

THE PANAMA CANAL
DEPARTMENT OF OPERATION AND MAINTENANCE
SECTION OF METEOROLOGY AND HYDROGRAPHY

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Lat. 8° 57' 39" N.

Long. 79° 33' 29" W.

h=36 meters.

Lithologic foundation: Basalt.

Time Correction: Within 1.0 sec.

INSTRUMENTS—FIXED CONSTANTS

| INSTRUMENTS | SYMBOL | REGISTRATION | DAMPING | PAPER SPEED | MASS |
|---------------|--------|--------------|----------|-----------------|---------|
| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | 1.3 gr. |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | 100 kg. |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T. | V | G | DETERMINED |
|---------------|-------------------|-----|------|---------|---------------|
| Wood-Anderson | N-S | 1.0 | 1370 | 14 to 1 | June 30, 1947 |
| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori | | | | | |
| Bosch-Omori | Not in Operation. | | | | |

Month JANUARY 1951Page No. 22

| No. and Date | Phase | Time G. M. T. | Period | AMPLI- TUDE | REMARKS |
|--------------|-------|------------------|--------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | h m s | | mm | |
| #1 Jan. 5 | 1P | 00:53:13 | | 45.0 N | Felt by many spectators at the ball game in the Balboa Stadium and generally felt throughout the Canal Zone. Rated Intensity III Modified Mercalli Scale. Approximate distance 140 miles. |
| | 1S | 00:53:42 | | 47.0 E | |
| | F | 01:15 | | 65+ N 65+ E | |
| #2 Jan. 5 | 1P | 20:18:33 | | 7.5 N | Felt by a few residents. Intensity I Modified Mercalli Scale. Approximate distance 140 miles. |
| | 1S | 20:19:03 | | 6.0 E | |
| | F | 20:26 | | 29.0 N 24.5 | |
| #3 Jan. 5 | 1P | 20:31:59 | | | Approximate distance 140 miles. |
| | 1S | 20:32:29 | | | |
| | F | 20:35 | | | |
| #4 Jan. 6 | 1P | 07:34:28 | | 6.5 N | Approximate distance 140 miles. |
| | 1S | 07:34:58 | | 7.5 E 26.0 N 24.0 E | |
| | F | 07:44 | | | |
| #5 Jan. 6 | 1P | 07:52:03 | | 65+ N | U. S. Coast & Geodetic Survey reports preliminary epicenter at 7-1/2° N. Lat., 81° W. Long. |
| | 1S | 07:52:33 | | 65+ E | |
| | F | 08:27 | | 65+ N 65+ E | |

This shock was rated Intensity V Modified Mercalli Scale and was the heaviest earthquake in the Canal Zone since May 2, 1943. The shock awakened most residents on both sides of the Isthmus, and many were alarmed. Unstable objects overturned and dishes, pots, pans, and windows rattled with some being broken. Plaster walls in numerous rooms of the Panama Canal Administration Building at Balboa Heights were cracked and many previous breaks reopened. The pendulum on the master clock, used as a time marker for the seismograph records, was stopped at 07:52:47 G.C.T. No other damage has been reported.

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

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Month JANUARY 1951

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|------------------------|---------------|-------------------------------|---|---|----------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| # 5 Jan. 6 Cont. | | | | | | | From reports in the Interior of Panama at Calobre, Veraguas Province and Fenssons, Coclé Province, many people were frightened and ran into the streets with their children in their arms. During the quake the accelerometer at Balboa Heights was set off for the first time since May 6, 1936. The epicenter was approximately 140 miles away. |
| # 6 Jan. 6 | 1P 1S F | 08:04:42 08:05:12 08:09 | | | | | Earthquakes # 1 to # 51 inclusive all centered approximately 140 miles from Balboa Heights. |
| # 7 Jan. 6 | 1P 1S F | 08:27:12 08:27:40 08:33 | | | 12.5M 19.0M | | |
| # 8 Jan. 6 | 1P 1S F | 08:49:34 08:50:04 08:53 | | | | | * The time of the primary waves on earthquakes # 6 through # 13 may be a few seconds off as the clock had stopped. |
| # 9 Jan. 6 | 1P 1S F | 09:18:44 09:19:13 09:22 | | | | | |
| # 10 Jan. 6 | 1P 1S F | 09:30:33 09:31:02 09:36 | | | 9.5M 9.0M | | |
| # 11 Jan. 6 | 1P 1S F | 10:11:55 10:12:24 10:15 | | | | | |
| # 12 Jan. 6 | 1P 1S F | 10:15:02 10:15:31 10:18 | | | | | |
| # 13 Jan. 6 | 1P 1S F | 11:16:44 11:17:14 11:22 | | | 8.5M 12.5M | | |
| # 14 Jan. 6 | 1P 1S F | 13:01:30 13:02:00 13:04 | | | | | |
| # 15 Jan. 6 | 1P 1S F | 14:14:03 14:14:33 14:17 | | | | | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Page No. 24--

