

LAMONT GEOLOGICAL OBSERVATORY
COLUMBIA UNIVERSITY
PALISADES, NEW YORK

OCEAN BOTTOM GEOPHYSICAL STATION
OPERATION AND DATA ANALYSIS
PROGRESS REPORT # 32
FOR
OCTOBER AND NOVEMBER 1966

Contract: Nonr. 266 (92)
ARPA Order No: 218
Project Code No.: 3810

2/2/67

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1.0 OBS OPERATION

All instrumentation in the ocean-bottom units and at the shore station continue to operate properly. Daily checks of the engineering status voltages do not show any signs of degradation in the system. As far as can be determined, all three pressure vessels remain completely dry.

Some minor difficulty has been experienced in command crosstalk, i.e., sending one command will occasionally result in execution of a different command. A check of the shore terminal by Lamont personnel in November revealed no obvious defect in the system and the problem is not serious enough to warrant further effort.

2.0 RESULTS OF DATA ANALYSIS FOR CURRENT REPORTING PERIOD.

2.1 Earthquakes. As a part of the data analysis using the long and short-period seismograms from the ocean bottom seismograph, two preliminary bulletins have been prepared. These are appended to this progress report along with instrument response curves. The first bulletin lists all teleseisms recorded at the OBS site. The second bulletin lists all events that occur within four degrees of the OBS. The teleseism bulletin includes USCGS preliminary locations, depths, and magnitudes. The local bulletin lists all events recorded, including those for which only a T phase is observed. Magnitudes computed from p-wave amplitudes are also included. Preparation of these bulletins has been the principal task in the area of seismic data analysis during the current reporting period.

A curve showing the frequency of local shocks as a function of distance from the detector site (s-p time) is shown in Figure 1. Two peaks in the frequency distribution are observed at s-p times of approximately 22 and 27 seconds corresponding to distances of 227-278 km. These distances are about right for the Mendicino Scarp and it is suggested that the two frequency peaks correspond to two areas of relatively high seismic activity associated with the scarp. This suggestion remains to be verified.

2.2 Currents and Tides. Data obtained from the current meter, the current direction sensor and the vibrotan for a 45 day period have been analyzed. Spectral analysis of the current amplitude data have revealed significant spectral

peaks (amplitudes greater than the 95% confidence level) at periods corresponding to the K1, N2, M2, and S2 tidal components. The O1 component amplitude is under the 95% confidence level. The maximum spectral amplitude, 2.4 cm/sec, was obtained for the M2 component of current (period = 12.421 hours).

By averaging the current data over the entire 45 day period, the net water transport has been determined to be 2.1 cm/day toward the NE. This is a factor of nearly 10^5 smaller than the semi-diurnal variation. Hence, it appears that the observed current is, for all practical purposes, produced entirely by tidal variations.

Spectral amplitudes for the vibrotron (ocean-bottom pressure) signal have revealed various tidal components for the oceanic tide above the OBS III site. Similar spectra have been published for OBS II data.

There is good correlation between the water current velocity and tidal amplitude which supports the hypothesis that the primary current component is related to tides. Cross correlation analysis between current and vibrotron signals is underway. From this study we hope to estimate the phase difference between current and tide for each of the spectral peaks.

3.0 PLANNED PROGRAM FOR NEXT REPORTING PERIOD.

In addition to the routine operation and maintenance of the recording station at Pt. Arena, California, the investigations listed below will be carried forward during the next reporting period.

3.1 Three papers will be published on the following topics:

- 3.1.1 Summary of early results and brief description of station (Science).
- 3.1.2 Waves, Weather, and Microseisms.
- 3.1.3 Oceanic Tides, Current, and Temperatures Recorded on the Floor of the Pacific Ocean.

3.2 Comparison between signals produced by nuclear explosions as detected on land and on the ocean bottom.

3.3 Comparative efficiency of hydrophones and seismometers as ocean-bottom seismic detectors. Consider use of the T-phase for detection purposes.

3.4 Study long-period background signal.

3.5 Locate local earthquakes and relate to regional geology.

3.6 Study equivalent filter characteristics of the continental-oceanic interface for body waves and surface waves.

- 3.7 Search records for unusual phases or record characteristics related to nuclear events as recorded on the ocean bottom.
- 3.8 Conduct surface wave dispersion studies to determine Pacific Basin structure. In these studies, pure oceanic paths will be used.
- 3.9 Study signal enhancement by proper combination of pressure and particle motion.

International
Seismological
Centre

NUMBER OF LOCAL QUAKES VS. DISTANCE (S-P TIME)

