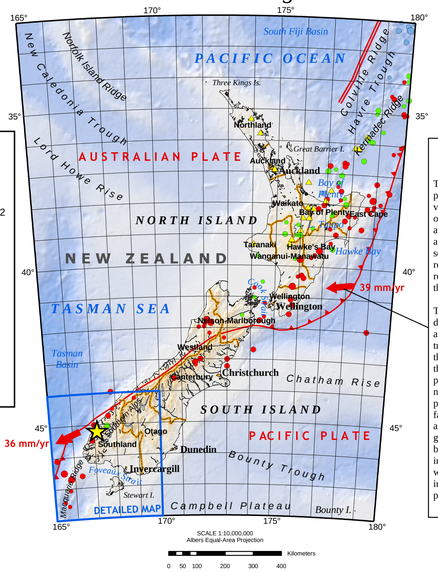
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

M7.2 Fiordland, New Zealand Earthquake of 21 August 2003

Tectonic Setting



EXPLANATION

Main Shock

21 August 2003

Major Earthquakes 1900 - 2002

0 - 69 km

70 - 299

300 - 700

Plate Boundaries

Convergent

Divergent

Transform

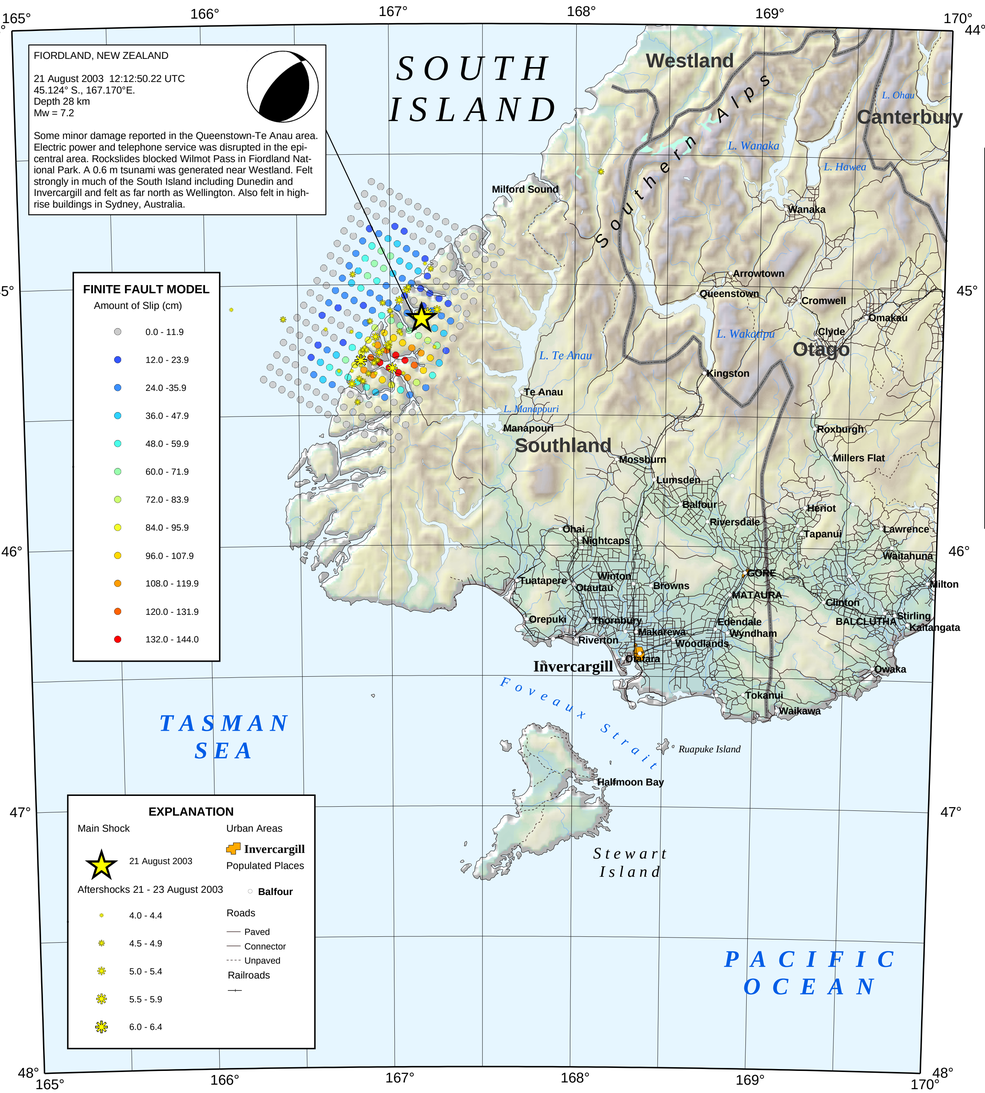
Volcanoes

RELATIVE PLATE MOTIONS

The relative motion of adjacent tectonic plates is depicted on the map by short vectors located at selected locations on the plate boundary. In this presentation, one plate is assumed to be rigid and fixed. The vector therefore represents the direction of the moving plate relative to the fixed 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.

