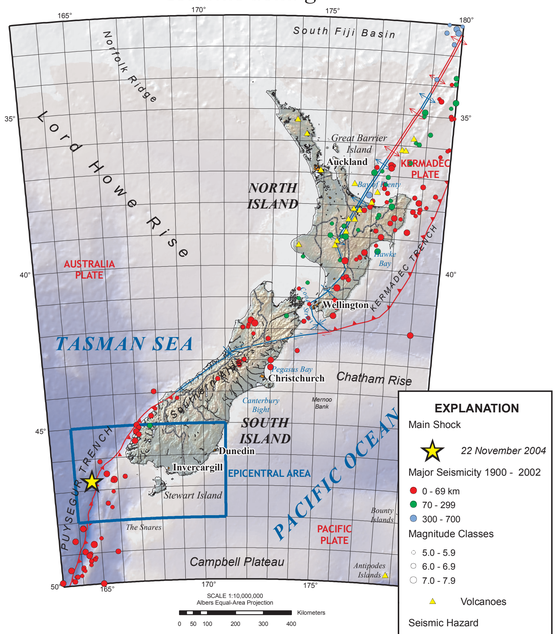
M7.1 Puysegur Trench Earthquake of 22 November 2004

Tectonic Setting



EXPLANATION

Main Shock

22 November 2004

Major Seismicity 1900 - 2002

- 0 - 69 km
- 70 - 299
- 300 - 700

Magnitude Classes

- 5.0 - 5.9
- 6.0 - 6.9
- 7.0 - 7.9

Volcanoes

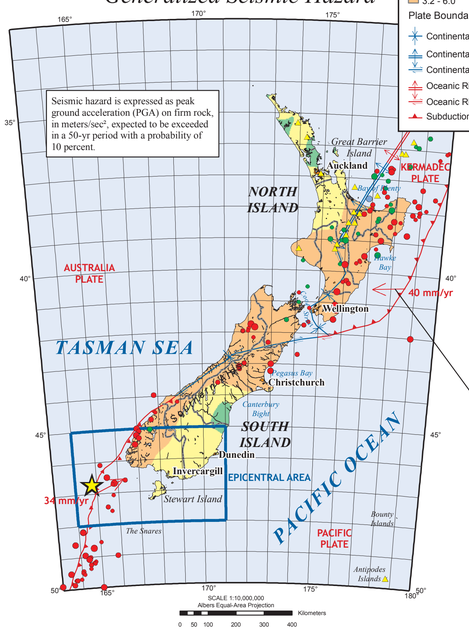
Seismic Hazard

- 0.4 - 0.8 m/sec²
- 0.8 - 1.6
- 1.6 - 3.2
- 3.2 - 6.0

Plate Boundaries

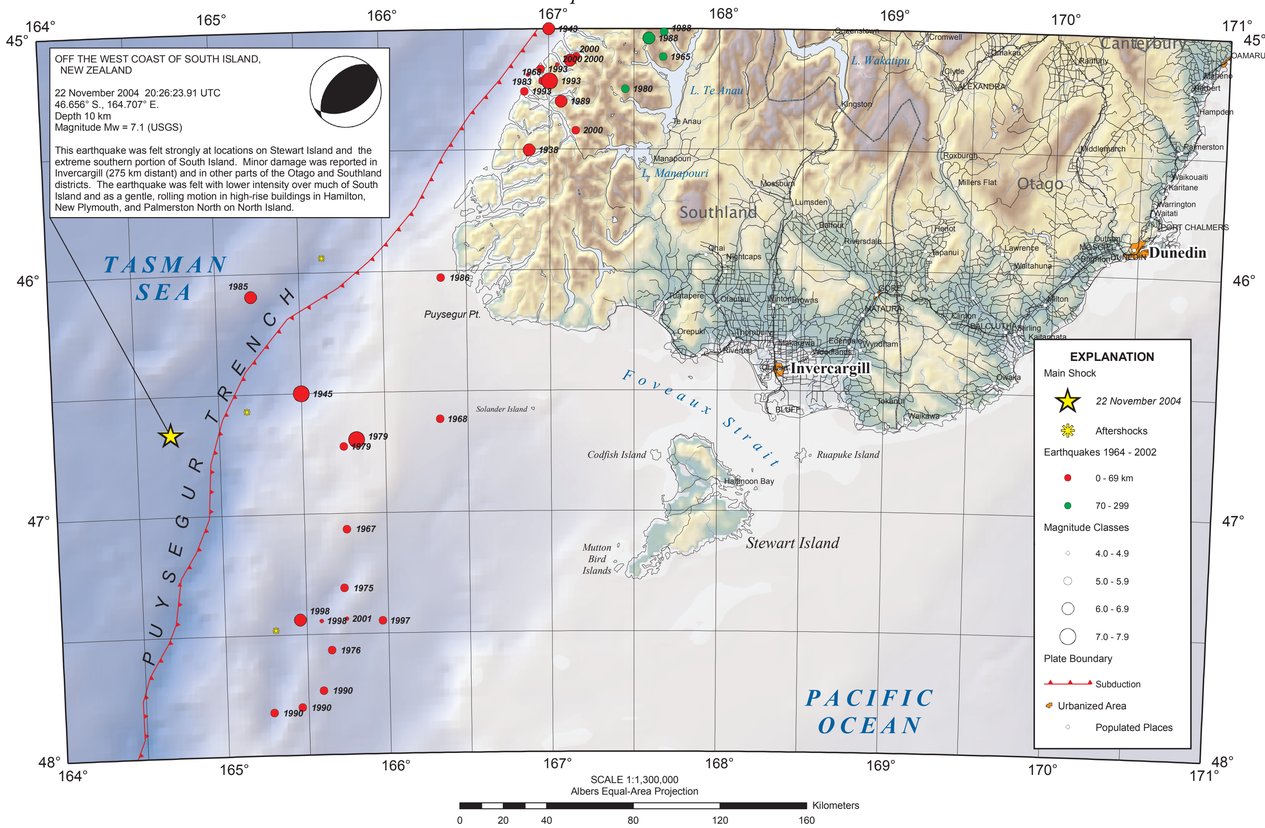
- Continental Convergent
- Continental Rift
- Continental RL Transform
- Oceanic Rift
- Oceanic RL Transform
- Subduction

