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Seismicity of the Earth 1900–2007
Nazca Plate and South America

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TECTONIC SUMMARY

The South American arc extends over 7,000 km, from the Chilean margin triple junction offshore of southern Chile to its intersection with the Panama fracture zone, offshore of the southern coast of Panama in Central America. It marks the plate boundary between the subducting Nazca plate and the South America plate, where the oceanic crust and lithosphere of the Nazca plate begin their descent into the mantle beneath South America. The convergence associated with this subduction process is responsible for the uplift of the Andes Mountains, and for the active volcanic chain present along much of this deformation front. Relative to a fixed South America plate, the Nazca plate moves slightly north of eastwards at a rate varying from approximately 80 mm/yr in the south to approximately 70 mm/yr in the north.

Subduction zones such as the South America arc are geologically complex and generate numerous earthquakes from a variety of tectonic processes that cause deformation of the western edge of South America. Crustal deformation and subsequent mountain building in the overriding South America plate generate shallow earthquakes. Slip along the dipping interface between the two plates generates frequent and often large interplate earthquakes between depths of approximately 10 to 60 km. Since 1900, numerous magnitude 8 or greater earthquakes have occurred on the interface between the Nazca and South America plates, including the 1960 M9.5 earthquake in southern Chile, the largest instrumentally recorded earthquake in the world (large yellow area on main map from 37°S to 45°S) and the 2010 M8.8 earthquake north of the 1960 quake. Earthquakes can also be generated to depths greater than 600 km from internal deformation of the subducting Nazca plate. Although the rate of subduction varies little along the entire subduction zone, there are complex changes in geologic processes along the subduction zone that dramatically influence volcanic activity, earthquake generation and occurrence. For example, an extended zone of crustal seismicity in central-northern Argentina highlights a well-known 'flat-slab' region of this subduction zone, where the Nazca plate moves horizontally for several hundred kilometers before continuing its descent into the mantle. This transition in slab structure is coincident with a marked break in the Andes volcanic chain. (see profile C–C")

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, and others, 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, estimated magnitude of 8 or greater, Modified Mercalli Intensities 8 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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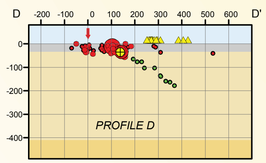
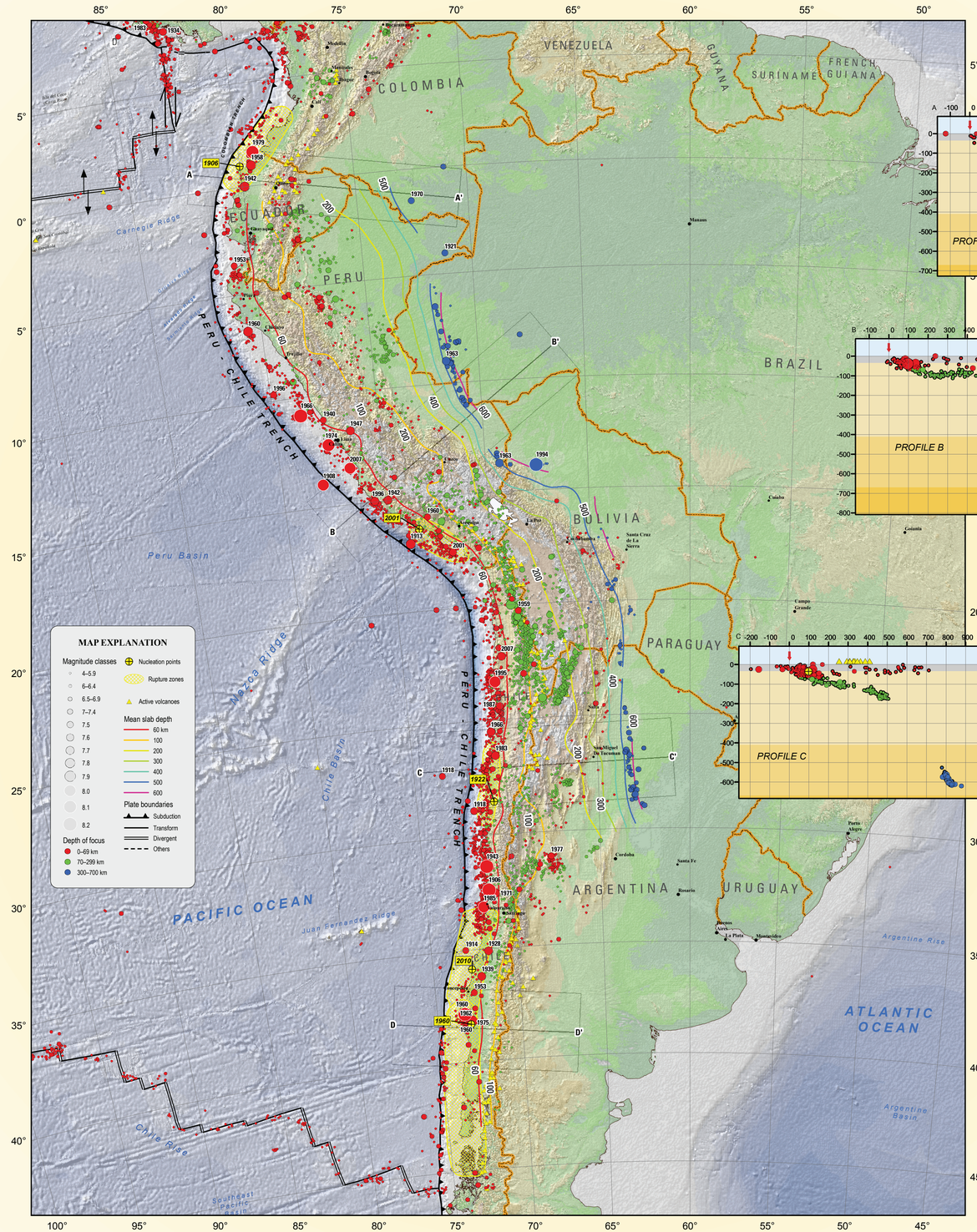
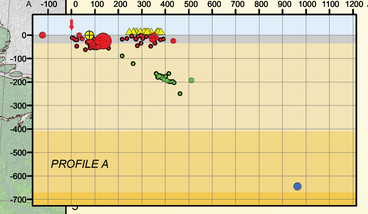
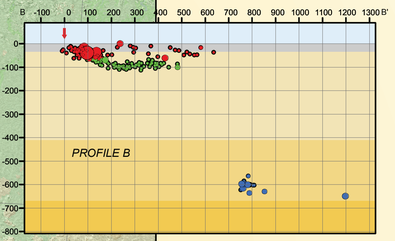


