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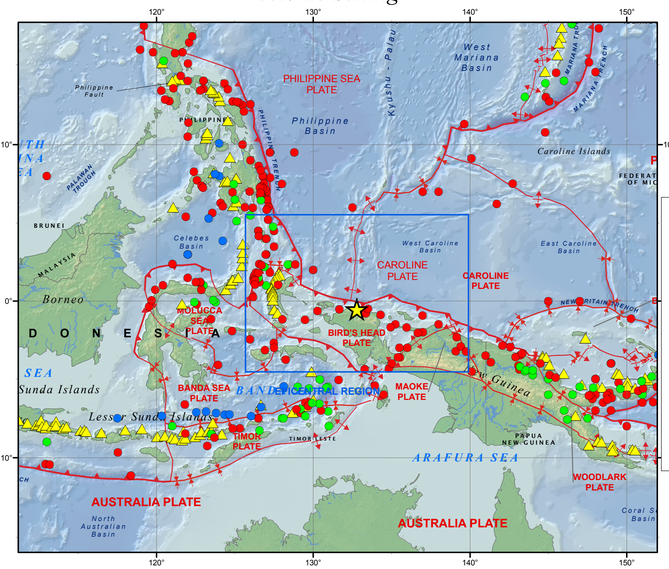
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

EARTHQUAKE SUMMARY MAP XXX

Prepared in cooperation with the Global Seismographic Network
GSN

M7.6 and M7.4 Papua, Indonesia, Earthquakes of 3 January 2009

Tectonic Setting



RELATIVE PLATE MOTIONS

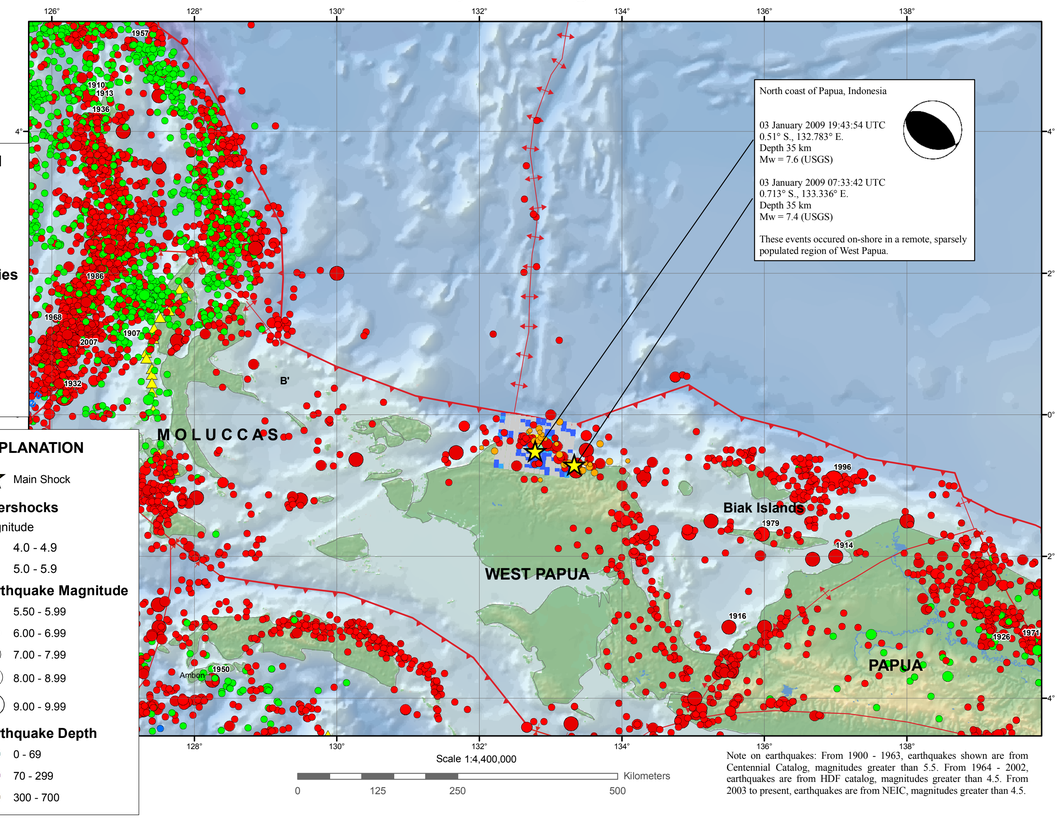
Eastern Indonesia is a region of complex plate interactions. From a global perspective, eastern Indonesia consists of microplates whose relative motions absorb the convergence of the Pacific, Australia, and Eurasia plates.(Pacific Plate boundary is east of this map).

