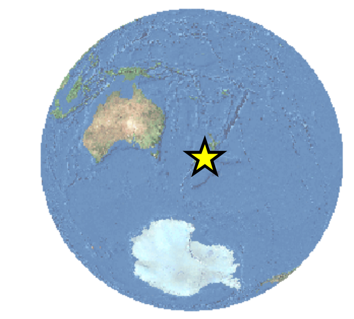
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

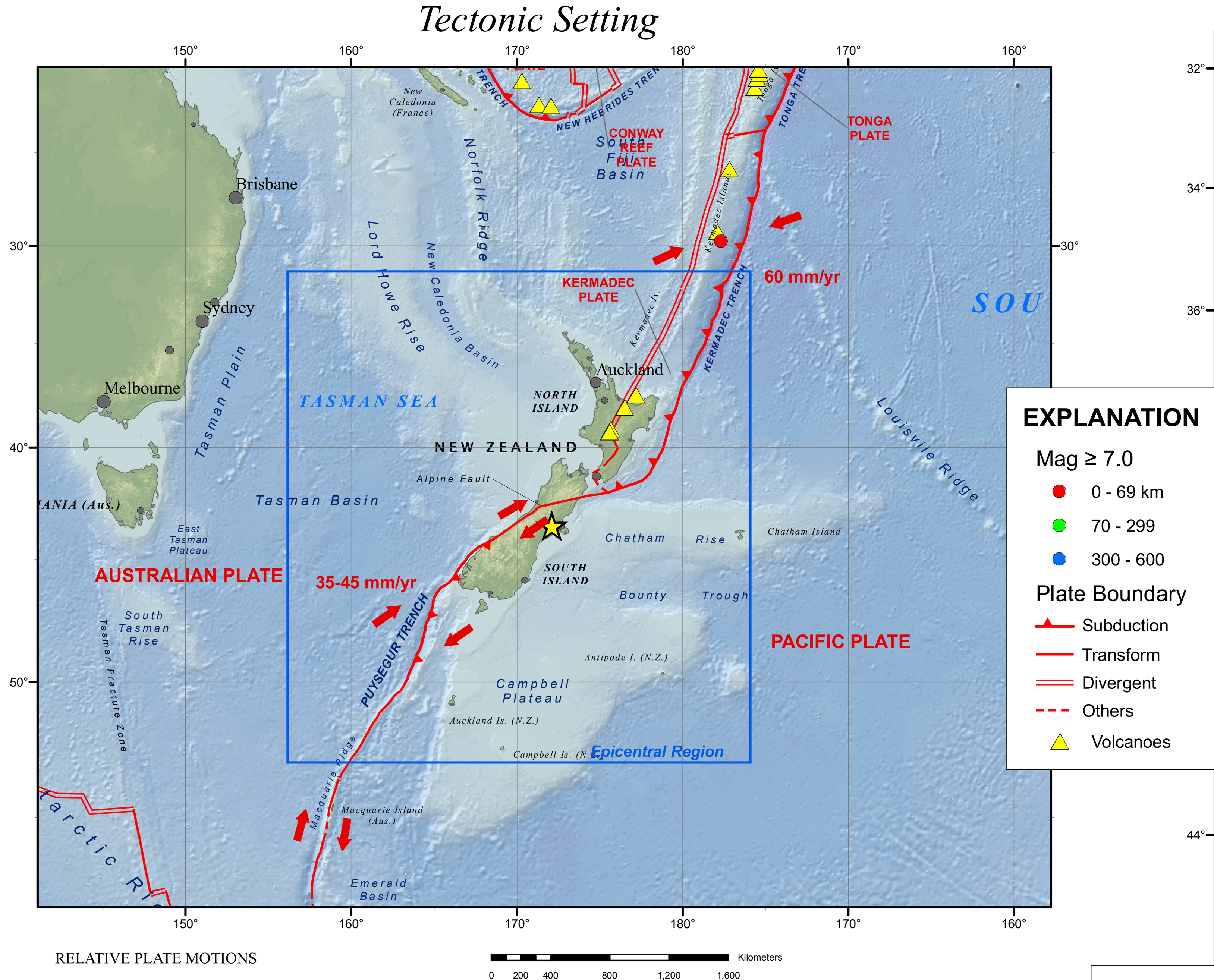
EARTHQUAKE SUMMARY MAP

M7.0 South Island, New Zealand Earthquake of 3 September 2010



Prepared in cooperation with the Global Seismographic Network