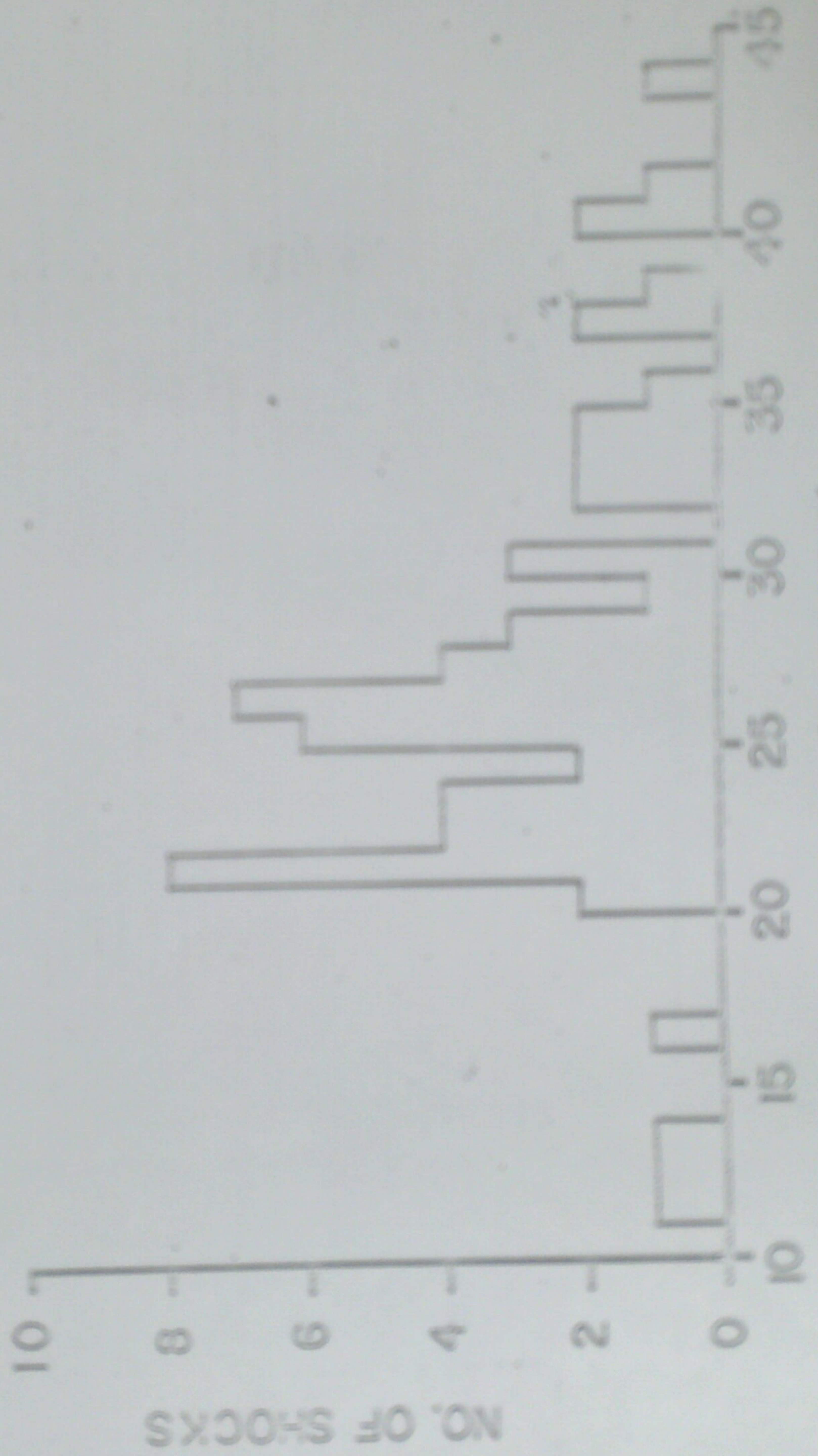


FIGURE 1

LAMONT GEOLOGICAL OBSERVATORY
OCEAN BOTTOM SEISMOGRAPH
PRELIMINARY BULLETIN
FOR
LOCAL EARTHQUAKES ($\Delta < 4^\circ$)
MAY 24 - OCTOBER 29, 1966

Symbols used for T-phase:

T_0 = Time of beginning of T-phase

T_{max} = Time of maximum amplitude of T-phase

Ocean Bottom Seismograph
Point Arena, California

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Date	Phase	h	m	s	Date	Phase	h	m	s
✓ May 24	iP	03	50	40.6	8	iP	17	11	30.0
	iS	03	51	10.7		eS	17	12	22.2
	eTo	03	51	44		eTo	17	14	57
	eTmax	03	51	55		eTmax	17	15	27
	Mag = 3.6					Mag = 4.9			
✓ 24	iP	05	49	31.0	9	eTo	14	35	05
	iS	05	49	51.5		eTmax	14	35	15
	iTo	05	51	00.1	11	iP	10	09	28
	Depth = 1 km					iS	10	09	55.5
	Dist. = 200 km					eTo	10	10	40
	Mag. = 5.2					eTmax	10	10	55
26	iP	02	10	16.6		Mag = 3.3			
	eS	02	10	50.8	11	iP	11	59	32.0
	eTo	02	11	35		iS	11	59	57
	eTmax	02	11	48		eTo	12	01	30
26	eTo	23	57	12		eTmax	12	01	55
	eTmax	23	57	24	13	iP	11	32	50.0
27	eTo	23	53	19		iS	11	33	02.4
	eTmax	23	53	50		eTo	11	34	23
						eTmax	11	34	55
						Mag = 2.8			
30	eP	13	59	34.8	14	iP	08	21	27.5
	eS	14	00	07.1		iS	08	21	50.3
	eTo		02	22		eTo	08	23	20
	eTmax		02	36		eTmax	08	23	42
						Mag = 4.0			
31	iP	17	05	10.4	15	iP	02	26	20
	iS	17	05	36.8		iS	02	26	36
	eTo		07	48		eTo	02	28	07
	eTmax		08	03		eTmax		28	24
	Mag = 4.3					Mag = 2.9			
✓ Jun 6	iP	07	23	51.8	19	iP	16	06	08.0
	i	07	23	58.6		iS	16	06	22.5
	eS	07	24	23.8		eTo	16	07	08
	eTo		25	05		eTmax	16	07	22
	eTmax		25	20		Mag = 2.8			
	Mag = 3.5				19	eTo	20	16	26
6	eTo	07	53	21		eTmax	20	16	45
	eTmax	07	53	41					
6	iP	08	54	19.8					
	iS	08	54	43.3					
	eTo	08	56	22					
	eTmax	08	56	43					
	Mag = 4.2								

