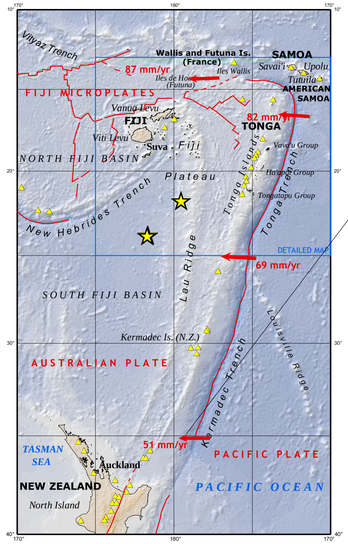
U.S. Department of the Interior
U.S. Geological Survey

Tonga - Fiji Earthquakes of 19 August 2002

Plate Tectonic Setting



Mercator Projection
Scale 1:20,000,000
Kilometers
0 100 200 400 600 800

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.

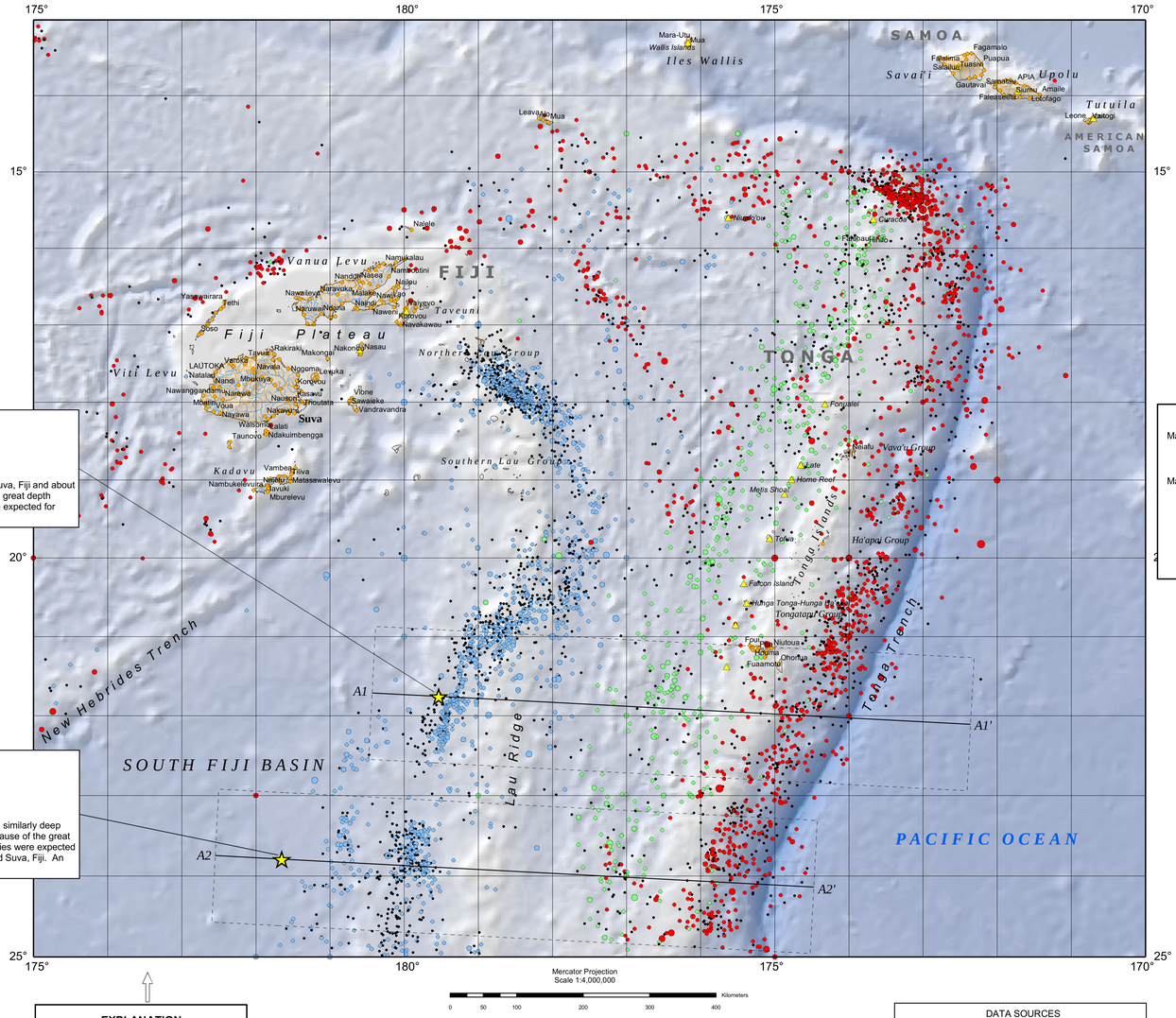
The components of the vector perpendicular and parallel to the plate margin approximate convergent/divergent and transverse direction of motion between the plates,respectively. As viewed from the rigid plate, an inward directed component suggests compression at and near the plate boundary that may be 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.

