of Fukui or 460 km (285 miles) west-northwest of Tokyo at 8:17 AM MDT, Jul 16, 2007 (11:17 PM local time in Japan). The magnitude and location may be revised when additional data and further analysis results are available. There have been no reports of damage.

West Coast of Honshu, Japan

16 July 2007 1:13:22 UTC

37.57° N., 138.478° E.
Depth 10 km
Mw = 6.6 (USGS)

An earthquake occurred NEAR THE WEST COAST OF HONSHU, JAPAN, about 70 km (45 miles) WSW of Niigata or 245 km (155 miles) NNW of TOKYO at 7:13 PM MDT, Jul 15, 2007 (Jul 16 at 10:13 AM local time in Japan). The magnitude and location may be revised when additional data and further analysis results are available. At least 150 people injured. Buildings collapsed, roads and bridges damaged at Kashiwazaki. 50-cm waves were reported on coastal areas close to epicenter. Felt (IV) at Niigata and (III) at Tokyo.

EXPLANATION

Earthquake Magnitude

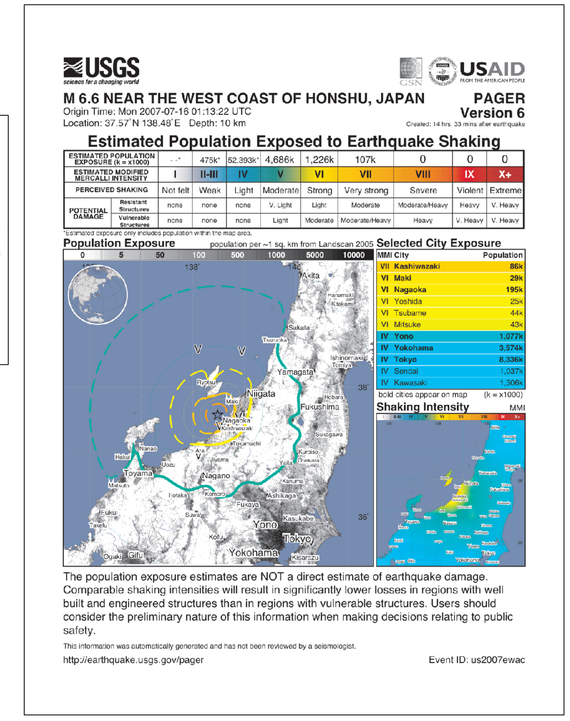
- 4.00 - 5.99
- 6.00 - 6.99
- 7.00 - 7.99
- 8.00 - 9.00

Earthquake Depth

- 0 - 69
- 70 - 299
- 300 - 700

Scale at the Equator 1:3,850,000
Mercator Projection

0 100 200 400 Kilometers



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M 6.6 NEAR THE WEST COAST OF HONSHU, JAPAN
Origin Time: Mon 2007-07-16 01:13:22 UTC
Location: 37.57° N 138.48° E Depth: 10 km

PAGER
Version 6
Created: 14 hrs. 33 mins after earthquake

Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	475k*	52,393k*	4,686k	1,226k	107k	0	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
POTENTIAL DAMAGE: 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 2005

0 5 50 100 500 1000 5000 10000

Selected City Exposure

MMI	City	Population
VII	Kashiwazaki	86k
VI	Maki	29k
VI	Nagaoka	195k
VI	Yoshida	25k
VI	Tsubame	44k
VI	Mitsuke	43k
IV	Yono	1,077k
IV	Yokohama	3,574k
IV	Tokyo	8,336k
IV	Sendai	1,037k
IV	Kawasaki	1,306k

bold cities appear on map (k = x1000)

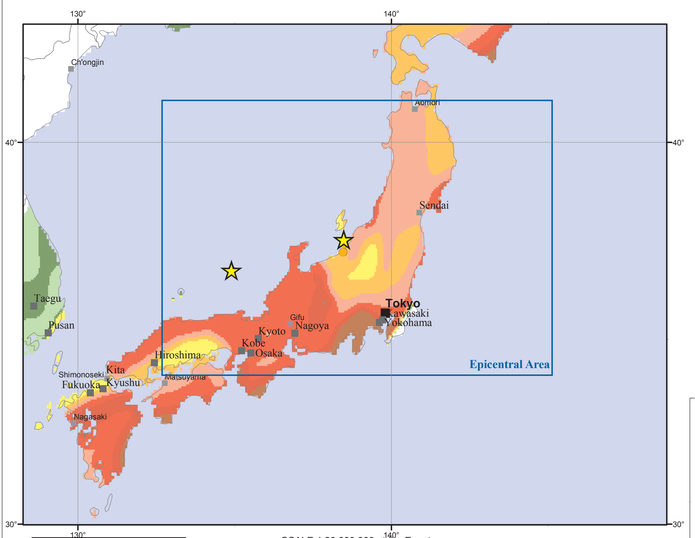
Shaking Intensity MMI

The population exposure estimates are NOT a direct estimate of earthquake damage. Comparable shaking intensities will result in significantly lower losses in regions with well built and engineered structures than in regions with vulnerable structures. Users should consider the preliminary nature of this information when making decisions relating to public safety.