Ocean Bottom Seismograph
Point Arena, California

2

Date	Phase	h	m	s	Date	Phase	h	m	s
Jun 20	iP	11	00	28.5	Jul 9	iP	13	49	34.5
	eS	11	00	53.5		iS	13	50	01.2
	eTo	11	03	02		eTo	13	52	07.0
	eTmax	11	03	15		eTmax	13	52	24.0
	Mag = 3.2					Mag = 4.0			
20	iP	16	29	32	11	eTo	01	51	50
	iS	16	29	59.5		eTmax	01	52	20
	eTo	16	32	06	12	iP	02	50	51.0
	eTmax	16	32	18		iS	02	51	31.0
	Mag = 3.9					eTo	02	54	23
20	eP	21	51	38		eTmax	02	54	55
	eS	21	51	49		Mag = 4.6-4.7			
	eTo	21	52	35	13	eTo	05	48	58
	eTmax	21	52	46		eTmax	05	49	07
21	iP	00	39	34	13	eTo	10	36	28
	i	00	39	36		eTmax	10	36	35
	iS	00	39	59.5	13	eTo	14	18	07
	eTo	00	42	05		eTmax	14	18	15
	eTmax		42	15	14	iP	06	51	26.0
	Mag = 3.5					iS	06	51	54.6
21	eTo	03	57	52		eTo	06	53	43
	eTmax	04	58	03		eTmax	06	53	54
26	eTo	04	23	35		Mag = 3.3			
	eTmax	04	23	57	14	iP	15	47	27.1
27	iP	06	04	56.1		iS	15	47	51.0
	iS	06	05	17.5		eTo	15	49	24
	eTo	06	06	04		eTmax	15	49	40
	eTmax	06	06	12		Mag = 3.2			
	Mag = 3.3				15	iP	13	56	27.8
Jul 2	e	08	29	43.5		iS	13	56	53.8
3	eTo	14	40	43		eTo	13	58	49
	eTmax	14	41	10		eTmax	13	58	58
3	iP	18	22	23.2		Mag = 3.2			
	i	18	22	24.5	15	eTo	22	05	51
	iS	18	22	45.5		eTmax	22	06	03
	eTo	18	24	16	16	eTo	01	07	05
	eTmax	18	24	36		eTmax	01	07	15
	Mag = 4.5				16	eTo	03	14	47
8	iP	06	57	30.1		eTmax	03	14	57
	i	06	57	35.1	17	eTo	15	07	40
	iS	06	57	51.7		eTmax	15	08	02
	i	06	57	56.8					
	eTo	06	59	19.1					
	eTmax	06	59	46.1					

Ocean Bottom Seismograph
Point Arena, California

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Date	Phase	h	m	s	Date	Phase	h	m	s
Jul 18	eTo	06	07	20	Jul 27	eTo	14	09	06
	eTmax	06	07	37		eTmax	14	09	28
18	eTo	14	11	17	27	eTo	21	12	39
	eTmax	14	11	28		eTmax	21	12	55
19	eTo	12	59	37	29	eTo	14	29	25
	eTmax	12	59	48		eTmax	14	29	45
19	eTo	21	35	06	29	eTo	16	34	08
	eTmax	21	35	22		eTmax	16	34	18
20	eTo	10	15	19	31	eTo	03	38	21
	eTmax	10	15	44		eTmax	03	38	38
20	eTo	14	29	34	31	eTo	14	41	53
	eTmax	14	29	58		eTmax	14	42	16
22	eTo	17	19	22	31	eTo	15	33	45
	eTmax	17	19	40		eTmax	15	34	03
23	eTo	01	31	01	Aug 2	iP	00	36	22.3
	eTmax	01	31	15		iS	00	36	51.0
23	eTo	04	23	28		eTo	00	38	14
	eTmax	04	23	40		eTmax	00	38	49
23	iP	11	29	16.3		Mag = 3.6			
	iS	11	29	37.4	3	iP	02	26	33.8
	eTo	11	31	05		iS	02	26	42.9
	eTmax	11	31	39		iTo	02	27	56.8
	Mag = 3.5					eTmax	02	28	12
23	iP	17	02	24.4	4	eP	14	36	26.1
	iS	17	02	45.8		eS	14	37	01.5
	eTo	17	04	16		eTo	14	38	47
	eTmax	17	04	37		eTmax	14	38	58
	Mag = 3.2					Mag = 3.4			
24	eTo	00	58	17	5	eTo	06	36	23
	eTmax	00	58	30		eTmax	06	36	39
24	eTo	08	30	30	8	eTo	17	05	27
	eTmax	08	30	56		eTmax	17	05	50
26	iP	11	18	54.9	8	eP	19	38	27.2
	iS	11	19	33.6		eS	19	38	53.6
	eTo	11	22	21		eTo	19	40	32
	eTmax	11	22	56		eTmax	19	40	46
	Mag. = 4.2					Mag = 3.4			
27	eTo	05	58	41	9	eP	10	15	08.2
	eTmax	05	58	56		eS	10	15	21.0
27	eTo	13	37	36	9	iP	15	51	56.3
	eTmax	13	37	58		iS	15	52	20.5
						eTo	15	54	23
						eTmax	15	54	40

Ocean Bottom Seismograph
Point Arena, California

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1966

Date	Phase	h	m	s	Date	Phase	h	m	s
Aug 9	Mag = 3.8				Aug 28	eTo	12	35	32
11	iP	11	26	40.6		eTmax	12	35	51
	iS	11	28	10.6	28	eTo	12	35	32
	eTo	11	32	41		eTmax	12	35	51
	eTmax	11	32	58	28	eTo	14	05	42
	Mag = 3.2					eTmax	14	06	01
14	iP	02	38	37	29	eTo	00	09	12
	iS	02	39	10		eTmax	00	09	28
	eTo	02	40	46	29	eTo	23	02	58
	eTmax	02	40	54		eTmax	23	03	22
	Mag = 3.4				30	iP	18	54	33.7
16	eTo	17	24	16		iS	18	55	00.0
	eTmax	17	24	55		eTo	18	57	04
17	eTo	04	44	47		eTmax	18	57	20
	eTmax	04	45	04		Mag. = 3.8			
19	eTo	12	03	22	31	eTo	16	15	43
	eTmax	12	04	08		eTmax	16	16	02
21	eTo	23	05	49	Sep 1	eTo	14	27	20
	eTmax	23	06	05		eTmax	14	27	50
22	eTo	04	50	31	2	eTo	05	05	56
	eTmax	04	50	51		eTmax	05	06	3
22	eTo	11	48	42	2	eTo	09	05	15
	eTmax	11	49	16		eTmax	09	05	26
22	eTo	12	32	39	2	eTo	22	55	26
	eTmax	12	32	57		eTmax	22	55	58
23	eTo	06	08	13	3	iP	20	29	30.3
	eTmax	06	08	32		i	20	29	43.9
23	eTo	07	03	38		iS	20	29	57.3
	eTmax	04	04	02		i	20	30	07.0
23	eTo	17	06	10		eTo	20	31	43
	eTmax	17	06	20		eTmax	20	32	05
24	eTo	06	52	30		Mag = 3.4			
	eTmax	06	52	50	4	eTo	01	36	43
24	iP	15	14	24.2		eTmax	01	37	03
	iS	15	14	29.4	4	eTo	08	13	50
	eTo	15	16	28		eTmax	08	14	15
	eTmax	15	16	42	4	eTo	12	03	50
24	eTo	23	52	04		eTmax	12	04	14
	eTmax	23	52	21	5	eTo	14	18	14
						eTmax	14	18	24