FIJI ISLANDS REGION
19 August 2002 11:01:01.74 UTC
21.694 S., 179.513 W.
578 km depth
Magnitude 7.60 MW (USGS)

This earthquake is located about 455 km SSE of Suva, Fiji and about 455 km west of Nuku'alofa, Tonga. Because of the great depth and remote location, no damage or casualties were expected for this event.

SOUTH OF FIJI ISLANDS
19 August 2002 11:08:25.48 UTC
23.876 S., 178.411 E.
694 km depth (Geophysicist)
Magnitude 7.70 MW (USGS)

This earthquake is located about 315 km SW of a similarly deep shock that occurred about 7 minutes earlier. Because of the great depth and remote location, no damage or casualties were expected for this event. Felt at Auckland, New Zealand and Suva, Fiji. An mb = 6.0 aftershock occurred at 11:23 at 681 km.



Mercator Projection
Scale 1:4,000,000
Kilometers
0 50 100 200 300 400

LARGEST EARTHQUAKES M >= 7.5
1900 - 2002

YR	MO	DY	LAT	LON	DEPTH	MAG
1901	8	9	-22.000	170.000	0	7.90
1903	1	4	-20.000	-175.000	400	7.80
1909	2	22	-18.000	-179.000	550	7.60
1913	6	26	-20.000	-174.000	0	7.70
1917	5	1	-29.000	-177.000	0	8.00
1917	6	26	-15.500	-173.000	0	8.50
1919	1	1	-19.971	-177.914	203	7.70
1919	4	30	-19.823	-172.215	35	8.20
1928	3	16	-22.281	170.476	35	7.50
1931	2	2	-39.772	176.025	35	7.70
1932	5	26	-25.399	179.049	569	7.50
1937	4	16	-20.768	-177.144	349	7.50
1948	9	8	-21.000	-174.000	0	8.00
1950	12	14	-19.250	-175.750	200	7.50
1955	2	27	-28.406	-175.370	18	7.80
1957	4	14	-15.403	-173.129	35	7.50
1959	9	14	-28.722	-177.079	35	7.80
1962	4	26	-17.873	-178.683	552	7.50
1962	5	21	-19.962	-177.272	416	7.50
1963	12	18	-24.776	-176.520	35	7.70
1975	12	26	-16.241	-172.364	15	7.70
1976	1	14	-29.172	-177.316	32	7.90
1976	1	14	-29.213	-177.638	44	7.80
1977	6	22	-22.912	-175.744	66	8.10
1980	4	13	-23.593	-177.225	148	7.60
1980	10	25	-21.941	170.056	39	7.50
1981	7	6	-22.251	171.814	30	7.60
1981	9	1	-15.112	-173.019	14	7.50
1982	12	19	-24.193	-175.575	32	7.50
1986	10	20	-28.159	-176.291	27	7.70
1990	3	3	-21.945	175.259	33	7.60
1994	3	9	-17.972	178.356	565	7.60
1997	10	14	-22.258	-176.628	165	7.70
1998	1	4	-22.239	171.017	97	7.50
2000	2	25	-19.528	173.818	33	7.50
2002	8	19	-21.694	-179.513	578	7.60
2002	8	19	-23.791	178.349	693	7.70

