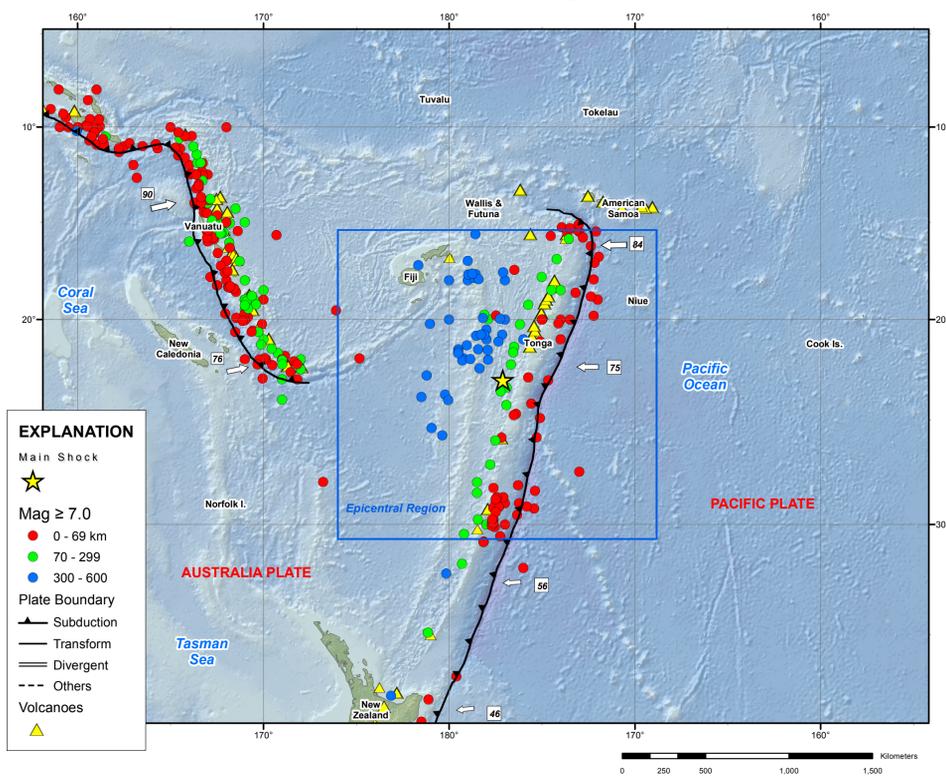


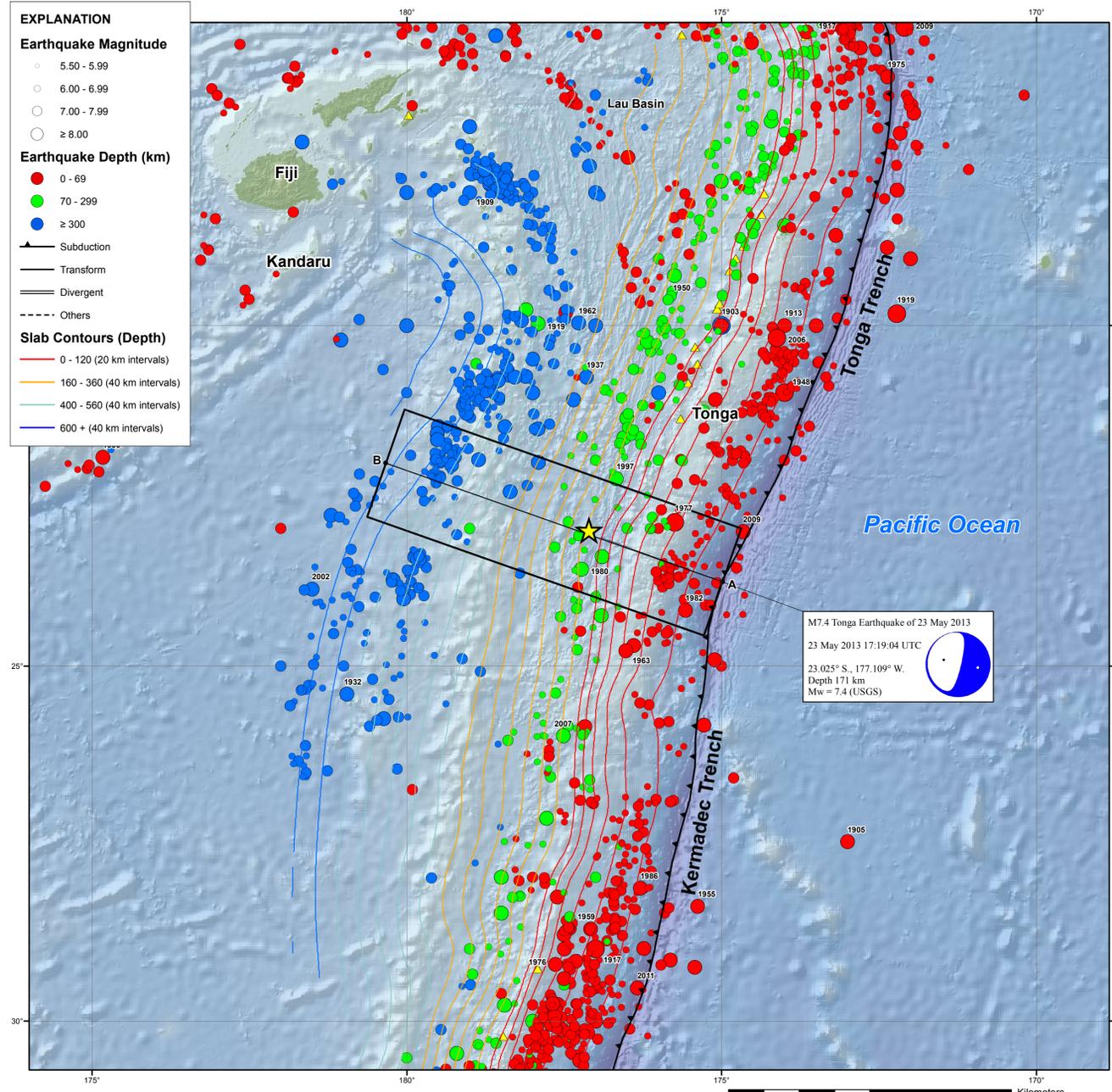
M7.4 Tonga Earthquake of 23 May 2013



Tectonic Setting



Epicentral Region



M7.4 Tonga Earthquake of 23 May 2013
 23 May 2013 17:19:04 UTC
 23.025° S, 177.109° W
 Depth 171 km
 Mw = 7.4 (USGS)

PAGER

USGS Earthquake Shaking Green Alert

M 7.4, SOUTH OF THE FIJI ISLANDS
 Origin Time: Thu 2013-05-23 17:19:04 UTC (05:19:04 local)
 Location: 23.02°S 177.11°W Depth: 171 km

Estimated Fatalities (Green Alert for shaking-related fatalities and economic losses. There is a low likelihood of casualties and damage.)