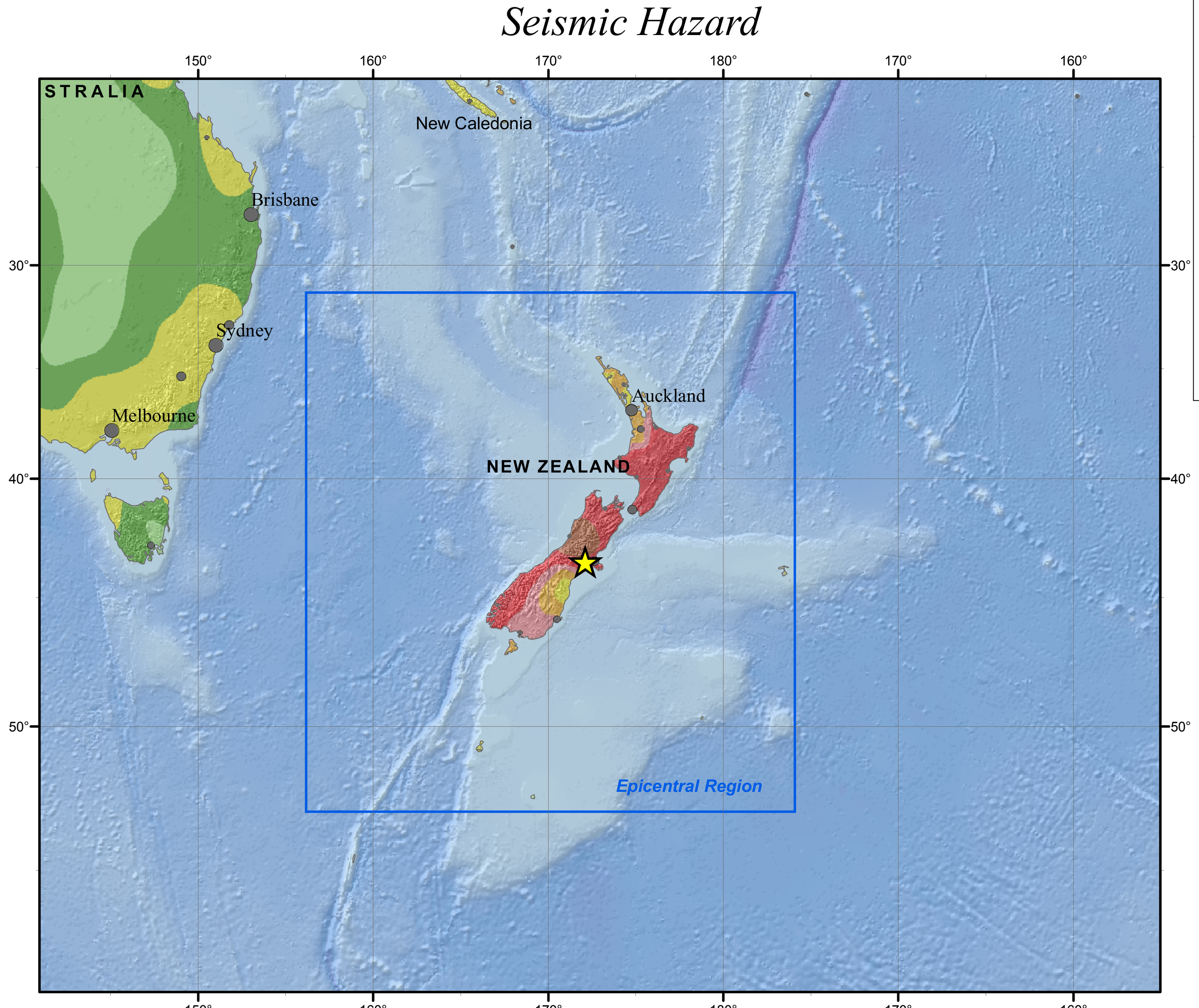
Tectonic Setting



RELATIVE PLATE MOTIONS

The broad red vectors represent the motion of tectonic plates relative to the adjacent plate. In the vicinity of this earthquake, the Australia Plate and Pacific Plate are converging at about 35-45 mm/yr along the Puysegur Trench.