EXPLANATION

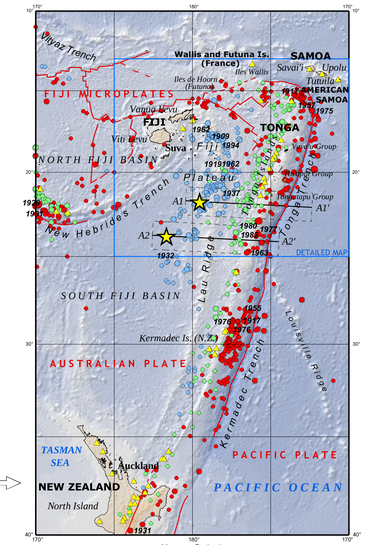
Main Shocks
- 19 August 2002

Magnitude
- 6.0 - 7.0
- 7.0 - 8.0
- M >= 8.0

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

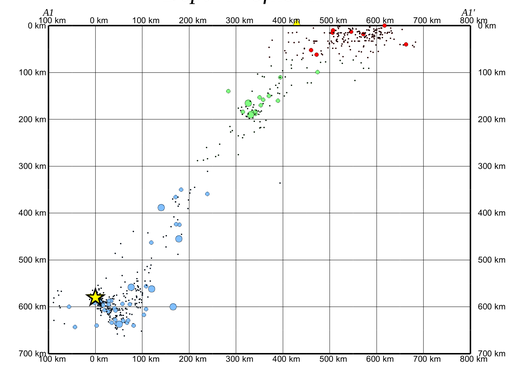
Volcanoes
Plate Boundaries

Large Earthquakes 1900 - 2002

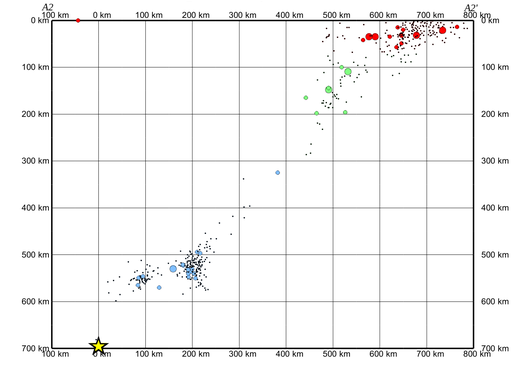


Mercator Projection
Scale 1:20,000,000
Kilometers
0 100 200 400 600 800

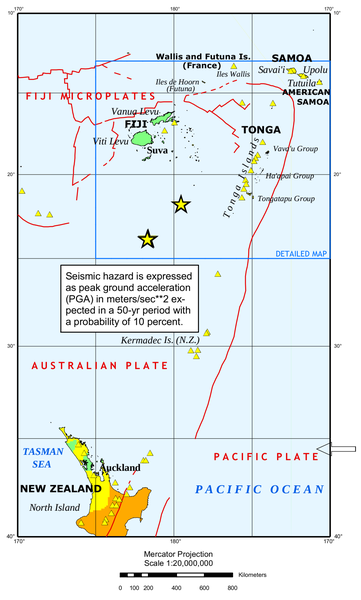
Depth Profile A1 - A1'



Depth Profile A2 - A2'



Seismic Hazard



Mercator Projection
Scale 1:20,000,000
Kilometers
0 100 200 400 600 800

EXPLANATION
Peak Ground Acceleration
- 0.4 - 0.8 m/sec**2
- 0.8 - 1.6
- 1.6 - 3.2
- 3.2 - 4.7

Main Shocks
Volcanoes
Plate Boundaries

EXPLANATION
Main Shocks
- 19 August 2002

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

Volcanoes
- Tofua

Magnitude
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- M > 8.0

Populated Places
- Ohonua

DISCUSSION

On 19 August 2002, two extraordinary and large earthquakes occurred in an isolated portion of the Pacific Ocean between the Fiji Islands and North Island, New Zealand. Neither event was damaging or caused casualties and only the second shock was felt, in the distant cities of Auckland, New Zealand and Suva, Fiji. The pair of shocks is interesting because they occurred within 7 minutes and 315 km of each other, had large magnitudes (Mw = 7.60 and 7.70, respectively), and were at great depth (578 km and 694 km, respectively). Very large earthquakes are commonplace in this area of the Pacific (35 other shocks greater than magnitude 7.5 since 1900) and deep - focus earthquakes (depth greater than 300 km) are plentiful. What is unusual about this pair of shocks is the near coincidence in both time and space at the extreme lower depth limit of global earthquakes.

The earthquakes occurred in the Tonga Fiji seismic zone, one of the most active on Earth. Earthquakes occur here because of the interaction of two tectonic plates (the Australian Plate and the Pacific Plate), both composed of relatively cold and rigid lithosphere (thin oceanic crust and uppermost mantle), moving towards one another at a rate of between 50 and 90 mm/yr. At the zone of contact, the cold Pacific Plate slides (subducts) under the overlying Australian Plate and sinks into the hotter upper mantle. Where the rigid plates are in contact, a deep trench or trough forms (the Tonga Trench) and (often) large and numerous shallow - focus earthquakes occur, typically of the thrust mechanism type expected in this zone of strong horizontal compression and brittle deformation. As the subducting plate continues to plunge to greater depths, earthquakes within the relatively cold slab indicate strain release. The inclined pattern of earthquake foci from shallow (typically 0 km to 70 km) to intermediate (70 km – 300 km) and deep depths (greater than 300 km) is called the Wadati – Benioff zone. Volcanoes are frequently found above the Wadati – Benioff zone at 50 to 70 km depth.

Relative to the Australian Plate, the westerly - moving Pacific Plate converges on the Tonga Trench at a rate of about 75 mm/yr and plunges into the upper mantle at an angle of about 45 to 50 deg. The first 19 August main shock is located in a cloud of deep - focus activity near the bottom of this portion of the Pacific Plate. The second main shock is located at the greatest depth of the Wadati – Benioff zone. Furthermore, the computed depth of 694 km is based upon an excellent and large set of observations of "depth phases", characteristic signatures of seismic waves reflected off the underside of Earth's surface. Thus, the depth of the second main shock is nearly at a record value for the global catalog of historical and recent seismic activity.

DATA SOURCES

EARTHQUAKES AND SEISMIC HAZARD
USGS, National Earthquake Information Center
IASPEI, Centennial Catalog (1900 - 1999)
Handbook of Seismology and Earthquake Engineering
Global Seismic Hazard Assessment Program

PLATE TECTONICS
Smithsonian Institution, Global Volcano Program
University of Texas

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

Map prepared by U.S. Geological Survey
National Earthquake Information Center
10 July 2003
Approved for Release by Director xx xxxxxx, 2002

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.