Generalized 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.

Epicentral Area



EXPLANATION

Main Shock

22 November 2004

Aftershocks

Earthquakes 1964 - 2002

- 0 - 69 km
- 70 - 299

Magnitude Classes

- 4.0 - 4.9
- 5.0 - 5.9
- 6.0 - 6.9
- 7.0 - 7.9

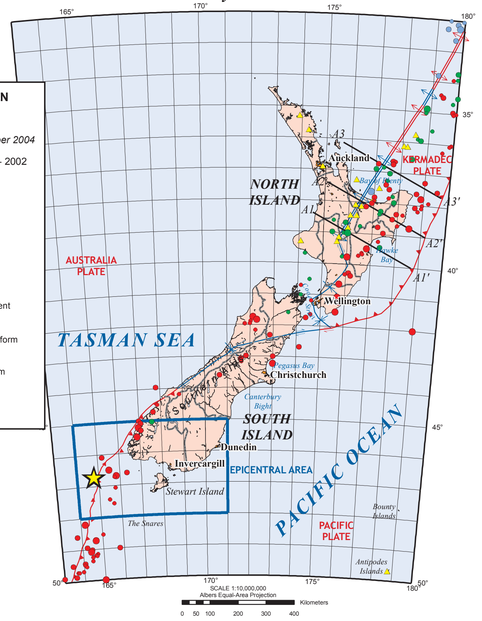
Plate Boundary

- Subduction

Urbanized Area

Populated Places

Seismicity 1900 - 2002



EXPLANATION

Main Shock

22 November 2004

Major Seismicity 1900 - 2002

- 0 - 69 km
- 70 - 299
- 300 - 700

Magnitude Classes

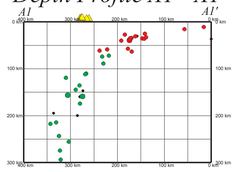
- 5.0 - 5.9
- 6.0 - 6.9
- 7.0 - 7.9

Plate Boundaries

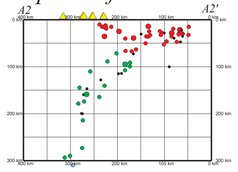
- Continental Convergent
- Continental Rift
- Continental RL Transform
- Oceanic Rift
- Oceanic RL Transform
- Subduction

Volcanoes

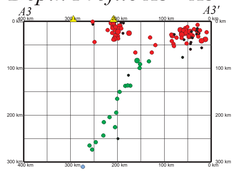
Depth Profile A1 - A1'



Depth Profile A2 - A2'



Depth Profile A3 - A3'



RELATIVE PLATE MOTIONS

The relative motion of adjacent tectonic plates is depicted on the map by short vectors located at selected points on the plate boundary. In this presentation, one plate (the reference plate) is assumed to be fixed. The vector therefore represents the direction of the moving plate relative to the reference plate. The rate of relative motion is labelled next to the vector.