EXPLANATION

Mag ≥ 7.0
- 0 - 69 km
- 70 - 299
- 300 - 600

Plate Boundaries
- Subduction
- Transform
- Divergent
- Convergent
- Volcanoes

Epicentral Region



North coast of Papua, Indonesia

03 January 2009 19:43:54 UTC
0.51° S., 132.783° E.
Depth 35 km
Mw = 7.6 (USGS)

03 January 2009 07:33:42 UTC
0.713° S., 133.336° E.
Depth 35 km
Mw = 7.4 (USGS)

These events occured on-shore in a remote, sparsely populated region of West Papua.

EXPLANATION

Main Shock

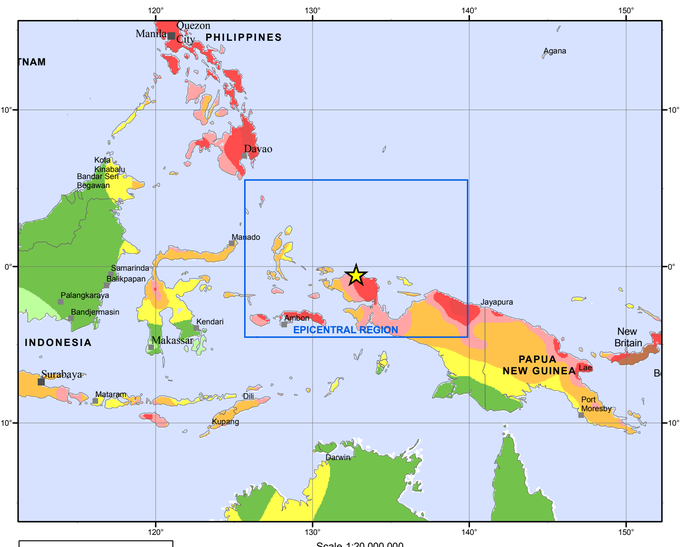
Aftershocks
Magnitude
- 4.0 - 4.9
- 5.0 - 5.9

Earthquake Magnitude
- 5.50 - 5.99
- 6.00 - 6.99
- 7.00 - 7.99
- 8.00 - 8.99
- 9.00 - 9.99

Earthquake Depth
- 0 - 69
- 70 - 299
- 300 - 700

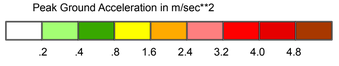
Note on earthquakes: From 1900 - 1963, earthquakes shown are from Centennial Catalog, magnitudes greater than 5.5. From 1964 - 2002, earthquakes are from HDF catalog, magnitudes greater than 4.5. From 2003 to present, earthquakes are from NEIC, magnitudes greater than 4.5.

Seismic Hazard



Seismic hazard is expressed as peak ground acceleration (PGA) on firm rock, in meters/sec², expected to be exceeded in a 50-yr period with a probability of 10 percent.

