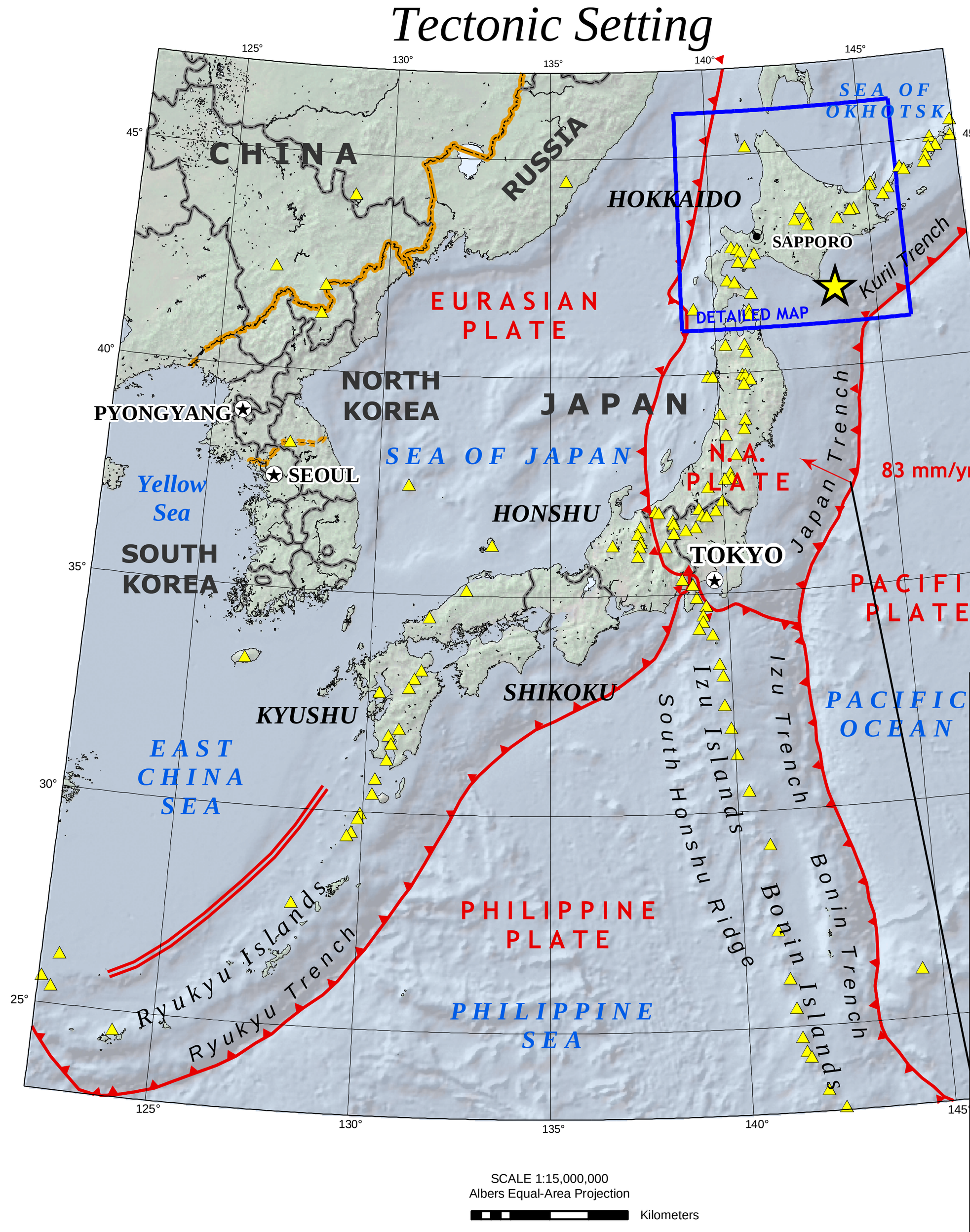
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

