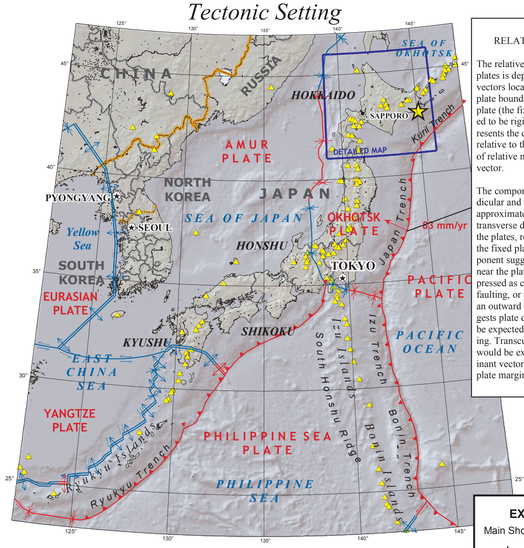
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

M7.0 Hokkaido, Japan Earthquake of 28 November 2004

Tectonic Setting



SCALE 1:15,000,000
Albers Equal-Area Projection
Kilometers
0 50 100 200 300 400

RELATIVE PLATE MOTIONS

The relative motion of adjacent tectonic plates is depicted on the map by short vectors located at selected points on the plate boundary. In this presentation, one plate (the fixed reference plate) is assumed to be rigid. The vector therefore represents the direction of the moving plate relative to the reference plate. The rate of relative motion is labelled next to the vector.

The components of the vector perpendicular and parallel to the plate margin approximate convergent/divergent and transverse direction of motion between the plates, respectively. As viewed from the fixed plate, an inward directed component suggests convergence at and near the plate boundary that may be expressed as crustal folding, uplift, thrust faulting, or plate subduction. Similarly, an outward directed component suggests plate divergence such as would be expected at a zone of crustal spreading. Transcurrent or transform faulting would be expected when the predominant vector component is parallel to the plate margin.

EXPLANATION

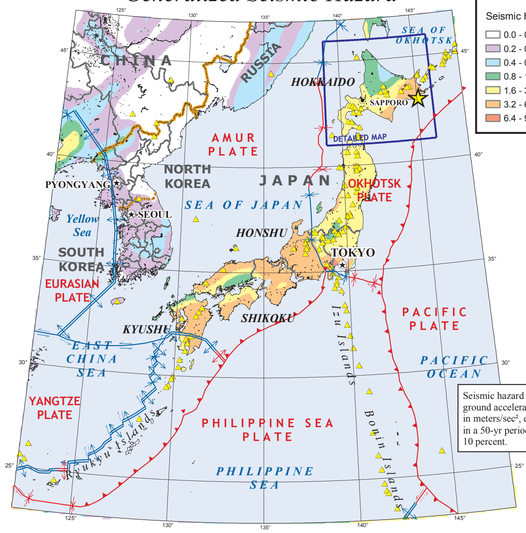
Main Shock
- *28 November 2004*

Plate Boundaries
- Continental Convergent
- Continental Rift
- Continental LL Transform
- Continental RL Transform
- Oceanic Convergent
- Oceanic Rift
- Oceanic LL Transform
- Oceanic RL Transform
- Subduction

Volcano

Seismic Hazard
- 0.0 - 0.2 m/sec²
- 0.2 - 0.4
- 0.4 - 0.8
- 0.8 - 1.6
- 1.6 - 3.2
- 3.2 - 6.4
- 6.4 - 9.4