Seismic Hazard

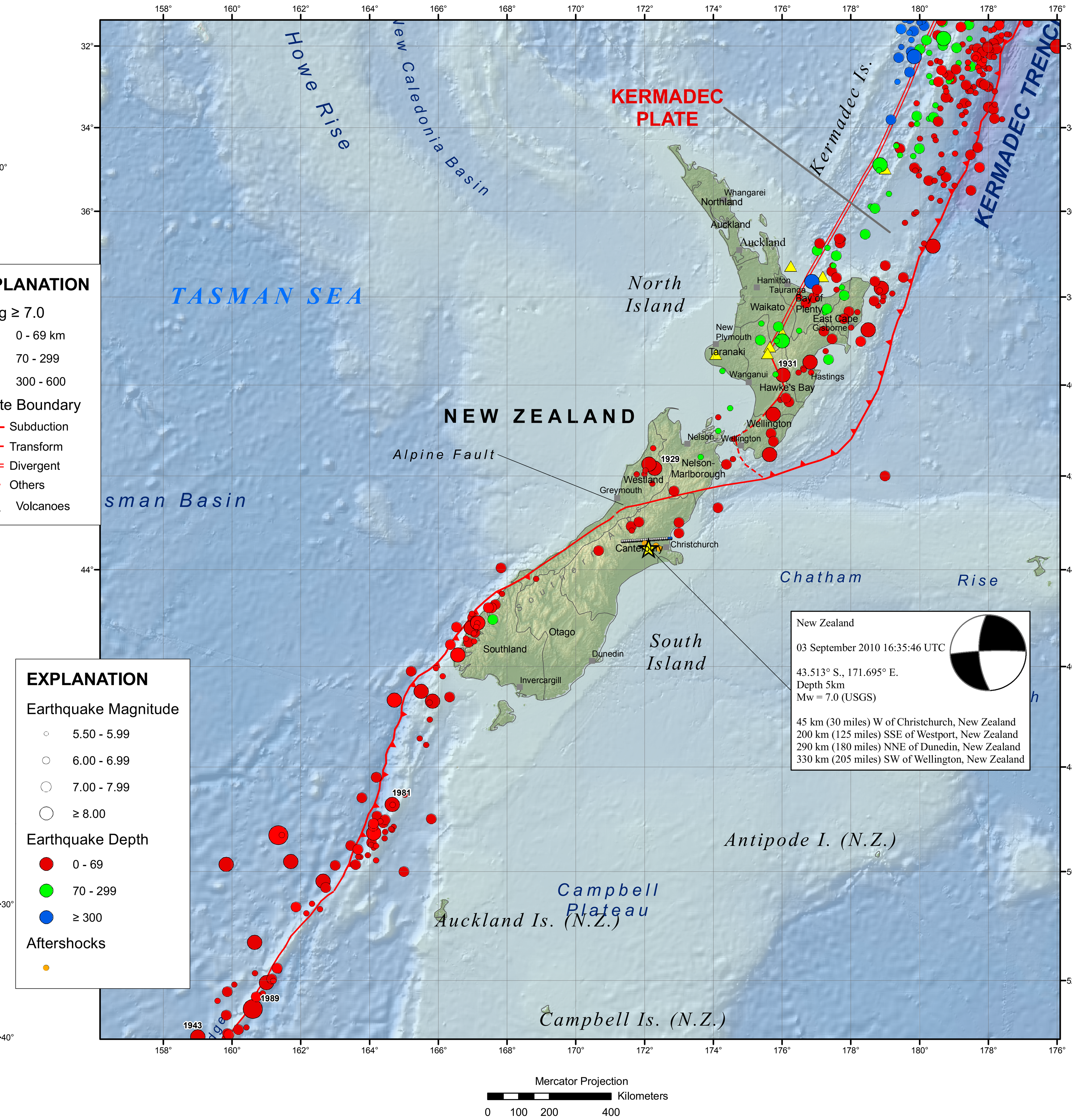


Seismic hazard is expressed as peak ground acceleration (PGA) on firm rock, in meters/sec², expected to be exceeded in a 50-yr period with a probability of 10 percent.

Peak Ground Acceleration in m/sec**2

.2 .4 .8 1.6 2.4 3.2 4.0 4.8

Epicentral Region



DISCUSSION

The September 3, 2010 South Island, New Zealand earthquake occurred as a result of strike-slip faulting within the crust of the Pacific plate, near the eastern foothills of the Southern Alps at the western edge of the Canterbury Plains. The earthquake struck approximately 50 km to the west-northwest of Christchurch, the largest population center in the region, and about 80-90 km to the south and east of the current expression of the Australia:Pacific plate boundary through the island (the Alpine and Hope Faults). The earthquake, though removed from the plate boundary itself, likely reflects right-lateral motion on one of a number of regional faults related to the overall relative motion of these plates and may be related to the overall southern propagation of the Marlborough fault system in recent geologic time.