M8.3 Hokkaido, Japan Earthquake of 25 September 2003

Tectonic Setting

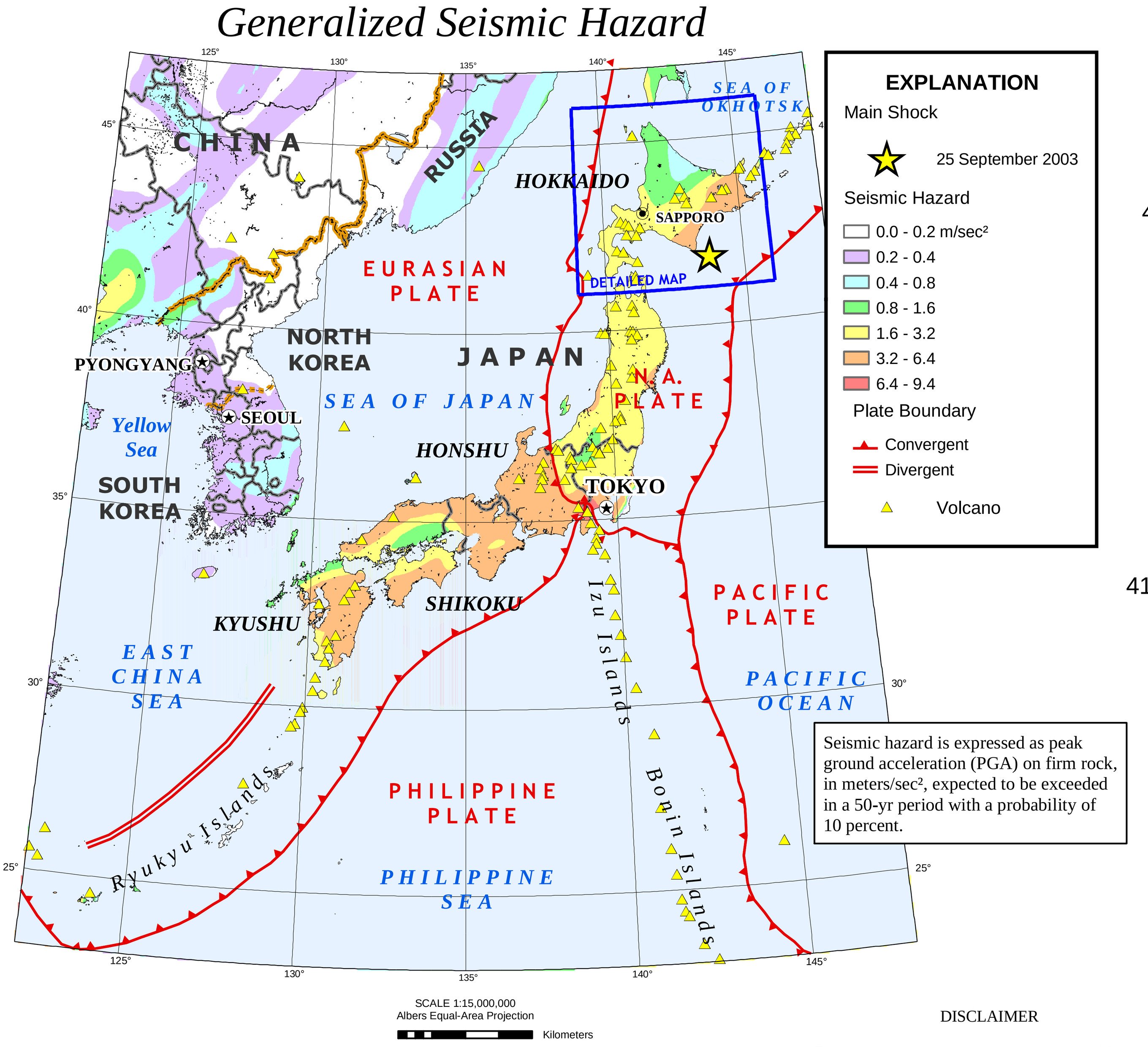


RELATIVE PLATE MOTIONS

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.