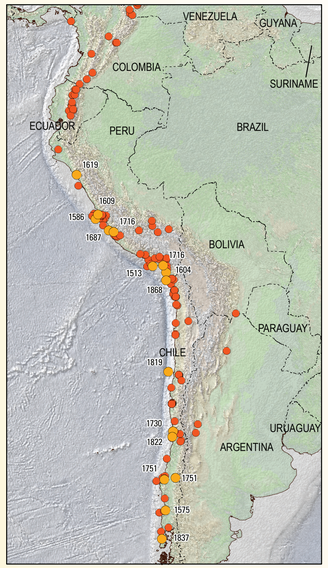






PRE-INSTRUMENTAL SEISMICITY 1500–1899

Deaths, tsunami, MMI ≥ 8, or M ≥ 8
M ≥ 8.5 labled with year



SEISMIC HAZARD AND RELATIVE PLATE MOTION

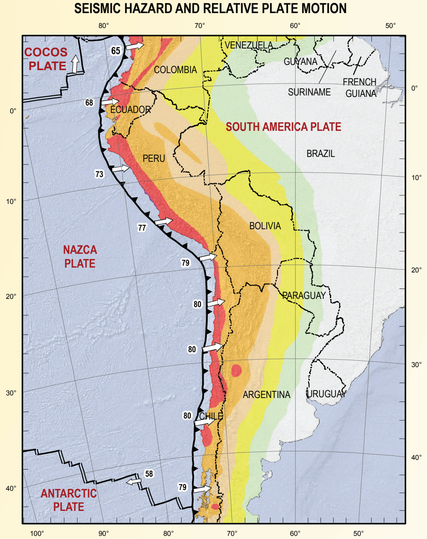


FIGURE EXPLANATION

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

DEPTH PROFILE 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

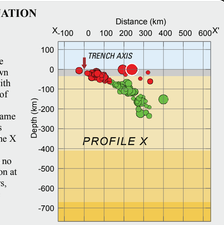
Depth of focus: 0–69 km; 70–299 km; 300–700 km

Nucleation points

Active volcanoes

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

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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South America Albers Equal Area Projection

Digital map database and cartography by Susan Rhea and Art Tarr

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