APIA OBSERVATORY,

SAMOA.

REPORT FOR 1921.

WELLINGTON.
BY AUTHORITY: W. A. G. SKINNER, GOVERNMENT PRINTER
—
1923.

CONTENTS.

EDITORIAL NOTE.

THE Apia Observatory was founded in 1902 by the Royal Society of Sciences of Göttingen, originally for a period of three years, and later as a permanent institution. Its principal functions relate to terrestrial magnetism, seismology, and meteorology,* and the observations and results were published generally in the *Göttinger Nachrichten*. When Samoa was occupied by the New Zealand troops in 1914 the Observatory was taken over by the New Zealand Government, and during the military occupancy it continued to be carried on by the Director, Dr. G. Angenheister, with a staff of assistants. At the close of the war the British, Australian, and Canadian Governments were invited to contribute with a view to maintaining the Observatory as efficiently as during the Göttingen regime. When these negotiations fell through and it was considered that the Observatory would have to be partially closed, timely help was received from the Carnegie Institution of Washington. It is now being carried on under the control of the New Zealand Government, with the counsel of an Honorary Board of Advice, and at the joint cost of the New Zealand Government and the Carnegie Institution, assisted by an annual grant from the British Admiralty.

In July, 1920, Mr. C. J. Westland, F.R.A.S., was appointed Acting-Director by the New Zealand Government, and proceeded to Samoa to take charge. At the same time the Carnegie Institution sent Dr. H. M. W. Edmonds to undertake observations and investigations on their behalf. Dr. Edmonds was succeeded early in 1922 by Mr. Andrew Thomson, and in December, 1922, the latter was given the appointment of Acting-Director with Mr. Westland as Assistant, the staff being completed by three Samoan clerks.

This, the first report under the present administration, deals with the year 1921. The Magnetic Report was prepared by Mr. Westland, and has had the benefit of his revisal of the proof-sheets.

As appendices are added English abstracts of certain papers by Dr. Angenheister, which have appeared in full elsewhere.

D. M. Y. S.

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* For a more detailed description of the Observatory and its functions reference may be made to an article "The Samoan Observatory," by Dr. C. E. Adams and Professor E. Marsden, *N.Z. Jour. Sci. and Tech.*, vol. 3 (1920), 157–161.

SEISMOLOGICAL REPORT, 1921.

LIST OF THE MOST IMPORTANT EARTHQUAKES REGISTERED AT THE OBSERVATORY, APIA, SAMOA, FROM 1913 TO 1920.

By Dr. G. Angenheister.

Position of Observatory.—13° 48′ 26″ S., 171° 46′ 30″ W.; height, 2 m.

The following list contains the date and time of occurrence at the epicentre; the longitude, latitude, and geographical name of the epicentre; the times of arrival of the first (P) and second (S) preliminary tremors at Apia, the distance of the epicentre from Apia, and the maximum displacement of the ground at Apia in mikrons for the N.–S., E.–W., and vertical components.

For some of these ninety-three earthquakes other observatories have already calculated the epicentre and time of origin: among these are Shide, De Bilt, Sydney, &c. Most of these epicentres have been more or less corrected to agree with the observations of the Samoa Observatory and other later published observations. For a few of the very near earthquakes it was necessary to rely on one station (Apia) only, as there were no records from other stations available. In this case the azimuth of the epicentre is taken from comparison of the N.–S., E.–W., and vertical components of the very first movement of the ground; and the distance is determined from the difference in time of the arrival of the P and S waves. This method has been carefully tested on Tonga earthquakes, as referred to elsewhere.

No.	Date.	Place.	Latitude.	Longitude.	Δ	Time at Origin.	P.	S.	Amplitude.		
									AE.	AN.	AV.
	1913.					h. m. s.	h. m. s.	h. m. s.	μ	μ	μ
1	Mar. 14	Mindanao Island	6° N.	125° E.	68°	8 44 30	8 55 46	9 4 35	250	250	..
2	May 30	Solomon Islands	5° S.	155° E.	37°	11 46 47	11 54 17	..	300	130	..
3	June 26	Tonga	21° S.	174° W.	8°	4 57 3	4 58 49	5 0 11	>400	>400	..
4	Aug. 6	Peru	16° S.	73° W.	97°	22 14 25	22 28 18	22 38 30	300	150	..
5	Sept. 3	Solomon Islands	6·5° S.	153·5° E.	35°	20 51 10	20 58 18	21 3 48	150	80	..
6	Nov. 10	New Hebrides	18° S.	170° E.	..	21 12 10	..	..	..	..	..
	1914.										
7	April 11	New Hebrides	16° S.	168° E.	20°	16 22 30	..	..	..	..	..
8	May 26	New Guinea	0·3° S.	133·8° E.	52°	14 22 40	14 32 4	14 40 6	200	170	200
9	June 26	Sumatra	5° S.	99° E.	90°	19 6 44	19 19 58	19 30 34	250	290	..
10	June 26	New Hebrides	13° S.	167° E.	21°	4 50 8	4 55 4	4 58 47	380	360	80
11	Oct. 6	S.W. from Kermadec	32·5° S.	178° E.	21°	19 16 3	19 21 18	19 25 52	30	30	10
12	Oct. 28	New Zealand	41° S.	179° E.	28°	0 16 1	0 22 10	..	10	10	16
13	Nov. 22	New Zealand	37° S.	177° E.	26·5°	8 13 40	8 19 38	8 25 33	124	110	..
14	Nov. 24	Guam	21°N.	142° E.	57°	11 52 55	12 2 54	12 10 31	240	170	..
15	Dec. 20	Tonga	16·5° S.	173·5° W.	3·1°	14 8 43	14 9 35	14 10 19	>300	>300	750
	1915.										
16	Jan. 5	New Hebrides	17° S.	169° E.	19·5°	14 33 6	14 37 40	14 41 17	165	75	160
17	Jan. 5	Formosa	23° N.	121° E.	75·5°	23 25 58	23 38 1	23 47 21	58	57	38
18	Feb. 25	Fiji	21° S.	179° E.	10°	20 36 8	20 38 24	20 40 12	128	138	122
19	May 1	Kurile Islands	49° N.	154° E.	69·8°	4 59 55	5 11 16	5 20 9	650	1760	750
20	May 3	New Guinea	4° S.	136° E.	53·5°	4 1 47	4 11 21	4 19 12	81	85	55
21	June 6	Tonga	16·5° S.	174° W.	3·2°	7 6 49	7 7 38	7 8 1	70	208	150
22	June 6	Chile	19° S.	69° W.	100°	21 28 46	21 42 52	21 53 19	170	110	60
23	July 21	Tonga	15° S.	174° W.	2·9°	21 32 33	21 33 18	21 33 38	>500	>500	100
24	July 22	Tonga	16° S.	173·7° W.	2·8°	15 24 41	15 25 25	15 25 43	>400	>400	?
25	July 31	Kamchatka	55° N.	162° E.	71·8°	1 31 14	1 42 49	1 52 4	103	360	150
26	Sept. 6	Tonga	17·2° S.	173·5° W.	3·6°	17 25 13	17 26 8	17 26 38	>250	>250	..
27	Sept. 7	Central America	14° N.	90° W.	88°	1 20 37	1 33 21	1 44 6	400	160	..
28	Oct. 3	California	36° N.	118° W.	72°	6 52 49	7 4 53	0 14 0	40	60	..
29	Nov. 1	Japan	40°N.	142° E.	68·5°	7 23 48	..	..	200	480	80

	1916.																
30	Jan.	1	New Britain	3° S.	152° E.	35·8°	13	20	2	13	27	31	13	33	30	800	900	1000
31	Jan.	13	New Guinea	3° S.	138° E.	52°	6	18	21	6	27	52	6	35	0	160	150	80
32	Jan.	13	New Guinea	3° S.	138° E.	52°	8	20	36	8	30	12	8	37	58	1000	1500	1250
33	Jan.	26	Fiji	18° S.	179° W.	8·5°	12	25	14	12	27	9	12	28	36	280	340	..
34	Jan.	30	Fiji	19° S.	178° W.	7·5°	20	36	8	20	37	48	20	39	0	200	400	360
35	Feb.	27	Nicaragua	85° W.	10° N.	92·5°	20	20	48	20	34	0	20	44	22	240	100	150
36	June	13	.. ..	..	..	3·1°	21	42	25	21	43	12	21	43	34	>460	>460	32
37	June	21	Brazil	17° S.	57° W.	111°	21	32	33	..			..			..	..	..
38	Aug.	3	New Guinea	4° S.	144·5° E.	44·5°	1	30	0	1	37	50	1	43	34	85	170	50
39	Aug.	30	Keppel Island	15° S.	174° W.	2·9°	15	4	25	15	5	10	15	5	30	>490	400	530
40	Oct.	1	Keppel Island	16° S.	173° W.	3·3°	2	13	51	2	14	42	2	15	6	290	270	100
41	Oct.	3	Peru	14° S.	74·5° W.	98°	1	26	13	1	39	24	1	50	11	110	45	..
42	Oct.	11	Tonga	15° S.	175° W.	2·9°	18	5	30	18	6	18	18	6	38	>320	>490	650
43	Oct.	20	Tonga	16° S.	173° W.	2·8°	17	4	37	17	5	6	17	5	18	>1000	>200	320
44	Oct.	20	Tonga	16° S.	173·5° W.	3·4°	19	31	17	19	32	8	19	32	43	>850	>100	340
45	Oct.	31	S. from Kamchatka	46·5° N.	160° E.	62·5°	15	30	33	..			15	51	24	51	66	..
46	Nov.	18	Tonga	16·5° S.	173° W.	4·2°	11	35	26	11	36	37	11	37	11	>700	>750	140
47	Dec.	2	Samoa	14° S.	172·5° W.	1°	22	54	1	22	54	16	22	54	20	260	250	70
	1917.																	
48	Jan.	30	E. from Kamchatka ..	56° N.	167° E.	72·5°	2	45	20	2	57	0	3	6	36	400	1800	400
49	Jan.	31	Celebes	6° N.	125° E.	67°	4	0	0	4	10	56	4	19	37	55	55	..
50	May	1	Kermadec	26·5° S.	177·5° W.	14°	18	26	45	18	30	19	18	33	18	>1500	>1500	1000
51	May	18	Samoa	15° S.	173° W.	1·5°	18	26	25	19	5	46	19	6	3	>404	>400	75
52	May	23	Tonga	17° S.	173° W.	4°	21	38	52	21	39	49	21	40	24	600	>450	100
53	May	31	Aleutian Islands	54° N.	160° W.	70°	8	47	30	8	58	40	9	7	49	400	470	90
54	June	7	Tonga	17° S.	173° W.	4°	19	24	30	19	25	28	19	26	0	360	460	115
55	June	13	Kermadec	28° S.	178° W.	15·5°	6	42	0	6	45	43	6	48	36	320	240	240
56	June	24	.. ..	..	..	6°	19	49	29	19	50	47	19	51	47	250	250	90
57	June	26	Keppel Island	16° S.	173° W.	2·5°	5	49	23	5	50	8	5	50	24	5000	5000	5000
58	June	28	Keppel Island	16° S.	173·5° W.	2·9°	13	54	46	13	55	31	13	55	51	390	450	270
59	July	11	Samoa	14·5° S.	173° W.	1·4°	22	41	43	22	42	5	22	42	23	700	700	500
60	July	25	Keppel Island	16° S.	173·5° W.	3.0°	6	47	41	6	48	28	6	48	50	360	540	200
61	Aug.	5	New Zealand	40° S.	175° E.	30°	15	50	0	15	56	27	6	2	0	35	30	30
62	Aug.	5	Keppel Island	16° S.	173·5° W.	3°	19	26	16	19	26	59	19	27	23	600	450	300
63	Nov.	16	Kermadec	29·8° S.	178·7° W.	17·2	3	19	28	3	23	28	3	26	36	240	320	700

No.	Date.	Place.	Latitude.	Longitude.	Δ	Time at Origin.	P.	S.	Amplitude.		
									AE.	AS.	AV.
	1918.					h. m. s.	h. m. s.	h. m. s.	μ	μ	μ
64	Jan. 12	Keppel Island	16° S.	173·5° W.	3·2°	18 40 31	18 41 21	18 41 46	400	600	300
65	Feb. 19	..	..	.	..	..	16 24 17	16 29 30	50	30	..
66	April 19	..	..	.	..	.	6 0 2	6 4 18	70	35	12
67	May 20	..	..	.	..	.	14 59 45	..	60	100	..
68	May 23	Mexico	26° N.	108° W.	74½°	11 57 10	12 18 ..	12 27 30	80	100	..
69	June 4	Fiji	16° S.	180° W.	8°	17 11 46	17 13 34	17 15 0	280	300	500
70	July 3	Bismarck Archipelago .	3° S.	149° E.	41°	6 52 10	7 0 20	7 6 40	100	95	125
71	July 21	Bismarck Archipelago ..	5° S.	153° E.	37°	6 8 50	6 16 8	6 22 ..	240	340	200
72	Aug. 15	Celebes	4·5° N.	125° E.	65·5°	12 17 57	12 29 7	12 38 9	1200	1200	1400
73	Aug. 23	Santa Cruz	9·5° S.	163° E.	26°	6 35 17	6 41 42	6 46 46	1100	600	420
74	Sept. 7	Kurile Islands	45·5° N.	152·5° E.	68°	17 16 3	17 27 26	17 36 17	6900	6000	2000
75	Sept. 30	E. from New Caledonia ..	23° S.	171° E.	18·5°	17 51 30	17 56 1	17 59 28	120	110	..
76	Nov. 8	Kurile Islands	47° N.	152·5° E.	70°	4 37 37	4 49 5	4 58 0	500	400	..
77	Nov. 18	Timor	7½° S.	131½° E.	58°	18 41 15	18 51 37	18 59 0	150	240	..
78	Dec. 4	Chile	27° S.	71° W.	96°	11 47 28	12 1 23	12 11 54	350	250	..
	1919.										
79	Jan. 1	..	..	..	..	..	3 44 24	3 53 0	75	70	..
80	Mar. 1	Tonga	17° S.	173·5° W.	3·8°	3 1 21	3 2 5	3 2 35	>500	>420	280
81	April 17	Kermadec	30° S.	178° W.	18°	11 22 9	11 26 14	11 29 36	300	360	300
82	April 30	Tonga	19·5° S.	173° W.	6°	7 16 48	7 18 12	7 19 12	>500	>500	1000
83	May 2	..	..	..	6°	2 7 12	2 8 30	2 9 27	500	500	450
84	May 6	Solomon Islands	6° S.	153° E.	36°	19 40 42	19 48 20	19 54 6	1300	1400	1500
85	Aug. 31	Solomon Islands	..	..	26°	17 19 23	17 25 8	17 29 35	1100	300	700
86	Oct. 3	Fiji	16½° S.	180° W.	14½°	9 37 21	9 39 23	9 40 59	450	400	600
87	Nov. 20	..	..	..	22°	14 11 16	14 16 9	14 20 3	120	200	..
	1920.										
88	Feb. 2	New Guinea	8° S.	152° E.	34°	11 22 26	11 29 28	11 35 0	300	.	240
89	Mar. 15	Fiji - New Hebrides ..	18° S.	174° E.	14·5°	12 3 20	12 8 30	12 11 8	640	..	140
90	Mar. 22	Fiji-Tonga	18° S.	178° W.	8°	20 1 30	20 3 19	20 4 35	530	600	50
91	Sept. 8	..	..	..	10½°	1 46 14	1 48 39	1 50 38	160	140	150
92	Sept. 20	New Hebrides	15° S.	167° E.	23°	14 38 3	14 43 30	14 47 16	1000	480	2500
93	Dec. 16	China	36° N.	108° E.	90°	12 5 59	12 19 18	12 30 6	600	800	1000

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SAMOA.

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1924.

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SEISMOLOGICAL REPORT, 1922.

A CATALOGUE OF EARTHQUAKES REGISTERED AT THE OBSERVATORY, APIA, SAMOA, DURING THE YEAR 1921.

THIS catalogue is a continuation of the one drawn up by my predecessor for the years 1913 to 1920. The numbers have been made consecutive for convenience in referring to them.

NOTES.

No. 97 was felt throughout Samoa, Toga, and islands between them; some small damage was reported from Vavau.

No. 104 was reported from New Zealand; the epicentre is probably identical with Nos. 12, 61, and others.

The following identities in the epicentres are also noticeable:—

Nos. 105, 106, 111, 114, and 115 are identical with one another and with several of the earlier numbers.

No. 94 is identical with 69 and 86.

No. 96 is identical with 20, 31, and 32.

Nos. 100, 103, and 110 are identical with one another.

No. 109 is identical with 50 and 55, and possibly with 95 and several others.

C. J. WESTLAND, Seismologist.

The Observatory, Apia, Samoa, 16th May, 1923.