Month JANUARY 1951

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TITUDE mm | REMARKS |
|----------------|-------|------------------|---|---|-------------|------------------------|---------------------------------------|
| | | h | m | s | | | |
| # 16 Jan. 6 | 1P | 14:54:32 | | | | | |
| | 1S | 14:55:01 | | | | 14.0M 9.5M | |
| | F | 14:58 | | | | | |
| # 17 Jan. 6 | 1P | 14:59:04 | | | | 45.0M | Intensity II modified Mercalli scale. |
| | 1S | 14:59:32 | | | | 34.0M 70+ N | |
| | F | 15:13 | | | | 70+ E | |
| # 18 Jan. 6 | 1P | 15:42:34 | | | | | |
| | 1S | 15:43:03 | | | | | |
| | F | 15:45 | | | | | |
| # 19 Jan. 6 | 1P | 17:22:25 | | | | | |
| | 1S | 17:22:54 | | | | | |
| | F | Merged with # 20 | | | | | |
| # 20 Jan. 6 | 1P | 17:24:39 | | | | | |
| | 1S | 17:25:08 | | | | | |
| | F | 17:28 | | | | | |
| # 21 Jan. 6 | 1P | 18:39:18 | | | | | |
| | 1S | 18:39:47 | | | | | |
| | F | 18:42 | | | | | |
| # 22 Jan. 6 | 1P | 19:22:36 | | | | | |
| | 1S | 19:23:04 | | | | | |
| | F | 19:26 | | | | | |
| # 23 Jan. 6 | 1P | 19:33:21 | | | | | |
| | 1S | 19:33:51 | | | | 11.0M 10.5M | |
| | F | 19:39 | | | | | |
| # 24 Jan. 6 | 1P | 20:18:05 | | | | | |
| | 1S | 20:18:35 | | | | | |
| | F | 20:21 | | | | | |
| # 25 Jan. 6 | 1P | 20:27:27 | | | | | |
| | 1S | 20:27:55 | | | | | |
| | F | Merged with # 26 | | | | | |
| # 26 Jan. 6 | 1P | 20:28:33 | | | | | |
| | 1S | 20:29:02 | | | | | |
| | F | 20:33 | | | | | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

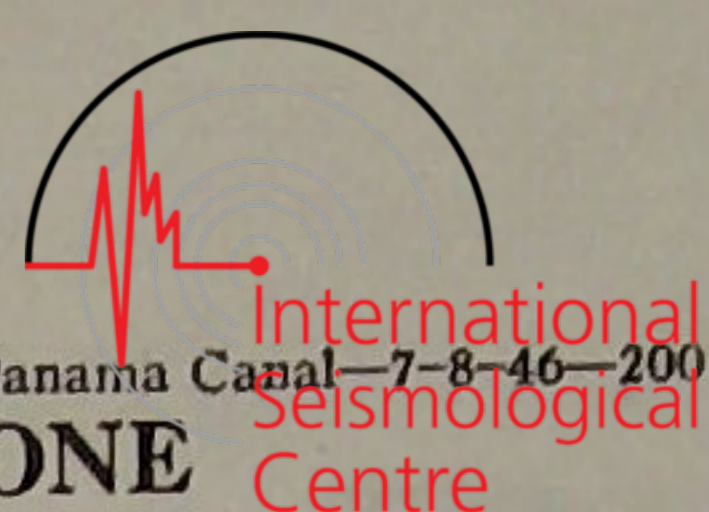
Month JANUARY

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|----------------|-------|------------------|----|----|-------------|----------------------|--------------------------------------|
| | | h | m | s | | | |
| # 27 Jan. 6 | 1P | 21 | 18 | 55 | | | |
| | 1S | 21 | 19 | 24 | | 5.0M 7.0M | |
| | F | 21 | 22 | | | | |
| # 28 Jan. 7 | 1P | 00 | 17 | 03 | | | |
| | 1S | 00 | 17 | 33 | | | |
| | F | 00 | 20 | | | | |
| # 29 Jan. 7 | 1P | 00 | 39 | 35 | | | |
| | 1S | 00 | 46 | 05 | | | |
| | F | 00 | 43 | | | | |
| # 30 Jan. 7 | 1P | 02 | 05 | 29 | | | |
| | 1S | 02 | 05 | 58 | | | |
| | F | 02 | 09 | | | | |
| # 31 Jan. 7 | 1P | 02 | 09 | 31 | | | |
| | 1S | 02 | 09 | 59 | | | |
| | F | 02 | 14 | | | | |
| # 32 Jan. 7 | 1P | 02 | 46 | 22 | | | |
| | 1S | 02 | 46 | 50 | | 10.0M 10.0M | |
| | F | 02 | 51 | | | | |
| # 33 Jan. 7 | 1P | 04 | 57 | 58 | | | |
| | 1S | 04 | 58 | 27 | | | |
| | F | 05 | 01 | | | | |
| # 34 Jan. 7 | 1P | 06 | 43 | 50 | | | |
| | 1S | 06 | 44 | 18 | | | |
| | F | 06 | 47 | | | | |
| # 35 Jan. 7 | 1P | 14 | 59 | 21 | | 20.0M | Intensity II modified Mercalli scale |
| | 1S | 14 | 59 | 50 | | 19.0M | |
| | F | 15 | 10 | | | 70+ M 70+ M | |
| # 36 Jan. 7 | 1P | 15 | 26 | 01 | | | |
| | 1S | 15 | 26 | 30 | | | |
| | F | 15 | 28 | | | | |
| # 37 Jan. 7 | 1P | 16 | 17 | 02 | | | |
| | 1S | 16 | 17 | 32 | | | |
| | F | 16 | 20 | | | | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month JANUARY 1951Page No. 26