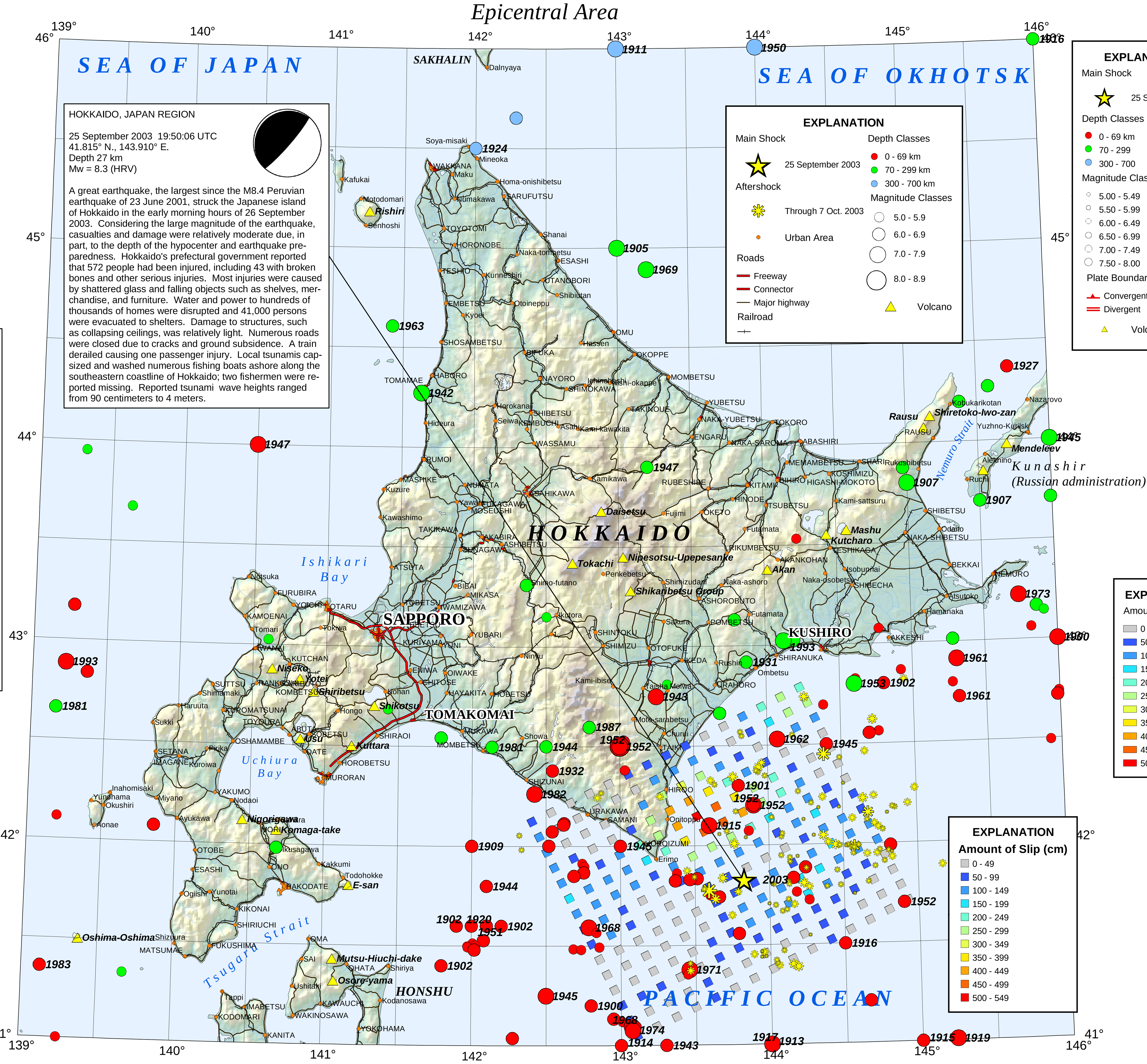
The components of the vector perpendicular and parallel to the plate margin approximate convergent/divergent and transverse direction of motion between the plates, respectively. As viewed from the fixed plate, an inward directed component suggests convergence at and near the plate boundary that may be 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.

Generalized 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.