No.	O		Δ	P	S	φ	λ	AE.	AN.	AV.
	d. h. m. s.		°	h. m. s.	h. m. s.	°	°	μ	μ	μ
94	Jan. 9	13 54 58	8	13 57 0	Not recd.	15 S.	180	83	118	70
95	Feb. 10	19 43 0	13	19 46 6	19 48 36	26 S	176 W	275	275	280
96	19	18 14 10	54	18 23 35	18 31 12	6 S	134 E	75	45	150
97	27	18 23 26	5	18 24 51	18 25 52	18 S	175 W	470	415	135
98	Mar. 28	7 49 37	85	8 2 13	8 12 47	14 N	91 W	105	36	..
99	30	15 2 6	59	15 12 8	Not recd.	13 S	127 E	20	20	..
100	April 1	12 0 15	25	12 5 46	12 10 36	10 S	163 E	210	45	170
101	22	6 21 22	20	6 25 59	Not recd.	16 S	167 E	12	40	30
102	May 4	21 13 10	3·2	21 13 59	21 14 38	17 S	173 W	275	350	250
103	14	20 18 21	25	20 24 ±	Not recd.	9 S	164 E	160	..	35
104	June 28	13 58 43	26	14 4 31	14 8 58	40 S	178 E	25	25	..
105	July 29	0 28 50	1·6	0 29 10	0 29 30	15 S	172 W	300	350	400
106	Sept. 2	18 33 16	1·3	18 33 33	18 33 50	15 S	172 W	100	100	30
107	11	4 1 33	75	4 13 23	4 23 12	12 S	111 E	20	70	..
108	19	2 36 9	1·6	2 36 31	2 36 50	15 S	172 W	50	80	15
109	19	23 15 54	14	23 19 31	Not recd.	28 S	176 W	80	150	30
110	Oct. 15	4 57 22	25	5 2 56	Not recd.	9 S	163 E	240	350	230
111	Nov. 3	12 28 42	2	12 29·2—	12 29·7—	15 S	172 W	20	50	70
112	6		0?	16 56 10	Purely local (?)			300	400	800
113	11	18 36 44	61	18 47 ±	18 55 28	1 S	128 E	60	180	180
114	29	22 46 32	2·5	22 47 14	22 47 57	17 S	173 W	200	150	60
115	Dec. 20	14 8 17	2	14 8 48	14 9 11	15 S	172 W	30	35	..
				ADDENDA.						
101A	April 25	17 33 40	14	17 36 ±	..	27 S	179 W	250	..	170
101B	May 3	10 42 48	1·5	10 43 10	10 43 28	15 S	172 W	..	490	320
105A	July 31	23 20 15	1·3	23 30 32	23 31 2	15 S	172 W	300	350	..

APIA OBSERVATORY,

SAMOA.

REPORT FOR 1923.

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1926

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SEISMOLOGICAL REPORT, 1923.

SUMMARY OF THE MOST IMPORTANT EARTHQUAKES REGISTERED DURING THE YEAR 1923.

Date.	Character.	Phase.	Time, G.C.M.T.	Period.	Amplitude.			Remarks.
					Ae.	An.	Av.	
1923.			h. m. s.	s.				
Feb. 1	Iv	M	21 30 0	15	..	..	..	Near Aleutian Islands.
3	IIIe	PR_2	16 13 24	..	..	..	..	Early part of record not clear.
		S	17 59					
		L	32 30	18	150	200	..	ϕ 52° N.
		M	39 30	16	500	800	250	λ 162° E.
		F	18 0 0					
3	Iv	M	19 25 0	15	..	..	..	Not located.
24	Iv	e	7 56 0					
		M	8 12 0	25	..	30	..	Possibly from same epicentre as shock on Feb. 3 d. 16 h.
Mar. 2	Iv	M	17 22 0	..	..	..	..	Between Mindanao and Celebes.
May 15	Iv	e	21 29 18					
		M	21 34 0	4	600	200	60	
		F	22 14 0					
23	Iv	e	23 18 0	21	..	20	..	Off coast of Kamtskatka.
		F	23 35 0					
June 1	Iv	..	17 50 0	20	..	40	..	In Japan.
1	Iv	..	20 48 0	20	..	40	..	In Japan.
18	..	..	8 17 0	..	..	..	..	Probably from epicentre near Keppel Island.*
25	Iv	e	21 16 1					
		L	21 17 30	8	..	..	..	In Tongan Deep.
		M	21 18 0	8	16	65	1	ϕ 19° S. λ 173° W.
July 4	Iv	M	23 3 0	20	..	45	..	Not located.
13	Iv	M	11 54 0	20	..	55	..	In Japan.
22	Iv	M	14 55 0	24	..	80	..	Near Aleutian Islands.
Sept. 1	IIIv	P	3 9 44	2	..	..	1	Reported from Japan.
			12 23					
			13 23	..	..	..	..	O = 2 h. 58 m. 20 s.
			15 17					
		S	19 7	6	.	..	14	
			29 50	23	..	..	930	
		M	31 35	23	..	..	1,100	
			3 38 0	18	..	..	350	
			3 50 0	20	..	..	220	
			4 0 0	20	..	..	175	
		Fv	4 25 0					
2	IIv	M	3 23 0	25	..	..	200	In Japan.
12	Iv	e	12 43 16					
		M	12 43 54	1	..	..	20	
13	Iv	e	20 16 29					
		M	20 17 24	1	..	..	15	
19	Iv	e_1	8 23 48	1	..	..	6	
		e_2	8 24 25	1	..	..	7	
21	Iv	e	11 57 58					
		M	11 58 25	1	..	..	6	
29	Iv	e	12 16 7	.	..	..	40	
		M	12 16 25	1	..	..	120	Felt in Apia.
		F	12 25 0					

* Record lost here because instrument put out of action by violence of motion.

SUMMARY—*continued.*

Date.	Character.	Phase	Time, G.C.M.T.	Period.	Amplitude.			Remarks
					Ac.	An.	Av.	
Oct. 30	Iv	P	16 19 17	1	3	7	32	Probably near Keppel Island.
		M	16 19 40	1	40	25	60	Felt in Apia
		F	16 26 0					
Nov. 2	IIIe	e	21 14 59	1	2			
		iP	21 15 42	2	16	6	2	Distance 34°.
			16 57	2	8	9	1	O = 21 h. 8 m. 42 s.
			17 36	2	15	10	..	ϕ 6° S.
		PS	20 8	5	12	..	..	λ 156° E.
		S	21 18	9	13	10		
		L	23 18					
		M_1	21 26 0	20	590	800	350	
		M_2	21 30 0	14	280	480	280	
		F	22 20 0					
3	Iu	M	16 56 0	20	5	65	..	At sea, south of Japan.
4	IIe	eP	0 11 36	3	2	7	1	
		S	17 13	11	4	6	..	Distance 34°.
		L	19 53	20	65	105	..	Probably from same epicentre as shock on Nov. 2.
		M_1	21 30	22	70	150		
		M_2	24 30	22	..	..	105	
		F	0 55 0					
5	Iu	e	21 44 0	4	1	3		
		e	21 51 0	16	..	15	..	At sea, south-west of Japan.
		e	22 2 0	22	3	70		
		F	22 30 0					
10	..	e	21 27 0	1	3	..	2	Not located.
		e	21 36 0	12 ?	..	7		
16	Iv	P	18 32 48	1	5	9	6	Dist. 5½°. Azim. 30° south-west. In Tongan Deep.
		L	34 16	8	80	50		
		M	34 50	7	100	70	..	ϕ 19° S. λ 173° W.
17	Iv	P	2 0 55	1	5	3	5	
			2 1 44	4	18	10	16	

EPICENTRES OF EARTHQUAKES REGISTERED AT APIA DURING 1922.

No.	O.				D.	P.	S.	Lat.	Long.	Ac.	An.	Av.
		d.	h.	m.	s.	°	h. m. s.	h. m. s.	°	°			
119	Jan.	1	19	47	45	1·5	19 48 6	..	15 S	172 W	300	300	300
120		31	13	17	17	71	13 28 34	13 37 51	43 N	126 W	200	150	.
121	April	25	21	18	4	26	21 23 50	21 28 10	26 S	168 E	20	..	60
122		25	21	38	37	26	21 44 23	21 49 0	26 S	168 E	30	20	60
123	May	12	18	39	28	19	18 43 55	18 47 24	24 S	172 E	28	40	..
124	Nov.	11	4	32	53	91	4 45 59	4 57 3	29 S	73 W	490	250	800
125	Dec.	25	3	33	20	32	3 40 0	..	43 S	174 E	20	25	..

No. 120 reported from several places on coast of California ; No. 124 reported from Chile ; No. 125 reported from New Zealand.

APIA OBSERVATORY,

SAMOA.

REPORT FOR 1924.

WELLINGTON.

BY AUTHORITY: W. A. G. SKINNER, GOVERNMENT PRINTER.

1927.

FOREWORD.

THE report comprises the magnetic and meteorological data obtained at the Apia Observatory during 1924. The seismological report has been printed separately. Investigators interested in the meteorological data of earlier years will find useful a "Summary of the Meteorological Observations from 1890–1919," by G. Angenheister, edited by E. Marsden and D. M. Y. Sommerville. Observations from 1921 to 1923 have been included in the annual reports of the Observatory.

The Observatory is located on Mulinu'u Peninsula, 1 km. west of the Town of Apia. Its general conditions closely approximate to those of a point with the same geographical position on the open sea. The grounds are about 2 m. above mean sea-level, and are almost entirely surrounded by a lagoon. There is an open exposure to winds from the north, but a mountain-range in the centre of the island (Upolu) deflects the south-east trade-winds so that they are felt as east and north-east winds.

The aerological programme of the Observatory initiated in 1923 was carried on successfully during 1924. Fifty-nine pilot-balloon flights were made on international days and on other favourable occasions. Fourteen balloons were observed to a computed altitude of 10 km. or higher.

A pyrheliometer consisting of an eighty-element Moll thermopile and a Richard recording millivoltmeter was set up in December. A description of the instrument is given in the *Monthly Weather Review*, June, 1924, vol. 52, No. 6, p. 299.

A tide-gauge was installed at the lagoon atmospheric electric station in May, and from June 1 to December 31 practically continuous records were obtained.

The Observatory was the co-ordinating centre for the wireless weather-reporting system in the South Pacific. The Apia wireless station received reports from Avarua, Rarotonga; Nukualofa, Tonga; Suva, Fiji; Vila, New Hebrides; and Norfolk Island. In the case of storms which threatened the Fiji Group warning messages were sent out independently by Captain Twentyman, of Suva. No destructive cyclones occurred in the tropical South Pacific during 1924. Efforts were made to increase the general accuracy at all stations. In the present report summaries of rainfall data are given. In the 1925 report more complete data will be furnished of these stations. It is hoped that eventually annual reports will contain fairly complete summaries of representative stations in the tropical South Pacific Ocean.

APIA OBSERVATORY,

APIA, WESTERN SAMOA.

Lat. 13° 48·4′ S.; long. 171° 46·5′ W.

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SEISMOLOGICAL REPORT FOR 1925.

The Apia Observatory is equipped with a 1000 kgm. horizontal seismograph and a 180 kgm. vertical seismograph, both of Wiechert design. These instruments are mounted on concrete platforms in the main building above a stratum of coral sand, which is at least 10 m. thick. The chief details of the more notable earthquakes registered during 1925 are summarized in the accompanying table.

Table 73.—Earthquakes, 1925.

1925.	P.	S.	L.	Maxima. AE.	Maxima. AN.	Maxima. AV.	Dist.	Epicentre.
	h. m. s.	h. m. s.	h. m. s.				°	
Jan. 18	12 17 14	12 26 3	12 36 40	..	300	..	66	Near Kurile Is.
23	17 1 54	..	17 2 11	?	?	..	1⅛	15° S., 172° W.
Feb. 9	14 14 16	..	14 17 43	75	80	2	14	23° S., 174° E.
13	13 53 6	13 55 41	13 56 40	16	15	..	14	27° S., 178° W.
24	0 5 43	..	0 29 48	12	27	..	73	Alaska.
Mar. 22	8 46 23	..	8 51 0	630	480	300	18	18° S., 170° E.
April 5	21 2 11	21 3 21	..	?	?	390	6	19° S., 173° W.
June 3	4 44 33	4 53 46	5 6 46	30	26	..	68	Near Celebes.
9	13 49 40	13 56 47	14 6 0	36	26	3	49	2° S., 142° E.
28	1 33 37?	..	2 2 0	5	8	..	84	Montana, U.S.A.
30	3 44 22	..	3 45 0	320	290	200	1½	15° S., 172° W.
July 4	9 16 48	..	9 26 30	15	2	..	34	Near Solomon Is.
Aug. 19	..	12 27 40	12 40 22	25	45	..	62	54° N., 167° E.
27	23 19 10	..	23 19 35	40	75	50	2	16° S., 173° W.
28	1 39 7	..	1 39 34	25	35	18	2	16° S., 173° W.
Sept. 11	3 33 23	..	3 33 39	180	150	130	1¾	15° S., 172° W.
11	3 38 57	..	3 39 17	90	105	80	1¾	15° S., 172° W.
Oct. 15	1 22 33	1 22 52	1 23 0	?	?	120	1½	15° S., 172° W.
15	1 33 11	..	1 34 2	130	140	60	1½	15° S., 172° W.
30	14 48 1	..	14 55 25	25	16	..	27	South of Solomon Is.
Nov. 10	14 0 44	14 8 52	14 18 13	400	235	130	59	2° S., 129° E.
13	12 25 55	12 34 51	12 46 30	230	270	90	67	13° N., 127° E.
28	16 18 5	16 22 9	16 23 15	330	700	90	22	17° S., 164° E.
Dec. 11	19 48 26	19 48 53	19 49 6	80	40	18	2	16° S., 173° W.

TIDAL HARMONIC CONSTANTS.

A tide-gauge (No. 11664–1923, Bausch and Lomb Optical Co.) was loaned in 1924 to the Apia Observatory by the Department Terrestrial Magnetism, Carnegie Institution of Washington. The gauge was installed in the lagoon station to determine the effect, if any, that the rise and fall of the tide had on the observed atmospheric potential. Apart from this investigation, the hourly heights of the tide were scaled and recorded on the routine forms of the Tide Division of the United States Coast and Geodetic Survey. The Director of the U.S. Coast and Geodetic Survey subsequently had the computations carried out and a complete determination made of the tidal harmonic constants. Through his courtesy the results of the tidal analysis are herewith published.

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APIA, WESTERN SAMOA.

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SEISMOLOGICAL REPORT FOR THE YEAR 1926.

The instruments installed at this Observatory are (1) a Wiechert horizontal seismograph with mass 1,000 kg., and (2) a Wiechert vertical seismograph with mass 180 kg. Both of these have been registering continuously during 1926, except during an interruption from September 14 to 30.

The list given herewith is an attempt to locate the epicentres of thirty-two of the more important earthquakes, of which three are within 1,000 miles of Apia. Between fifty and sixty shocks have been registered at distances varying from about 100 to 800 miles, but all of these are small. Local earthquakes have also been small and infrequent. Sixteen local shocks are known to have been felt, and the largest of these, on March 16, was of intensity 4 R.F. Twenty-four others show movement large enough to render it possible that they may have been felt, but no report as to any of them having actually been noticed has been received. There are 143 very feeble motions, most of them of amplitude not greater than that of the microseisms, and only to be distinguished from the microseisms themselves by the rapidity of the motion.

The usual quarterly seismological reports were published during the year.

Table XXII.—Seismological Summary, 1926.