Epicentral Area



FIORDLAND, NEW ZEALAND

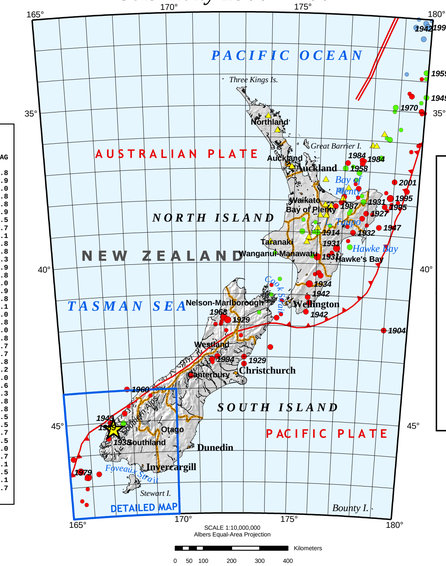
21 August 2003 12:12:50.22 UTC
45.124° S., 167.170°E.
Depth 28 km
Mw = 7.2

Some minor damage reported in the Queenstown-Te Anau area. Electric power and telephone service was disrupted in the epicentral area. Rockslides blocked Wilmot Pass in Fiordland National Park. A 0.6 m tsunami was generated near Westland. Felt strongly in much of the South Island including Dunedin and Invercargill and felt as far north as Wellington. Also felt in high-rise buildings in Sydney, Australia.

MAJOR EARTHQUAKES 1900-2002
NEW ZEALAND AND VICINITY

YR	MO	DY	LAT	LON	DEPTH	MAG
1901	11	15	-43.000	173.000	0.0	6.8
1904	8	8	-42.000	179.000	0.0	6.9
1914	11	22	-39.000	176.000	100.0	7.0
1921	6	28	-39.421	177.351	150.0	6.8
1927	2	25	-38.327	177.943	35.0	6.8
1929	3	9	-43.227	173.062	15.2	6.8
1929	6	16	-41.831	172.292	35.0	7.5
1931	2	2	-39.772	176.025	35.0	7.7
1931	2	13	-39.479	176.813	35.0	7.1
1931	9	21	-37.961	177.811	101.3	6.8
1932	9	15	-38.956	177.455	35.0	6.8
1934	3	5	-40.643	175.738	35.0	7.3
1938	12	16	-45.503	166.880	25.0	6.9
1942	6	15	-32.133	179.756	518.3	6.8
1942	6	24	-41.534	175.630	35.0	7.0
1942	8	1	-41.066	175.684	35.0	6.9
1943	8	2	-45.000	167.000	0.0	6.8
1945	9	1	-46.500	165.500	0.0	7.1
1947	3	25	-38.750	178.500	0.0	7.0
1949	12	18	-34.500	180.000	100.0	6.8
1953	9	29	-37.637	176.868	311.7	7.0
1958	12	10	-36.920	177.020	274.0	6.8
1959	6	27	-33.715	179.926	162.8	6.7
1960	5	24	-43.962	167.824	35.0	6.7
1961	12	27	-41.243	175.754	35.0	6.8
1968	5	23	-41.743	172.123	46.7	7.2
1970	1	8	-34.889	178.845	209.2	7.0
1976	5	4	-44.726	167.663	30.4	6.6
1979	10	12	-46.695	165.826	5.0	7.3
1984	12	30	-36.643	177.671	3.2	6.8
1984	12	30	-36.746	177.689	37.7	6.8
1987	3	2	-38.015	176.921	15.0	6.5
1987	3	2	-38.139	176.699	11.0	6.5
1988	6	3	-45.039	167.587	74.8	6.7
1989	5	31	-45.302	167.071	23.2	6.5
1993	8	10	-45.207	166.958	28.0	7.0
1994	6	18	-43.081	171.610	14.0	6.7
1995	2	5	-37.795	178.889	21.0	7.1
1995	2	10	-38.084	178.682	28.3	6.5
1997	5	25	-32.253	179.842	343.2	7.1
2001	10	21	-37.271	179.008	18.0	6.7

Seismicity 1900 - 2002



EXPLANATION

Main Shock

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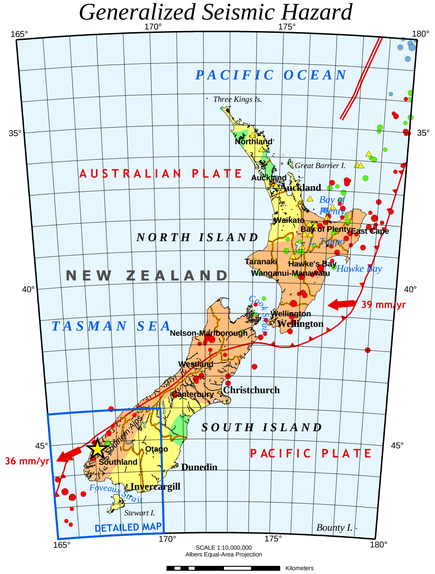
Generalized Seismic Hazard



