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Seismicity of the Earth 1900–2010

Kuril-Kamchatka Arc and Vicinity

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TECTONIC SUMMARY

This map shows details of the Kuril-Kamchatka arc not visible in an earlier publication (Tarr and others, 2010). The arc extends about 2,100 km from Hokkaido, Japan, along the Kuril Islands and the Pacific coast of the Kamchatka, Russia, peninsula to its intersection with the Aleutian arc near the Commander Islands, Russia. It marks the region where the Pacific plate subducts into the mantle beneath the Okhotsk microplate, a part of the larger North America plate. This subduction is responsible for the generation of the Kuril Islands chain and the deep offshore Kuril-Kamchatka trench. Relative to a fixed North America plate, the Pacific plate is moving northwest at a rate that decreases from 83 mm per year at the arc's southern end to 75 mm per year near its northern edge.

Subduction zones such as the Kuril-Kamchatka arc are geologically complex and produce numerous earthquakes from multiple sources. Deformation of the overriding North America plate generates shallow crustal earthquakes, whereas slip at the interface of the plates generates interplate earthquakes that extend from near the base of the trench to depths of 40 to 60 km. At greater depths, Kuril-Kamchatka arc earthquakes occur within the subducting Pacific plate and can reach depths of nearly 700 km. Since 1900, eight great earthquakes have occurred; their location, size, and references are in the table below.

Several relevant tectonic elements, plate boundaries and active volcanoes, provide a context for the seismicity presented on the main map panel. The plate boundaries (Bird, 2003) are defined most accurately along the axis of the Kuril-Kamchatka trench and are more diffuse or speculative in the western Sea of Okhotsk and Sakhalin Island, Russia. The active volcanic arc (Siebert and Simkin, 2002) follows the Kuril Islands chain and the eastern edge of the Kamchatka Peninsula, parallel to the Kuril-Kamchatka trench .

DATA SOURCES

The earthquakes portrayed on the main map and the depth profiles are taken from two sources: (a) the Centennial earthquake catalog (Engdahl and Villaseñor, 2002) and annual supplements for the interval 1900–2007, where the magnitude floor is 5.5 globally, and (b) a catalog of earthquakes having high-quality depth determinations for the period 1964–2002 and a magnitude range of 5.0≤M≤5.4 (Engdahl, personal comm. 2003)

The nucleation points of great earthquakes (M≥8.3) are designated with a label showing the year of occurrence. Their rupture areas are shown as pale reddish polygons. Major earthquakes (7.5≤M≤8.2) are labeled with the year of occurrence, while earthquakes (8.0≤M≤8.2) are lalbeled with the year of ocurrence and also denoted by a while outline. Slab contours are from Hayes and Wald (2010).

The Seismic Hazard and Relative Plate Motion panel displays the generalized seismic hazard of the region (Giardini and others, 1999) and representative relative plate motion vectors using the NUVEL-1A model (DeMets, and others, 1994.)

Pre-instrumental seismicity for the Kuril-Kamchatka arc was obtained from the NOAA National Geophysical Data Center (2010) database of significant earthquakes; locations are approximate, based on macro-seismic reports and field investigations. We selected earthquakes with associated reports of moderate to major damage, 10 or more deaths, an estimated magnitude of 7.5 or greater (if known), Modified Mercalli Intensity at least X, or tsunami generation.

Base map data sources include GEBCO 2008, Volcanoes of the World dataset (Siebert and Simkin, 2002), plate boundaries (Bird, 2003), Digital Chart of the World, and ESRI (2002). Slab contours are from Hayes and Wald (2010).