Estimated Economic Losses

Estimated Population Exposure to Earthquake Shaking

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

Population Exposure

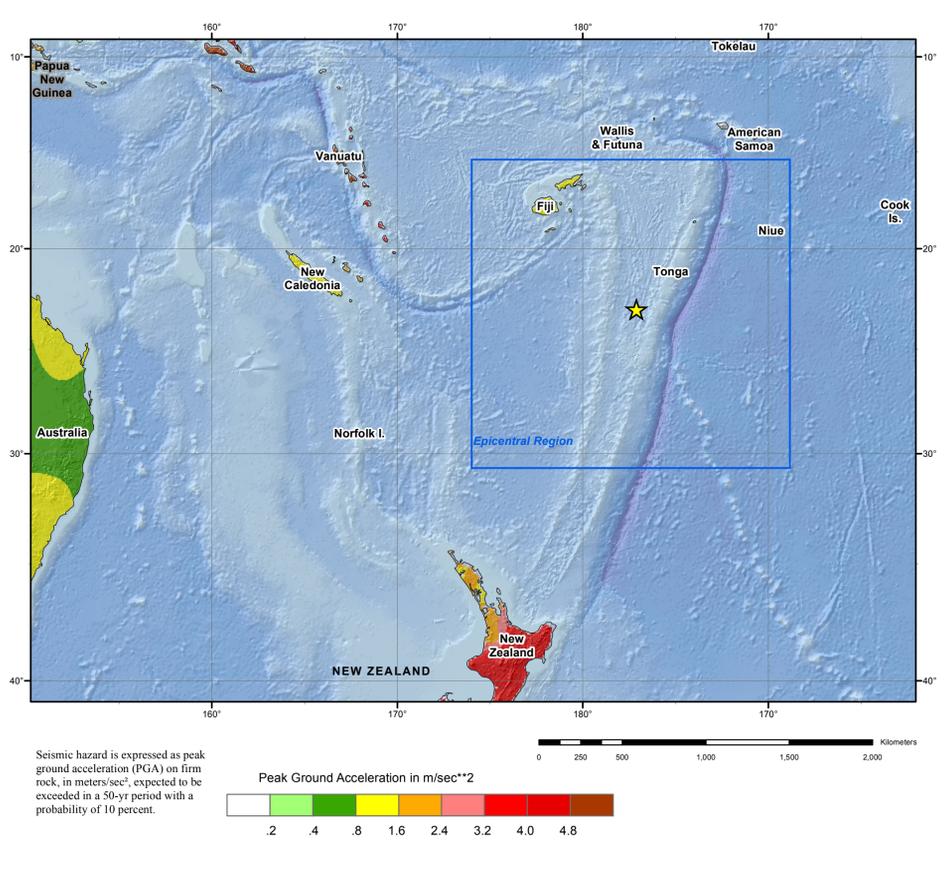
Estimated population only includes population within the near area.

Selected City Exposure

MMI City	Population
IV Vaini	3K
IV Havelu	3K
IV Nukualofa	22K
IV 'Ohonua	1K

Event ID: us000R3K3

Seismic Hazard



TECTONIC SUMMARY

The May 23, 2013 Mw 7.4 earthquake southwest of Vaini, Tonga, occurred as a result of normal faulting at a depth of approximately 170 km. At the location of this earthquake, the Pacific and Australia plates are converging at a rate of approximately 73 mm/yr in an east-west direction, resulting in the westward subduction of the Pacific plate beneath Tonga at the Tonga-Kermadec trench. The depth and faulting mechanism of the May 23rd earthquake indicate it ruptured a fault within the subducting Pacific lithosphere rather than on the shallower thrust interface between the two plates.

The Tonga-Kermadec arc has frequent moderate-to-large earthquakes, and has hosted over a dozen M6.5+ earthquakes within 500 km of the May 23rd earthquake over the past 40 years. Most of these also occurred at intermediate depths; the largest was an Mw 7.7 earthquake in October of 1997, approximately 110 km to the north-northeast of the May 23 2013 event. None are known to have caused significant damage. Intermediate-depth (70-300 km) and deep-focus (depth > 300 km) earthquakes are distinguished from shallow earthquakes (0-70 km) by the nature of their tectonic setting, and are in general less hazardous than their shallow counterparts, though they may be felt at great distances from their epicenters. The Tonga-Kermadec slab in the region of the May 23 2013 earthquake is seismically active to depths of over 650 km.