	O.				P, or according to Note.			S.			L.			d.	Notes.
	d.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	°	
Jan.	5	7	27	39	7	32	46	7	36	51	7	38	0	22	Between Solomon Islands and New Caledonia.
	25	0	37	32	0	42	30	0	46	27	0	49	0	22	12° S., 166° E.
	26	7	4	27	7	9	10	7	12	56	7	14	18	21	Apparently a repetition of the last.
Feb.	3	11	51	14	11	56	50	12	1	12	12	3	0	25	At sea, south-west of New Caledonia.
	8	15	17	20	..			..			15	57	20	87	Costa Rica. Record not clear.
	15	2	59	35	..			..			3	39	0	88	Nicaragua. Record not clear.
Mar.	17	11	53	40	..			..			12	40	0	97	Off coast of Columbia.
	18	14	5	52	14	26	5	..			14	59	20	150	The first wave may be |P|.
											15	39	40	..	The epicentre is on south coast of Asia Minor, and the two waves taken as L appear to be maxima which have come by minor and major arcs.
	22	18	29	20	18	39	34	..			18	48	40	44	The first wave = PR_1 2° S., 147° E.
	27	10	48	31	10	55	4	11	0	19	11	3	40	31	3° S., 158° E.
April	12	8	33	21	8	38	10	8	42	0	8	43	42	21	Between New Hebrides and Solomon Islands.
May	7	6	8	50	6	23	26	..			6	43	33	62	The first wave = PR_1 at sea, south of Japan.
June	3	4	47	23	4	51	28	4	54	39	4	55	20	17	New Hebrides.
	28	3	23	20	..			..			4	10	0	87	Sumatra.
	29	14	26	45	14	38	16	..			15	0	40	73	At sea, south of Japan.
July	2	6	0	22	6	3	48	6	8	28	6	8	16	14	23° S., 177° W.
	10	10	50	58	11	1	54	11	10	44	11	24	0	67	In vicinity of Celebes.
	16	2	4	20	2	12	54	..			2	22	0	45	At sea, north of New Guinea.
	28	8	51	48	8	58	39	9	4	3	9	7	20	32	6° S., 157° E.
Aug.	3	3	16	10	3	18	17	3	20	53	3	21	33	11	Probably south of Tongan Group.
	9	3	39	30	3	51	0	..			4	10	0	64	Aleutian Islands. Record not clear.
	25	5	45	41	5	48	54	5	51	24	5	52	7	13	23° S., 177° W.
Sept.	2	1	21	40	1	43	36	..			2	15	0	117	First wave = PR_1, Indian Ocean.
	10	10	34	4	10	48	25	10	53	(?)	11	16	0	72	The first wave = PR_1, Java. The record appears to be confused by another shock.
Oct.	3	19	36	42	19	45	36	19	52	37	19	57	0	48	Apparently far south, 50° S., 157° E.
	13	6	2	5	..			6	21	50	6	31	40	65	Near Aleutian Islands.
	13	14	17	43	.			14	37	45	14	48	0	68	Near Kamtschatka.
	13	19	8	8	19	18	58	..			19	35	30	66	Near Aleutian Islands.
	26	3	45	28	3	54	31	4	1	40	4	9	50	50	2° S., 140° E.
	26	6	11	30	6	20	31	6	27	56	6	35	15	50	Apparently from same epicentre as the last.
	26	14	16	12	..			14	31	54	14	42	0	47	7° N., 146° E.
Nov.	5	7	55	39	8	12	58	..			8	37	33	88	The first wave = PR_1, Nicaragua.

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APIA OBSERVATORY,

APIA, WESTERN SAMOA.

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SEISMOLOGICAL REPORT FOR 1927.

The seismographs in use during 1927 were the same as those in previous years—namely, the Wiechert astatic pendulum seismometer, with 1000 kg. mass, registering horizontal components in north-south and east-west directions, and the Wiechert vertical seismograph, with 180 kg. mass.

The following list recapitulates the more important earthquakes recorded during the year. The details given with references to the epicentres are derived from our own results in conjunction with those of other observatories which exchange seismological reports with us. Our own reports were published every three months, as usual.

Table 63.—Seismological Summary, 1927.

1927.	P.	S.	L.	N.			Dist.	Notes.
	h. m. s.	h. m. s.	h. m. s.	AE.	AN.	AV.	Deg.	
Jan. 24	1 10 15	1 14 14	1 15 55	130	450	140	22	Ambrym Is.
25	23 15 16	23 19 19	23 21 45	17	33	..	22	Repetition of the last.
26	15 41 27	15 45 19	15 46 45	11	8	..	21	Probably another repetition.
Feb. 16	1 47 6	..	2 27 51	20	50	..	67	Kurile Is.
28	..	..	14 50 0	6	13	..	92	Chile.
Mar. 3	1 16 26	..	1 41 9	7	..	..	74	Celebes.
7	9 39 20	9 48 23	10 1 2	..	..	..	70	Japan.
April 1	19 8 10	..	19 9 35	105	480	..	6	19° S., 173° W.
14	6 36 43	6 47 34	7 6 10	13	50	..	89	Chile and Argentina
27	2 53 21	2 55 17	2 55 49	10	60	..	10	19° S., 177° W.
May 22	..	22 57 47	23 14 20	..	400	..	95	China.
June 3	7 21 57	7 30 2	7 40 0	..	..	..	59	In Arafura Sea.
14	17 26 25	..	17 45 8	12	45	..	56	Very far South.
July 3	10 38 17	..	..	..	..	..	1½	Instruments put out of action.
5	7 24 32	7 25 44	7 26 0	170	260	6	6	19° S., 173° W.
19	9 10 59	9 13 31	9 13 40	20	28	..	13	Fiji.
28	16 29 11	16 38 11	16 50 20	..	25	..	68	Alaska.
Aug. 5	21 23 57	21 32 47	21 43 22	40	100	..	67	Japan.
10	11 46 12	11 54 14	12 3 22	60	65	..	58	In Benda Sea.
18	..	..	20 10 0	..	45	..	60	At sea, S.E. from Japan.
20	16 22 28	16 23 7	16 23 14	..	..	..	3	
Sept. 7	20 18 21	..	20 24 55	..	..	..	25	At sea, W. from New Hebrides.
13	..	..	23 37 0	..	..	..	140	Crimea.
30	23 53 0	23 54 34	23 55 10	70	35	..	8	Falcon Is. (?).
Oct. 24	16 12 5	16 21 39	16 36 25	..	..	..	74	59° N., 139° W.
Nov. 4	14 2 6	14 11 15	14 21 53	400	320	..	71	California.
14	..	..	5 47 0	..	..	..	97	Siberia.
14	7 33 5	7 43 55	8 2 0	40	30	..	89	Chile.
16	..	21 29 25	21 40 38	160	..	..	75	Dutch East Indies.
19	7 31 4	7 32 8	7 32 28	125	..	11	6	19° S., 173° W.
21	..	23 35 57	23 59 5	75	45	..	87	Chile.
Dec. 28	18 32 6	18 41 32	18 50 40	..	..	..	73	Kamchatka.

By Authority: W. A. G. SKINNER, Government Printer, Wellington.—1929.

APIA OBSERVATORY,

APIA, WESTERN SAMOA.

Lat. 13° 48·4′ S.; long. 171° 46·5′ W.

REPORT FOR 1928 AND 1929.

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—
1931.

Table 134.—Monthly Values, Atmospheric Electric Potential, Land Station, 1929.

Month.	Days of Character			Hours of Negative Potential.	Mean Potential Gradient.: Days of Character 0.	Number of Days used in Previous Column.
	0.	1	2.			
					V/m.	
January ..	8	18	3	38·6	114·5	2
February ..	3	20	3	49·4	128·6	1
March ..	9	16	6	44·8	110·5	9
April ..	21	8	1	14·1	110·8	18
May	13	15	3	24·3	102·7	11
June ..	19	10	1	14·0	121·4	14
July	24	7	0	9·4	125·9	16
August ..	27	4	0	2·7	111·9	19
September ..	24	6	0	7·4	123·4	19
October ..	11	16	4	37·6	103·9	9
November .	12	15	2	32·0	117·0	11
December ..	5	14	9	66·3	116·8	4
Year ..	176	149	32	340	116·6	133

SEISMOLOGICAL REPORT FOR 1928 AND 1929.

These summaries include only the larger and more important earthquakes recorded by this seismograph during the years 1928 and 1929. The information required for locating epicentres and computing times at origin has been derived from seismological publications received from other observatories.

The same instruments have been used as in previous years—namely, a Wiechert horizontal seismograph with mass 1,000 kg., and a Wiechert vertical seismograph with mass 180 kg. Several interruptions in the records have to be admitted owing to clock troubles; the longest of these were part of June and July, 1928, and from December 21 to February 9, 1929. Another breakdown in June, 1929, was partly remedied by the use of an improvised clock, but the results thus obtained left much to be desired.

The epicentres within a few hundred miles of Apia have been singularly quiet, and only small and infrequent shocks have been registered from them. Thirty-two local shocks have been felt, of which only one—on August 3, 1929—reached intensity 4 on the R.-F. scale. Fifty-nine other local shocks occurred, but were not actually reported to have been felt by any one. A total of 260 very slight movements, too small to be felt, has also been found on the records.

The usual quarterly seismological reports have been printed and published.

Table 135.—Seismological Summary, 1928.

	O.				P.			S.			L.			*d.*	Notes.
	d.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	°	
Mar.	9	18	5	20	..			..			18	54	0	100	2° S., 87° E.
	13	18	4	23	..			18	44	54	18	50	0	38	PR_1, 18 h. 40 m. 27 s. 5° S., 150° E.
	16	5	1	3	5	5	26	5	8	55	5	10	30	19	23° S., 171° E.
	18	3	3	20	3	6	49	3	10	17	3	11	48	19	Probably 23° S., 171° E.
	22	4	16	6	4	29	29	4	39	25	4	53	50	79	14° N., 95° W.
May	14	22	14	15	..			22	39	31	22	50	20	96	PR_1, 22 h. 31 m. 57 s. 5° S., 78° W.
	19	3	46	0	3	47	37	..			..			..	Confused. Felt in Lifuka, Haapai Islands, where tidal wave occurred, and pumice was deposited on beach.
	27	9	50	58	..			..			..			65	PR_1, 10 h. 4 m. 29 s. 30° N., 143° E.
June	6	19	7	47	19	10	7	19	12	18	..			10	South of Tonga.
	17	3	19	5	3	31	57	..			3	57	0	79	P. doubtful. 14° N., 96° W.
	21	10	40	4	10	42	22	10	44	14	.	.		9	18° S., 178° W.
	29	22	49	48	22	53	40	22	56	30	..			16	18° S., 173° E.
July	9	21	22	35	21	29	50	..			..			35	Not clear. Between New Guinea and Solomon Islands.
Aug.	4	18	25	54	..			..			19	2	0	78	SR_1, 18 h. 53 m. 17 s. 14° N., 98° W.
	24	21	44	8	21	48	0	20	50	59	21	52	4	16	18° S., 173° E.
Sept.	22	7	31	17	7	36	22	7	40	22	7	43	0	22	14° S., 164° E.
Oct.	9	3	1	10	3	13	46	3	24	12	3	39	40	83	15° N., 94° W.
Nov.	6	4	3	55	4	9	12	4	13	19	4	14	17	23	20° S., 167° E.
	20	20	35	20	..			20	52	10	21	20	0	90	23° S., 75° W.
	28	10	43	15	..			11	2	39	11	13	30	64	7° S., 144° E.
Dec.	1	4	6	44	4	19	32	4	30	4	1	47	30	85	35° S., 74° W.
	2	4	20	20	..			..			5	2	0	85	Weak repetition of shock on Dec. 1.
	7	9	14	15	..			..			9	46	0	63	Obscured by micros. In Banda Sea.
	12	20	19	30	20	23	9	20	26	2	..			15	27° S., 172° W.
	19	11	36	51	..			11	53	47	11	57	0	61	PR_1, 11 h. 48 m. 33 s. 7° N., 130° E. S. doubtful.

Table 136.—Seismological Summary, 1929.

	O.				P.			S.			L.			d.	Notes.
	d.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	°	
Mar.	7	1	35	1	1	45	26	1	53	50	2	4	20	62	Aleutian Islands.
	9	10	50	32	..			11	3	12	11	7	30	34	Arthur's Pass, New Zealand.
	19	20	53	30	..			..			21	23	(?)	85	13° N., 90° W.
	21	2	36	56	..			..			3	17	0	85	13° N., 90° W.
May	1	15	37	22	..			..			16	41	0	140	Near Caspian Sea.
	26	22	38	50	..			23	1	24	23	17	30	73	PR_g, 22 h. 53 m. 15 s. 54° N., 137° W.
June	16	22	47	13	22	53	51	22	59	16	..			32	New Zealand.
	27	12	47	30	..			13	10	49	13	37	0	100	PR_g, 13 h. 5 m. 51 s. South Atlantic.
	28	1	11	24	1	13	42	1	15	32	1	16	2	9	Tonga.
July	5	14	19	6	..			14	38	30	14	50	40	64	Aleutian Islands.
Sept.	17	19	17	6	19	28	34	19	38	16	19	53	0	76	53° N., 133° W.
	26	7	46	52	7	52	14	7	56	26	7	59	16	23	35° S., 178° W.
Oct.	6	7	52	12	7	59	3	8	4	49	8	9	0	34	19° N., 154° W.
	7	15	7	36	15	9	38	15	11	16	15	12	45	8	Felt at Nukualofa.
Nov.	15	18	50	43	18	59	48	19	6	42	19	14	0	47	8° N., 142° E.
	17	3	43	12	3	53	54	4	2	49	4	13	45	67	11° N., 124° E.
	18	20	32	0	..			..			21	30	12	116	Obscured by traces crossing. 46° N., 58° W.
Dec.	17	10	58	50	11	9	48	11	18	41	11	29	42	67	Aleutian Islands.

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Details of Earthquakes recorded at Apia, Samoa

1933

January 27th. O 22h 36·7m epicentre 16°S, 171°W (U.S.C.& G.S.) iP 22h 37m 35s. Pens thrown off and instrument put out of action. Felt generally in Samoa; rumbling heard. Rossi-Forel 5.

March 2nd O 17h 31·0m epicentre 39°N,144°E(U.S.C.&G.S) eP 17h 41m 57s ePP 44m 52s eS 50m 57s eSS 58m 44s eL 18h 04m M(E) 18h 06m 44s,period 8·3 seconds,amplitude 573 microns; M(Z) protracted,period 7 seconds,amplitude 169 microns. Distance 68·2 degrees. Destructive in Japan with tidal wave.

April 16th O 06h 00·0m epicentre 34°S,176°W (U.S.C.& G.S.) eP 06h 04m 36s eS 08m 18s eL 09m 39s M(E) 13½m period 12 seconds,amplitude 38 microns;distance 20·5 degrees. Early phases indistinct. North-east of New Zealand.

May 20th(i) O 04h 38·5m epicentre 19°S,171°W approx. (U.S.C.& G.S.) eP 04h 40m 05s eS 41m 20s M(E) 42·5m, period 10 seconds,amplitude 180 microns;distance 6·6 degrees. Felt in Apia,Rossi-Forel 2.

(ii) O 08h 07·1m epicentre unknown eP 08h 08m 36s eS 09m 50s M(E) 11½m period 10 seconds,amplitude 36 microns; distance 6·5 degrees.

June 18th O 03h 54·1m epicentre 15°S,172°W (U.S.C.& G.S) iP 03h 54m 21s eSg 54m 35s distance 1·2 degrees vertical record only. Felt in Apia. Rossi-Forel 2.

July 14th O 01h 39·5m epicentre Unknown iP 01h 41m 11s eS 42m 32s M(E) 42m 59s period 4 seconds,amplitude 10 microns; distance 7·2 degrees.

July 24th Seismograph out of action. U.S.C.& G.S.give O 12h 55·7m,epicentre 15°S,170°W; J.S.A.give H 12h 56m 36s,epicentre 15·2°S,174·5°W. Felt in Apia. Rossi-Forel 4-5.

August 9th O 03h 05·8m,epicentre unknown iP 03h 07m 03s eS 08m 01s distance 5·1 degrees vertical record only.

August 24th O 08h 52·8m epicentre unknown eP 08h 54m 53s S 56·6m (in time mark) distance 9 degrees.

August 28th H 22h 19m 46s epicentre 58°S,27°W(J.S.A) e 22h 47m 45s SS 52m 56s L 23h 02·1m M(E) 23h 28m 30s,

period 16 seconds, amplitude 68 microns; distance 100 degrees. Weak seismogram.

September 6th O 22h 08·5m, epicentre 22°S 179°W (U.S. C.& G.S), 24°S 178°W (J.S.A); iP 22h 10m 56s iS 12m 50s M(E) 13m 03s, period 2·7 seconds, amplitude 85 microns; M(Z) 13m 03s, period 2·5 seconds, amplitude 55 microns; distance 10·2 degrees. Pacific Ocean near Fiji Islands. Depth of focus 620 km. (U.S.C.& G.S).

November 19th O 03h 11·4m epicentre 16°S 167°E (U.S. C.& G.S) eP 03h 15m 54s eL 20·8m, period 11 seconds, amplitude(E) 88 microns; distance 19·2 degrees (from manuscript tables by C.J.Westland). Near New Hebrides.

November 22nd O 12h 42·5m epicentre 6°S 150°E (U.S. C.& G.S); 3°S 150°E (J.S.A); eP 12h 49m 33s ?ePPP 50m 19s eS 55m 13s eL 59m 33s; distance 35·8 degrees. Near New Guinea.

November 27th O 20h 24·5m epicentre unknown eP 20h 26m 08s L 27m 58s M(E) 28m 38s, period 6 seconds, amplitude 55 microns; M(N) 29m 14s, period 6 seconds, amplitude 86 microns: distance 7·1 degrees.

December 2nd O. 5h 16·3m epicentre unknown.
Note:- This is not the earthquake which was recorded by other stations for which the U.S.C.& G.S. gave the position of the epicentre as 53°S, 161°E and the time at the origin as 5h 17·2m.

December 24th O 10h 57·1m, epicentre 13½°S 170½°W iP 10h 57m 23s iL 57m 41s M(E) 57m 48s, period 3 sec., amplitude 129 microns; M(N) 58m 00s; M(Z) 58m 11s, period 1·8 seconds, amplitude 198 microns; distance 1·3 degrees. Felt generally in Samoa, Rossi-Forel 5. Initial wave condensational.

Abbreviations: U.S.C.& G.S. - United States Coast and Geodetic Survey.
J.S.A. - Jesuit Seismological Association

M(E), M(N), M(Z) refer to the maxima in the east, north and vertical components respectively

O - time at the origin

Other symbols have their usually accepted meanings.