Generalized Seismic Hazard



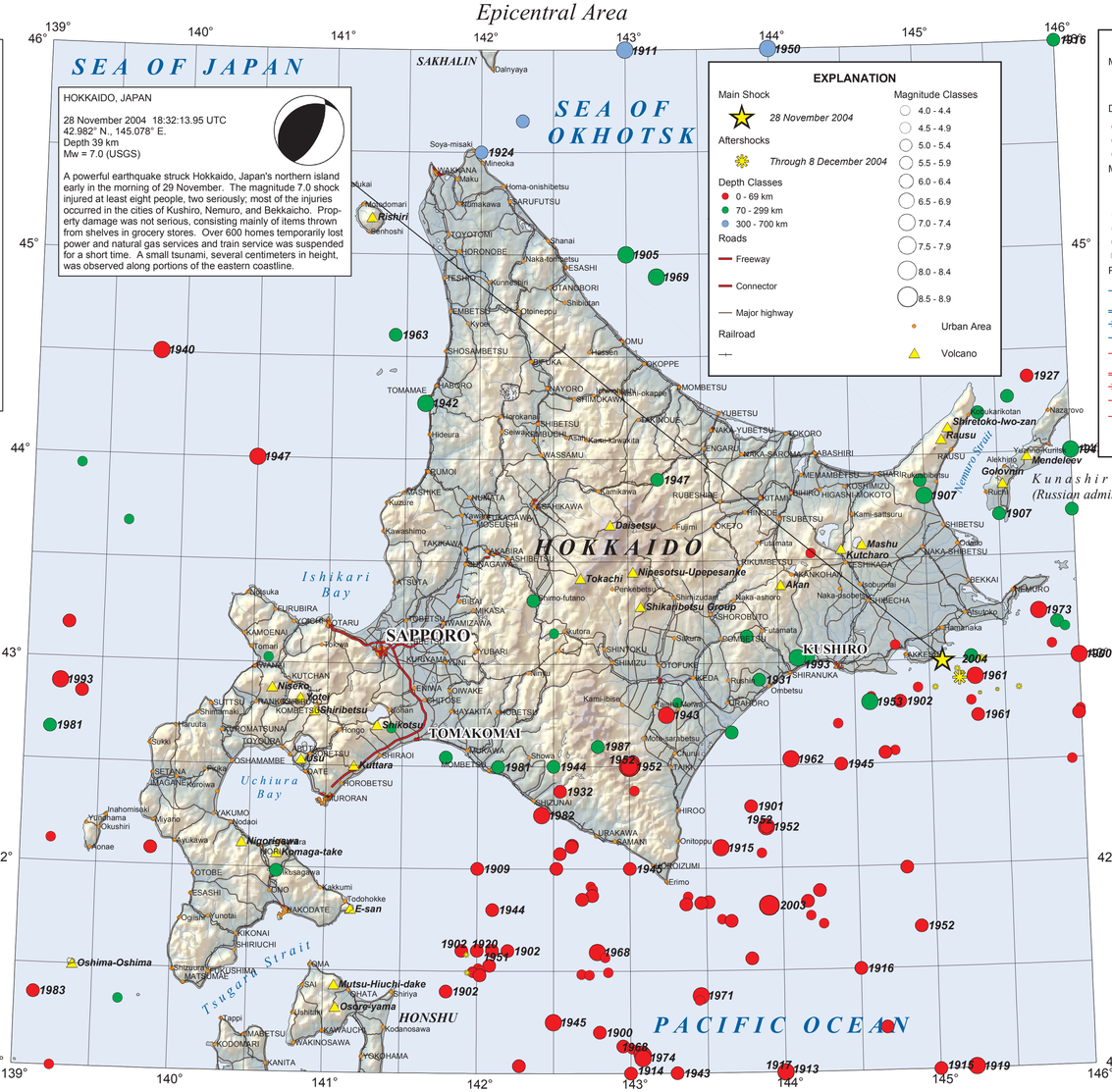
SCALE 1:15,000,000
Albers Equal-Area Projection
Kilometers
0 50 100 200 300 400

Seismic hazard is expressed as peak ground acceleration (PGA) on firm rock, in meters/sec², expected to be exceeded in a 50-yr period with a probability of 10 percent.

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.

Epicentral Area



EXPLANATION

Main Shock
- *28 November 2004*

Aftershocks
- *Through 8 December 2004*

Depth Classes
- 0 - 69 km
- 70 - 299 km
- 300 - 700 km

Roads
- Freeway
- Connector
- Major highway

Railroad

Magnitude Classes
- 4.0 - 4.4
- 4.5 - 4.9
- 5.0 - 5.4
- 5.5 - 5.9
- 6.0 - 6.4
- 6.5 - 6.9
- 7.0 - 7.4
- 7.5 - 7.9
- 8.0 - 8.4
- 8.5 - 8.9