The September 3, 2010 earthquake occurred approximately 50 km to the southeast of a M7.1, surface-rupturing event in Authur's Pass, on March 9th, 1929, which caused damage but injured no one. More recently, two earthquakes of M6.7 and M5.9 occurred in June 1994 approximately 40 km to the northwest of the 2010 event, but did not cause any known fatalities or significant damage.

Significant Earthquakes Mag >= 7.5

Year	Mon	Day	Time	Lat	Long	Dep	Mag
1929	06	16	2247	-41.831	172.292	35	7.5
1931	02	02	2246	-39.772	176.025	35	7.7
1943	09	06	0341	-53.000	159.000	0	7.6
1981	05	25	0525	-48.721	164.658	8.6	7.6
1989	05	23	1054	-52.507	160.602	4.3	8.1

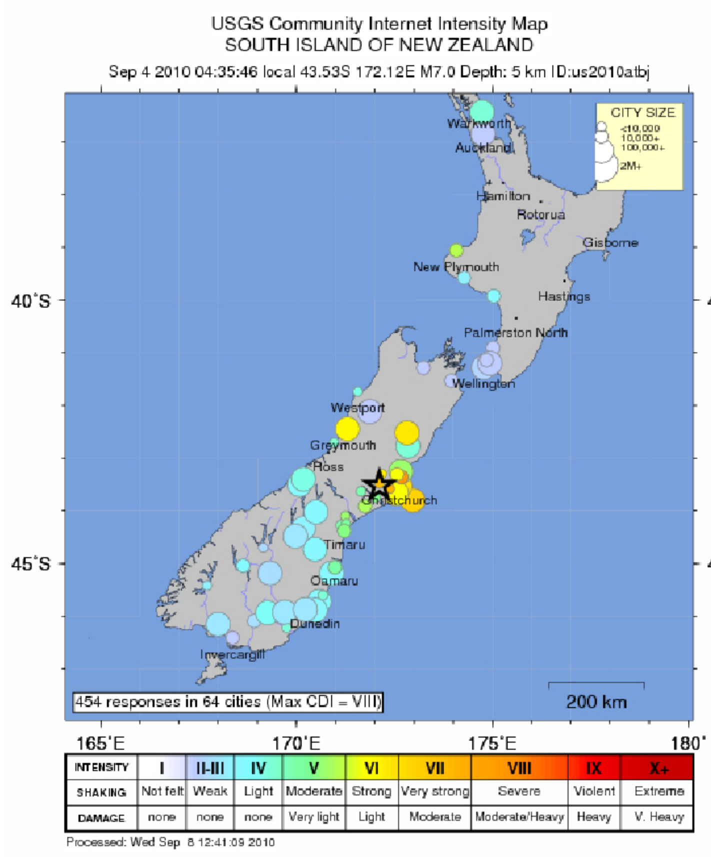
FINITE FAULT MODEL
Contributed by
Gavin Hayes, NEIC