Contents

Seismology, 1934

The present summary of earthquakes recorded at Apia during 1934 is based on the quarterly bulletins which were issued during that year. The preliminary readings contained in the quarterly bulletins have been revised where necessary after comparison with the records of other observatories.

The same instruments have been used as in previous years, namely a Wiechert 1000 kilogram horizontal seismograph for east and north components and a Wiechert 80 kilogram seismograph for the vertical component.

Epicentral distances have been deduced from the "Tables of the Times of Transmission of P and S Waves of Earthquakes" by Harold Jeffreys; but in near earthquakes where only the L - P intervals are known the table of V. Conrad has been used.

The total number of earthquakes recorded during 1934 was 200. They were distributed as follows:-

74 originated within three degrees of Apia; 9 between three and six degrees; 2 between six and nine degrees; 6 between nine and 45 degrees; 4 beyond 45 degrees.

The origins of the remaining 105 were indeterminate, many of them being very small local disturbances.

Sixteen shocks were felt by local residents. Ten were estimated to be of intensity 2 or less on the Rossi-Forel scale, three of intensity 3 and three of intensity 4.

The constants of the horizontal seismograph were as follows:-

10th March 1934

N-S	Free period 10.7 seconds; coefficient of friction (r/T^2) 0.0002 cm; damping ratio 3.5; static magnification 129
E-W	Free period 11.0; friction .0002; damping 4.0; magnification 127.

16th May 1934

N-S Period 9.7; friction .0005; damping 3.7; magnification 139
E-W Period 10.2; friction .0006; damping 5.1; magnification 138

31st July 1934

N-S Period 10.2; friction 0.0008; damping 4.3; magnification 157
E-W Unsatisfactory in respect of friction

6th November 1934

N-S Period 10.8; friction .0008; damping 4.3; magnification 172
E-W Period 9.3; friction .0006; damping 4.3; magnification 139.

1934

January

15th H = 08h 45m 16s (J.S.A.) Epicentre 25.6°N, 85.7°E (J.S.A.) ePP 09h 02m 18s o? 07m 33s iSKS 08m 30s iPS 11m 31s i? 12m 25s eSS 17m 02s iSSS 21m 30s eL 28.1m F 11h 27m 58s, period of L waves 30 seconds, amplitude 285 microns △ = 107° (from tables by J.B.Macelwane) Origin in India

18th 0 = 03h 21m 39s iP 03h 23m 21s iL 25m 08s
△ = 7.2° (vertical instrument only)

31st 0 = 10h 06m 44s Epicentre 14°S, 173°W iP 10h 07m 08s iS 27s M(Ż) 44s, period 2 seconds, amplitude (vertical) 990 microns. Distance 1.7° Felt generally in Samoa. Rossi-Forel 4. Initial wave compression. Arrival of S waves disarranged horizontal seismograph

February

14th 0 = 03h 59m 35s Epicentre 18.4°N, 119.5°E (J.S.A.) eP 04h 11m 23s iS 21m 08s eL 35m 02s period 23 seconds △ = 76°

March

15th 0 = 13h 11m 41s Epicentre 12°S, 162°E (from Wellington Observatory) iP 13h 17m 08s iS 21m 35s SS 22m 25s eL 23m 21s M(N) 25m 17s M(E) 25m 40s F 15h 06m 08s, period of L waves 14.3 seconds, distance 25.4°

24th 0 = 12h 04m 32s Epicentre 9.5°S, 161.5°E (J.S.A.) iP 12h 10m 15s iS 14m 55s, distance 27°. Solomon Islands

May

7th 0 = 22h 28m 57s iP 22h 29m 44s iS 30m 22s Δ = 3.3° M 30m 37s. Felt R.F.2. Initial wave compression

18th 0 = 23h 31m 07s Epicentre south-west of Samoa iP 23h 31m 31s iS 31m 51s Δ = 1.7° M(E) 31m 52s M(Z) 31m 58s M(N) 32m 17s, period 2 seconds. Ground movement 97 microns (N-S component). Felt R.F. 2. Initial wave dilatation

June

8th 0 = 18h 23m 15s iP 18h 23m 53s iS 24m 24s, distance 2.7°. Felt R.F.2

17th 0 = 14h 04m 18s iP 14h 04m 45s iS 05m 07s, distance 1.3°. Felt R.F.4

21st 0 = 15h 33m 30s iP 15h 33m 51s iS 34m 08s, distance 1.5°

25th 0 = 11h 05m (approximately) iP 11h 05m 44s, local distance probably less than 0.5°. Felt R.F. 3

27th 0 = 10h 41m 20s eP 10h 41m 56s iS 49s, distance 1.1°

30th 0 = 08h 05m 12s iP 08h 05m 33s iS 50s, distance 1.5°. Felt R.F. 2

30th 0 = 17h 47m 52s iP 17h 48m 15s iS 33s, distance 1.6°

30th 0 = 19h 41m 49s iP 19h 42m 09s iS 25s, distance 1.4°. Felt R.F. 3

July

18th Epicentre 8.2°N, 82.5°W (J.S.A.) O = 01h 36m 40s (S-P Jeffreys) iP 01h 49m 39s ePP 53m 37s ePPP 56m 18s iS 02h 00m 32s eSP 02h 01m 48s eSS 02h 06.9m SSS 02h 10.5m eL (Love) 02h 13m 20s eL (Rayleigh) 02h 32m F 03h 56m, distance from Apia 90.0° (S-P Jeffreys) distance to J.S.A. epicentre by computation 89.7°. Maxima occurred at 02h 23m, 02h 28m (period 15.4 seconds, amplitude 50 microns), 31m, 40m, 44m, 47m. All readings from N-S component

18th O = 19h 40m 47s (± 2½ seconds) (S-P Jeffreys) H (J.S.A.) 19h 40m 05s. Epicentre 16.8°S, 167°E (J.S.A.) iP 19h 45m 14s (both components) ePP 45m 43s (N only) eS 48m 49s (± 2½ seconds in time mark - N only) SS 49m 49s (±2½ seconds E only) L 50m 13s (?) N only, distance(S-P Jeffreys) 19.8°, distance Apia to J.S.A. epicentre (computed) 20.7°. Azimuth from traces 264° (approximately), from computation to J.S.A. epicentre 259°. Maximum amplitude about 20h 00m and approximately 600 microns (N component) E-W pen thrown off support. A slight tilting of E-W arm occurred at 19h 45m 10s but has not been regarded as a phase

August

2nd O = 10h 52m 45s, distance 2.7° eP 10h 53m 24s eS 10h 55m 55s eL 10h 54m 02s M(N) 45m, period not definite, occurs about 10h 57m. Record not very clear

14th O = 08h 48m 56s, distance 14.4°. Epicentre approximately 174°E, 19°S (based on Apia, Christchurch, Manila) iP 08h 52m 16s eS 54m 55s eL(?) 57m 00s (±2½ seconds) M 57.4m, amplitude 59 microns. All measurements from N-S component

September

8th Good trace of shock commencing at 11h 15m 35s apparent phases at 11h 15m 35s, 16m 31s, 21m 02s, 23m 02s, but shock cannot be reconciled with other stations. Maximum at 23m 24s (N), period 8.5 seconds, amplitude 81 microns F 12h 20m. Shows several maxima

10th eP 6h 32m 29s S 34m 9s L 25s M (north component) 35m 8s, period 5.5 seconds, amplitude 27 microns F 38m. Distance 8.9 degrees

September

13th P 8h 18m 22s S 19m 15s F 21m, distance 4.7°

14th P 16h 51m 33s S 54s, distance 1.8 degrees

24th e 10h 35m 7s L 36m 18s Phases not distinct. A disturbance was recorded at approximately the same time at Christchurch and at Riverview College, Sydney

26th eP 3h 15m 56s S 16m 44s, distance 4.1 degrees. Times uncertain to one second

October

5th O = 9h 7m 11s, epicentre 15°S, 172°W approximately iP 9h 7m 55s S 55s; M 58s, period 0.75 seconds, amplitude 104 microns (N-S component). Distance 1.7 degrees at azimuth of 209 degrees

10th eP 15h 44m 55s iP 59s iS 47m 6s eL 42s F 16h 13m, distance 11.2 degrees. L waves not prominent

11th eP 12h 52m 40s S 53m 8s F 55m, distance 2.5 degrees. Slight tremor

14th eP 12h 56m 11s S 29s L 33s F 15h 2m, distance 1.6 degrees, slight tremor

16th eP 6h 12m 54s S 13m 17s F 14m, distance 2.0 degrees, slight tremor

18th iP 7h 53m 28s PP 37s S 57m 14s SS 45s L 59m M 59m 48s, period 11.0 seconds amplitude 68 microns on north-south component F 8h 30m distance 20.9 degrees. Epicentre at 16°S, 170°E approximately O = 7h 48m 48s

19th (1) P 6h 43m 19s S 41s F 45m, distance 1.9 degrees, slight tremor
(2) P 12h 40m 23s S 48s F 42m, distance 2.3 degrees, slight tremor

27th e 10h 19m 19s L 21m 27s M 24m 10s, period 8.0 seconds, amplitude 25 microns on north-south component, F 11h

November

9th O = 5h 59m 1s iP 3h 59m 47s rarefaction iS 4h 0m 23s, distance 3.2 degrees at azimuth of 25 degrees from north. Epicentre at 10°54'S, 170°27'W

November

9th (contd.) approximately. The intensity of the shock at the Observatory was 3 on the Rossi-Forel scale and the pens were thrown off the instrument. A shock of smaller intensity preceded it giving a confused trace. A slight tremor followed it later on

12th (1) eP 11h 10m 35s S 11m 55s, distance 5.1 degrees
(2) eP 15h 59m 28s S 47s, distance 1.7 degrees

13th iP 18h 52m 51s S 54m 18s, distance 2.4 degrees
F 18h 57m

14th eP 20h 24m 8s L 48s, distance 3.5 degrees M 20h 28m, period 5.7 seconds, amplitude 29 microns (E-W component); M 28m (approximately), amplitude 23 microns (N-S component)

16th eP 9h 10m 26s eS 11m 13s M 12m 7s, period 6 seconds, amplitude 14 microns (N-S component); M 14m 46s, period 6 seconds, amplitude 24 microns (N-S component); M 13m approximately, period 6 seconds, amplitude 9 microns (E-W component) Distance 4.1 degrees

18th e 24h 47m 32s L 57m (E-W component) Phases not clear

23rd eP 17h 38m 55s S 39m 42s, distance 4.1 degrees. The pens of the horizontal seismograph were thrown off, the intensity of the shock at the Observatory being 2 on the Rossi-Forel scale

28th eP 19h 11m 13s S 55s, distance 1.8 degrees, intensity 2 on the Rossi-Forel scale. Pens thrown off

30th eP 2h 24m 51s PP 28m 54s PPP 37m 29s iS 31m 57s SS 35m 49s SSS 36m 49s L 40m, distance 49.4 degrees (Jeffreys). M 43m, period 9.3 seconds, amplitude 53 microns, F 4h approximately. Record not very clear owing to the existence of microseisms

December

1st L 10h 58m; M 59m, period 8 seconds, amplitude 94 microns (E-W component), 147 microns (N-S component)
Note:- There were large microseisms during the first few days of December when the weather was stormy

14th Local shock of intensity one on the Rossi-Forel scale. L = 20h 2m

December

20th P 14h 56m 24s S 46s, distance 1.9 degrees

21st (1) P 2h 8m 22s S 37s, distance 1.3 degrees
(2) P 22h 8m 34s S 8m 55s (in time mark) distance 1.8 degrees. Felt locally, Rossi-Forel 4, pen thrown off. F 22h 14m. Azimuth 41 or 221 degrees (no record on vertical seismograph)

28th eP 11h 26m 35s eL 29m. Epicentre perhaps near the Kermadec Islands. A second shock appears to have followed at 40m

30th e 14h 24m (Lower California - see J.S.A. reports)

31st e 19h 6m eL 19h 19m (Lower California - see J.S.A. reports).

Abbreviations: U.S.C. & G.S. = United States Coast and Geodetic Survey

J.S.A. = Jesuit Seismological Association

M(E), M(N), M(Z) refer to the maxima in the east, north and vertical components respectively

O = time at the origin

H = hypocentral time

R.F. = Rossi-Forel scale of intensity

Other symbols have their usually accepted meanings.

N.Z. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

APIA OBSERVATORY,

APIA, WESTERN SAMOA.

ANNUAL REPORT

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CONTENTS

Seismology, 1935

The present summary of earthquakes recorded at Apia during 1935 is based on the quarterly bulletins which were issued during that year. The preliminary readings contained in the quarterly bulletins have been revised where necessary after comparison with the records of other observatories.

The same instruments have been used as in previous years, namely a Wiechert 1000 kilogram horizontal seismograph for east and north components and a Wiechert 80 kilogram seismograph for the vertical component. The vertical seismograph, which is very insensitive has only been used to give the initial movement in near earthquakes of moderate intensity. The soil on which the Observatory stands is coral sand on volcanic rock.

In deducing the distance of the epicentre the following tables have been in use:-

"Tables of the Times of Transmission of P and S Waves of Earthquakes" by Harold Jeffreys (1932)

"A Preliminary Table of Observed Travel Times...." by James B. Macelwane (1933)

"Revised Travel Time Tables" by H. Jeffreys and K.E. Bullen (1935)

The constants of the horizontal seismograph were as follows:-

6th November 1934

N-S Free period = 10.6 seconds; coefficient of friction (r/T^2) = 0.0002 cm; damping ratio = 4.3; static magnification 172

E-W Free period = 9.3 seconds; coefficient of friction = 0.0006 cm; damping ratio = 4.3; magnification 139

17th May 1935

N-S Free period = 9.9; coefficient of friction = 0.0013; damping ratio = 2.8; static magnification = 173

E-W Free period = 10.6; coefficient of friction = 0.0010; damping ratio = 4.1; static magnification = 131

28th June 1935

N-S Free period = 10.1; coefficient of friction = 0.0013; damping ratio = 3.1 (see note); static magnification = 159

E-W Free period = 10.5; coefficient of friction = 0.0008; damping ratio = 4.0; static magnification = 132

Note: The damping ratio on the N-S arm was adjusted on 28th June. The value before adjustment was 3.1 and afterwards was 4.9

30th July 1935

N-S Free period = 9.5; coefficient of friction = 0.0014; damping ratio = 4.4; static magnification = 171

E-W Free period = 9.5; coefficient of friction = 0.0005; damping ratio = 3.9; static magnification = 128

15th October 1935

N-S Free period = 9.7; coefficient of friction = 0.0005; damping ratio = 4.3; static magnification = 174

E-W Free period = 9.0; coefficient of friction = 0.0005; damping ratio = 4.5; static magnification = 131

9th November 1935

N-S Free period = 10.4; coefficient of friction = 0.0007; damping ratio = 4.7; static magnification 156

E-W Free period = 9.0; coefficient of friction = 0.0003; damping ratio 4.1; static magnification 125

26th November 1935+

N-S Free period = 10.3; coefficient of friction = 0.0002; damping ratio = 4.9; static magnification = 160

9th December 1935+

N-S Free period = 8.3; coefficient of friction = 0.0004; damping ratio = 3.3; static magnification = 159

12th December 1935+

N-S Free period = 8.2; coefficient of friction = 0.0004; damping ratio = 3.1 (after setting 5.5); static magnification = 171

21st December 1935

N-S Free period = 8.4; coefficient of friction = 0.0004; damping ratio = 5.6; static magnification = 159

E-W Free period = 8.2; coefficient of friction = 0.0007; damping ratio = 4.4; static magnification = 123

+Friction in E-W excessive.

Abbreviations: USCGS = United States Coast and Geodetic Survey

JSA = Jesuit Seismological Association

M(E), M(N), M(Z) refer to the maxima in the east, north and vertical components respectively

T° = time at the origin

H = hypocentral time

RF = Rossi-Forel scale of intensity

Other symbols have their usually accepted meanings - see page 500 of Volume 25, Part II, Handbuch der Experimentalphysik (Wien-Harms), "Seismik" by O. Meisser and G. Krumbach - Leipzig 1931.

The components used in the measurement of phases have been shown during the last six months of the year by means of the letters N, E and Z, which refer to north, east and vertical components respectively. Thus the expression iPNEZ means that the phase P was sharply shown in all three components.