Ocean Bottom Seismograph
Point Arena, California

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Date	Phase	h	m	s	Date	Phase	h	m	s
Sep 7	eTo	14	59	25	Sep 11	eTo	18	47	59
	eTmax	14	59	40		eTmax	18	48	05
8	iP	22	03	32.0	12	iP	17	16	40.2
	iS	22	04	09.7		iS	17	18	40.1
	eTo	22	06	21		eTo	17	21	10
	eTmax	22	06	50		eTmax	17	22	55
	Mag = 4.0				13	eTo	15	45	50
8	eTo	23	58	08		eTmax	15	46	15
	eTmax	23	58	28	13	eP	20	17	24.7
9	iP	03	16	38.8		eS	20	18	06.4
	eS	03	17	07.8		Mag = 4.1			
	eTo	03	19	16	14	eTo	12	37	31
	eTmax	03	19	37		eTmax	12	37	46
	Mag = 3.9				16	eTo	03	26	37
9	iP	03	25	03.7		eTmax	03	27	03
	iS	03	25	30.8	19	eTo	19	58	51
	eTo	03	27	38		eTmax	19	59	05
	eTmax	03	27	54	20	eTo	04	48	45
	Mag = 3.8					eTmax	04	49	02
9	iP				20	eTo	21	38	33
	iS					eTmax	21	38	55
	eTo	18	48	13	22	iP	01	11	55.9
	eTmax	18	48	26		i		11	58.0
10	eTo	11	34	27		iS		12	19.4
	eTmax	11	34	41		i		12	21.6
10	iP	15	39	38.6		eTo		13	55
	iS	15	40	01.5		eTmax		14	25
	eTo	15	41	06		Mag = 3.7			
	eTmax	15	41	50	22	eP	07	02	25.3
	Mag = 3.7					eS	07	03	0.0
10	i	17	12	10.0		Mag = 4.3			
	eTo	17	14	10	24	eTo	18	33	57
	eTmax	17	14	31		eTmax		34	08
10	eTo	18	13	07	25	eTo	13	07	27
	eTmax	18	13	20		eTmax	13	07	32
10	eTo	18	13	47	25	eTo	17	42	35
	eTmax	18	14	06		eTmax	17	42	55
10	eTo	18	18	08	25	iP	22	57	46.6
	eTmax	18	18	31		i	22	57	51.5
11	iP	00	26	03.1		eS	22	58	10.4
	iS	00	26	24.1		eTo	22	59	50
	eTo	00	28	32		eTmax	22	00	03
	eTmax	00	28	53		Mag = 3.2			

Ocean Bottom Seismograph
Point Arena, California

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Date	Phase	h	m	s	Date	Phase	h	m	s
Sep 26	eTo	07	36	16	Oct 11	eTo	12	28	41
	eTmax	07	36	40		eTmax	12	28	59
28	eP	15	34	25.6	13	eTo	02	47	08
	iS	15	34	47.4		eTmax	02	47	40
	eTo	15	36	40	13	iP	03	36	29.6
	eTmax	15	36	55		iS	03	37	04.2
	Mag = 3.1					eTo	03	39	44
29	iP	04	43	29.8		eTmax	03	40	10
	iS	04	44	07.5		Mag = 4.0			
	eTo	04	45	15	14	iP	20	35	11.4
	eTmax	04	45	55		eS	20	35	45.2
	Mag = 4.3					eTo	20	36	22
30	eTo	05	21	52		eTmax	20	36	55
	eTmax	05	22	10		Mag = 4.1			
Oct 4	iP	20	52	43.4	15	iP	02	53	54.7
	i	20	52	46.2		eS	02	54	36.3
	iS	20	53	05.1		eTo	02	57	27
	eTo	20	54	35		eTmax	02	57	53
	eTmax	20	54	57		Mag = 4.1			
	Mag = 3.3				15	eP	22	59	55.8
4	eTo	22	16	27		eS	23	00	26.1
	eTmax	22	16	35		eTo	23	01	50
4	eTo	22	18	04		eTmax	23	02	20
	eTmax	22	18	11		Mag = 4.3			
5	eTo	14	35	55	17	iP	16	51	02.9
	eTmax	14	36	05		iS	16	53	10.2
6	iP	18	14	31.0		eTo	16	56	05
	iS	18	14	51.9		eTmax	16	56	30
	eTo	18	16	47	20	eTo	15	16	50
	eTmax	18	16	55		eTmax	15	17	04
	Mag = 3.1				20	eTo	18	27	32
6	eTo	23	55	30		eTmax	18	27	47
	eTmax	23	55	40	21	iP	07	05	11.1
8	eTo	23	17	31		iS	07	05	35.9
	eTmax	23	17	53		eTo	07	07	43
9	eTo	20	43	14		eTmax	07	07	58
	eTmax	20	43	31		Mag = 3.7			
10	eTo	06	13	44	21	iP	22	25	47.7
	eTmax	06	14	03		iS		26	10.6
10	eP	07	54	34.5		eTo		28	05
	e	07	54	37.0		eTmax		28	17
	eTo	07	54	50	21	eTo	20	26	07
	eTmax	07	55	03		eTmax	20	26	15