Urban Area

Volcano

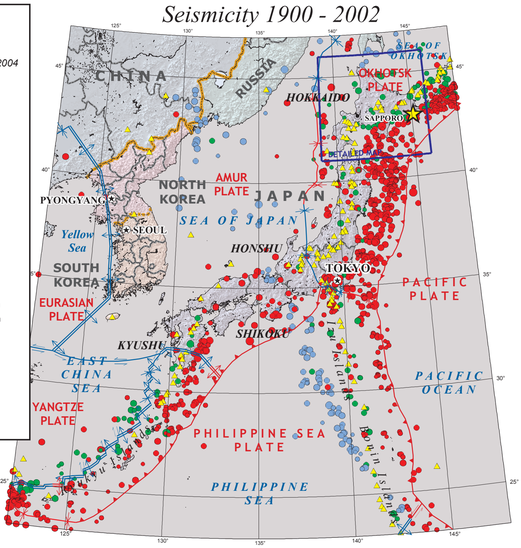
SCALE 1:1,500,000
Albers Equal-Area Projection
Kilometers
0 25 50 100 150 200

DISCUSSION

The preliminary location and focal-mechanism of this earthquake imply that it occurred as the result of thrust-faulting on the plate interface between the overriding Okhotsk plate and the subducting Pacific plate. The Pacific plate is moving northwest at a rate of about 80 mm per year relative to the Okhotsk plate. The Pacific plate begins its decent into the mantle at the Kuril trench that lies about 160 km to the southeast of the earthquake. At the trench, the Pacific plate subducts at an extremely low angle. When it reaches a depth of about 30 km, the angle of subduction steepens to about 30 degrees.

In addition to experiencing significant thrust earthquakes that originate at the interface between the plates, eastern Hokkaido experiences great earthquakes within the interior of subducted Pacific plate. The earthquakes of September 25, 2003, March 4, 1952, and May 16, 1968 (cited at far right) were interface-thrust earthquakes, whereas the earthquake of January 15, 1993 occurred within the interior of the subducted Pacific plate.

Seismicity 1900 - 2002



EXPLANATION

Main Shock
- *28 November 2004*

Depth Classes
- 0 - 69 km
- 70 - 299
- 300 - 700

Magnitude Classes
- 5.00 - 5.49
- 5.50 - 5.99
- 6.00 - 6.49
- 6.50 - 6.99
- 7.00 - 7.49
- 7.50 - 8.00

Plate Boundaries
- Continental Convergent
- Continental Rift
- Continental LL Transform
- Continental RL Transform
- Oceanic Convergent
- Oceanic Rift
- Oceanic LL Transform
- Oceanic RL Transform
- Subduction