Significant Earthquakes Mag ≥ 7.5

Year	Mon	Day	Time	Lat	Long	Dep	Mag
1901	08	09	13:01	-22.000	170.000	0	7.9
1903	01	04	05:07	-20.000	-175.000	400	8.0
1905	03	18	00:58	-27.500	-173.000	60	7.5
1909	02	22	09:21	-18.000	-179.000	550	7.6
1910	06	16	06:30	-19.000	-169.500	100	7.9
1910	11	09	06:02	-16.000	-166.000	70	7.5
1913	08	26	04:57	-20.000	-174.000	0	7.7
1913	08	06	22:14	-17.000	-174.000	0	7.8
1913	10	14	08:08	-19.500	-169.000	230	7.6
1917	05	01	18:26	-29.000	-177.000	0	8.0
1917	06	26	05:49	-15.500	-173.000	0	8.5
1918	05	20	17:55	-28.899	-71.893	35	7.6
1918	12	04	11:47	-27.275	-73.464	25	7.5
1919	01	01	03:00	-19.971	-177.914	202	7.7
1919	04	30	07:17	-19.823	-172.215	35	8.2
1920	09	20	14:39	-19.919	-168.530	35	7.8
1922	10	11	14:50	-16.125	-72.385	160	7.6
1922	11	11	04:32	-28.553	-70.755	35	8.7
1928	03	16	05:01	-22.281	-170.476	35	7.5
1932	05	26	16:09	-25.399	-179.049	568	7.5
1937	04	16	03:01	-20.768	-177.144	348	7.5
1948	09	08	15:09	-21.000	-174.000	0	8.0
1950	12	09	21:38	-23.500	-67.500	100	7.7
1950	12	14	01:52	-19.250	-175.750	200	7.5
1955	02	27	20:43	-28.406	-175.379	17.9	7.8
1959	06	14	00:12	-20.369	-68.881	111	7.5
1959	09	14	14:09	-28.722	-177.079	35	7.8
1960	01	13	15:40	-15.814	-72.788	95.4	7.5
1962	04	26	07:26	-17.873	-176.883	551	7.5
1962	05	21	21:15	-19.962	-177.272	416	7.5
1963	12	18	00:30	-24.776	-176.520	35	7.7
1965	08	11	22:31	-15.797	-167.268	45.8	7.6
1966	12	28	08:18	-25.502	-70.655	30	7.7
1975	12	26	15:56	-16.241	-172.364	15	7.7
1976	01	14	15:56	-29.213	-177.638	43.7	7.8
1976	01	14	16:47	-29.172	-177.316	31.7	7.9
1976	11	30	00:41	-20.472	-68.893	133	7.6
1977	08	22	12:08	-22.912	-175.744	65.5	8.1
1980	04	13	18:04	-23.593	-177.225	148	7.6
1980	10	25	11:00	-21.941	-170.056	39	7.5
1981	07	06	03:08	-22.251	-171.814	30	7.6
1982	12	19	17:43	-24.193	-175.575	31.6	7.5
1983	10	04	18:52	-26.539	-70.503	24.5	7.7
1986	10	20	06:46	-28.150	-176.291	26.7	7.7
1987	03	05	09:17	-24.395	-70.102	45.3	7.6
1989	03	03	12:16	-21.956	-175.171	35.5	7.6
1994	03	09	23:28	-17.950	-178.417	563	7.6
1995	05	16	20:12	-22.968	-169.945	23.6	7.7
1995	07	30	05:11	-23.285	-70.103	46	8.0
1997	10	14	09:53	-22.271	-176.672	169	7.7
1998	01	04	06:11	-22.239	-171.017	97.1	7.5
2001	06	23	20:33	-16.305	-73.550	29.8	8.4
2001	07	07	09:38	-17.522	-71.938	17.4	7.6
2002	08	19	11:01	-21.696	-179.514	152	7.8
2002	08	19	11:08	-23.884	-178.495	675	7.7
2005	06	13	22:44	-19.987	-69.197	115	7.8
2006	06	03	15:26	-20.187	-174.123	55	8.0
2007	11	14	15:40	-22.247	-69.890	40	7.7
2007	12	09	07:28	-25.996	-177.514	152	7.8
2009	03	19	18:17	-23.046	-174.659	34	7.6
2009	09	29	17:48	-15.489	-172.095	18	8.1
2011	07	06	19:03	-29.539	-176.340	17	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)
 EHB catalog (Engdahl et al., 1998)
 HDF (unpublished earthquake catalog, Engdahl, 2003)
 Global Seismic Hazard Assessment Program

PLATE TECTONICS AND FAULT MODEL
 PB2002 (Bird, 2003)
 Ji, C., D.J. Wald, and D.V. Helwegger. Source description of the 1999 Hector Mine, California earthquake: Part I. Wavelet domain inversion theory and resolution analysis. Bull. Seism. Soc. Am., Vol 92, No. 4, pp. 1192-1207, 2002.
 DeMets, C., Gordon, R.G., Argus, D.F., 2010. Geologically current plate motions. Geophys. J. Int. 181, 1-80.

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. Geochim. Geophys. Geosyst., v. 4, no. 3, pp. 1027-80.

Engdahl, E.R., and Villaseñor, A., 2002. Global Seismicity: 1900-1999, chap. 41 of Lec. W.H.K., and others, eds., International Earthquake and Engineering Seismology, Part A: New York, N.Y., Elsevier Academic 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
 23 May 2013
<http://earthquake.usgs.gov/>
 Map not approved for release by Director USGS