Peak Ground Acceleration in m/sec**2



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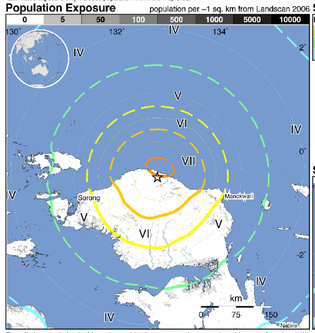
M 7.6, NEAR THE NORTH COAST OF PAPUA, INDONESIA **PAGER**
Origin Time: Sat 2009-01-03 19:43:54 UTC **Version 1**
Location: 0.51°S 132.78°E Depth: 35 km Created: 33 mins, 0 secs after earthquake

Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	-.-*	56k*	147k	358k	72k	26k	0	0	0
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE: Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
POTENTIAL DAMAGE: Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

*Estimated exposure only includes population within the map area.

Population Exposure population per ~1 sq. km from Landscan 2006

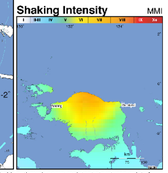


Selected City Exposure

MMI	City	Population
V	Manokwari	53k
V	Sorong	125k
III	Nabire	43k

bold cities appear on map (k = x1000)

Shaking Intensity

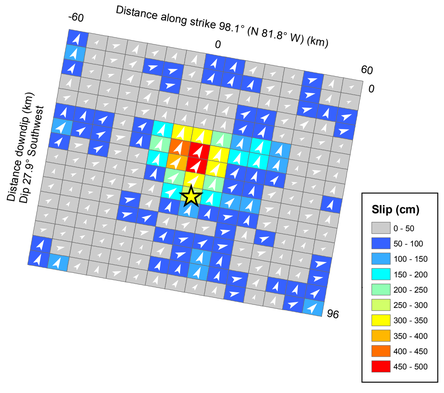


Overall, the population in this region resides in structures that are vulnerable to earthquake shaking, though some resistant structures exist. A magnitude 7.5 earthquake and tsunami 208 km Northeast of this one struck Indonesia on October 10, 2002 (UTC), with estimated population exposures of 6,000 at intensity IX or greater and 7,000 at intensity VIII, resulting in an estimated 8 fatalities. On September 12, 1979 (UTC), a magnitude 7.5 earthquake and tsunami 378 km Northeast of this one struck Indonesia, with estimated population exposures of 10,000 at intensity IX or greater and 27,000 at intensity VIII, resulting in an estimated 15 fatalities. Recent earthquakes in this area have caused tsunamis, landslides and liquefaction that may have contributed to losses.

This information was automatically generated and has not been reviewed by a seismologist.

http://earthquake.usgs.gov/pager Event ID: us2009bjbn

Finite Fault Model for M7.6 Earthquake



FINITE FAULT MODEL
Contributed by
Gavin Hayes, NEIC

Distribution of the amplitude and direction of slip for subfault elements (small rectangles) of the fault rupture model are determined from the inversion of teleseismic body waveforms. Arrows indicate the amplitude and direction of slip (of the hanging wall with respect to the foot wall); the slip amount is also color-coded as shown. The view of the rupture plane is from above.

The strike of the fault rupture plane is N98.1°E and the dip is 27.9° SW. The dimensions of the subfault elements are 8 km in the strike direction and 6 km in the dip direction. The seismic moment released based on the plane is 3.39E+027 dyne.cm.

TECTONIC SUMMARY

The magnitude 7.6 and 7.4 Papua, Indonesia earthquakes of January 3, 2009, 19:43 UTC and 22:33 UTC, respectively, occurred as a result of thrust faulting on a plate-boundary along the northwest coast of the island of New Guinea. Eastern Indonesia is characterized by complex tectonics in which motions of numerous small plates are accommodating large-scale convergence between the Australia, Pacific, and Eurasia plates. In broad-scale plate-tectonic models that do not subdivide continent sized plates into smaller plates, the location of today's earthquake would be on the boundary of the Pacific and Australia plates. The Pacific plate (located north and northeast of the epicenter) is moving southwest with respect to the Australia plate (located south of the epicenter) with a velocity of about 112 mm/year at the epicenter of the earthquake, and the focal-mechanism of today's earthquake is broadly consistent with Pacific plate lithosphere being subducted beneath Australia plate lithosphere. The subduction zone along the northwest coast of the island of New Guinea is characterized by an offshore oceanic trench, the New Guinea trench, but teleseismically recorded earthquake hypocenters do not show a well-developed inclined seismic zone (a Wadati-Benioff zone) dipping south-southwest from the trench.