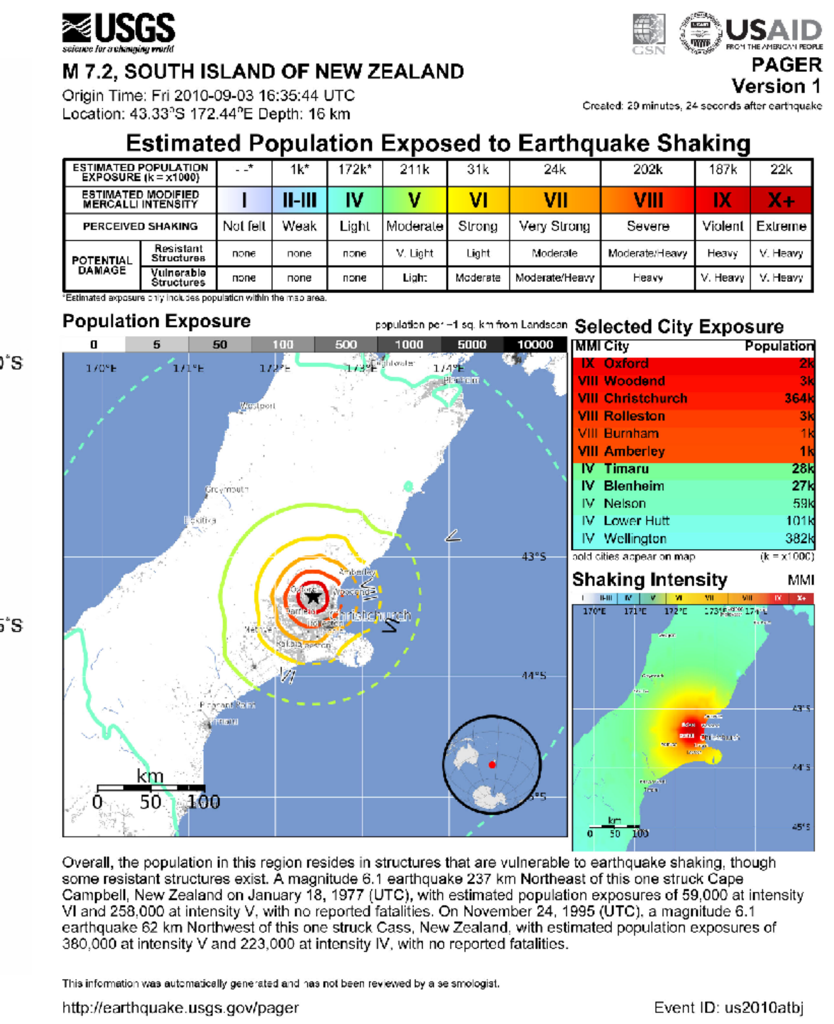
Distribution of the amplitude and direction of slip for subfault elements (small rectangles) of the fault rupture model are determined from the inversion of teleseismic body- and surface-waves. Arrows indicate the amplitude and direction of slip (of the hanging wall with respect to the foot wall); the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

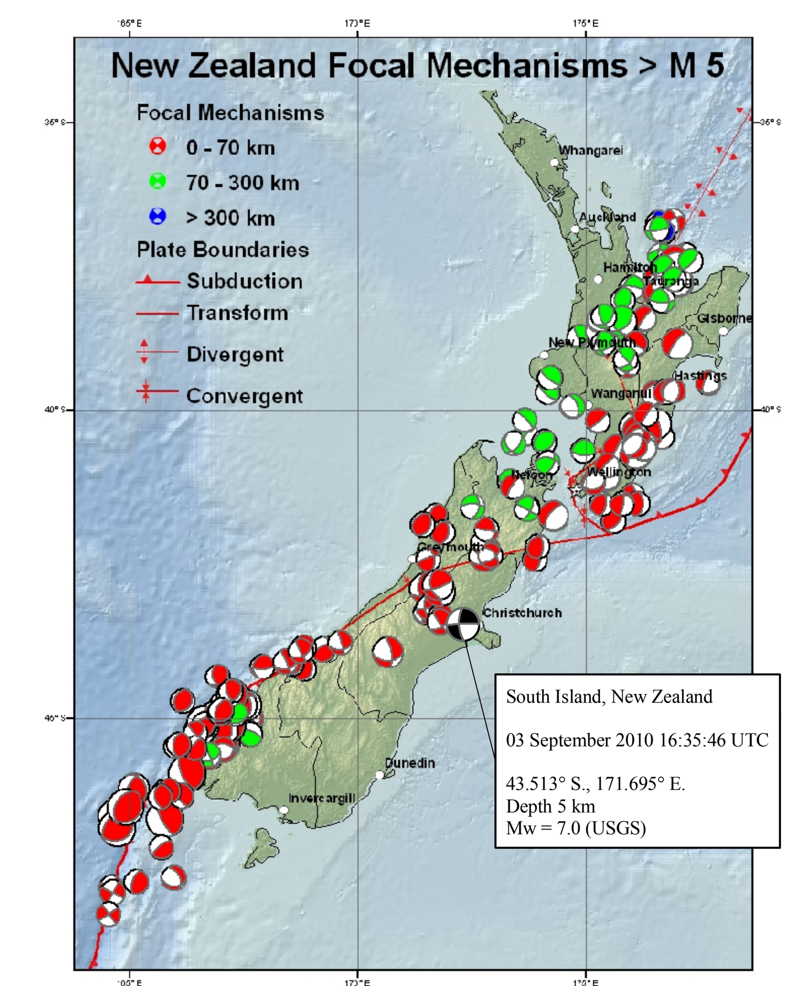
The strike of the fault rupture plane is N88°E and the dip is 87° SSE. The dimensions of the subfault elements are 5 km in the strike direction and 3.5 km in the dip direction. The seismic moment released based on the plane is 3.82E+026 dyne.cm. The source exhibits approximately 20 sec, of complex moment release.

