

# Seismicity of the Earth 1900–2010 New Guinea and Vicinity

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2011

## TECTONIC SUMMARY

There have been 22 M7.5+ earthquakes recorded in the New Guinea region since 1900. The dominant earthquake mechanisms are thrust and strike slip, associated with the arc-continent collision and the relative motions between numerous local microplates. The largest earthquake in the region was a M8.2 shallow thrust fault event in the northern Papua province of Indonesia that killed 166 people in 1996.

The Australia-Pacific plate boundary is over 4,000 km long on the northern margin, from the Sunda (Java) trench in the west to the Solomon Islands in the east. The eastern section is over 2,300 km long, extending west from northeast of the Australian continent and the Coral Sea until it intersects the east coast of Papua New Guinea. The boundary is dominated by the general northward subduction of the Australia plate.

Along the South Solomon trench, the Australia plate converges with the Pacific plate at a rate of approximately 95 mm/yr towards the east-northeast. Seismicity along the trench is dominantly related to subduction tectonics and large earthquakes are common; there have been 13 M7.5+ earthquakes recorded since 1900. On April 1, 2007, a M8.1 interplate megathrust earthquake occurred at the western end of the trench, generating a tsunami and killing at least 40 people. This was the third M8.1 megathrust event associated with this subduction zone in the past century; the other two occurred in 1939 and 1977.

Further east at the New Britain trench, the relative motions of several microplates surrounding the Australia-Pacific boundary, including north-south oriented seafloor spreading in the Woodlark Basin south of the Solomon Islands, maintain the general northward subduction of Australia-affiliated lithosphere beneath lithosphere. Most of the large and great earthquakes east of New Guinea are related to this subduction; such earthquakes are particularly concentrated at the cusp of the trench south of New Ireland. 33 M7.5+ earthquakes have been recorded since 1900, including three shallow thrust fault M8.1 events in 1906, 1919, and 2007.

The western end of the Australia-Pacific plate boundary is perhaps the most complex portion of this boundary, extending 2,000 km from Indonesia and the Banda Sea to eastern New Guinea. The boundary is dominantly convergent along an arc-continent collision segment spanning the width of New Guinea, but the regions near the edges of the impinging Australia continental margin also include relatively short segments of extensional, strike-slip and convergent deformation. The dominant convergence is accommodated by shortening and uplift across a 250–350 km-wide band of northern New Guinea, as well as by slow southward-verging subduction of the Pacific plate north of New Guinea at the New Guinea trench. Here, the Australia-Pacific plate relative velocity is approximately 110 mm/yr towards the northeast, leading to the 2–8 mm/yr uplift of the New Guinea Highlands.

Whereas the northern band of deformation is relatively diffuse east of the Indonesia-Papua New Guinea border, in western New Guinea there are at least two small (<100,000 km<sup>2</sup>) blocks of relatively undeformed lithosphere. The westernmost of these is the Birds Head Peninsula microplate in Indonesia's West Papua province, bounded on the south by the Seram trench. The Seram trench was originally interpreted as an extreme bend in the Sunda subduction zone, but is now thought to represent a southward-verging subduction zone between Birds Head and the Banda Sea.

The western portion of the northern Australia plate boundary extends approximately 4,800 km from New Guinea to Sumatra and primarily separates Australia from the Eurasia plate, including the Sunda block. This portion is dominantly convergent and includes subduction at the Sunda (Java) trench, and a young arc-continent collision.

In the east, this boundary extends from the Kai Islands to Sumba along the Timor trough, offset from the Sunda trench by 250 km south of Sumba. Contrary to earlier tectonic models in which this trough was interpreted as a subduction feature continuous with the Sunda subduction zone, it is now thought to represent a subsiding deformational feature related to the collision of the Australia plate continental margin and the volcanic arc of the Eurasia plate, initiating in the last 5–8 Myr. Before collision began, the Sunda subduction zone extended eastward to at least the Kai Islands, evidenced by the presence of a northward-dipping zone of seismicity beneath Timor Leste. A more detailed examination of the seismic zone along its eastern segment reveals a gap in intermediate depth seismicity under Timor and seismic mechanisms that indicate an eastward propagating tear in the descending slab as the negatively buoyant oceanic lithosphere detaches from positively buoyant continental lithosphere. On the surface, GPS measurements indicate that the region around Timor is currently no longer connected to the Eurasia plate, but instead is moving at nearly the same velocity as the Australia plate, another consequence of collision.

