U.S. DEPARTMENT OF THE INTERIOR
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Seismicity of the Earth 1900–2010

Caribbean Plate and Vicinity

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2011

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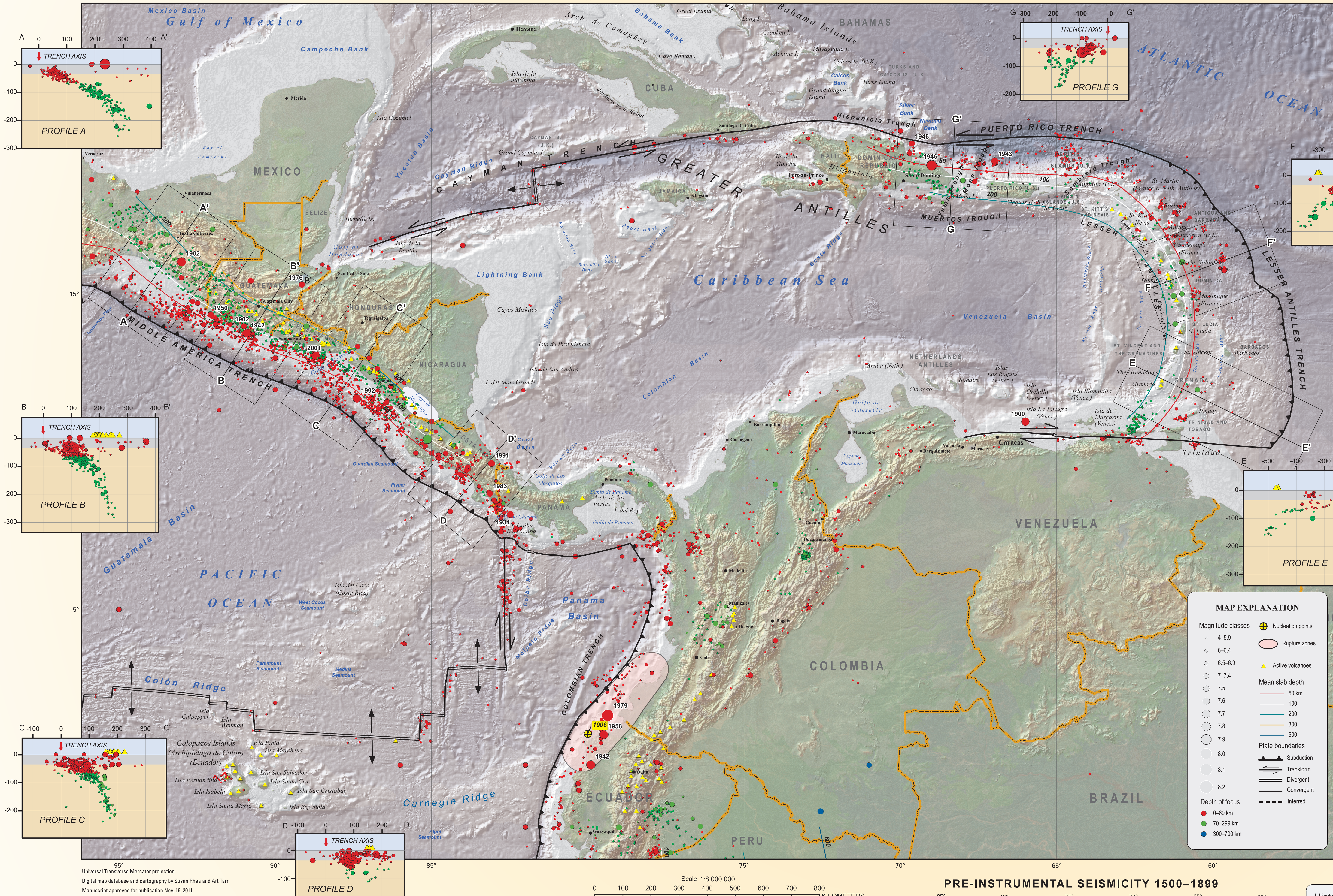