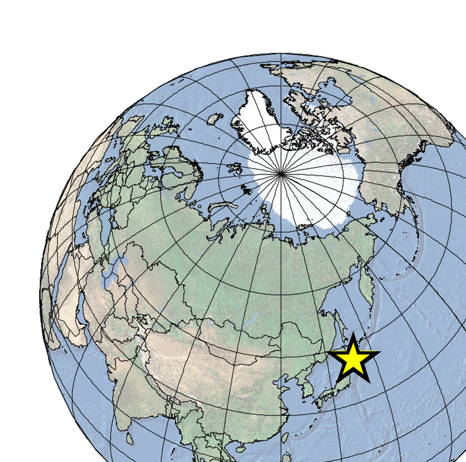
Epicentral Area



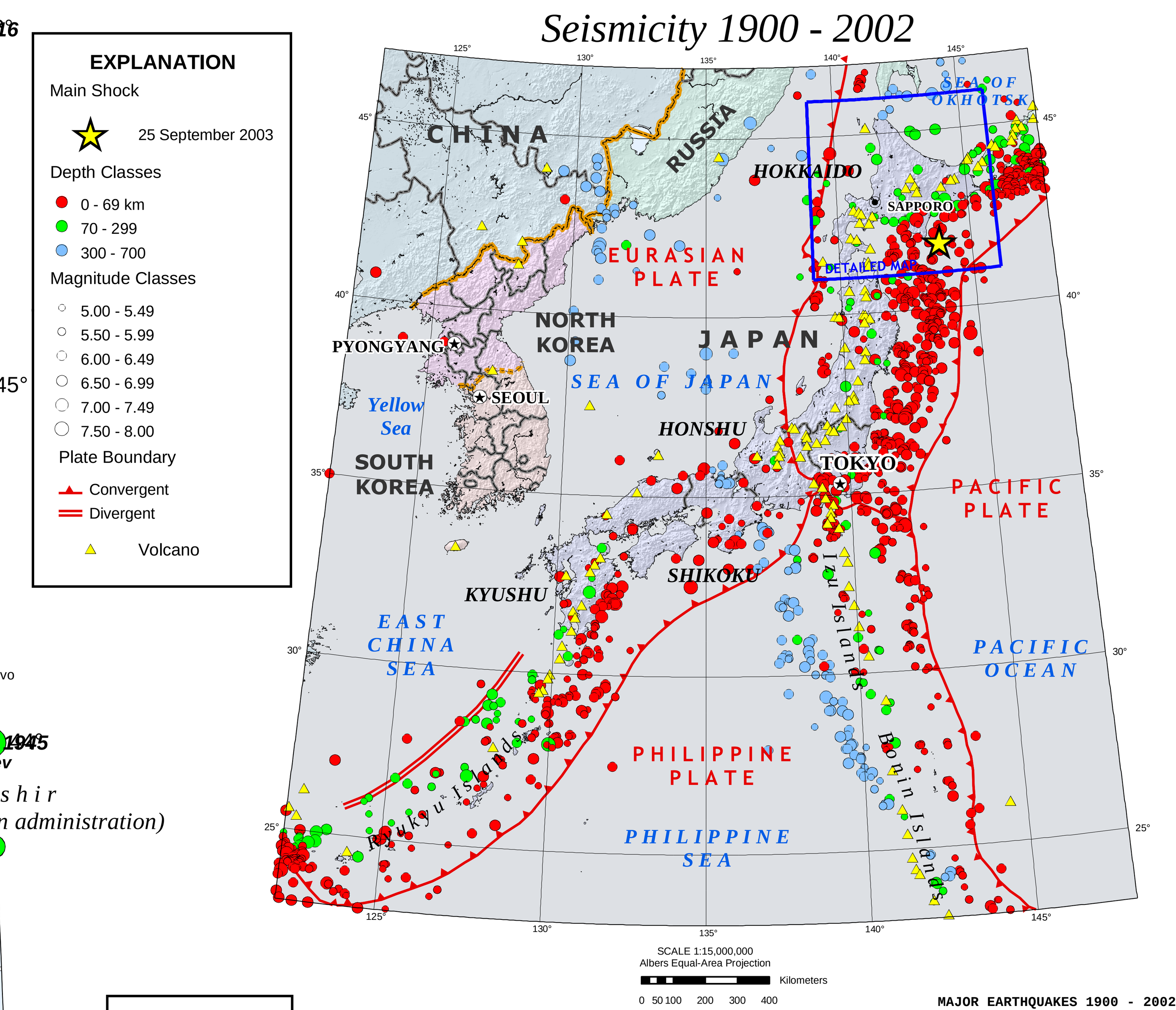
HOKKAIDO, JAPAN REGION

25 September 2003 19:50:06 UTC
41.815° N., 143.910° E.
Depth 27 km
Mw = 8.3 (HRV)

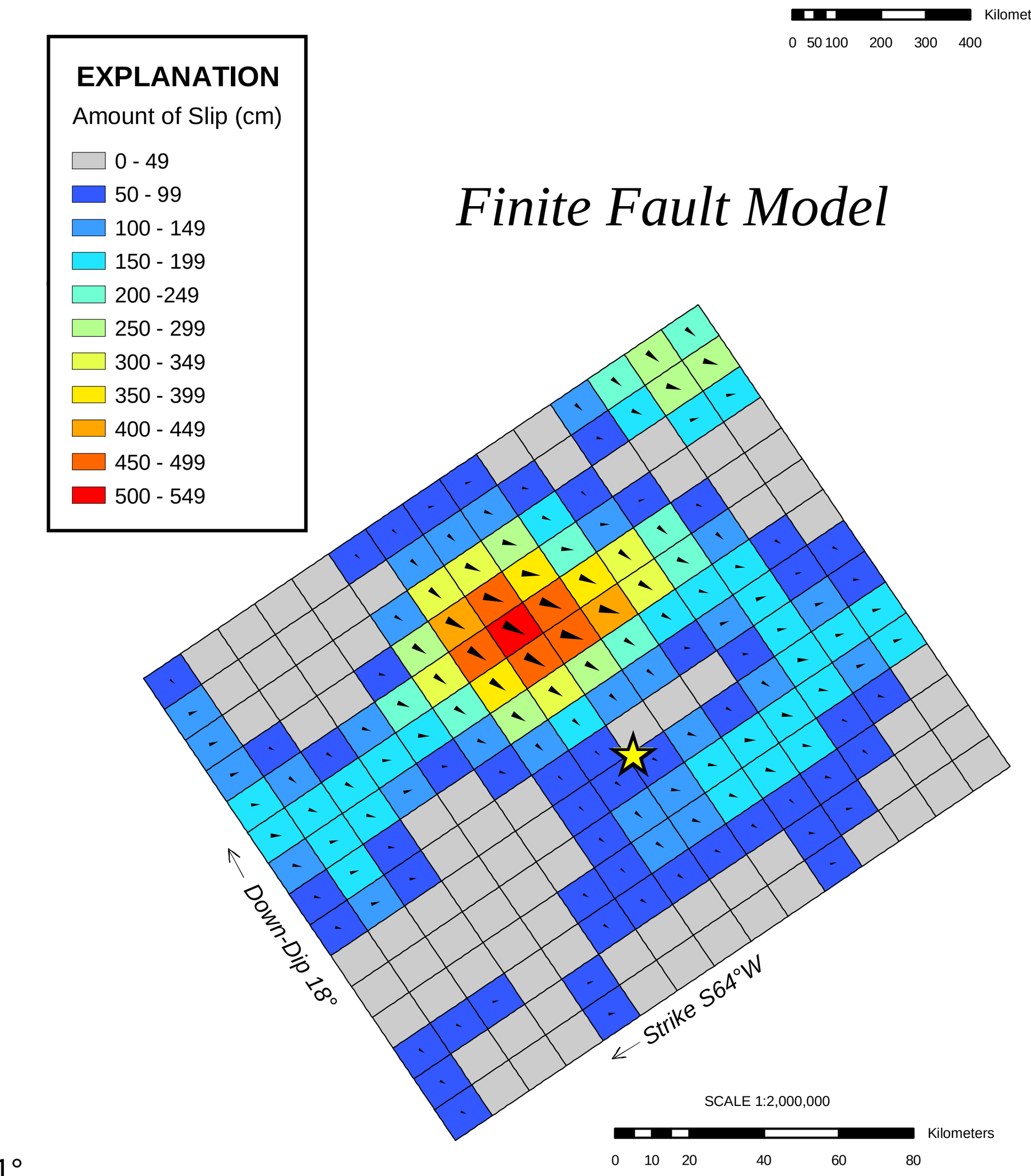
A great earthquake, the largest since the M8.4 Peruvian earthquake of 23 June 2001, struck the Japanese island of Hokkaido in the early morning hours of 26 September 2003. Considering the large magnitude of the earthquake, casualties and damage were relatively moderate due, in part, to the depth of the hypocenter and earthquake preparedness. Hokkaido's prefectural government reported that 572 people had been injured, including 43 with broken bones and other serious injuries. Most injuries were caused by shattered glass and falling objects such as shelves, merchandise, and furniture. Water and power to hundreds of thousands of homes were disrupted and 41,000 persons were evacuated to shelters. Damage to structures, such as collapsing ceilings, was relatively light. Numerous roads were closed due to cracks and ground subsidence. A train derailed causing one passenger injury. Local tsunamis capsized and washed numerous fishing boats ashore along the southeastern coastline of Hokkaido; two fishermen were reported missing. Reported tsunami wave heights ranged from 90 centimeters to 4 meters.