EXPLANATION

Seismic Hazard

0.2 - 0.4 m/sec²

0.4 - 0.8

0.8 - 1.6

1.6 - 3.2

3.2 - 6.4

6.4 - 9.8

Main Shock

21 August 2003

Plate Boundaries

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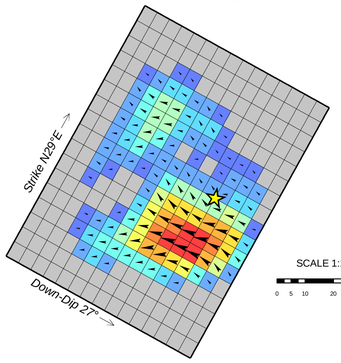
Seismic hazard is expressed as peak ground acceleration (PGA) on firm rock, in meters/sec², expected to be exceeded in a 50-yr period with a probability of 10 percent.

Finite Fault Model



EXPLANATION

Amount of Slip (cm)

0.0 - 11.9

12.0 - 23.9

24.0 - 35.9

36.0 - 47.9

48.0 - 59.9

60.0 - 71.9

72.0 - 83.9

84.0 - 95.9

96.0 - 107.9

108.0 - 119.9

120.0 - 131.9

132.0 - 144.00

FINITE FAULT MODEL
(C. Ji, California Institute of Technology)

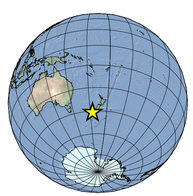
Distribution of the amplitude and direction of slip for subfault elements (small rectangles) of the fault rupture model are determined from the inversion of teleseismic body waveforms. Arrows indicate the amplitude and direction of slip (or rake vector); the slip amount is also color-coded as shown.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

The fact that the orientation of the finite fault plane may differ from the corresponding best double couple nodal plane depicted in the focal mechanism diagram on the main map reflects differing methods of analysis and data sets.

The strike of the fault rupture plane is N29°E and the dip is 27°. The dimensions of the subfault elements are 6 km in the strike direction and 5 km in the dip direction.

ONLINE RESOURCES

USGS Earthquake Program
http://earthquake.usgs.gov
Significant Earthquake Posters
http://neic.usgs.gov/neis/poster/
New Zealand GeoNet Data Centre
http://www.geonet.org.nz/datacentre.htm



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.

DISCUSSION

New Zealand straddles the boundary of the Australian and Pacific plates. Along New Zealand, the Australian plate moves to the northeast at a rate of 35 to 45 mm/yr relative to the Pacific plate. In the central South Island, this plate motion results in predominantly strike-slip movement along the Alpine Fault. In southwestern South Island, relative plate motion is accommodated by oblique subduction of the Australian plate along the Puysegur trench and deformation of the overriding Pacific plate inland of the trench. The Southern Alps of New Zealand result from this oblique plate convergence.

The 21 August 2003 thrust earthquake occurred near the southern tip of South Island in a region known as Fiordland. The preliminary location, depth, and estimate of fault orientation are consistent with the earthquake having resulted from slip on the thrust interface between the Pacific and Australian plates. The deformed and subducted Australian plate beneath Fiordland and below the thrust interface is also highly active, and several surface strands of the Alpine Fault are observed in the vicinity of the earthquake epicenter in the overriding Pacific plate above the thrust interface.

Over the past two decades, several large earthquakes have occurred in Fiordland. A magnitude 7.0 event on August 10, 1993 caused power outages in the Te Anau area and was felt throughout South Island and as far away as Sydney, Australia. A magnitude 6.4 earthquake struck on May 31, 1989 and was felt strongly in the southwestern part of South Island and a magnitude 6.7 quake struck on June 3, 1988.

DATA SOURCES

EARTHQUAKES AND SEISMIC HAZARD
USGS, National Earthquake Information Center
New Zealand Institute of Geological & Nuclear Sciences, GeoNet Data Centre
NOAA, National Geophysical Data Center
IASPEI, Centennial Catalog (1900 - 1999)
Handbook of Seismology and Earthquake Engineering
Global Seismic Hazard Assessment Program

PLATE TECTONICS
Smithsonian Institution, Global Volcano Program

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

ONLINE NEWS REPORTS
Go Asia Pacific
Independent Online
NZCity News

Map prepared by U.S. Geological Survey
National Earthquake Information Center
28 August 2003
Map not approved for release by Director USGS