Universal Transverse Mercator projection

Digital map database and cartography by Susan Rhea and Art Tarr

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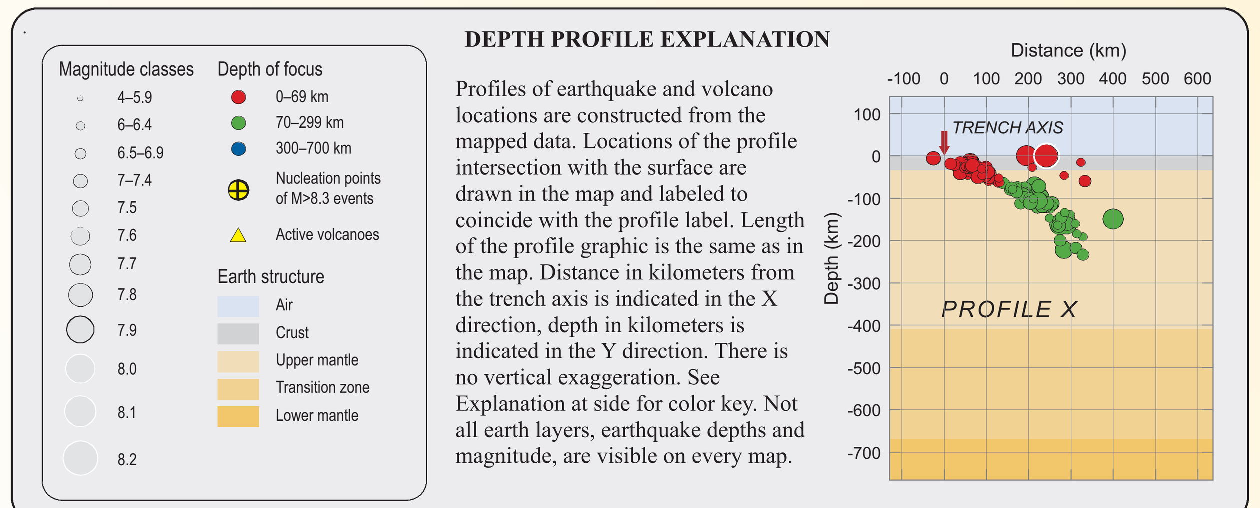
Scale 1:8,000,000

0 100 200 300 400 500 600 700 800 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. 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 and magnitude, are visible on every map.



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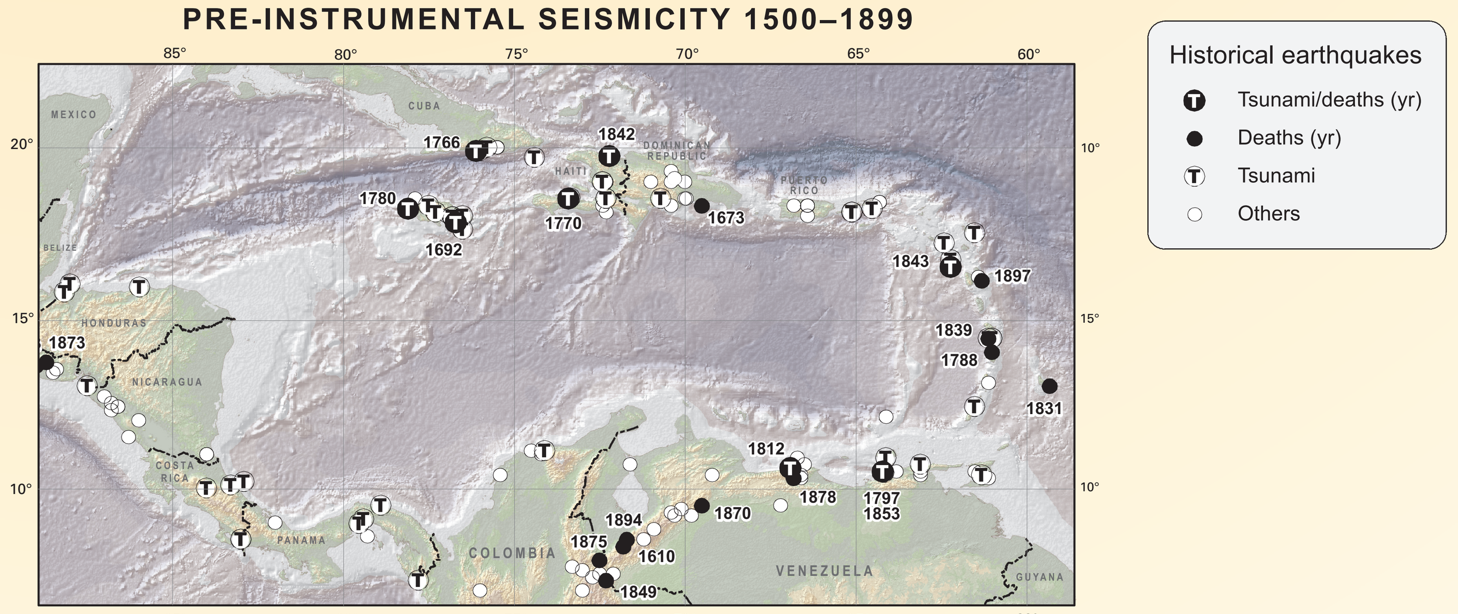
PRE-INSTRUMENTAL SEISMICITY 1500–1899