Seismicity 1900 - 2002



Finite Fault Model



MAJOR EARTHQUAKES 1900 - 2002
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	142.000	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

DISCLAIMER

DATA SOURCES

EARTHQUAKES AND SEISMIC HAZARD
USGS, National Earthquake Information Center
NOAA, National Geophysical Data Center
IASPEI, Centennial Catalog (1900 - 1999)
Handbook of Seismology and Earthquake Engineering
Global Seismic Hazard Assessment Program

PLATE TECTONICS
Smithsonian Institution, Global Volcano Program

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

NEWS SOURCES

Associated Press
CNN.com/WORLD http://www.cnn.com/2003/WORLD
Japan Today http://www.japantoday.com
The Japan Times Online http://www.japantimes.co.jp
VOANews.com http://www.voanews.com

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 North American plate (which extends into the northeast corner of the Eurasian landmass) and the subducting Pacific plate. The Pacific plate is moving west-northwest at a rate of about 8.2 cm per year relative to the North American plate. In addition to experiencing great thrust earthquakes that originate on the interface between the plates, eastern Hokkaido experiences great earthquakes that originate from the interior of subducted Pacific plate. The earthquakes of 4 March 1952, and 16 May 1968 were interface-thrust earthquakes, whereas the earthquake of 15 January 1993 occurred within the interior of the subducted Pacific plate. The 25 September earthquake appears to have involved rupture of the same section of the plate interface that ruptured in 1952.

The last great earthquake (magnitude 8 or greater) in the world was a magnitude 8.4 that occurred on 23 June 2001, near the coast of Peru. This earthquake killed at least 75, including 26 killed by the associated tsunami.

PREVIOUS DEADLY EARTHQUAKES IN THIS REGION

4 March 1952 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.

16 May 1968 Damage estimated at 25 million USD.

15 January 1993 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 Kurilsk, Kuril Islands. Landslides and subsidence occurred in the epicentral area.

FINITE FAULT MODEL
(C. Ji, California Institute of Technology)

Distribution of the amplitude and direction of slip for subfault elements (small rectangles) of the fault rupture model are determined from the inversion of teleseismic body waveforms. Arrows indicate the amplitude and direction of slip (or rake vector); the slip amount is also color-coded as shown. The view is from above, perpendicular to the fault plane.

The fact that the orientation of the finite fault plane may differ from the corresponding best double couple nodal plane depicted in the focal mechanism diagram on the main map reflects differing methods of analysis and data sets.

The strike of the fault rupture plane is N64°E and the dip is 18°. The dimensions of the subfault elements are 12 km in the strike direction and 10 km in the dip direction.

Map prepared by U.S. Geological Survey
National Earthquake Information Center
22 December 2003
Map not approved for release by Director USGS