Large earthquakes in eastern Indonesia occur frequently but interplate megathrust events related to subduction are rare; this is likely due to the disconnection of the descending oceanic slab from the continental margin. There have been nine M7.5+ earthquakes recorded from the Kai Islands to Sumba since 1900. The largest was the great Banda Sea earthquake of 1938 (M8.5) an intermediate depth thrust faulting event that did not cause significant loss of life.

## DATA SOURCES

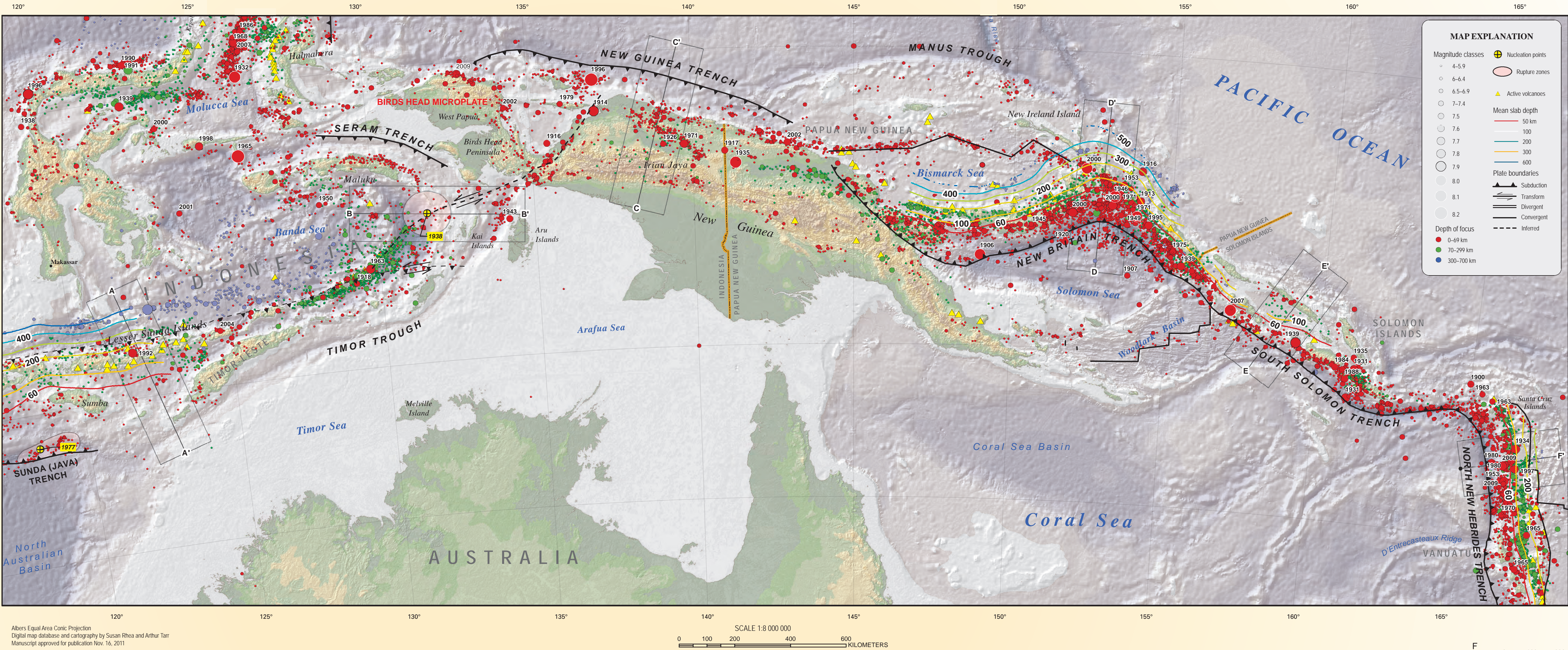
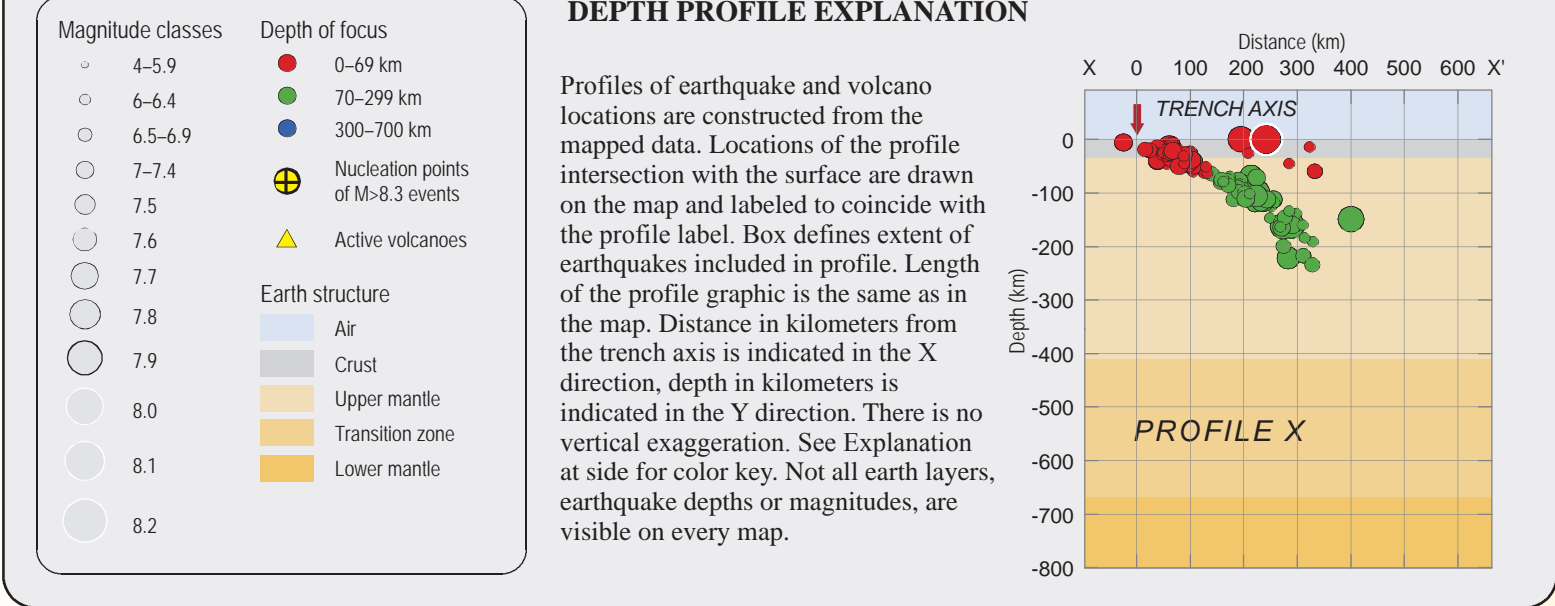
The earthquakes portrayed on the main map and the depth profiles are taken from two sources: (a) the Centennial earthquake catalog (Engdahl and Villaseñor, 2002) and annual supplements for the interval 1900–2007, where the magnitude floor is 5.5 globally, and (b) a catalog of earthquakes having high-quality 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<8.3) are labeled with the year of occurrence, while earthquakes (6.0≤M<7.5) are labeled with the year of occurrence and also denoted by a white outline. (Tarr and others, 2010). The aftershock rupture zone of the M8.4 1938 Banda Sea earthquake could not be determined. Consequently, a radial area comparable to the aftershock zone expected for such an event is shown.