The components of the vector perpendicular and parallel to the plate margin approximate convergent/divergent and transverse direction of motion between the plates, respectively. As viewed from the fixed plate, an inward directed component suggests convergence at and near the plate boundary that may be expressed as crustal folding, uplift, thrust faulting, or plate subduction. Similarly, an outward directed component suggests plate divergence such as would be expected at a zone of crustal spreading. Transcurrent or transform faulting would be expected when the predominant vector component is parallel to the plate margin.

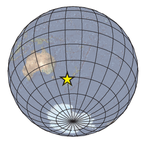
DISCUSSION

New Zealand is part of a largely submerged microcontinent in the South Pacific Ocean. It has two main islands, North Island and South Island. These islands straddle the boundary between the Pacific and Australian tectonic plates and are undergoing a gradual elongation and compression, due to the continuous 40 mm/year northeastwards motion of the Australian plate relative to the Pacific plate. Along New Zealand, the plate boundary consists of a transform fault system connecting two subduction zones of opposing convergent directions that lie to the north and south of South Island.

The 22 November 2004 earthquake occurred in the Fiordland and Puysegur Region. This region includes the southwest corner of South Island (Fiordland) and extends offshore to the southwest and covers the Puysegur Trench. Oblique subduction of the Australian plate beneath the Pacific plate occurs along the Puysegur trench. The subducted plate is moderately dipping in the southern part of the trench and further to the north a gradual change in strike of 17 degrees accompanies a steepening in dip of the slab to near vertical below Fiordland. The exact age and mechanism of this young subduction zone is presently being debated in the scientific community.

Off the south coast of Fiordland, active subduction at the Puysegur Trench produces earthquakes in three areas: within the subducting Australian plate; in the overlying Pacific plate; and at the interface between the plates. The earthquake occurred to the west of the trench in the Australian plate. There are many fault systems in the region and the USGS is not certain of the particular fault responsible for this recent earthquake.

Although Fiordland is sparsely populated, some earthquakes in this region are felt by people throughout the South Island, such as the magnitude 7.2 thrust earthquake of 21 August 21 2003. People felt this event as far north as Wellington on North Island and Sydney, Australia. Most of the historic major earthquakes have occurred offshore. For example, on 12 October 1979, a magnitude 7.3 thrust earthquake occurred beneath the Puysegur trench.



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.

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
PB2003 (Bird, 2003)

VOLCANOES
Smithsonian Institution, Global Volcano Program

BASE MAP
NIMA and ESRI, Digital Chart of the World
USGS, EROS Data Center

NEWS SOURCES

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.

EARTHQUAKES IN THE EPICENTRAL AREA
1900 – 2002

YR	MO	DY	LAT	LON	DEPTH	MAG
1938	12	16	-45.503	166.880	25.0	6.9
1943	8	2	-45.000	167.000	0.0	6.8
1945	9	1	-46.500	165.500	0.0	7.1
1965	5	20	-45.117	167.672	105.8	5.4
1967	6	28	-47.066	165.757	34.9	5.6
1968	4	2	-45.217	166.963	26.5	5.0
1968	9	25	-46.615	166.333	10.0	5.8
1975	9	16	-47.310	165.734	27.5	5.6
1976	1	7	-47.567	165.649	1.5	5.5
1979	10	12	-46.695	165.826	5.9	7.3
1979	10	12	-46.723	165.749	22.8	5.6
1980	1	28	-45.251	167.450	108.6	5.2
1983	6	26	-45.191	166.877	1.7	4.6
1985	1	31	-46.095	165.211	27.1	6.3
1986	7	11	-46.029	166.349	29.8	5.6
1988	6	3	-45.040	167.587	74.8	6.7
1988	7	19	-45.014	167.677	127.0	5.5
1989	5	31	-45.302	167.071	23.2	6.5
1990	3	12	-47.802	165.460	10.3	5.4
1990	3	13	-47.734	165.594	15.0	5.5
1990	3	24	-47.822	165.286	15.0	5.5
1993	8	10	-45.217	167.004	28.0	7.0
1993	8	11	-45.167	166.953	37.4	5.6
1993	8	11	-45.260	166.856	15.0	5.2
1997	5	26	-47.448	165.965	25.0	5.2
1998	1	7	-47.445	165.590	19.9	4.8
1998	1	26	-47.439	165.459	15.0	5.9
2000	4	25	-45.423	167.157	69.3	4.9
2000	11	1	-45.131	167.125	30.4	6.1
2000	11	1	-45.149	167.050	17.7	4.3
2000	11	12	-45.117	167.162	27.6	5.4
2001	4	12	-47.438	165.744	6.7	4.4

Map prepared by U.S. Geological Survey
National Earthquake Information Center
13 December 2004
Map not approved for release by Director USGS