The 19:43 and 22:33 UTC earthquakes of January 3, 2008, occurred about 470 km and 400 km west, respectively, of the magnitude 8.2 earthquake of February 17, 1996. The 1996 earthquake produced a tsunami that was destructive on the island of Biak. At least 108 people were killed by the earthquake and associated tsunami.

The magnitude 7.4 earthquake of January 3, 2009, 22:33 UTC, had the same focal-mechanism as the magnitude 7.6 , 19:43 UTC, shock of the same date, and was located about 70 km east of the earlier shock. It was almost certainly triggered by the earlier earthquake. Seismologists sometimes refer to a pair of similarly sized shocks that occur at nearly the same time and location as an earthquake "doublet."

Significant Earthquakes Mag >= 7.5

Year	Mon	Day	Time	Lat	Long	Dep	Mag
1907	06	25	1754	1.000	127.000	200	7.5
1910	12	16	1445	4.500	126.500	0	7.6
1913	03	14	0845	4.500	126.500	0	7.9
1914	05	26	1422	-2.000	137.000	0	7.9
1916	01	13	0820	-3.000	135.500	0	7.6
1926	10	26	0344	-3.219	139.097	35	7.5
1932	05	14	1311	0.258	126.169	35	8.1
1936	04	01	0209	4.165	126.521	35	7.7
1950	10	08	0323	-3.750	128.250	0	7.5
1957	09	24	0821	5.230	127.117	35	7.7
1965	01	24	0011	-2.455	125.965	28.4	8.2
1968	08	10	0207	1.422	126.260	19.6	7.6
1971	01	10	0717	-3.232	139.744	54.9	7.7
1979	09	12	0517	-1.688	135.966	18.9	7.5
1986	08	14	1939	1.805	126.485	30.9	7.5
1996	02	17	0559	-0.919	136.973	36.5	8.2
2007	01	21	1127	1.065	126.282	22	7.5
2009	01	03	1943	-0.510	132.783	35	7.6

DATA SOURCES

EARTHQUAKES AND SEISMIC HAZARD
USGS, National Earthquake Information Center
NOAA, National Geophysical Data Center
IASPEI, Centennial Catalog (1900 - 1999) and extensions (Engdahl and Villaseñor, 2002)
HDF (unpublished earthquake catalog) (Engdahl, 2003)
Global Seismic Hazard Assessment Program

PLATE TECTONICS AND FAULT MODEL
PB2002 (Bird, 2003)
Finite Fault Model, Chen Ji, UC Santa Barbara (2007)

BASE MAP
NIMA and ESRI, Digital Chart of the World
USGS, EROS Data Center
NOAA GEBCO and GLOBE Elevation Models

REFERENCES

Bird, P., 2003, An updated digital model of plate boundaries: Geochem. Geophys. Geosyst., v. 4, no. 3, pp. 1027- 80.

Engdahl, E.R. and Villaseñor, A., 2002, Global Seismicity: 1900 - 1999, chap. 41 of Lee, W.H.K., and others,eds., International Earthquake and Engineering Seismology, Part A: New York, N.Y., Elsevier Academeic Press, 932 p.

Engdahl, E.R., Van der Hilst, R.D., and Buland, R.P., 1998, Global teleseismic earthquake relocation with improved travel times and procedures for depth determination: Bull. Seism. Soc. Amer., v. 88, p. 722-743.

DISCLAIMER

Base map data, such as place names and political boundaries, are the best available but may not be current or may contain inaccuracies and therefore should not be regarded as having official significance.

Map prepared by U.S. Geological Survey
National Earthquake Information Center
8 January 2009
Map not approved for release by Director USGS