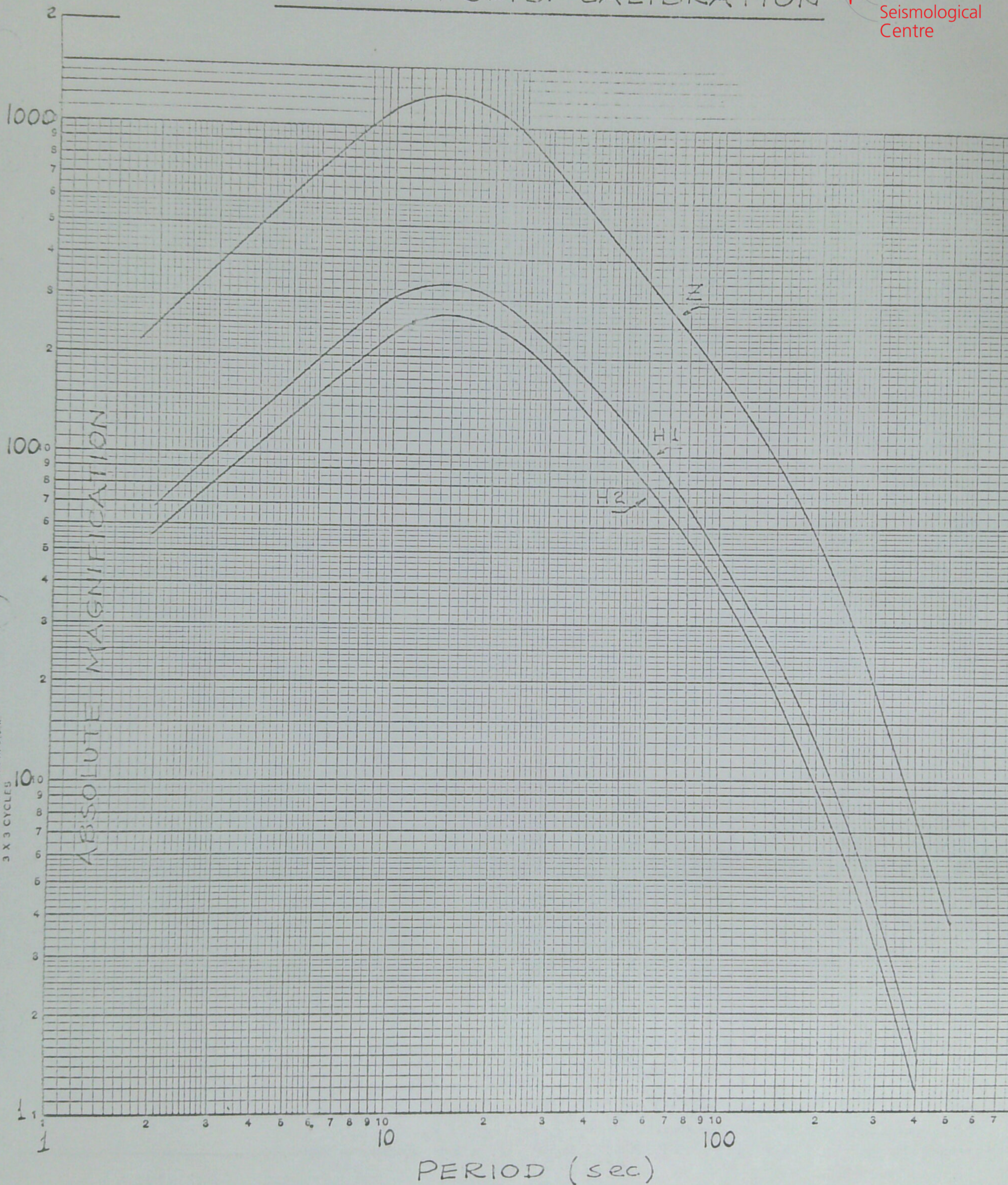
Ocean Bottom Seismograph
Point Arena, California

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Date	Phase	h	m	s
Oct 22	iP	07	32	36.7
	iS	07	33	11.7
	eTo	07	36	12
	eTmax	07	36	27
	Mag = 3.8			
25	iP	19	29	04.8
	iS	19	29	30.1
	eTo	19	31	26
	eTmax	19	31	35
26	eTo	13	52	14
	eTmax	13	52	27
26	eTo	16	55	40
	eTmax	16	55	50
26	eTo	18	24	28
	eTmax	18	24	45
26	eTo	21	31	12
	eTmax	21	31	27
27	eTo	12	09	04
	eTmax	12	09	17
28	eP	15	50	12.0
29	iP	03	52	35.0
	iS	03	53	01.0
	eTo	03	54	40
	eTmax	03	55	05
	Mag = 3.5			
29	iP	05	23	16.0
	iS	05	23	41.8
	eTo	05	25	20
	eTmax	05	25	30
	Mag = 3.5			

LAMONT GEOLOGICAL OBSERVATORY
OCEAN BOTTOM SEISMOGRAPH
PRELIMINARY BULLETIN
FOR
TELESEISMS
MAY 25 - AUGUST 30, 1966

OBS L.P. SEIS. CALIBRATION



GAIN SETTING : MEDIUM (Z) - LOW (H)

RECORD. SENS : 28.3 mm/v (Z)

18.0 mm/v (H1), 18.3 mm/v (H2)

SA

Date

May 25 eLR 14 12 42
Macquarie Island Reg.
USCGS 13 20 56.2
52.9°S 160.0°E
Depth 33 km
Dist. 111.8°
Azim. 219.°
Mag. 6.6