During October, November and December the letter M was used to show the beginning of Rayleigh waves; but elsewhere it has its usually accepted meaning of a maximum within the L phase

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January

1st (1) iP 13h 22m 1s iS 22m 47s distance 4.1 degrees azimuth 233°. Local shock felt in Samoa Pens thrown off Rossi-Forel 3-4 Epicentre 17°S 174°W and time at origin 13h 21.1m (USCGS) Focal depth 300km (JSA)

(2) iP 22h 52m 47s iS 33s F 23h 0m distance 4.1° azimuth not known

17th iP 2h 13m (approx.) eS 16.4m (time marks failed) distance 18.8°. Origin south of New Hebrides Epicentre 20°S 170°E Time at origin 2h 11m approximately

23rd iP 0h 56m 50s iS 57m 9s distance 1.3° Rossi-Forel 2

26th e 15h 13m 48s eL 14m 11s slight shock probably local

31st i 17h 50m 44s ?eL 55m 3s F 18h 9m weak trace Distance about 20°

February

1st eP 8h 47m 49s iS 48m 9s F 50m distance 1.7° Rossi-Forel 2

9th-16th Large microseisms (Cyclone in Cook Islands)

18th iP 10h 33m 17s iS 33m 42s F 37m 6s distance 2.2° Rossi-Forel 2

21st eL 12h 19m F 29m
22nd e 17h 19m 22s (?PP) S 26m 31s (?SP) eL 35m F 19h Epicentre 50½°N 176½°E and time at origin 17h 5m 59s (JSA)
23rd ?L 3h 41m

24th eP 11h 1m 49s i 2m 21s F 12h (N-S component) The times on the E-W record do not agree exactly with these. M 11h 2m 39s, period 11 seconds, amplitudes E-W 166 N-S 222 microns

March

7th iP 0h 22m 9s iS 28s Pens thrown off but restored by observer F 32m RF 4 distance 3.6° azimuth 40° or 220°
20th Fairly big microseisms

27th iP 14h 24m 26s L 26m 6s F 35m distance 725km or 6½° (Conrad)
29th Ill defined phases at 15h 26m 14s and 28m 57s eL 30m M 47m, period 10 seconds, amplitude 73 microns (N-S) F 17h 4m A small shock at no great distance from Samoa

30th(1) eP 10h 1m 33s S 2m 17s L 35s distance 3.9°
(2) eP 16h 45m 16s iS 46m 32s L 47m distance 6.7°

April

3rd e 20h 53m 57s The phases are indistinct in this record
4th e 9h 49.6m e 52.8m e 10h 5.0m
5th P 2h 57m 11s (±2½s) eS 2h 58m 30s eL 2h 58m 46s distance 7° time at origin 2h 55m 32s ±2½s) A small shock with indications of multiple P phases. Epicentre near 16°S 180° longitude (Fiji Islands)

7th eP 12h 16m 0s iS 16m 21s distance 1.8° (Wegener's Type C)
9th iP 13h 0m 50s
16th(1) i 5h 29m 24s (2) iP 13h 36m 58s iSg 37m 19s distance 1.8°
17th(1) eL 0h 11m 12s F 0h 19m earlier phases lost
(2) iP 1h 0m 51s iS 1h 1m 41s distance 4.4° time at origin 0h 59m 48s

18th iP 18h 10m 12s iS 18h 10m 34s distance 1.9°
19th eL 16h 40m period 30 seconds at first Epicentre 32°N 15°E (JSA) H = 15h 23m 32s (JSA)
20th iP 9h 39m 12s eS 9h 42m 27s distance 17.8° time at origin 9h 35m 9s Epicentre ?55°S 175°W (Wellington bulletin)

21st eP 16h 58m 28s iS 58m 21s distance 2°
22nd(1) eP 9h 0m 32s(?) eS 9h 4m 5s SS 4m 34s distance 19.6° time at origin 8h 56m 7s P obscured by microseisms. No distinct L phase
(2) iP 11h 9m 47s iS 10m 32s distance 4° time at origin 11h 8m 50s

23rd eP 2h 28m 59s
24th eP 15h 25m 41s iS 26m 6s distance 2.2° time at origin 15h 25m 10s
28th eP 5h 6m 48s iS 7m 18s distance 3.3° time at origin 5h 6m 1s

May

1st(1) iP 9h 33m 6s iSg 33m 27s distance 1.8° time at origin 9h 32m 40s
(2) eP 16h 11m 52s iSg 12m 12s distance 1.8° time at origin 16h 11m 26s
11th iP 5h 38m 36s iS 38m 54s distance 1.6° time at origin 5h 38m 13s

13th eP 16h 21m 31s iS 22m 5s distance 3° time at origin 16h 20m 48s
14th(1) iP 21h 36m 52s iS 37m 15s distance 2° time at origin 21h 36m 23s
(2) e 23h 46m 40s i 47m 22s (?SKS) i 49m 23s (?S); M 48m, period 9½ seconds, amplitude 116 microns (E-W) 45 microns (N-S). Record not very clear; first movements have a very short period and may be only a local shock. Epicentre 58°S 25°W (JSA)

16th eS 21h 5m 23s e 5m 54s ?L 6h 40m M(E) 9m 49s, amplitude of trace 9 mm., period 8 seconds; M(N) 9m 40s, amplitude 12.3 mm., period 8 seconds. Very regular waves, possibly L, from about 21h 7m
19th iP 10h 30m 25s iS 30m 47s distance 1.9° time at origin 10h 29m 58s RF3

21st (1) eP 6h 59m 37s eS 7h 5m 36s e 5m 55s
e 6m 30s eL 9m 23s weak trace
Epicentre 148°E 5°S (approx.), distance
from Apia about 40°
(2) Indistinct record commencing at 12h 59m 27s
which cannot be reconciled with the records
of other observatories

24th P 5h 47m 43s eS 56m 36s ePS 57m 10s
SS 6h 3m 51s e 4m 26s eL 6h 7m 43s (E)
7m 57s (N) M(E) 6h 9.6m, amplitude 8.4mm.,
period 25 seconds M(N) 6h 10.0m, amplitude
9.5mm., period 25 seconds Distance 67°
Epicentre 13°N 125°E (JSA)

26th (1) eP 1h 34m 8s iP 25s
(2) e 3h 24m Regular waves of small amplitude
and period of 6½ seconds. Similar waves
occurred again at 8h 58m

27th eP 3h 15.6m ePP 18m 41s ePPP 19.8m
?e 21m 12s eS 23m 2s (E) eS 23m 15s (N)
eSS 27m 5s (N) 26m 27s (E) eL 32m 16s
iL 33m 17s M(E) 23m 19s amplitude 6.2mm.
period 12 seconds M(N) 33m 40s amplitude
12mm., period 9½ seconds. Distance 53°
Epicentre not known, might be near 65°S and
180° longitude

28th iP 20h 2m 37s iS 56s distance 1.7°
time at origin 20h 2m 13s

29th iP 11h 45m 49s iS 11h 46m 13s distance 2.1°
time at origin 11h 45m 19s E-W pen dislodged
RF 4

30th (1) i 8h 40.5m small local disturbance
(2) ePP 22h 6m eSKS 22h 11m eSS 23.3m
eL (Love) 34.8m eL (Rayleigh) 45m Origin
at Quetta in India

June

2nd eP 06h 44m 52s iS 45m 11s distance 1.7°
time at origin 06h 44m 28s slight shock

7th (1) e 12h 50.1m eL(N) 50m 52s iL(E) 51m 31s
i(N) 52m 22s i(E) 52m 28s M(N) 51m 41s
Period (N) 9.7 seconds, amplitude (N) 35 microns
M(E) 52m 14s period (E) 8 seconds, amplitude
(E) 35 microns

7th (2) P 13h 30m 03s (±2½ seconds - in time mark) iS 30m 38s distance 3.1° F 13h 38m time at origin 13h 29m 19s (±2½ seconds)
(3) e 15h 53m (approx.) no distinct phases
8th (1) i 0h 02m 26s e 04.8m
(2) iP 14h 38m 37s iS 39m 06s distance 2.5° time at origin 14h 38m 01s

10th eP 6h 28m 10s iS 28m 28s distance 1.6° time at origin 6h 27m 47s
12th (1) eP 14h 14m 17s iS 14m 55s distance 3.3° time at origin 14h 13m 30s
(2) iP 20h 35m 49s iS 36m 10s distance 1.8° time at origin 20h 35m 23s, amplitude (N) 9mm (approx.) short period EW pen thrown off

13th iP 7h 48m 53s iS 49m 09s distance 1.4° time at origin 20h 48m 33s
15th (1) Indistinct phases, commencement at 01h 43m 32s
(2) eP 04h 38m 37s iS 39m 14s distance 3.3° time at origin 04h 37m 50s
18th eL(?) 17h 29.7m, regular waves, period 11 seconds. No phases distinguishable

19th eP 22h 20m eS 25m 16s eL 28m 04s (±2½ seconds - in time mark), period (E) 21 seconds
20th iP 18h 23m 40s iS 23m 55s distance 1.3° time at origin 18h 23m 22s

24th (1) eP 7h 40m 22s e 40m 35s iSg 40m 56s distance 3.0° time at origin 7h 39m 39s
(2) iP 23h 27m 38s ?pP or PP 28m 17s ?sP 28m 49s iSS (or sS?) 31m 59s M(N) 34m 35s, period 11 seconds, amplitude 126 microns M(E) 34m 11s, period 16 seconds, amplitude 356 microns F 1h 18m Epicentre 15½°S 167½°E H = 23h 23m 12s depth of focus 140km distance from Apia 20.2° (JSA)

27th (1) eP 4h 55m 55s iS 56m 16s distance 1.8° time at origin 4h 55m 29s
(2) eS 4h 59.7m masked by earlier shock
28th eP 17h 31m 24s iS 31m 46s distance 1.9° time at origin 17h 30m 57s

29th (1) e(E) 7h 23m (approx.) long period, about 20 seconds, phases indistinct
(2) e 18h 45.5m e 18h 56.6m phases indistinct
(3) eP 21h 34m 43s iS 35m 19s distance 3.2° time at origin 21h 33m 57s

July

3rd	e 01h 08m 14s i 09m 04s i 09m 34s i 09m 43s
3rd	iP 11h 41m 11s iS 41m 32s distance 1.8° time at origin 11h 40m 45s azimuth second quadrant
3rd	14h 05.3m (ca) indistinct phases
5th	P 5h 2m 02s (±2½s in time gap) iS 02m 28s distance 2.3° time at origin 5h 01m 29s (±2½s)
15th	eP 14h 15m 48s iS 17m 30s iSZ 17m 33s deep
17th	e 20h 05m 20s e 06m 20s e 06m 30s e 08m 50s
19th	eN 01h 09m 32s regular long period waves (about 25 seconds)at about 1h 20m
20th	eP 3h 16m 12s eS 16m 34s distance 1.9° time at origin 15m 45s
22nd	iP 11h 10m 30s eS 10m 53s distance 2.0° time at origin 10m 01s Azimuth 223° epicentre 15°.3'S 173°.2'W RF 3/4
28th	PnN 3h 02m 29s SnN 02m 50s SxN 02m 52s SgN 02m 56s distance 1.8°
29th	iP 7h 41m 7s azimuth SSW. The S waves dislodged the E-W pen temporarily but the vertical seismograph shows iS at 42m 54s. Prominent movements exist near 45m 45s; 46m 40s; 48m 10s; 49m 10s on the N-S trace. Epicentre 23°S 178°W depth of focus 490km (JSA). Assuming the epicentre and focal depth to be as given in the JSA bulletin there are phases at 51m 50s and 56m 45s on the Apia record which may be SoS and sSoS
30th	ePN 11h 27m 37s SNE 11h 29m 07s distance 8.0°
31st	ePNE? 18h 45± no time eclipses S-eP? 1m 59s S-LN 30s distance 10.6°

August

3rd	ePPE 1h 27m 04s ePPPE 1h 29m 09s iSKSNE 33m 53s iSNE 34m 31s (SKKS?) PPSE 36m 01s SSE 40m 31s SSSE 44m 28s eL 1h 54.5m (ca) 94°± (Macelwane's Tables)
3rd	ePNE 11h 28m 48s SNE 29m 08s

5th ePNE? 13h 39m 02± in minute gap eSnNE 40m 32s SgE 41m 29s distance 8.0°

7th PxNE 8h 25m 37s eSnNE 8h 26m 09s SxNE 8h 26m 26s SgE 26m 41s distance 4.1°

7th ePNE 16h 10m 19s eNE 10m 49s followed by shallow sinusoidal waves

8th ePnNE 21h 52m 27s eSnNE 52m 48s iSxNE 52m 55s distance 1.8°

9th ePnNE 9h 27m 10s eSnNE 27m 33s iSxNE 27m 40s distance 2.0°

12th PnZ 3h 19m 08s, on minute offset SnNEZ 19m 37s Sx? 19m 47s distance 3.1°

16th ePNE 01h 06m 13s eSNE 06m 47s distance 3.0° Very small

17th ePNEZ 01h 48m 48s iSNE 52m 40s

18th PNE 9h 49m 00s+ in minute gap SNE 49m 29s A small shock

18th ePNE 19h 06m 29s SNE 06m 55s distance 2.3° A small shock

18th PnNEZ 22h 36m 54s PxN 37m 09s PgNE 37m 19s SnNEZ 37m 40s SxNE? 37m 58s, just before time gap SgNE 38m 13s distance 4.1°

21st iPNEZ 13h 49m 21s iSZ 49m 47s distance 2.3° azimuth 240°, horizontal cups dislodged before S RF 5 time at origin 48m 48s

23rd eNE 20h 37m 49s eNE 38m 51s very small movements

24th ePNEZ 9h 04m 31s iSNEZ 04m 55s eSgN 05m 12s (small) distance 2.1°

25th ePE 2h 40m 28s SEZ 40m 59s distance 2.7°

26th ePNE 3h 27m 08s, 27m 38s distance 2.6°

27th iPN 19h 02m 28s ePEZ 02m 28s ePxNE 02m 40s eSZ 03m 07s NE in minute gap eSxNE 03m 22s (small) eSg 03m 34s (small) distance 3.4°

28th eE 2h 07m (ca), few small surface waves

28th ePNE? 12h 33m 40s iSNE 33m 47s very small distance 0.8°

28th PNE 15h 30m 03s±, in minute gap SNE 30m 24s distance 1.8°±

28th ePNE 20h 42m 28s SNEZ 42m 52s distance 2.1°

29th ePNE 2h 27m 49s SNEZ 28m 19s distance 2.6°

29th PnNEZ 14h 01m 28s PgN 01m 38s SnNEZ 01m 46s SxN 01m 53s distance 1.6°

31st ePN? 7h 37m 12s SNE 37m 34s distance 1.9°

September

4th ePN 1h 39m 03s eSNE 48m 49s eSSNE 54m 16s eNE 58m 28s time at origin 27m 14s distance 76.6° Epicentre 63°N 151°W (JSA)

4th ePNE 2h 54m 35s SNE 55m 56s± in minute gap

6th Near 16h 52m S-P 26 seconds distance 2.3°± minute marks failed

9th PNE 6h 26m 35s PPNE 28m 23s SNE 33m 55s± in minute gap SoSN 35m 29s iSSE 37m 22s iSSSNE 38m 42s LNE 42m 07s MNE 45m 23s Time at origin 17m 30s± distance 51.6° Epicentre 6°N 139°E (JSA)

9th PnNEZ 9h 01m 41s PrNEZ 01m 48s PgNEZ 01m 53s SnNEZ 02m 03s SrNEZ 02m 14s SgEZ 02m 24s. Time at origin 01m 14s distance 2.5°, SW quadrant RF 4

10th ePE 7h 11m 16s S in minute gap SrN 12m 18s SgN 12m 32s distance 3.9°

10th eE 11h 21m (ca) a few shallow surface waves

10th ePNE 16h 54m 06s eSNE 55m 14s distance 6.0° very small

11th ePNE? 11h 49m 31s eSNE? 52m 51s distance 18.3°? Weak trace. Wellington bulletin suggests an epicentre near the Kermadec Islands

11th PNE 14h 15m 01s SNE 23m 55s± in minute gap distance 67.2° Epicentre 44½°N 147°E; focal depth 60km H = 14h 4m 12s (JSA)

12th iPNEZ 16h 03m 35s iSNE 05m 09s distance 8.3° from SW

15th (1) eNE 6h 25.5m (ca) a few shallow waves

(2) eNE 11h 28m 04s (S?) eNE 31m 08s (L?) distance 28.0°?