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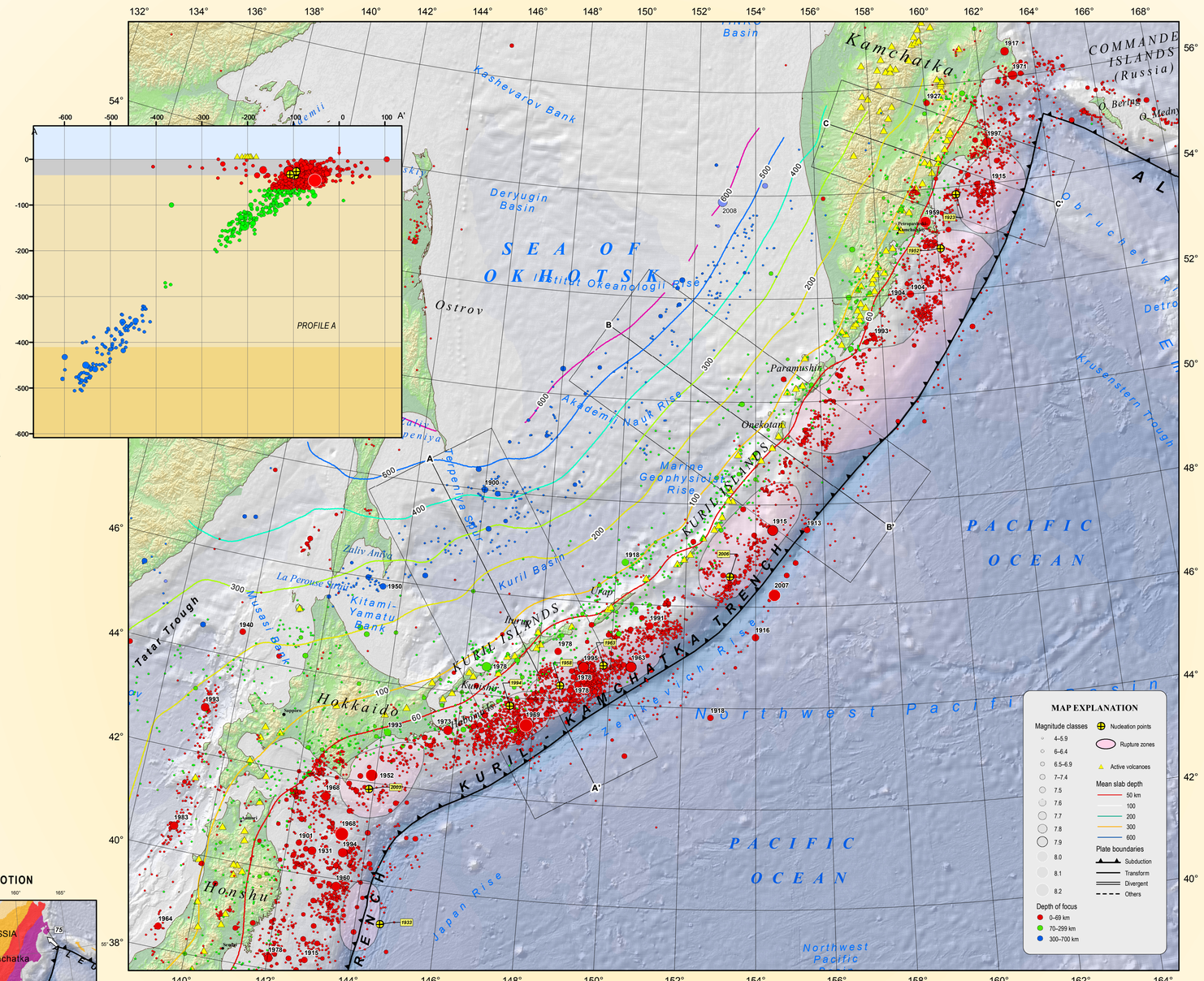