Jun 1 eLR 12 26 03
Tonga Islands
USCGS 11 47 33.1
23.4°S 174.9°W
Depth 24 km
Dist. 77.4°
Azim. 226.6°
Mag. 5.9

2 eS 03 41 58
eLR 03 47 35
Rat Island
USCGS 03 27 53.3
51.1°N 176.0°E
Depth 41 km (R)
Dist. 43.2°
Azim. 307.4°
Mag. 6.0

2 iP 15 31 46.9
e 15 31 50.5

3 iP 14 01 44.4
eLR 14 03 51

5 eLR 05 15 00
Kuriles
USCGS 23 48 17.8
46.5°N 152.5°E
Depth 27 km
Dist. 59.3°
Azim. 307.1°
Mag. 5.9

6 ePP 08 04 14.6
epPP 08 04 56
esPP 08 05 30
ePPP 08 06 12
esPPP 08 07 32
esPPPP 08 09 15
es 10 58
ePS 13 14
ePPS 14 08
ePKKP 16 14
eSS 18 12

Jun 6 esSS 19 44
ePcPPKP 20 43
eSSS 21 32
eSSSS 25 43
eLR 28 30
Afghanistan - USSR Brdr.
USCGS 07 46 16.2
36.3°N 71.2°E
Depth 225 km
Dist. 104.5°
Azim. 347.0°
Mag. 6.3

6 eLR 21 32 18
Philippines
USCGS 20 47 11.5
9.6°N 126.4°E
Depth 48 km
Dist. 98.8°
Azim. 289.5°
Mag. 5.7

7 eLR 01 34 00
Peru
USCGS 00 59 46.6
150.0°S 75.8°W
Depth 50 km
Dist. 69.8°
Azim. 129.4°
Mag. 6.5

7 iP 14 12 9.3
ePP 15 58
e 16 20
ePPPP 18 15
eSKS 22 48
eSP 23 58
eSS 28 45
eSSS 32 32
e 36 23
eLR 39 02
Caroline Islands
USCGS 13 59 36.0
11.3°N 139.6°E
Depth 50 km
Dist. 87.6°
Azim. 282.5°
Mag. 6.5

13 eLR 08 17 24
New Hebrides
USCGS 07 33 13.4
21.2°S 171.4°E
Depth 49 km
Dist. 82.5°
Azim. 235.8°
Mag. 5.9

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Date	Phase	h	m	s	Date	Phase	h	m	s
Jun 13	iP	18	20	24.5	Jun 22	eSSS		05	38
	ipP		21	27.0		esSSS		08	19
	esP		21	51		eSSSS		09	48
	ePP		23	27		Banda Sea			
	esPP		24	50		USCGS 20 29 03.6			
	esPPP		26	46		7.2°S 124.6°E			
	esPPPP		27	56		Depth 507 km			
	eS		30	24		Dist. 110.9°			
	eScS		30	28		Azim. 277.4°			
	eSPP		31	34		Mag. 6.1			
	ePPS		32	11					
	esPS		32	39	25	eLR	02	21	40
	esSSS		40	29		Japan Region			
	Santa Cruz Island					USCGS 01 46 10.4			
	USCGS 18 08 38.4					29.6°N 142.1°E			
	12.2°S 167.1°E					Depth 49 km			
	Depth 259 km					Dist. 74.9°			
	Dist. 81.2°					Azim 295.8°			
	Azim. 247.0°					Mag. 5.5			
	Mag. 6.2				27	ePS	11	09	42
15	Solomon Islands					eLR	11	41	40
	USCGS 00 59 45.8					Nepal-India Brdr.			
	10.4°S 160.8°E					USCGS 10 41 08.6			
	Depth 31 km					29.7°N 80.9°E			
	Dist. 84.7°					Depth 37 km			
	Azim. 252.5°					Dist. 108.5°			
	Mag. 6.1					Azim. 336.9°			
						Mag. 6.1			
15	eLR	17	16	44	27	ePS	11	27	48
	Solomon Islands					eSS	11	34	13
	USCGS 16 36 24.1					eLR	11	52	08
	10.3°S 160.7°E					Nepal-India Brdr.			
	Depth 18 km					USCGS 10 59 18.1			
	Dist. 84.7°					29.7°N 81.0°E			
	Azim. 252.6°					Depth 40 km			
	Mag. 5.8					Dist. 108.4°			
						Azim. 337.1°			
22	eSKS	20	49	44		Mag. 6.0			
	ePKS		50	24	28	iP	04	10	56.2
	epPPP		50	54		e	04	11	22
	epPKS		51	56		iS	04	11	58
	eSKS		52	39		eLR	04	12	30
	eSP		56	03		California			
	ePS		56	52		USCGS 04 08 54.7			
	ePKKP		58	14		35.8°N 120.6°W			
	esPPS		59	32		Depth 5 km			
	e	21	00	24		Dist. 3.81°			
	eSS		02	04		Azim. 126.5°			
	esSS		04	18		Mag. 5.0			