TECTONIC SUMMARY

Extensive diversity of tectonic regimes characterizes the perimeter of the Caribbean plate, involving no fewer than four major adjacent plates (North America, South America, Nazca, and Cocos). Inclined zones of deep earthquakes (Wadati-Benioff zones), deep ocean trenches, and arcs of volcanoes clearly indicate subduction of oceanic lithosphere along the Central American and Atlantic Ocean margins of the Caribbean plate, while shallow seismicity and focal mechanisms of major shocks in Guatemala, northern Venezuela, and the Cayman Ridge and Cayman Trench indicate transform fault and pull-apart basin tectonics.

The depth profile panels on this map portray earthquakes that extend from the Middle America Trench axis in the west to depths as great as 300 km beneath Guatemala, and from the Lesser Antilles Trench axis in the east to depths of approximately 200 km beneath Guadeloupe and the northeast Caribbean. In contrast, seismicity along the segments of the Caribbean plate margins from Guatemala to Hispaniola and from Trinidad to western Venezuela is indicative of transform fault tectonics.

Along the northern margin of the Caribbean plate, the North America plate moves west, relative to the Caribbean plate, at approximately 20 mm/yr, resulting in major transcurrent faults and troughs. Farther east, the North America plate subducts beneath the Caribbean plate resulting in surface expression of the deep Puerto Rico Trench and a zone of intermediate focus earthquakes in the subducted slab.

The plate boundary curves around Puerto Rico and the northern Lesser Antilles where the plate motion vector of the Caribbean plate relative to the North and South America plates is less oblique, resulting in active island-arc tectonics. The North and South America plates subduct beneath the Caribbean plate along the Lesser Antilles Trench at rates of about 20 mm/yr; consequently, there are both intermediate focus earthquakes within the subducted South America plate and a chain of active volcanoes along the island arc.

The southern Caribbean plate boundary along with the South America plate strikes east-west across Trinidad and western Venezuela and is characterized by major strike-slip faults and shallow seismicity, resulting from relative plate motion of about 20 mm/yr. Further to the west, a broad zone of convergent deformation trends southwest across western Venezuela and central Columbia. Plate boundaries are not well defined across northern South America, but there is a transition from Caribbean/South America convergence in the east to Nazca/South America convergence in the west, described in more detail below. The transition zone is characterized by high seismic hazard.

The Nazca-Caribbean plate boundary offshore of Columbia is characterized by convergence (Nazca plate subducting under South America plate) at about 65 mm/yr. The January 6, 1906 Mw = 8.5 megathrust subduction earthquake occurred on a shallow-dipping interface of this plate boundary segment. The 1906 earthquake occurred in the Colombia-Ecuador region, with a seismic moment (Mo; equivalent to radiated energy) of 6×10 Exp 28 dyne-cm (Okal, 1992), and a moment magnitude (Mw) of 8.5 (Tarr and others, 2010). The nucleation point of this earthquake is indicated on the map (rupture area is from Kanamori and McNally, 1982).

Along the western coast of Central America, the Cocos plate subducts beneath the Caribbean plate at rates of 72–81 mm/yr, resulting in a relatively high seismic hazard and a chain of numerous active volcanoes; here intermediate-focus earthquakes occur within the subducted Cocos plate to depths of nearly 300 km.

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 Caribbean plate relative to the adjacent North and South America plates using the NUVEL–1A model (DeMets and others, 1994, 2000) and updates (Dixon and others, 1998; Weber and others, 2001).

Pre-instrumental seismicity for the Caribbean basin 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 Intensities 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 Environmental Sciences Research Institute (ESRI, 2002). Slab contours are from Hayes and Wald (2010).

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SEISMIC HAZARD AND RELATIVE PLATE MOTION