Albers Equal Area Conic Projection

Digital map database and cartography by Susan Rhea and Arthur Tarr

Manuscript approved for publication Month Day, 2011

Scale 1:5,000,000

0 100 200 300 400 500 600 700 800 KILOMETERS

SEISMIC HAZARD AND RELATIVE PLATE MOTION

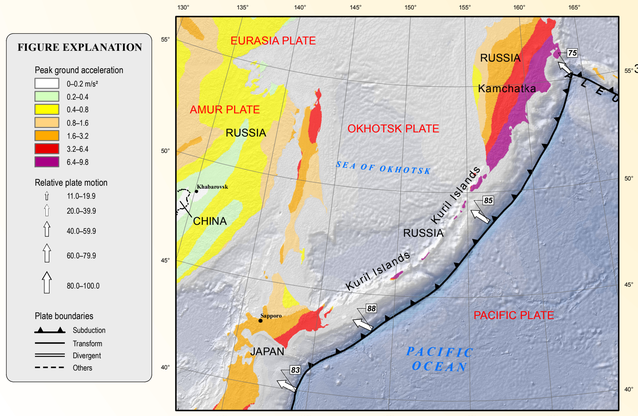


FIGURE EXPLANATION

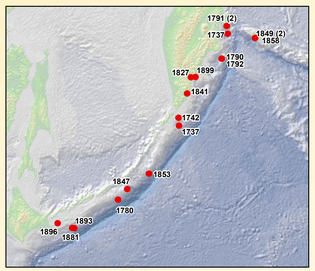
Peak ground acceleration
- 0–0.2 m/s²
- 0.2–0.4
- 0.4–0.8
- 0.8–1.6
- 1.6–3.2
- 3.2–6.4
- 6.4–9.8

Relative plate motion
- 11.0–19.9
- 20.0–39.9
- 40.0–59.9
- 60.0–79.9
- 80.0–100.0

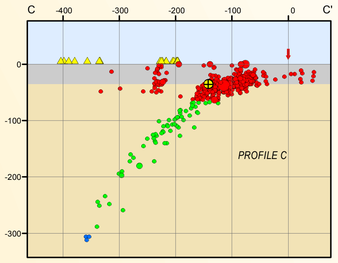
Plate boundaries
- Subduction
- Transform
- Divergent
- Others

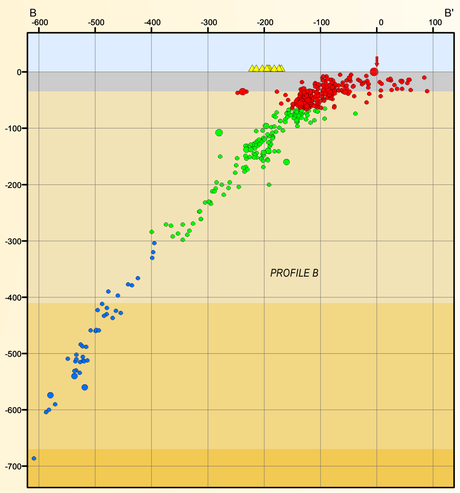
Magnitude of nucleation points of great earthquakes

Year/Mo/Dy	Place	Mag	Mag Source
1923/02/03	Kamchatka, Russia	8.4	Johnson and Satake (1999)
1933/03/02	Sanriku-oki, Japan	8.6	Kawakatsu and Seno (1983)
1952/11/04	Kamchatka, Russia	9	Johnson and Satake (1999)
1958/11/06	Kuril Islands, Russia	8.4	Tarr and others (2010)
1963/10/13	Kuril Islands, Russia	8.5	Beck and Ruff (1987)
1994/10/04	Kuril Islands, Russia	8.3	Kikuchi and Kanamori (1995)
2003/09/25	Hokkaido, Japan	8.3	Miyazaki and others (2004)
2006/11/15	Kuril Islands, Russia	8.3	Tarr and others (2010)



PRE-INSTRUMENTAL SEISMICITY 1500–1899
Tsunami generated or M ≥7.5





Magnitude classes
- 4–5.9
- 6–6.4
- 6.5–6.9
- 7–7.4
- 7.5
- 7.6
- 7.7
- 7.8
- 7.9
- 8.0
- 8.1
- 8.2

Depth of focus
- 0–69 km
- 70–299 km
- 300–700 km

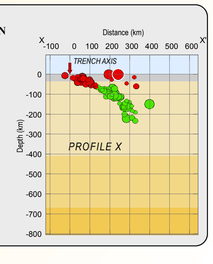
Nucleation points

Active volcanoes

Earth structure
- Air
- Crust
- Upper mantle
- Transition zone
- Lower mantle

DEPTH PROFILE EXPLANATION

Profiles of earthquake and volcano locations are constructed from the mapped data. Locations of the profile intersection with the surface are drawn in the map and labeled to coincide with the profile label. Box defines extent of earthquakes included in the profile. Length of the profile graphic is the same as in the map. Distance in kilometers from the trench axis is indicated in the X direction, depth in kilometers is indicated in the Y direction. There is no vertical exaggeration. See Explanation at side for color key. Not all earth layers, earthquake depths or magnitude, are visible on every profile.



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