This information was automatically generated and has not been reviewed by a seismologist.

http://earthquake.usgs.gov/pager Event ID: us2007ewac

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.

SCALE 1:20,000,000 at the Equator

0 200 400 800 1,200 1,600 Kilometers

Seismic Hazard

PGA m/sec2**

- .2
- .4
- .8
- 1.6
- 2.4
- 3.2
- 4.0
- 4.8

DISCUSSION

This magnitude 6.6 earthquake occurred near the west coast of Honshu, Japan, in a zone of compressional deformation that is associated with the boundary between the Amur plate and the Okhotsk plate. At this latitude, the Okhotsk plate is converging to the west-northwest towards the Amur plate with a velocity of about 9 mm/yr. The Amur and Okhotsk plate are themselves relatively small plates that lie between the Eurasia plate and the Pacific plate. The Pacific plate converges west-northwest towards the Eurasia plate at over 90 mm/yr. Most of the relative motion between the Pacific plate and the Eurasia plate is accommodated approximately 400 km to the east-southeast of the epicenter of the earthquake, where the Pacific plate subducts beneath the Okhotsk plate.

This shallow crustal earthquake was followed 13 hours later by a deep focus magnitude 6.8 quake roughly 330 km to the west, 350 km below the Sea of Japan. The two earthquakes were generated by different mechanisms. The first earthquake was caused by deformation within the crust of the Okhotsk plate and the second quake was likely caused by faulting resulting from internal deformation of the subducted Pacific plate. Given their different mechanisms and physical separation of at least 10 rupture lengths, the second earthquake is not considered an aftershock of the first.

Shallow earthquakes cause more damage than intermediate- and deep-focus ones since the energy generated by the shallow events is released closer to the surface and therefore produces stronger shaking than is produced by quakes that are deeper within the Earth.

Other deadly earthquakes have occurred in this region: In 2004, a magnitude 6.6 earthquake occurred in the Niigata Prefecture, 50 km to the southeast of the recent quake, killing 40 people and injuring about 3,000. In June, 1964, a M7.5 earthquake occurred about 115 km to the north-northeast of the recent quake, killing 37 people; and in April, 1995 a M5.4 earthquake 80 km to the northeast injured at least 39 people.

During the 20th century Japan has suffered nine devastating earthquakes that killed more that 1000 people each. Among these are the 1923 M7.9 earthquake that triggered the great Tokyo fire that killed 143,000 people and the more recent 1995 M6.9 Kobe earthquake that killed about 5,500 people.

Significant Earthquakes Mag >= 7.5

Year	Mon	Day	Time	Lat	Long	Dep	Mag
1901	08	09	1833	40.600	142.300	35	7.5
1909	03	13	1429	34.500	141.500	35	7.6
1915	11	01	0724	38.300	142.900	35	7.5
1923	09	01	0258	35.405	139.084	35	7.9
1923	09	02	0246	34.900	140.200	35	7.6
1927	03	07	0927	35.802	134.924	9.6	7.6
1931	03	09	0348	40.484	142.664	35	7.7
1933	03	02	1731	39.224	144.622	35	8.4
1938	05	23	0718	36.458	141.755	35	7.7
1938	11	05	0843	37.009	142.045	35	7.9
1938	11	05	1050	37.108	142.081	35	7.8
1938	11	06	0853	37.287	142.283	35	7.7
1960	03	20	1707	39.871	143.435	2.1	7.8
1964	06	16	0401	38.434	139.226	13.1	7.5
1968	05	16	0049	40.903	143.346	25.8	8.3
1978	06	12	0814	38.224	142.009	53.3	7.7
1983	05	26	0300	40.468	139.080	20	7.7
1994	12	28	1219	40.530	143.403	29.2	7.8

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.

National highway is cut off following a powerful quake in Nagaoka, Honshu, Monday, July 16, 2007. (AP Photo/Kyodo News)

Hundreds of buildings were flattened or damaged to some degree. Kyoda News, via Reuters

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)
HDF (unpublished earthquake catalog) (Engdahl, 2003)
Global Seismic Hazard Assessment Program

PLATE TECTONICS AND FAULT MODEL
PB2002 (Bird, 2003)
Finite Fault Model, Chen Ji, UC Santa Barbara (2007)

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 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 Academeic 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.

Map prepared by U.S. Geological Survey
National Earthquake Information Center
2007
Map not approved for release by Director USGS