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

Seismicity of the Earth 1900–2010

Aleutian Arc and Vicinity

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TECTONIC SUMMARY

This map shows details of the Aleutian arc not visible in an earlier publication (Tarr and others, 2010).The Aleutian arc extends about 3,000 km from the Gulf of Alaska to the Kamchatka Peninsula. It marks the region where the Pacific plate subducts into the mantle beneath the North America plate. This subduction is responsible for the generation of the Aleutian Islands and the deep offshore Aleutian Trench. Relative to a fixed North America plate, the Pacific plate is moving northwest at a rate that increases from about 55 mm per year at the arc's eastern edge to 75 mm per year near its western terminus. In the east, the convergence of the plates is nearly perpendicular to the plate boundary. However, because of the boundary's curvature, as one travels westward along the arc, the subduction becomes more and more oblique to the boundary until the relative plate motion becomes parallel to the arc at the Near Islands near its western edge.

Subduction zones such as the Aleutian 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, Aleutian arc earthquakes occur within the subducting Pacific plate and can reach depths of 300 km. Since 1900, six great earthquakes have occurred along the Aleutian Trench, Alaska Peninsula, and Gulf of Alaska: M8.4 1906 Rat Islands (Okal, 2005); M8.6 1938 Shumagin Islands (Estabrook and others, 1994); M8.6 1946 Unimak Island (Lopez and Okal, 2006); M8.6 1957 Andreanof Islands (Johnson and Satake, 1993); M9.2 1964 Prince William Sound (Kanamori, 1970); and M8.7 1965 Rat Islands (Wu and Kanamori, 1973).

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 most accurate along the axis of the Aleutian Trench and more diffuse or speculative in extreme northeastern Russia. The active volcanoes (Siebert and Simkin, 2002) parallel the Aleutian Trench from the Gulf of Alaska to the Rat Islands.

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 commun., 2009.)

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 labeled with the year of occurrence and also denoted by a white outline (Tarr and others, 2010).

The Seismic Hazard and Relative Plate Motion map displays the generalized seismic hazard of the region (Giardini and others, 1999) and representative relative plate motion vectors of the Pacific plate relative to the adjacent North America plate using the NUVEL–1A model (DeMets and others, 1994).

Pre-instrumental seismicity for the Aleutian 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 (1992), 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
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Scale 1:5,000,000
0 100 200 300 400 500 600 700 800 KILOMETERS

MAP EXPLANATION

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

Nucleation points
Rupture zones
Active volcanoes

Mean slab depth: 50 km; 100; 200; 300; 600

Plate boundaries: Subduction; Transform; Divergent; Convergent; Inferred

Depth of focus: 0–69 km; 70–299 km; 300–700 km

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 on 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 on 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.

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

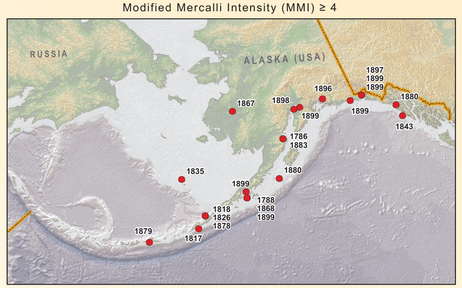
Nucleation points of M>8.3 events

Active volcanoes

Earth structure: Air; Crust; Upper mantle; Transition zone; Lower mantle

PRE-INSTRUMENTAL SEISMICITY 1500–1899

Modified Mercalli Intensity (MMI) ≥ 4



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SEISMIC HAZARD AND RELATIVE PLATE MOTION

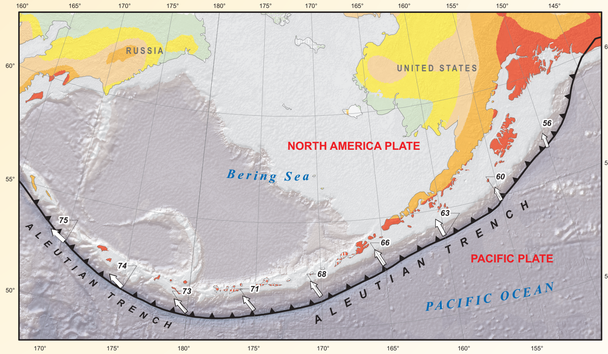

FIGURE EXPLANATION

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 mm/yr; 20.0–39.9; 40.0–59.9; 60.0–79.9; 80.0–100.0

Plate boundaries: Subduction; Transform; Divergent; Convergent; Inferred