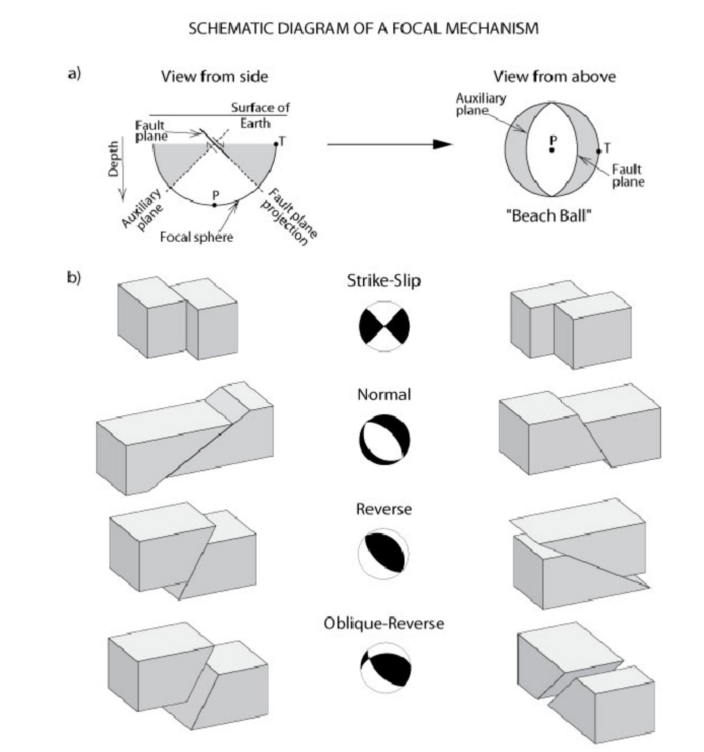
Slip (cm)

- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250





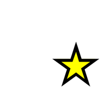


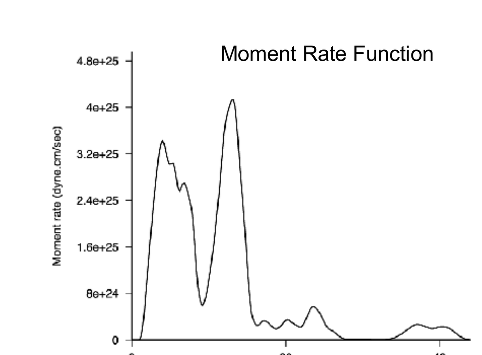


Seismologists refer to the direction of slip in an earthquake and the orientation of the fault on which it occurs as the focal mechanism. They use information from seismograms to calculate the focal mechanism and typically display it on maps as a "beach ball" symbol, as shown in part a). This symbol is the projection on a horizontal plane of the lower half of an imaginary, spherical shell focal sphere) surrounding the earthquake source. A line is scribed where the fault plane intersects the shell. The stress field orientation at the time of rupture governs the direction of slip on the fault plane; the beach ball depicts this stress orientation through shading. The black quadrants contain the tension axis (T), which reflects the minimum stress direction, and the white quadrants contain the pressure axis (P), which reflects the maximum stress direction.

For mechanisms calculated from the first-motion direction of seismograms, there is an ambiguity in identifying the fault plane on which slip occurred from the orthogonal, mathematically equivalent, auxiliary plane. In part b) we illustrate this ambiguity with four examples. The block diagrams adjacent to each focal mechanism illustrate the two possible types of fault motion that the focal mechanism could represent. Note that the view angle is 30° to the left of and above each diagram. The ambiguity may be resolved by comparing the two fault plane orientations to the alignment of small earthquakes and aftershocks shown in map and cross-section views. The first three examples describe fault motion that is purely horizontal (strike-slip) or vertical (normal or reverse). The oblique-reverse mechanism illustrates that slip may also have components of horizontal and

Finite Fault Model for M7.0 Earthquake





Source time function, describing the rate of moment release with time after earthquake origin.

DATA SOURCES and REFERENCES:

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NOAA, National Geophysical Data Center
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http://www.seismo.ethz.ch/GSHAP/

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

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

NEW ZEALAND FOCAL MECHANISMS
Global Centroid-Moment-Tensor (CMT) Project
Lamony-Doherty Earth Observatory (LDEO), Columbia University
http://www.globalcmt.org/

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 regraded as having official significance.

Map prepared by U.S. Geological Survey National Earthquake Information Center
09 September 2010
http://earthquake.usgs.gov/
Map not approved for release by Director USGS