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 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.

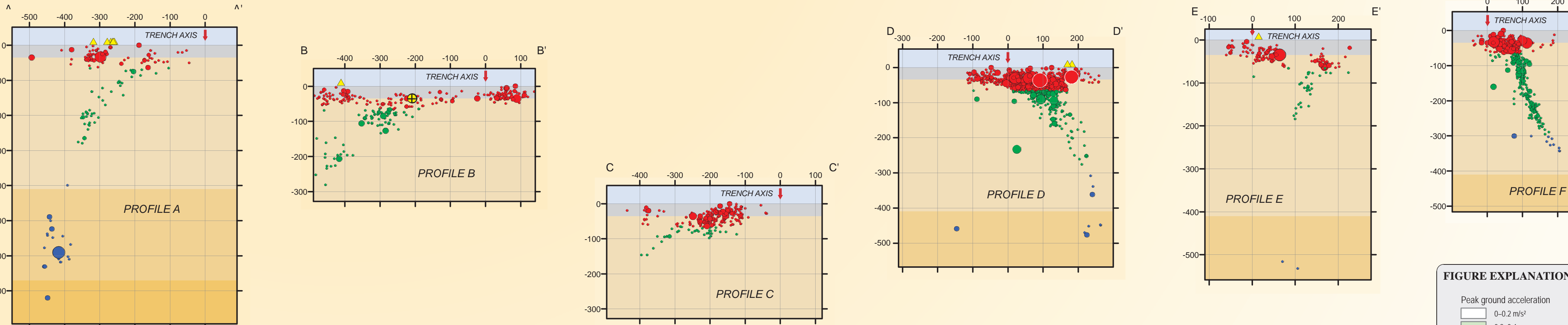
Base map data sources include GEBCO 2008, Volcanoes of the World Dataset (Siebert and Simkin (2002), plate boundaries (Bird, 2003), Digital Chart of the World (1992), and ESR1 (2002). Slab contours from Hayes and Wald (2010).



