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Seismicity of the Earth 1900–2007
Japan and Vicinity

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TECTONIC SUMMARY

This map shows details of Japan and vicinity not visible in an earlier publication (Tarr and others, 2010). Japan and its island possessions lie across four major tectonic plates: Pacific plate; North America plate; Eurasia plate; and Philippine Sea plate. The Pacific plate is subducted into the mantle, beneath Hokkaido and northern Honshu, along the eastern margin of the Okhotsk microplate, a proposed subdivision of the North America plate (Bird, 2003). Farther south, the Pacific plate is subducted beneath volcanic islands along the eastern margin of the Philippine Sea plate. This 2,200 km-long zone of subduction of the Pacific plate is responsible for the creation of the deep offshore Ogasawara and Japan trenches as well as parallel chains of islands and volcanoes, typical of Circumpacific island arcs. Similarly, the Philippine Sea plate is itself subducting under the Eurasia plate along a zone, extending from Taiwan to southern Honshu, that comprises the Ryukyu Islands and the Nanseri-Shoto trench.

Subduction zones at the Japanese island arcs are geologically complex and produce numerous earthquakes from multiple sources. Deformation of the overriding plates 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, Japanese arc earthquakes occur within the subducting Pacific and Philippine Sea plates and can reach depths of nearly 700 km. Since 1900, two great earthquakes occurred off Japan and three north of Hokkaido. They are the M8.4 1933 Sanriku-oki earthquake (Kawakatsu and Seno, 1983), the M8.3 2003 Tokachi-oki earthquake (Miyazaki and others, 2004), M8.4 1958 Etorofu earthquake (Fukao and Furamoto, 1979), the M8.5 1963 Kuril earthquake (Beck and Ruff, 1987), and the M8.3 1994 Shikotan earthquake (Kikuchi and Kanamori, 1995).

Several relevant tectonic elements, plate boundaries and active volcanoes, provide a context for the seismicity presented on the main map. The plate boundaries (Bird, 2003) are known most accurately along the axis of the trenches and are more diffuse or speculative in the Sea of Japan, China, and Russia. The active volcanic arcs (Siebert and Simkin, 2002) follow the Izu, Volcano, and Ryukyu island chains and the main Japanese islands parallel to the Japan 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 yellow polygons. Major earthquakes (7.5≤M≤8.2) are labeled with the year of occurrence. 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, et.al., 1994.)

Pre-instrumental seismicity 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 for earthquakes with associated reports of moderate to major damage, deaths, an estimated magnitude of 7.5 or greater, 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).

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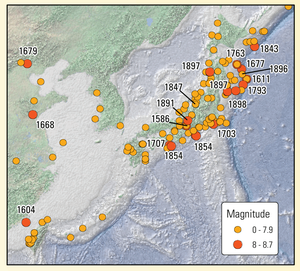
PRE-INSTRUMENTAL SEISMICITY 1500–1899
M ≥ 7.5, tsunami, or deaths



SEISMIC HAZARD AND RELATIVE PLATE MOTION

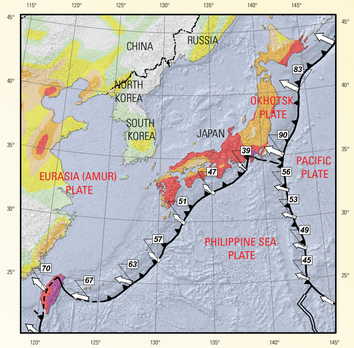


FIGURE EXPLANATION

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

This map was produced on request, directly from digital files, on an electronic plotter.

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1-888-ASK-USGS

A PDF for this map is available at
http://pubs.usgs.gov/of/2010/1083/d/

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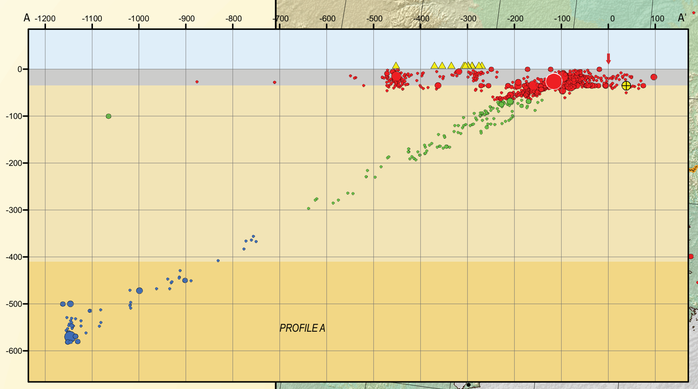

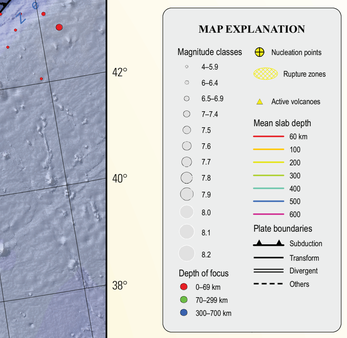

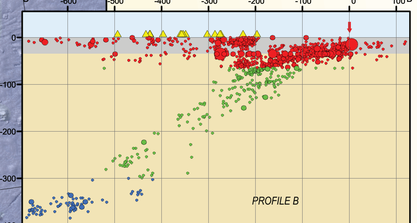

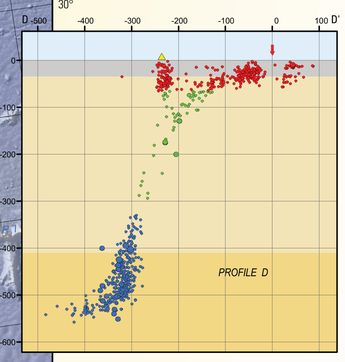

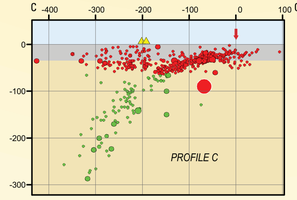

Albers Equal Area Conic Projection

Digital map database and cartography by Susan Rhea and Arthur Tarr

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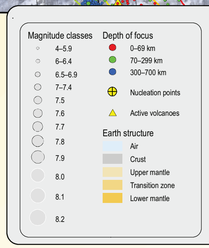
Albers Equal Area Conic Projection
SCALE 1:6 000 000

0 100 200 400 600 800 Kilometers



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 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 magnitudes, are visible on every map.