(3) ePNE 14h 18m 48s SNE 26m 37s time at origin 9m 09s distance 56.3° Epicentre 28°S 113°W focal depth 110km H = 14h 9m 10s (JSA)

17th ePNE 6h 15m 47s eSNE 18m 10s distance 12.8° May be two separate tremors

19th ePNE 2h 32m 48s eSN 38m 06s eLNE 42m 12s distance 32.3°

20th PNE 1h 55m 07s iNEZ 55m 34s iNE 57m 09s iSNE 02h 02m 13s iPSE 02m 50s iSSE 05m 29s iSSS 06m 46s distance 49.4° Epicentre 4°S 140½°E H = 1h 46m 39s (JSA)

20th eP 5h 31m 47s SNE 38m 22s distance 44.2° epicentre 0°N 146°E H = 5h 23m 41s (JSA)

20th iPnNEZ 8h 15m 01s iPxNEZ 15m 07s ePgNEZ 15m 11s iSnNEZ 15m 22s iSxEZ 15m 30s eSgEZ 15m 37s distance 1.9°

20th eE 21h 26m (ca) followed by shallow waves

23rd ePNE 9h 26m 40s eSNE 33m 46s distance 49.4° Epicentre ½°N 141½°E H = 9h 18m 30s (JSA)

24th ePNE 9h 46m 29s SN 46m 49s very feeble distance 1.8°

25th ePNE? 11h 35m 05s eSNE? 40m 16s distance 31.3°? very small

26th NE 22h 36m (ca) Large 15 second period waves soon decreasing in period, earlier phases not recognised

October

2nd e 5h 44m 2s e 52m 41s eL 6h 4m weak trace Epicentre 44°N 146½°E H = 5h 33m 6s, focal depth 80km (JSA)

2nd Pn 8h 13m 55s ePxN 14m 10s Sn 14m 43s eSx 15m 02s distance 4.2°

2nd e 19h 40m 38s e 19h 41m 59s rapidly developed into maximum amplitudes

4th e 20h 03m 12s iS 03m 31s

5th ePn 5h 20m 56s Sn 21m 17s Sx 21m 25s distance 1.8°

6th e 4h 40m 43s e 45m 5s L 47m 32s weak trace The epicentre appears to be near 20°S 170°E i.e. about 19° from Apia

6th EPN 18h 38m 01s ePcPN 43m 18s iPcSN 46m 14s ScSNZ 51m 04s distance 14°+ deep

10th eP 3h 03m 54s S 94m 13s distance 1.7°

10th eP 12h 29m 35s iS 30m 48s distance 6.5° small

12th e 17h 05.2m (ca) eL 17h 16.0m (ca)

14th Pn 7h 54m 27s Px 54m 36s Pg 54m 41s Sn 54m 54s Sx 55m 05s SgE 55m 14s distance 2.4°

16th e 10h 42m (ca) followed by a few shallow waves

18th eP 0h 23m 12s PPN 25m 38s S 32m 12s PSN 32m 43s LN 44m 37s distance 58.2° Epicentre 44°N 147°E H = 0h 12m 54s, focal depth 80km (JSA)

18th eP 2h 32m 15s eS 35m 50s M 39.1m distance 19.8° time at origin 2h 27m 48s

18th iP 11h 14m 44s S 22m 13s L 30.0m distance 53.0° time at origin 11h 05m 28s Epicentre near 12°N 143°E

20th Pn 20h 40m 42s Px 40m 48s Sn 41m 02s
Sx 41m 10s distance 1.8°

24th P 23h 57m 03s S 00m 27s M 24h 02m 53s
iPcSE? 04m 29s distance 18.7° time at origin
23h 52m 49s

29th iPnZ 0h 06m 58s iPgNE 07m 07s iS 07m 16s
iSxNE 07m 23s iSgNE 11m 29s distance 1.6°
probably in SE quadrant

November

3rd eP 1h 25m 24s S 25m 44s distance 1.8°

9th i 18h 04m 22s, 12 second waves, e 05m 27s,
shorter period larger amplitudes
i 07m 41s, small impulse

11th eP 12h 21m 22s e 22m 34s eS? 23m 10s
i 23m 32s, maximum in E i 28m 12s, becomes
maximum in N, distance 10.8°? time at origin ?
12h 18m 54s

13th ePnNEZ 23h 18m 40s iPg 19m 09s iSn 19m 34s
iSg 20m 14s i 24m 03s, becomes largest phase
on N and Z distance 4.8°

14th e 20h 03m 50s ?S 09m 20s eLE 14m 31s weak
trace, P probably lost. The epicentre appears
to be near 9°S 151°E (approximate only)

15th iPnNEZ 4h 42m 21s PxNE 42m 29s PgNE 42m 34s
iSnNEZ 42m 46s SxN 42m 56s SgN 43m 04s
distance 2.2° E out of cups after S

15th P 15h 18m 24s S 18m 47s distance 2.0° very
small

15th A few surface waves centering at 16h 03m (ca)
and 17.30 (ca)

17th iPNEZ 7h 43m 42s iSNE 45m 56s absent on Z
iLN 46m 45s eLZ? 46m 45s iMNE 47m 40s
eMZ 47m 40s± ePcPEZ 48m 53s PcSN 52m 18s
eScSNEZ 55m 25s distance 12.0° time at origin
7h 40m 54s Epicentre near 18°S 175°E

19th eP 5h 34m 53s iS 35m 41s distance 4.2°

19th eP 6h 05m 15s eS 8m 26s eL 9m 30s
M 10m 40s distance 17.4° time at origin 6h
01m 17s

20th e 20h 59m 40s e 21h 04m 40s e 05m 58s
MN 10m 50s doubtful

22nd eP? 10h 39m 27s eS 42m 27s eLE 43m 31s
eLN 43m 49s distance 16.4° time at origin
10h 35m 42s

23rd SKS? 8h 23m 12s SSS? 28m 26s L 32m 45s Epicentre 0°N 86°W H = 7h 52m 34s, focal depth 170km (JSA)

24th Shallow seismic activity for an hour from 6h 10m

December

4th ePx 13h 21m 21s iSn 21m 43s iSx 21m 56s distance 2.8°

5th ?eP 17h 51m 13s iS 53m 38s followed by large amplitudes. An epicentre near the Ellice Islands is suggested, but the data available is insufficient to confirm this. P is uncertain and the distance may be only 10°

6th ePEZ 0h 34m 30s SEZ 34m 56s distance 2.3°

7th ePnZ 6h 05m 02s PxN 05m 11s PgE 05m 17s SnNEZ 05m 32s Sx 05m 43s SgNE 05m 53s distance 2.6°

8th e 21h 56m 36s L 57m 35s

14th ePnZ 15h 46m 02s PxNE 46m 11s PgNE 46m 18s Sn 46m 32s SxNE 46m 44s SgZ 46m 54s distance 2.6°

14th eP? 22h 17m 57s in microseisms ?S 28m 01s, in minute gap LE 43m 47s weak trace. Epicentre 15°N 93°W H = 22h 5m 20s (JSA)

15th PNEZ 7h 13m 35s S 17m 55s LE 20m 10s MEZ 22m 24s distance 24.6° Epicentre 12½°S 161°E (USCGS) time at origin 7h 8m 6s (USCGS)

20th L 47m 30s MNE 51m 23s Early phases lost in microseisms Epicentre apparently in Solomon Islands about 30° from Apia

22nd P 9h 27m 55s S 30m 58s eL 32m 27s PcP 32m 55s M 34m 07s PcSE 36m 47s distance 16.6° time at origin 9h 24m 07s

23rd Pn 16h 38m 13s Sn 38m 32s Sx 38m 40s. SgN 38m 46s distance 1.7°

24th Pn 5h 53m 04s PxN 53m 14s PgN 53m 21s Sn 53m 36s iS? NEz 53m 43s Sx 53m 49s iS?NZ 53m 54s SgNZ 53m 59s distance 2.8° possibly 5 layers

25th iPn 6h 33m 25s P? 33m 32s Px 33m 38s PgNE 33m 53s iSn 34m 19s S? 34m 30s iSx 34m 41s S? 34m 50s SgZ 34m 59s distance 4.8°, n phases very sharp, SW quadrant 233° (approx.) time at origin 6h 32m 17s

26th e 5h 40m (ca) followed by train of shallow waves

27th e 17h 46m 39s followed by shallow sinusoidal waves e 47m 48s, change to larger waves of shorter period

28th P 2h 48m 36s PPE 51m 57s SKS 59m 02s
S 59m 24s PS 59m 51s SSE 04m 35s
eLE 16m 32s ME 23m 22s distance 85°
Epicentre 2½°S 99½°E H = 2h 35m 20s, approx. (JSA)

29th e 23h 47m 46s e 55m 41s

30th P 19h 08m 33s S 08m 54s distance 1.8°

30th Pn 23h 45m 17s Px 45m 23s Pg 45m 27s
Sn 45m 38s Sx 45m 46s SgN 45m 53s
distance 1.8° superimposed on distant shock

N.Z. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

APIA OBSERVATORY,

APIA, WESTERN SAMOA.

ANNUAL REPORT

FOR

1936.

Issued under the authority of the Hon. D. G. SULLIVAN, Minister of Scientific and Industrial Research.

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1940.

Apia Observatory

Annual Report for the Year 1936

Contents

Seismology, 1936

The following summary of earthquakes recorded at Apia is based on the quarterly bulletins which have already appeared in print. The preliminary identification of the phases given in the quarterly reports has sometimes been revised after comparison with the reports received from other observatories. We have used, as a general rule, the positions of epicentres given by the Jesuit Seismological Association or the United States Coast and Geodetic Survey; but in some examples the position of the epicentre has been calculated by us at the Observatory using the stereographic projection.

The same instruments have been used as in previous years, namely a Wiechert 1000 kilogram horizontal seismograph for east and north components and a Wiechert 80 kilogram seismograph for the vertical component. The vertical seismograph, which is very insensitive has only been used to give the initial movement in near earthquakes of moderate intensity. The soil on which the Observatory stands is coral sand on volcanic rock.

In deducing the distance of the epicentre the following tables have been in use:-

"Tables of the Times of Transmission of P and S Waves of Earthquakes" by Harold Jeffreys (1932)

"A Preliminary Table of Observed Travel Times...." by James B. Macelwane (1933)

"Revised Travel Time Tables" by H. Jeffreys and K.E. Bullen (1935)

The total number of earthquakes recorded during 1936 was 236. They were distributed as follows:-

110 originated within three degrees of Apia; 18 between three and six degrees; 15 between six and nine degrees; 18 between nine and 45 degrees; 15 beyond 45 degrees. The origins of the remaining 60 were indeterminate.

The constants of the horizontal seismograph were as follows:-

January 31, 1936

E-W Free period = 8.4 seconds; coefficient of friction $(\pi^2/T^2) = 0.0007$ (cm); damping ratio 2.5; static magnification 127

N-S Free period = 8.5 seconds; coefficient of friction = 0.0005 ; damping ratio = 5.9; static magnification 163

May 1st, 1936

E-W Free period = 8.3 seconds; coefficient of friction = 0.0004; damping ratio=5.5; static magnification 124

N-S Free period 8.5 seconds; coefficient of friction = 0.0005; damping ratio = 6.8; static magnification 162

June 18, 1936

E-W Free period 8.5 seconds; coefficient of friction = 0.0003; damping ratio 5.2; static magnification 124

N-S Free period 8.4 seconds; coefficient of friction 0.0011; damping ratio 5.8; magnification 163

October 2, 1936

E-W Free period 8.3 seconds; coefficient of friction = 0.0010; damping ratio 5.4; magnification 129

N-S Free period 8.2 seconds; friction 0.0013; damping ratio 5.0; magnification 162

December 10, 1936

E-W Free period 8.3 seconds; friction 0.0010; damping 5.1; magnification 127

N-S Free period 8.4 seconds; friction 0.0014; damping 5.0; magnification 171

Abbreviations: USCGS = United States Coast and Geodetic Survey

JSA = Jesuit Seismological Association

M(E), M(N), M(Z) refer to the maxima in the east, north and vertical components respectively

H = hypocentral time

RF = Rossi-Forel scale of intensity

Other symbols have their usually accepted meanings: see page 500 of Volume 25, Part II, Handbuch der Experimentalphysik (Wien-Harms), "Seismik" by O. Meisser and G. Krumbach - Leipzig 1931.

1936

January

1st 1P 0h 54m 11s e 54m 15s 1 54m 19s 1S 54m 30s 1S 54m 30s distance 1.7° time at origin 0h 53m 47s Rossi-Forel 2

10th 1P 3h 51m 43s e 48s 1 53s 1S 52m 13s Rossi-Forel 2-3

11th 1P 23h 30m 57s 1S 58s

13th 1P 0h 47m 46s 1S 48m 19s; 1P 12h 1m 49s 1S 2m 28s

14th Long surface waves commencing 6h 23m 48s

14th eP 12h 20m 47s

14th 1P 17h 45m 46s PP 46m 7s sP 29s eS 49m 54s SS 50m 22s focal depth 110 km distance 23.2° H 17h 40m 49s ?PcP 49m 23s ScS 56m 56s ?sScS 57m 35s epicentre 165°30'E, 17°44'S (approx.)

15th eP 14h 47m 54s PP 48m 5s sP 48m 58s S 51m 33s SS 52m 0s (in time mark) distance 21° focal depth 200 km H 14h 43m 26s (approximate only) epicentre 169°0'E 20°48'S

17th eP 11h 59m 16s large microseisms

19th 1P 15h 24m 21s 1S 24m 54s distance 2.9° time at origin 15h 23m 40s

20th eP 17h 7m 4s eS 15m 22s eSS 19m 9s eL 25m 44s distance 64° time at origin 16h 56m 53s epicentre 129°30'E, 6°25'N

22nd eLg 0h 47m 27s

24th eP 22h 45m 48s 1Pg 46m 5s eS 46m 20s distance 2.8°

February

2nd 1P 01h 58m 33s 1S 59m 14s eS* 59m 29s

eSg 59m 44s distance 3.5° time at origin 1h 57m 43s

3rd eP 4h 18m 30s eS 19m 36s distance 5.8° time at origin 4h 17m 8s

4th iP 12h 30m 17s other phases lost in microseisms

7th P 0h 49m 16s P* 49m 28s Pg 49m 37s S 49m 53s e 50m 0s S* 50m 10s Sg 50m 22s distance 3.4° time at origin 0h 48m 28s

10th P 4h 44m 46s P* 49m 28s Pg 45m 6s S 45m 23s S* 45m 35s Sg 45m 49s distance 3.2°, time at origin 44m 0s Felt Rossi-Forel 2

10th iP 18h 7m 26s iS 8m 52s distance 7.6°, time at origin 7m 4s

12th iP 5h 21m 31s iS(?) 21m 50s pens thrown off, distance 1.7° Felt Rossi-Forel 2

15th eP 12h 56m 33s eS 13h 4m 26s L 13h 15m distance 57.0° (Jeffreys) time marks failed ?ScS 13h 6m 29s ?SS 8m 18s (approx.) Epicentre 3°S 133°E 12h 46m 58s

17th P 20h 33m 59s S 34m 14s F 36m distance 1.3°

18th P 12h 24m 27s S 48s F 28m distance 1.8°

20th e 13h 36m F 42m

21st iP 0h 18m 36s L 57s F 21m distance 1.8°

22nd iP 15h 39m 40s ePP 40m 57s S 45m 54s eSS 48m 1s eL 53m F 17h distance 41°, time at origin 15h 31m 56s. Epicentre near 51½°S, 162°E.

27th eP 10h 14m 8s e 45s ?pP 14m 58s S 22m 9s e 29s e 23m 9s ?sS 23m 49s e 24m 10s eL 29m 34s, but L waves almost entirely absent. If pP and sS are as shown the focal depth is 240 km and distance 61° (Brunner) giving the hypocentral time as 10h 4m 22s. Epicentre near 11°S 127°E (Formula of H.P.Berlage gives focal depth 215 km)

March

1st e 6h 51m 38s

2nd eL 3h 54m

6th eP 14h 27m 24s eS 28m 43s eL 29m 15s distance 7.0° H 14h 25m 45s and agrees with the focal time deduced from the readings at Wellington; but the computed distances from Apia and Wellington using normal travel time tables are not quite compatible. The suggested epicentre at 175°W 22°S(Tongan Islands) does not conform with readings at Batavia.

But there are also other prominent phases on the record at Apia as follows:- e 30m 7s e 31m 4s i 31m 46s i 35m 6s i 36m 9s

11th e 19h 3m 20s e 4m 9s e 5m 55s
14th eP 8h 59m 54s lost in hour mark, distance probably about 1.3°
19th eP 4h 1m 0s L 21s distance 1.8°
20th iP 23h 53m 38s pens thrown off; Rossi-Forel 4; azimuth 228° or 48° no vertical record

22nd e 12h 29m F 45m
23rd eP 11h 57m 20s eS 58m 8s i 59m 56s distance 4.2°
24th eP 21h 46m 22s iS 43s distance 1.8°
30th eP 22h 51m 0s iS 21s distance 1.8°

April

1st eP 2h 20m 4s PP 22m 18s PPP 23m 49s iS 28m 35s L 39m distance 63° epicentre near 4°N, 128°E time at origin 2h 9m 39s
2nd eS 6h 30m 15s e(?sS) 32m 9s SS 33m 12s ScS 34m 55s ?sScS 36m 43s M 40m epicentre near 3½°S, 152°E. The record at Apia suggests a focal depth of 250 km.
7th eP 1h 40m 6s eS 42m 9s. Except at P the record is not very clear, the amplitudes being small with no great development of L waves. The bulletin from Wellington also suggests a deep focus.