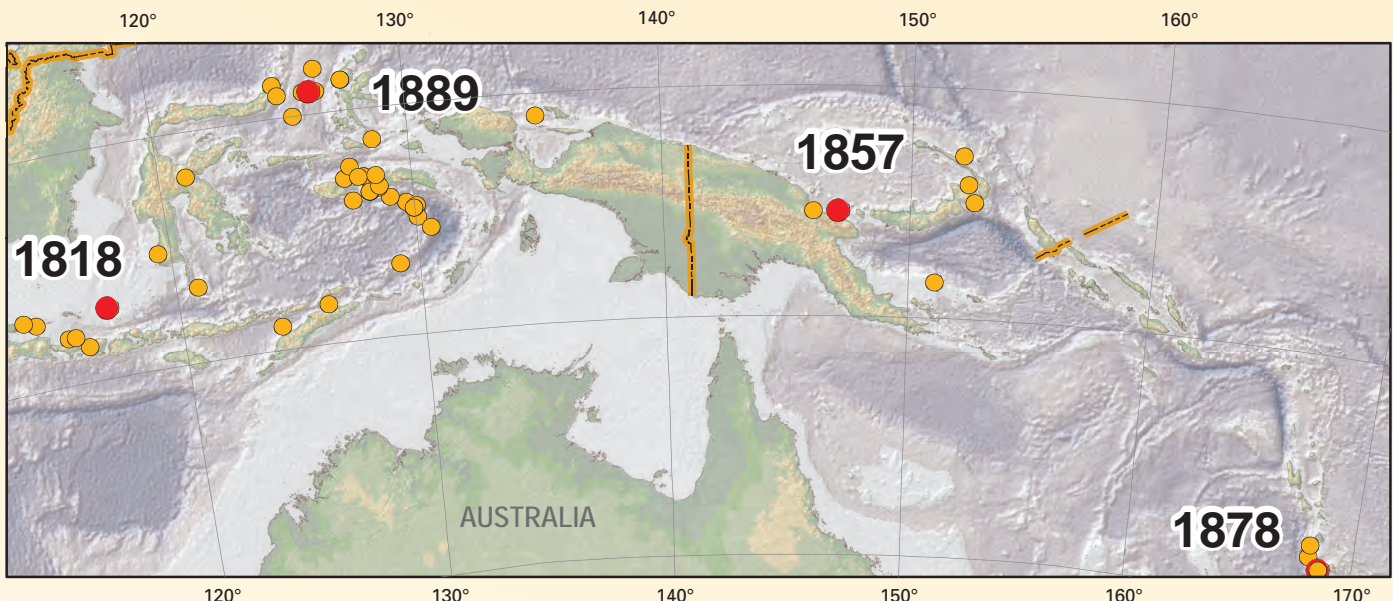
Albers Equal Area Conic Projection  
Digital map database and cartography by Susan Rhea and Arthur Tarr  
Manuscript approved for publication Nov. 16, 2011

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## PRE-INSTRUMENTAL SEISMICITY 1500–1899 M ≥ 8.0, tsunami, or deaths



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**Suggested citation:**  
Benz, H.M., Herman, Matthew, Tarr, A.C., Hayes, G.P., Furlong, K.P., Villaseñor, Antonio, Dart, R.L., and Rhea, Susan, 2011, *Seismicity of the Earth 1900–2010 New Guinea and vicinity*: U.S. Geological Survey Open-File Report 2010–1083-H, scale 1:8,000,000.

## SEISMIC HAZARD AND RELATIVE PLATE MOTION