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Date	Phase	h	m	s	Date	Phase	h	m	s
Jun 28	iP	04	27	15.3	Jul 4	ePPP		43	28
	eS	04	28	17		eS		47	26
	eLR	04	28	44		eLQ		50	22
	California					eLR		52	11
	USCGS 04 26 12.4					Aleutians			
	35.9°N 120.5°W					USCGS 18 33 35.7			
	Depth 4 km					51.7°N 179.9°E			
	Dist. 3.8°					Depth 13 km			
	Azim. 124.6°					Dist. 40.7°			
	Mag. 5.3					Azim. 308.0°			
29	iP	19	54	25		Mag. 6.2			
	eS	19	55	34	6	eLR	19	46	48
	eLR	19	56	06		Easter Island			
	California					USCGS 19 23 38			
	USCGS 19 53 24.1					4.4°S 104.9°W			
	35.8°N 120.5°W					Depth 33 km (R)			
	Depth 5 km					Dist. 46.0°			
	Dist. 3.9°					Azim. 152.4°			
	Azim. 125.7°					Mag. 4.8			
	Mag. 4.9				10	eL	10	39	20
29	eLR	22	24	10		Kermadec			
	New Hebrides					USCGS 10 00 39.1			
	USCGS 21 46 54.5					30.5°S 177.8°W			
	13.8°S 166.7°E					Depth 40 km			
	Depth 35 km					Dist. 84.5°			
	Dist. 82.5°					Azim. 224.1°			
	Azim. 246.1°					Mag. 5.8			
	Mag. 6.2				10	eL	16	54	05
30	iP	01	18	38		Ryukyu Japan			
	eS	01	19	26		USCGS	16	12	41.5
	California					24.2°N 125.2°E			
	(Parkfield Series)					Depth 28 km			
Jul 1	iP	06	03	38		Dist. 90.0°			
	eS	06	14	24		Azim. 301.1°			
	eSP	06	15	53		Mag. 5.9°			
	eLR	06	33	08	11	eL	23	20	40
	Taiwan Region					Tonga Region			
	USCGS 05 50 39.2					USCGS 22 46 05.7			
	24.8°N 122.5°E					19.2°S 173.6°W			
	Depth 117 km					Depth 120 km (R)			
	Dist. 91.4°					Dist. 81.4°			
	Azim. 303.3°					Azim. 237.5°			
	Mag. 6.4					Mag. 5.6			
4	eP	18	41	19	12	eLR	19	44	57
	epP	18	41	30.5		Western Caucasus			
	ePP		42	25		USCGS 18 53 08.5			
	e		42	48		44.6°N 37.4°E			

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Date	Phase	h	m	s	Date	Phase	h	m	s
Jul 12	Depth 26 km Dist. 96.0° Azim. 13.0° Mag. 5.9				Jul 20	eLR	13	47	27
13	eLR Nicaragua USCGS 08 20 59.4 12.6°N 87.7°W Depth 61 km (R) Dist. 41.4° Azim. 118.0° Mag. 5.3	08	43	42		Easter Islands USCGS 13 22 54 13.3°S 111.4°W Depth 33 km Dist. 52.6° Azim. 164.0° Mag. 5.0			
14	eLR Gulf of Alaska USCGS 12 18 17.0 56.2°N 149.8°W Depth 33 (R) Dist. 24.7° Azim. 325.1° Mag. 5.2	12	79	45	21	eLR	05	53	56
19	eS eSS eLR Komandorsky Region USCGS 01 40 53.9 56.2°N 164.9°E Depth 18 km Dist. 49.0° Azim. 315.7° Mag. 5.4	01	56	53		N. Easter Island Cord. USCGS 05 32 18.2 3.9°S 104.3°W Depth 33 km (R) Dist. 45.8° Azim. 151.4° Mag. 5.1			
		02	00	20	22	eP	10	24	58
		02	03	37		eS	10	30	09
						eSS	10	32	50
						eLR	10	33	50
						Aleutians USCGS 10 17 22.5 51.7°N 173.5°W Depth 56 km (R) Dist. 36.6° Azim. 307.9° Mag. 5.6			
19	eS eSS eLR Andreanof Islands USCGS 19 20 33.4 51.7°N 173.2°W Depth 47 km (R) Dist. 36.5° Azim. 307.9° Mag. 5.5	19	33	16	23	eS	14	44	30
		19	35	55		eSS	14	47	14
		19	37	05		eLR	14	48	12
						Aleutians USCGS 14 31 51.2 51.7°N 173.5°W Depth 55 km (R) Dist. 36.6° Azim. 307.9° Mag. 5.3			
20	eLR Easter Islands USCGS 10 55 57 4.1°S 104.5°W Depth 33 km (R) Dist. 45.9° Azim. 151.8° Mag. 4.6	11	17	26	24	eLR	09	27	14
						Samoa Islands USCGS 08 52 13 16.3°S 172.8°W Depth 49 km Dist. 70.7° Azim. 229.6° Mag. 4.8			

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Date	Phase	h	m	s	Date	Phase	h	m	s
Jul 25	eLR	09	35	53	Aug 1	West Pakistan			
	Fox Islands, Aleutians					USCGS 21 02 59.6			
	USCGS	09	18	36.7		30.0°N 68.7°E			
	52.1°N 170.0°W					Depth 33 km (R)			
	Depth 31 km					Dist. 111.1°			
	Dist.					Azim. 347.8°			
	Azim.					Mag. 6.2			
	Mag. 4.3				5	eL	05	13	36
26	eLR	06	48	10		Solomon Islands			
	N. Easter Island Cord.					USCGS 04 33 07.4			
	USCGS 06 26 39					10.9°S 162.3°E			
	03.8°S 103.3°W					Depth 93 km			
	Depth 33 km (R)					Dist. 33.9°			
	Dist. 46.1°					Azim. 251.1°			
	Azim. 150.1°					Mag. 5.7			
	Mag. 4.5				7	iP	02	19	54.0
27	eL	05	27	18		e	02	20	35
	Northern Chile					ePP	02	21	18.7
	USCGS 04 48 59.4					eS	02	25	28
	24.2°S 70.3°W					eScP	02	26	19
	Depth 35 km (R)					eSS	02	27	49
	Dist. 81.9°					eLR	02	28	42
	Azim. 130.5°					eTo	02	57	08
	Mag. 6.0					eTmax	02	59	03
28	eLR	01	57	11		Aleutians			
	New Hebrides					USCGS 02 13 05.1			
	USCGS 01 18 27.4					50.6°N 171.3°W			
	17.2°S 167.7°E					Depth 39 km (R)			
	Depth 17 km					Dist. 35.2°			
	Dist. 84.1°					Azim. 306.1°			
	Azim. 242.9°					Mag. 6.5			
	Mag. 5.3				7	eLR	14	23	24
Aug 1	eLR	20	03	07		Gulf of Alaska			
	West Pakistan					USCGS 14 11 51.2			
	USCGS 19 04 55.1					59.6°N 144.4°W			
	29.9°N 68.8°E					Depth 4 km			
	Depth 33 km (R)					Dist. 25.0°			
	Dist. 109.5°					Azim. 335.7°			
	Azim. 346.6°					Mag. 5.5			
	Mag. 5.8				7	iP	17	38	57
1	ePP	21	22	19		e	17	39	56
	eSP		32	27		eS	17	41	01
	eSS		38	07		eLR	17	41	28
	eSSS		43	13		Gulf of California			
	e		46	56		USCGS 17 36 26.7			
	e		49	03		31.8°N 114.5°W			
	eLR		53	23		Depth 33 km (R)			
						Dist. 10.3°			