9th(1) eP 7h 13m 45s eL 16m (2) eL 16h 12m
13th(1) eP 3h 56m 51s iS 57m 10s F 4h 1m distance 1.7° Rossi-Forel 2
(2) eL 21h 8m
16th e 8h 48m 47s L 51m
17th eP 6h 42m 1s S 26s F 45m distance 2.2° Rossi-Forel 2
18th L 0h 42m M 44m period 6½ seconds, amplitudes 109 microns (N-S), 70 microns (E-W)

19th(1) iP 5h 13m 42s PP 14m 51s PcP 16m 23s S 19m 0s (in time gap) iSS 21m 4s eL 22½m distance 31.9° azimuth approximately 270°; epicentre (JSA) 9°S 156°E H 5h 7m 42s

(2) eP 18h 14m 49s L 15m 9s distance 1.8°

20th(1) iP 3h 52m 47s iS 53m 21s distance 3° azimuth 229° epicentre 15°47'S, 174°2'W. Dilatation

(2) Three other slight tremors, that at 10h 3m being of intensity 2 (Rossi-Forel)

26th eP 22h 41m 43s S 42m 3s distance 1.8° F 48m

28th eL 5h 52m weak trace, early phases lost in microseisms distance 28° (approx), epicentre near 10°S, 160°E

29th eL 8h 23m weak trace, early phases lost in microseisms

May

1st(1) e 0h 7m (2) e 16h 51m M 59m

9th(1) eL 2h 32m (2) eL 6h 46m F 7h 5m (approx.) M 6h 36.5m period 13 seconds, amplitudes 58 microns (N-S) 29 microns (E-W)

15th e 12h 44m F 49m

19th Slight shock which put the seismograph off balance eL 3h 11.5m

22nd e 23h 23m (approx.) eL 29½m Epicentre near 20°S 170°E at a distance of 19° approximately.

23rd e 23h 38m

24th Slight shock 17h 46m distance about 1½°

28th(1) e 9h 17m F 22m (2) e 9h 25.5m (3) L 19h 20m till 20h (approx.) Epicentre (USCGS) 10°N 104°W. The distance 73° from Apia agreed roughly with L-E = 35m (Macelwane)

June

1st e 13h 10m

2nd P 1h 0m 40s S 58s F 7m distance 1.3°

6th Slight irregular movement at 6h 43m

10th iP 8h 30m 54s (E-W). Epicentre 5.4°S 147.0°E, H 8h 23m 20s focal depth 150 km (JSA). Using this epicentre which is at a distance of 41.4° from Apia the following phases have been found on the N-S trace at Apia:-

sP 8h 31m 49s PP 32m 32s PcP 32m 45s
S 37m 1s (obscured in time gap) SS 38m 6s
(obscured in time gap) ScS 40m 32s

12th e15h 56m 18s F 16h 10m

15th iP 9h 20m 37s ?S 21m 26s azimuth SSW
F 28m distance 4°(?) Dilatation. Focus
may be deep

16th eP 0h 34m 23s ?S 36m (approximately)
amplitudes large, azimuth SSW, dilatation
but vertical record not clear in initial
movement

17th eP 16h 9m 33s iS 55s distance 2° F 8m

30th iP 15h 17m 45s PcP 18m 10s iS 26m 52s
PS (confused with S) 27m 17s SS 31m 9s
ScS 27m 45s SSS 34m 26s F 38m time at
origin 15h 6m 37s distance 69½° laegest
movement in N-S, azimuth of epicentre
probably northerly, but no vertical record
available to confirm this.
Epicentre (USCGS) 51½°N, 160°E, time at
origin 15h 6m 41s, depth normal, distance
from Apia 7700 km
Epicentre (JSA) 51.0°N 161.1°E H 15h 6m
48s depth about 50 km (Brunner chart),
distance from Apia 69.0°

July

3rd eP 3h 04m 24s; eS 09m 06s; rather weak
trace; distance about 27°: ePP 5m 11s
eSS 10m 19s ?SSS 10m 39s iP 11m 12s
eL 12m epicentre (from Wellington bulletin)
10°S 160°E depth of focus normal

4th eP 1h 37m 41s; eS 38m 05s; M 38m 42s; dis-
tance 2.1°

5th e 19h 14m 45s; eL 26m; The earlier phases
of this shock occurred while records were
being changed. Epicentre(JSA) 4.0°N 124.9°E
H 18h 55m 4s 70 km deep

7th eP 9h 32m 16s; iS 32m 38s; distance 1.9°;
slight shock

12th eP 02h 43m 46s; iS 45m 11s (N-S) iSg 46m
24s; distance about 8° - interpretation
doubtful.

13th iP 11h 25m 51s; ipP 26m 09s; iPP 29m 42s;
eSKS 36m 09s; iS 36m 40s iPS 38m 08s; eSS
43m 22s; eL 56m (approx.) Epicentre (JSA)

23.0°S 70.2°W depth of focus 60 km
H 11h 12m 29s distance from Apia 95.5°

14th eP 9h 48.7m; eL 50.2m; F 10h 16m; weak trace

15th eP 10h 46m 38s; e 47m 26s; eS 49m 01m; iL 50m 21s; i 51m 20s; iPoP 53m 11s; distance about 11° - interpretation doubtful

16th e 21h 52m; F 22h 5m; (approx.)

17th (1) eP 10h 49m 40s; S 49m 57s; (in time mark) distance 1.6° approx.
(2) e 11h 29m

20th e 1h 39.5m; L 40m; (approx.) weak trace

21st e 4h 4m 12s; weak trace - probably local tremor

22nd eP 06h 20m 21s; e 21m 28s; e 21m 56s;

23rd eP 06h 21m 58s; (in time mark); eS(?) 22m 53s; distance 4.9°(?)

24th L 8h 54m - slight movement

26th e 8h 01m 36s; e 08.0m; eL 21m small amplitudes epicentre (JSA) 22.8°S; 70.8°W

27th (1) Slight local shock commencing at 9h 07m (in time gap) R.F.Z.
(2) Slight tremor at 10h 01m

28th (1) Slight movements at about 5h 40m and 8h 20m (long waves of distant earthquake?)
(ii) Slight local tremor at 17h 09m

30th (1) eP 9h 17m 19s; iS 17m 39s; distance 1.8° (ii) eP 12h 53m 03s (in time gap); iS 53m 18s; distance 1.3° (iii) P 14h 04m 05s; iS 14h 04m 22s; distance 1.5°

August

4th iP 10h 50m 22s; iS 44s; distance 1.9° slight tremor

8th slight tremor at 03h 52m distance about 1.9°

9th eP 2h 18m 13s; eS 18m 45s distance 2.8° slight

11th (1) iP 11h 40m 01s; iS 40m 19s distance about 2° dilatation SW quadrant; fairly large amplitudes in all components
(ii) eP 20h 43m 49s; S 44m 08s distance 1.7° slight tremor

12th 1P 21h 05m 27s; 1S 06m 01m distance 3°- sharp shock but apparently not felt.

15th (i) 1P 2h 25m 14s; i 25m 32s SW, dilatation, large amplitudes - possibly deep focus
(ii) eP 3h 08m 07s; i 08m 21s; i 09m 07s slight
(iii) 1P 5h 26m 43s; i 27m 05s (in time gap) azimuth SW or NE large amplitudes.
(iv) eP 6h 26m 31s; 1S 26m 49s distance 1.6° slight

16th slight local tremor at 5h 04m
17th (i) eP 6h 16m 18s; 1S(?) 17m 36s; i 17m 48s; L 18m (approx.) distance about 7°(?)
(ii) eL 14h 15m epicentre 12°S 158°E according to Wellington bulletin

22nd 1S 7h 12m 50s eL 27m epicentre (JSA) 22.3°N 121.5°E focal depth 50-60 km H 6h 51m 38s Formosa
Less distinct phases:- eP 3m 21s ePP 6m 23s eS? 7m 46s approximately

23rd i 21h 36m 50s may be PS, but SKS, S and PS all arrive approximately at this time. Epicentre (JSA) 5.8°N 95.4°E focal depth 90 km, northern tip of Sumatra H 21h 12m 19s

24th a few long period waves at about 22h 48m
25th (i) ePn 18h 44m 54s; eP* 45m 10s; eSn 46m 14s; eS* 46m 36s; i 46m 48s; e 53m 23s (?) distance 7°
(ii) eP 21h 11m 24s; 1S 11m 40s distance 1.6°

26th slight tremor at 21h 50m
27th slight local tremor at 10h 19m

September

1st 1P 3h 02m 48s; 1S 03m 26s distance 3.3° slight shock
2nd i 10h 24m 34s slight - maximum amplitudes at beginning

3rd (i) eP 8h 58m 39s; 1S 58m 57s distance 1.6° slight shock
(ii) e 12h 31m 45s slight trace of apparently distant shock

5th ePn 17h 26m 37s; eSn 27m 47s; 1S* 28m 15s distance about 7°

6th eP 17h 41m 35s; eS 42m 58s distance about 7.3° - somewhat masked by microseisms

7th e 6h 47m 30s; e 48m 58s very small - possibly two distinct shocks

16th Pn 9h 24m 06s (in time mark); 1Sn 25m 31s; eSg 26m 24s distance about 7.5° - fairly strong microseisms - weak trace

18th (i) Pn 7h 32m 01s (in time mark); eP* 32m 18s; eSn 33m 30s; S* 34m 10s; 1Sg 34m 28s distance about 8° small amplitudes
(ii) eP 12h 24m 45s; 1S 25m 15s distance 2.6°, slight

19th (i) eP 1h 15m 5s ?eSKS 25m 34s ?SP 26m 7s ?S 27m 20s epicentre (JSA) 4.3°N 97.8°E H 1h 1m 58s depth 100 km Sumatra (see also shock of August 23rd 1936)
(ii) eP 1h 20m 32s: 1S 20m 50s distance 1.6° - small shock superimposed upon previous one.

20th (i) eP 3h 52m 29s; 1S 52m 42s distance 1.1°
(ii) several small local tremors
(iii) P 11h 00m 04s (in hour gap); 1S 00m 24s distance approx. 2° RF1
(iv) very slight disturbance at about 18h.

21st (i) slight local tremor at about 12h 59m
(ii) indistinct trace of apparently distant shock - commences about 16h 32m

22nd eP 13h 23m 51s; 1S 24m 07s distance 1.4° slight

24th (i) 1P 6h 46m 52s; 1S 47m 43s distance 4.5°
(ii) eP 14h 25m 07s; 1S 25m 24s distance 1.5° small amplitudes

25th very slight traces of distant shock - commences about 13h 23m

28th (i) eP 2h 08m 22s; 1S 08m 39s distance 1.5°
(ii) traces of long waves about 05h weak

29th (i) slight traces of two local tremors at about 07h 30m and 07h 33m
(ii) very faint trace - distant shock - about 16h 41m

October

4th eP 23h 57m 38s e 57m 57s 1S 5d 0h 1m 1s e 4m 57s distance 18° epicentre in Kermadec Islands

5th P 09h 54m 52s (in time gap); ipP 55m 28s; ePP 57m 18s; ePPP 58m 43s; 1S 10h 03m 18s; esS 04m 7s; eSS 08.0m; L(N) 12m; L(E) 18m; distance 65°; focal depth about 150 km; amplitudes small. Epicentre (JSA) 3.0°N 126.4°E depth of focus 100 km H 9h 44m 34s near Celebes Sea

10th very faint traces of disturbance about 05h 40m.

12th (i) ePn 06h 54m 41s; eSn 56m 09s; eS* 56m 34s; distance 7.8°; slight tremor.
(ii) eP 09h 28m 01s; eS 29m 16s; distance 6.7° - small.

15th P 03h 32m 52s(time gap);1S 33m 43s; 4.5°-small.

16th eL 12h 11m epicentre in Solomon Islands (see Manila bulletin) distance from Apia approximately, 30°

17th eP 18h 39m 58s; 1S 40m 33s; distance 3.1°; sharp shock -

22nd two very small local tremors at 16h 10m and 16h 13m.

23rd eL 7h 0m. Earlier phases lost in microseisms, but faint movements at 6h 46m might be S. Epicentre (JSA) 60.8°N 149.4°W H 6h 24m 27s depth of focus 25 km Alaska. Distence from Apia approximately 75°

26th indecipherable record of slight tremor - trace confused - no time assignable.

29th eP 18h 48.1m; ePP 49m 20s; ePPP 50m 12s; S 55m 28s; weak trace. L waves shown clearly, but commencement of L lost while changing the recording paper.
Epicentre (USCGS) 12°N 146°E H 18h 38.6m near island of Guam. Distance from Apia approximately 50°

November

2nd (i) S 15h 17.8m (in time gap) sL 28.3m P obscured by microseisms distance about 67.5° H 14h 58m. Approximate epicentre 48°N 155°E (Kew, Pasadena, Hong Kong, Batavia reports)

(ii) eP 20h 56m 45s ePP 58m 47s eS 21h 5m 47s eSS 9m 33s e 14m 7s eL 21h 16.3m distance about 67° H 20h 45m 54s. Epicentre (U.S.C.G.S.) 37.5°N 142°E

3rd (i) eP 14h 39m 00s; iS 39m 18s; distance 1.6°

(ii) eP 21h 02m 27s; eS 02m 50s; distance 2.0°; slight.

4th (i) ePn 05h 46m 40s; eP* 46m 46s; ePg 46m 53s; eSn 47m 10s; distance 2.6°; slight

(ii) eP 06h 23m 17s; eS 24m 09s; distance 4.6°; slight.

6th iP 06h 12m 17s; iS 12m 42s; distance 2.2°; slight.

13th (i) eP 12h 42m 50s; ePP 43m 38s; eS 52m 29s eSS 57m 10s; e 13h 02m; eL 04.4m; distance about 74° - good trace. Epicentre (JSA) 56.7°N 162.3°E H 12h 31m 37s

(ii) very slight local tremor at 14h 03m.

14th (i) ePn 03h 44m 28s; ePg 44m 38s; Sn 44m 56s (in time gap) distance 2.5°.

(ii) eP 05h 11m 18s; iS 11m 41s; distance 2.0°; slight.

15th eP 21h 52m 24s S 53m 58s (in time gap) PcP 58m 24s H 50m 20s. Approximate epicentre 18° 179°W Depth 400 km (Reports from Manila, Batavia, Pasadena, Chiufeng)

17th eP 2h 02m 31s; ePg 02m 49s; iS 03m 07s; distance 3.2°.

22nd faint traces of distant tremor about 19h - time marks failed.

26th (1) iP 8h 35m 23s S 37m 3s PcP 41m 3s no long waves H 33m 36s distance 7.5°. Approximate epicentre 16°S 180°W depth about 550 km (Using reports from Batavia, Chiufeng, Pasadena).

(2) Faint trace of distant tremor about 23h 32m

29th (1) eP 8h 30m 20s ePP 42s e 31m 30s eS 33m 53s H 25m 55s distance 18.8° Epicentre 22.3°S 170.8°E (Lunkenheimer's method of successive approximations

using Apia, Wellington, Riverview).

(ii) Pn 23h 29m 05s (in time gap); ePg 29m 08s; iPg 29m 14s; iSn 29m 25s; distance 1.7° - Sharp tremor.

December

4th P 22h 30m 42s PP 31m 1s SS 35m (in time gap) S doubtful Approximate epicentre 170°E 21°S Wellington, Apia, Riverview.

5th (i) e 19h 18m 06s (in time gap); e 20m 33s; e 20m 33s; earlier phases during change of records - apparently distant tremor.

(ii) e 23h 15.4m followed by train of waves - no phases discernable.

6th e 12h 15m 44s; e 16m 21s; e 16m 50s; e 18m 27s; e 18m 57s; e 22m 21s; - rather weak trace.

17th (i) e 3h 42m 40s; e 43m 27s; e 44m 55s; e 45m 20s; e 46m 20s; e 46m 51s; e 52m 27s; large microseisms masking phases - interpretation difficult.

(ii) e 13h 15m 15s; e 16m 35s; e 16m 48s; e 18m 15s; e 24m 06s; e 24m 48s; possibly about 38° distant - large microseisms masking phases.

(iii) ePP 13h 28m 27s; ePP 28m 54s; ePcP 31m 34s; eS(?) 32m 18s; eSS 33m 30s; eSSS 33m 45s; ePcS 35m 48s; eScS 39m 24s - about 24° distant - fairly large microseisms.

(iv) traces of distant tremor at about 21h 06m - large microseisms

26th (i) eP 13h 02m 34s; eS 03m 00s; distance 2.3° slight.

(ii) iP 22h 56m 40s eP 57m 34s e 59m 32s eS 23h 0m 0s distance 18° weak trace. Epicentre (JSA) 33.8°S 175.4°W.

27th e(?) 23h 55m 24s; iPn 55m 42s; iSn 56m 24s; iS* 56m 32s; iSg 56m 44s; distance 3.7°.

29th eP 14h 55m 0s i 38s epP 55m 49s ?sP 56m 22s ?PcP 57m 7s esS 15h 2m 15s distance 37.4° depth 200 km. Epicentre (JSA) 4.8°S 154.2°E H 14h 48m 07s

N.Z. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

APIA OBSERVATORY,

APIA, WESTERN SAMOA.

ANNUAL REPORT

FOR

1937.

Issued under the authority of the Hon. D. G. SULLIVAN, Minister of Scientific and Industrial Research.

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1940.