Volcano

SCALE 1:15,000,000
Albers Equal-Area Projection
Kilometers
0 50 100 200 300 400

MAJOR EARTHQUAKES 1900 - 2003
HOKKAIDO, JAPAN REGION

YR	MO	DAY	LAT	LON	DEPTH	MAG
1900	8	29	41.200	142.800	35.0	6.8
1900	12	25	43.000	146.000	35.0	7.1
1901	1	13	42.300	143.800	35.0	6.8
1902	1	17	41.600	141.900	35.0	6.5
1902	1	31	41.600	142.200	35.0	6.6
1902	2	20	41.400	141.800	35.0	6.7
1902	5	28	42.800	144.800	35.0	6.5
1905	9	1	45.000	143.000	250.0	7.3
1907	7	5	43.700	145.500	100.0	6.8
1907	12	23	43.800	145.000	150.0	6.9
1909	9	16	42.000	143.000	35.0	6.8
1911	9	6	46.000	143.000	350.0	7.0
1913	2	20	41.000	144.000	0.0	7.0
1914	2	7	41.000	143.000	35.0	6.8
1915	3	17	42.100	143.600	35.0	7.2
1915	12	6	41.000	145.000	35.0	6.5
1916	1	25	45.000	144.000	250.0	6.9
1916	3	18	41.500	144.500	35.0	6.6
1916	10	28	46.000	146.000	100.0	6.5
1917	7	29	41.000	144.000	0.0	7.0
1919	5	3	41.007	145.233	35.0	7.3
1920	9	16	41.600	142.100	35.0	6.5
1924	11	25	45.500	142.000	300.0	6.7
1927	7	12	44.367	145.722	35.0	6.8
1931	3	29	42.918	143.866	89.7	6.8
1932	11	26	42.379	142.543	45.5	6.8
1940	8	1	44.508	139.829	35.0	7.5
1942	3	5	44.272	141.632	259.0	7.0
1943	6	13	42.750	143.250	60.0	7.1
1943	6	13	41.000	143.300	0.0	6.5
1944	2	1	41.800	142.100	0.0	6.6
1944	10	2	42.500	142.500	75.0	6.8
1945	2	10	41.250	142.500	50.0	7.1
1945	2	18	42.000	143.000	50.0	6.7
1945	6	22	44.000	146.000	120.0	6.9
1945	9	19	42.500	144.400	65.0	6.6
1947	11	4	44.000	140.500	0.0	7.1
1947	11	14	43.900	143.200	160.0	6.7
1950	2	28	46.000	144.000	340.0	7.5
1951	10	18	41.600	142.000	33.0	6.5
1952	3	4	42.500	143.000	0.0	8.1
1952	3	4	42.200	143.900	0.0	7.1
1952	3	4	41.700	144.900	64.0	6.5
1952	3	9	42.500	143.000	0.0	7.2
1952	5	19	42.200	143.900	0.0	6.8
1953	10	14	42.800	144.600	128.0	6.9
1961	8	11	42.913	145.304	35.0	7.2
1961	11	15	42.723	145.315	52.3	6.8
1962	4	23	42.529	144.069	35.0	6.9
1963	4	1	44.606	141.422	260.7	6.7
1968	5	16	41.593	142.786	11.8	7.8
1968	6	17	41.095	143.072	37.2	7.0
1969	1	19	44.891	143.207	237.1	7.3
1971	8	2	41.378	143.459	53.8	7.2
1973	6	17	43.223	145.743	43.3	7.8
1974	10	10	41.074	143.078	43.4	7.0
1981	1	23	42.498	142.134	115.9	6.8
1981	5	8	42.657	139.166	219.1	6.5
1982	3	21	42.262	142.423	27.4	6.9
1983	6	21	41.358	139.124	17.1	6.8
1987	1	14	42.597	142.793	102.0	6.8
1993	1	15	43.022	144.124	102.0	7.6
1993	7	12	42.883	139.225	20.4	7.7
2003	9	25	41.815	143.910	27.0	8.3

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
PB2003 (Bird, 2003)

VOLCANOES
Smithsonian Institution, Global Volcano Program

BASE MAP
NIMA and ESRI, Digital Chart of the World
USGS, EROS Data Center

NEWS SOURCES

Associated Press
Reuters.com

PREVIOUS NOTEWORTHY EARTHQUAKES IN THIS REGION

2003 September 25, Magnitude 8.3
At least 589 people injured, extensive damage, landslides and power outages occurred and many roads damaged in southeastern Hokkaido. A tsunami generated with an estimated wave height of 4.0 meters along the southeastern coast of Hokkaido. Felt strongly in much of Hokkaido. Also felt in northern and much of central Honshu as far south as Tokyo.

1993 January 15, Magnitude 7.6
2 killed. 614 injured and substantial damage (VI JMA) at Kushiro, Hokkaido and Hachinohe, Honshu. Felt (V JMA) at Hiroo, Nemuro, Obihiro, Otaru and Urakawa; (IV JMA) at Hakodate and Tomakomai; (III JMA) at Sapporo, Hokkaido. Felt (IV JMA) at Aomori and Morioka; (III JMA) at Akita, Fukushima, Sendai, Tokyo and Yokohama, Honshu. Also felt (VII) on Shikotan and (VI) at Kuriisk, Kuril Islands. Landslides and subsidence occurred in the epicentral area.

1968 May 16, Magnitude 7.9
48 killed. Damage estimate at 25 million USD.

1952 March 4, Magnitude 8.1
31 killed, 72 injured; 713 houses destroyed, 5,980 damaged. 28 killed and warehouses destroyed at Kushiro. 3 killed and 309 houses destroyed at Kiratapu. 1,000 houses destroyed or damaged at Shiranuka and 400 schools collapsed at Sapporo. 10-foot tsunami.

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
13 December 2004