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Date	Phase	h	m	s
Aug 7	Azim. 125.0° Mag. 6.3			
8	eP	08	08	03
	eS	08	12	24
	eLR	08	13	50
	Rev.-Gig Islands Reg. USCGS 08 02 45.8 19.3°N 108.1°W Depth 33 km (R) Dist. 23.5° Azim. 138.4° Mag. 5.4			
10	eL	05	35	00
	Tonga Region USCGS 05 01 09.4 20.1°S 175.3°W Depth 96 km (R) Dist. 75.1° Azim. 229.0° Mag. 5.8			
10	eLR	13	14	43
	New Britain USCGS 12 33 42.2 5.5°S 151.8°E Depth 55 km Dist. 88.5° Azim. 261.9° Mag. 5.3			
11	eLR	05	51	10
	Tonga Region USCGS 05 12 42 19.3°S 173.9°W Depth 33 km Dist. 73.6° Azim. 228.0° Mag. 5.4			
12	eLR	20	30	15
	South of Alaska USCGS 20 16 59.8 52.9°N 161.6°W Depth 31 km (R) Dist. 29.6° Azim. 312.1° Mag. 5.6			

Date	Phase	h	m	s
Aug 15	eLR	03	31	42
	Mindoro, Philippine Islands USCGS 02 45 32.3 13.3°N 121.3°E Depth 14 km Dist. 100.1° Azim. 295.7° Mag. 5.7			
15	eLR	13	48	45
	South Alaska USCGS 13 36 23.7 60.4°N 146.0°W Depth 9 km Dist. 26.1° Azim. 235.46° Mag. 5.3			
16	eLR	04	49	32
	Gulf of Alaska USCGS 04 43 25 30.2°N 113.5°W Depth 33 km (R) Dist. 12.00° Azim. 128.1° Mag. 4.5			
16	eP	18	04	42.6
	eS	18	06	35.2
	e	18	07	20.8
	e	18	08	22.1
	e	18	09	21.1
	e LR	18	10	08
	S. Nevada USCGS 18 02 36.1 37.4°N 114.2°W Depth 33 km (R) Dist. 8.1° Azim. 92.2° Mag. 6.1			
17	eL	21	19	22
	Aleutians USCGS 20 58 35.9 52.3°N 174.9°E Depth 32 km (R) Dist. 43.7° Azim. 309.2° Mag. 5.6			

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Date	Phase	h	m	s	Date	Phase	h	m	s
Aug 18	e	09	19	51.0	Aug 20	eLR	23	30	36
	S. Nevada					South of Fiji Islands			
	USCGS 09 15 34.9					USCGS 22 55 03.0			
	37.3°N 114.1°W					23.4°S 176.0°W			
	Depth 9 km					Depth 57 km			
	Dist. 8.1°					Dist. 78.1°			
	Azim. 92.9°					Azim. 227.4°			
	Mag. 5.1					Mag. 5.6			
18	eP	10	40	25.2	21	eLR	05	45	16
	epP	10	40	41.5		Mindanao Philippine Islands			
	eS	10	46	27.4		USCGS 05 00 26.8			
	e	10	49	27		8.5°N 126.7°E			
	eLR	10	51	56		Depth 67 km			
	Guatemala					Dist. 99.3°			
	USCGS 10 33 16.5					Azim. 288.5°			
	14.6°N 91.7°W					Mag. 6.0			
	Depth 76 km (R)				22	eP	17	54	46
	Dist. 37.2°					eS	18	05	22
	Azim. 120.1°					eSS	18	11	06
	Mag. 5.9					eSSS	18	14	34
19	eLR	03	24	40		ePcPPKP	18	17	50
	Gulf of Alaska					eLR	18	20	50
	USCGS 03 10 04.2					Loyalty Islands			
	59.5°N 144.6°W					USCGS 17 42 10.6			
	Depth 33 km (R)					22.4°S 170.6°E			
	Dist. 25.0°					Depth 39 km			
	Azim. 335.3°					Dist. 85.7°			
	Mag. 4.6					Azim. 237.3°			
19	eP	12	40	25		Mag. 5.5			
	ePKS	12	49	14	26	eLR	09	45	56
	ePPS	12	54	55		Loyalty Islands			
	eSS	12	58	52		USCGS 09 06 50.4			
	eLR	13	09	54		22.1°S 170.0°E			
	Turkey					Depth 33 km			
	USCGS 12 22 09.6					Dist. 85.9°			
	39.2°N 41.7°E					Azim. 237.9°			
	Depth 26 km (R)					Mag. 5.6			
	Dist. 102.0°				30	eLR	20	33	40
	Azim. 11.00°					Southern Alaska			
	Mag. 6.1					USCGS 20 20 54.0			
20	eLR	12	46	58		61.3°N 147.5°W			
	Turkey					Depth 36 km (R)			
	USCGS 11 59 12.1					Dist. 27.3°			
	39.3°N 40.9°E					Azim. 335.6°			
	Depth 37 km					Mag. 5.9			
	Dist. 101.8°								
	Azim. 11.6°								
	Mag. 5.4								