SEISMOLOGY, 1937

The following summary of earthquakes recorded at Apia is based on the quarterly bulletins which have already appeared in print. The preliminary identification of the phases given in the quarterly reports has sometimes been revised after comparison with the reports received from other observatories. We have used, as a general rule, the positions of epicentres given by the Jesuit Seismological Association or the United States Coast and Geodetic Survey; but in some examples the position of the epicentre has been calculated by us at the Observatory.

The same instruments have been used as in previous years, namely a Wiechert 1000 kilogram horizontal seismograph for east and north components and a Wiechert 80 kilogram seismograph for the vertical component. Two small devices were made for the vertical seismograph which increased the length of its natural period of vibration to more than six seconds. From July 14th onwards this instrument worked satisfactorily and recorded microseisms for the first time. The soil on which the Observatory stands is coral sand on volcanic rock.

In deducing the distance of the epicentre the following tables have been in use:-

H. Jeffreys and K.E. Bullen, Revised Travel-Time Tables (1935)
H. Jeffreys, Tables of P and S (1932)
J.B. Macelwane, Preliminary Table of Observed Travel Times (1933)
B. Gutenberg and C.F. Richter, Materials for the Study of Deep-focus Earthquakes (1936)
G.J. Brunner and J.B. Macelwane, The Brunner focal depth-time-distance chart
V. Conrad, Tables of L and P
Tables given by A. Sieberg in "Erdbebenkunde" 1923

The total number of earthquakes recorded during 1937 was 221. They were distributed as follows:-

94 originated within three degrees of Apia; 12 between three and six degrees; 3 between six and nine degrees; 19 between nine and 45 degrees; 11 beyond 45 degrees. The origins of 22 were indeterminate. A swarm of 60 earthquakes occurred principally during October and November which are at a distance of 5 degrees approximately and it is thought that they probably originated in the Tongan deep.

It is regretted that insects have destroyed the greater part of the seismograms which were recorded during the year 1930.

The seismograph constants were as follows:-

February 27, 1937

E-W Free period = 8.2 seconds; coefficient of friction (r/T^2)=0.0011 (cm); damping ratio 5.1; static magnification 127

N-S Free period = 8.4 seconds; coefficient of friction = 0.0016; damping ratio 5.2; static magnification 159

June 4th, 1937

E-W Free period = 8.1 seconds; static magnification 158; coefficient of friction = .0008; damping ratio 5.8; total friction 1.2 dynes

N-S Free period = 7.9 seconds; static magnification 168; coefficient of friction = .0006; damping ratio 5.7; total friction = 1.0 dynes

July 14th, 1937

Z Free period = 6.0 seconds; static magnification 73; coefficient of friction = .0008; damping ratio 2.2; total friction = 1.5 dynes

October 18th, 1937

E-W Free period = 8.3 seconds; static magnification 159; coefficient of friction = .0006; damping ratio 5.3; total friction=0.9 dynes

N-S Free period = 8.3 seconds; static magnification 161; coefficient of friction = .0007; damping ratio 6.0; total friction = 1.0 dyne

November 10th, 1937

Z Free period = 6.0 seconds; static magnification 82; coefficient of friction = .0007; damping ratio 2.5; total friction = 1.0 dyne

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Abbreviations: USCGS = United States Coast and Geodetic Survey

JSA = Jesuit Seismological Association

M(E), M(N), M(Z) refer to the maxima in the east, north and vertical components respectively

H = hypocentral time

RF = Rossi-Forel scale of intensity

Other symbols have their usually accepted meanings: see page 500 of Volume 25, Part II, Handbuch der Experimentalphysik (Wien-Harms), "Seismik" by O. Meisser and G. Krumbach - Leipzig 1931.

Earthquakes

1937

January

2nd eP 17h 55m 24s 1S 55m 57s distance 2.9° - slight

5th iP 22h 30m 17s 1S 30m 44s distance 2.4° - slight

7th SKS 13h 46m 0s S 47m 24s SS 52m 43s Epicentre (JSA) 36.1°N 98.6°E depth normal H 13h 20m 40s

10th e 5h 33m 45s e 34m 30s e 34m 55s e 36m 47s

23rd eP 11h 02m 59s ipP 03m 18s iPP 03m 45s e 04m 49s e 05m 47s 1S 08m 18s 1sS 08m 54s eSS 09m 47s e 10m 50s distance 33° 100 km deep epicentre (Wellington) 7°S 153°E

25th iP 06h 39m 28s ePPP 40m 23s i(?) 41m 26s eS 43m 45s eSS 44.9m iPcS(?) 46m 36s 1ScS 49m 45s distance 24° azimuth west by north; epicentre (JSA) 10.6°S 163.3°E H 6h 34m 0s depth not known

29th eP 4h 23m 51s ePP 24m 16s 1PcP 27m 24s eS 28m 03s 1SS 28m 48s distance 18° (approx.)

30th (i) eP 8h 22m 52s 1Sn 23m 26s 1S 23m 34s 1Sg 23m 40s distance 3.0° - slight
(ii) eP 17h 02m 29s eS 03m 23s distance 4.8° - slight

February

1st (i) eP 16h 06m 25s 1S 06m 28s distance 0.3° - slight

(ii) e 20h 20.7m e 30.4m e 34.9m e 38.2m e 40.5m - very weak trace

7th iPn 10h 37m 47s iPg 37m 54s en 38m 06s (in time gap) distance 1.7° R.F.2

9th eP 14h 33m 18s iS 33m 37s distance 1.7° - slight

12th iS 03h 23m 49s iP 24m 22s distance 2.9° - sharp tremor

21st ?eP 7h 14m 4s obscured by microseisms PP 17m 1s S 23m 15s eL (E-W) 30m eL(N-S) 33m distance 69° Epicentre (JSA) 45.2°N 148.6°E H 7h 2m 45s depth of focus 50-60km

March

6th P 13h 51m 01s (in time gap) eP 51m 13s iPg 51m 23s eS 51m 48s slight tremor - distance 4.1°

8th P 10h 14m 59s (in time gap) iS 15m 14s - distance 1.3° - slight

13th eP 17h 51m 54s iS 52m 53s distance 5.2°- slight

16th iP 07h 00m 37s iS 00m 59s distance 1.9°- R.F.3

27th eP 16h 51m 08s iS 51m 22s distance 1.2°- slight

28th eP 9h 37m 44s ePg 38m 41s eS 39m 43s ePcP 43m 19s distance 10.6°-small amplitudes

30th ePn 14h 49m 04s (in time mark) iPg 49m 46s iSg 51m 16s e 51m 53s e 53m 16s distance 7.2°approximately, amplitudes fairly large

April

1st (i) eP 12h 21m 21s iS 21m 41s distance 1.7°

(ii) eP 17h 20m 58s iS 21m 18s distance 1.7° amplitudes very large Rossi-Forel 2

(iii) eP 17h 49m 13s iS 49m 32s distance 1.7°

(iv) eP 18h 2m 12s iS 2m 30s distance 1.6°

(v) eP 18h 43m 54s iS 44m 20s distance 2.3°

(vi) eP 20h 14m 18s iS 14m 35s distance 1.5°

2nd (i) eP 5h 32m 39s 1S 5h 34m 22s
(ii) eP 6h 37m 53s 1S 38m 10s distance 1.5°
6th (i) eP 8h 17m 29s 1S 17m 58s distance 2.5° RF 2
(ii) eP 8h 23m 32s 1P 23m 37s 1S 24m 2s distance 2.6° RF 4

8th e 0h 21m 57s 1Pn 22m 15s 1Pg 22m 46s 1Sn 23m 22s 1S* 23m 39s distance 5.9°
10th (i) eP 10h 50m 16s 1S 50m 35s distance 1.7°
(ii) eP 12h 3m 57s 1S 4m 16s distance 1.7°
16th 1P 3h 3m 37s i 56s 1S 5m 11s pens thrown off distance 10.2° Epicentre 21.1°S 179.3W deep focus

18th P 18h 57m (lost in time gap) 1S 57m 21s
21st eP 5h 17m 23s i 18m (in time gap) i 19m (in time gap); M 19m amplitude 193 microns (N-S), 111 microns (E-W), period 4.1 seconds
24th 1P 4h 59m 55s S(? in time gap) 5h 1m 6s distance about 6°
29th eP 19h 3m 44s e 12m 38s e 13m 42s eL 24m Much of this record was lost while the paper was being changed. Epicentre (JSA) 53.8°N 160.5°W time at origin 18h 52m 43s

May

10th 1P 15h 28m 54s 1S 31m 26s i 31m 30s distance 15.7° Epicentre 26°S 177°E depth of focus 600km or more.

16th e 11h 44m 1s eL 44m
20th P 20h 7m 56s S (in time gap) 8m 5s distance 1.8°
28th Shock at about 15h 30m RF 3
31st Shock at about 0h 40m RF 3

June

14th eP 13h 14m 55s confused in microseisms i 15m 31s e 18m 19s e 28m 11s
15th 1P 44m 11s 1S 30s distance about 2° RF2
19th eP 17h 10m 38s 1P 39s eS 13m 3s 1S 8s L waves absent. Epicentre near 28°S 179°E focal depth 600+km. H 17h 7m 21s

21st 1P 15h 26m 2s ePP 29m 21s eSKS 36m 34s 1S 37m 8s PS 38m 26s eSS 43m (approx.) eL 54.5m eL 57m distance 91.5° Epicentre (JSA) 6.8°S 79.9°W H 15h 13m 17s

28th iP 19h 22m 29s 1S 51s azimuth 214° (or 34°) RF 3

July

2nd iP 2h 41m 58s PP 42m 20s 1S 45m 59s L 47m distance 22° epicentre 13°S 166°E near Santa Cruz islands

3rd eP 2h 28m 19s S 42s less distinct on E-W F 35m

4th (1) iP 6h 0m 26s 1 35s 1 1m 2s 1S 5m 3s distance 26.2° epicentre 12°S 162°E approximately
(2) iP 6h 44m 8s 1 49s 1 45m 27s ?S 48m 53s e 49m 27s focus may be deep
(3) iP 7h 31m 34s 1 35m 14s S 36m 47s distance 31° F 8h 30m H 7h 25m 13s

21st e 11h 42m M 43m (N-S) F 50m

22nd PS 17h 32m 22s SS 37m 17s ?SSS 40m 18s earlier phases lost in microseisms. Epicentre (JSA) 64.5°N 145.1°W H 17h 9m 36s depth nearly normal. In Alaska about 80° distant from Apia

30th eL 14h 11m

August

5th eL 15h 0m. Epicentre in New Guinea (Papua).

9th eP 8h 35m 33s (E-W) eP 39s (N-S) eL 36m

11th P 1h 6m 17s (E-W) P 18s (N-S) S 14m 48s distance 71.5° focal depth 600km Pasadena epicentre 7°S 116°E H 00h 55m 55s

12th eP 8h 50m 44s 1S 51m 5s distance 2°

20th eP 12h 10m 51s PP 13m 42s PPP 15m 41s S 20m 0s (in time gap) SS 24m 25s distance 70° H = 11h 59m 49s. Epicentre (Manila) 14.2N 122.1 E H 11h 59m 13s

24th eP 18h 29m 5s 1S 50s 1 30m 6s

27th eP 19h 6m 31s eL 7m 18s

September

1st eP 8h 43m 14s 1P 16s PP 43m 41s e 47m (in time gap) 1 47m 48s distance 18° approximately eL 48m 43s (approx.) U.S.C. G.S. epicentre 31°S 179°W H 8h 38.9m

3rd P 18h 58m 53s ?pP 59m 30s S 19h 07m 31s Scs 7m 51s ?sS 8m 46s distance 67° depth of focus 175km H 18h 48m 21s (Brunner chart) U.S.C.G.S. epicentre 52.5°N 177.5°W

4th P 6h 17m 42s (E-W) P 45s (N-S) ?S 20m 24s (N-S) ?S 37s (E-W

10th eP 1h 17m 18s 1S 36s distance 1.5° (approx.)

15th 1P 12h 33m 6s eL 40m distance about 27° JSA epicentre 8.3°S 162.0°E

20th eP 16h 6m 30s 1S 52s distance about 2° RF2 (felt)

21st P 15h 17m 39s L 18m 5s F 22m slight shock distance about 2°

22nd P 22h 47m 37s S 59s F 23h 0m distance about 2°

23rd eP 13h 12m 46s (E-W) 1P 53s 1PPP 14m 14s 1S 18m 13s L 21m M 22m H 13h 6m 6s distance 33° azimuth WNW (297°) near Solomon Islands JSA epicentre 6.5°S 153.8°E

24th 1P 0h 51m 47s 1S 52m 23s distance 3° epicentre 170°W 12°S approximately

27th (1) eP 0h 9m 16s 1S 48s H 8m 41s F 12m distance 2.5°
(2) P 7h 14m 16s (N-S) P 17s (E-W) 1S 42s H 13m 46s F 17m distance 2°
(3) P 9h 7m (in time gap) 1(?pP) 7m 34s 1S 16m 47s weak trace no pronounced L waves distance 78° focal depth 100km

29th 1P 22h 10m 24s 1S 43s H 10m 0s F 26m distance 1.7° azimuth 232° dilatation from SW

30th (1) 1P 19h 38m 57s (N-S) eP 58s (E-W) 1S 39m 13s H 38m 36s F 42m distance 1.4° azimuth N or S
(2) P 21h 38m 11s S 39m 1s distance 4.4° trace principally long waves

October

1st eL 19h 21.6m

3rd (1) 1P 3h 38m 59s 1S 39m 36s H 38m 12s distance 3.3° R-F scale 3, azimuth S-W compression.
(11) 1P 14h 57m 15s (N-S) 1P 16s (E-W) 1E 58m 8s 1S 20s distance 5.7° H 55m 55s azimuth SSW dilatation.

6th eP 17h 11m 36s 1(Z) 16m 26s e S(?) 16m 49s eL 20m M 21.9m
16th P 20h 55m 31s 1S 53s F 21h distance 2°

18th (1) eL 2h 21m, eL 3h 38m
(2) 1P 5h 21m 14s 1S 21m 57s distance 3.7° R-F scale 2 epicentre about 17.3°S 173°W SSW compression
(3) 1P 7h 56m 36s 1S 57m 10s distance 3° R-F scale 3 SSW dilatation, epicentre 16.5S 173°W
(4) eL 13h 30m, eL 14h 53m, eL 16h 13m, eL 17h 33m, el 18h 48m eL 21h 1m, eL 22h 9m

19th eL 0h 21m; eL 1h 33m; eL 2h 40m, eL 3h 54m, eL 4h 47m eL 7h 7m, eL 9h 46m; eL 12h 50m, eL 15h 30m, eL 19h 6m eL 0h 0m, eL 4h 10m, eL 6h 16m, eL 11h 28m, eL 15h 59m eL 19h 12m, eL 22h 7m

21st eL 9h 36m
22nd eL 0h 38m 1 56.6m, eL 12h 25m, eL 18h 34m
23rd eL 3h 19m el 9h 25m, eL 14h 34m, eL 17h 5m,
24th eL 15h 3m also large microseisms.

25th eL 0h 36m, eL 5h 24m, eL 10h 40m, eL 12h 6m, eL 15h 2m, eL 16h 45m
26th eL 2h 30m, eL 3h 35m, eL 7h 48m, eL 13h 46m
28th eL 3h 11m
29th eL 0h 25m, eL 19h 31m, eL 23h 19m

The series of shocks between 18th-23rd consisted almost entirely of long waves.

November

3rd eL 19h 8m
4th eL 7h 53m
5th eL 19h 8m

13th (1) 1P 9h 54m 47s (Vertical) 1P 49s (N-S, E-W) eS 58m 49s 1 55m 13s 1 59m 29s azimuth SSW compression, distance 22°
(2) P 58m 8s (time gap) 1PP 58m 28s 1S 2m 2s e 3m 16s distance 22° Epicentre approximately 177°W 35°S H 53.5m

14th eL 11h 20m
15th eL 11h 37m
18th eL 16h 12m
22nd 1P 1h 24m 23s 1 14s 1S 57s distance 3°
23rd Seismic action at 15h 20m

25th 1 4h 45m 42s eL 49m M 52m
27th (1) 1P 6h 27m 2s 1S 27m 15s R-F scale 2 distance 1.2°
(2) eL 9h 55m, eL 10h 58m
28th eL 0h 4m

December

5th eL 15h 25m
6th eL 13h 35m
7th eL 22h 44m
22nd eL 4h 10m

23rd 1P 13h 30m 12s 1PP 33m 9s 1S 40m 4s (in time gap) PS 42s 1SS 45m 14s L 50.3m L 54.1m M 14h 1.5m distance 77° azimuth E compression. Epicentre off the coast of Central America. Epicentre 16.6N 98.0W (JSA) H 13h 17m 56s

29th eL 12h 27m
30th (1) 1P 10h 59m 28s 1S 41s distance 1.2 azimuth SSW R-F scale 2
(2) 1P 12h 14m 34s 1S 51s distance 1.5° R-F scale 1
31st 1P 21h 44m 21s 1S 45m 23s distance 5.5°

Note: Slight tremors and other indeterminate seismic disturbances which were shown in the quarterly bulletins are not given in this report.