| No. and Date | Phase | Time G. M. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|-----------------|---------------|-------------------------------|---|---|-------------|----------------------|---------|
| | | h | m | s | | | |
| # 38 Jan. 7 | 1P 1S F | 17:06:00 17:06:30 17:08 | | | | | |
| # 39 Jan. 7 | 1P 1S F | 17:51:32 17:52:00 17:54 | | | | | |
| # 40 Jan. 7 | 1P 1S F | 18:34:01 18:34:30 18:36 | | | | | |
| # 41 Jan. 7 | 1P 1S F | 19:30:33 19:31:03 19:33 | | | | | |
| # 42 Jan. 7 | 1P 1S F | 21:07:31 21:08:00 21:10 | | | | | |
| # 43 Jan. 8 | 1P 1S F | 06:22:42 06:23:11 06:25 | | | | | |
| # 44 Jan. 9 | 1P 1S F | 09:42:40 09:43:10 09:45 | | | | | |
| # 45 Jan. 10 | 1P 1S F | 12:28:26 12:28:55 12:31 | | | | | |
| # 46 Jan. 10 | 1P 1S F | 20:38:26 20:38:55 20:41 | | | | | |
| # 47 Jan. 10 | 1P 1S F | 22:51:18 22:51:46 22:53 | | | | | |
| # 48 Jan. 11 | 1P 1S F | 01:23:34 01:24:04 01:26 | | | | | |
| # 49 Jan. 11 | 1P 1S F | 05:32:44 05:33:14 05:35 | | | | | |



SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month JANUARY 1951

Page No. 27

| No. and Date | Phase | Time G. M. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|-----------------|-------------|-------------------------------|---|---|--------------|----------------------|---------------------------------------------|
| | | h | m | s | | | |
| # 50 Jan. 11 | P S F | 05:58:58 05:59:28 06:01 | | | | | |
| # 51 Jan. 11 | P S F | 06:14:15 06:14:45 06:16 | | | | | Approximate distance 140 miles |
| # 52 Jan. 12 | P S F | 17:34:12 17:34:38 17:36 | | | | | Weak. Approximate distance 125 miles |
| # 53 Jan. 13 | P S F | 09:04:28 09:04:55 19:06 | | | | | Very weak. Approximate distance 130 miles. |
| # 54 Jan. 13 | P S F | 17:24:50 17:25:17 17:27 | | | | | Weak. Approximate distance 130 miles |
| # 55 Jan. 13 | P S F | 23:47:10 23:47:41 23:49 | | | | | Very weak Approximate distance 145 miles |
| # 56 Jan. 14 | P S F | 19:36:27 19:36:53 19:39 | | | | | Approximate distance 125 miles |
| # 57 Jan. 15 | P S F | 04:44:44 04:45:11 04:47 | | | | | Very weak Approximate distance 130 miles |
| # 58 Jan. 15 | P S F | 09:11:53 09:12:19 09:15 | | | 5.0M 4.0M | | Approximate distance 130 miles |
| # 59 Jan. 15 | P S F | 12:06:33 12:07:03 12:11 | | | 5.0M 6.0M | | Approximate distance 145 miles |
| # 60 Jan. 15 | P S F | 12:11:34 12:11:59 12:15 | | | 7.0M 5.0M | | Approximate distance 120 miles |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month JANUARY 1951

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|------------------|---------------|-------------------------------|---|---|--------------|-----------------------------------------|---------|
| | | h | m | s | | | |
| #61 Jan. 17 | 1P 1S F | 16:05:39 16:05:58 16:08 | | | | Approximate distance 80 miles. Weak. | |
| #62 Jan. 18 | 1P 1S F | 02:01:07 02:01:35 02:05 | | | 5.0m 5.0e | Approximate distance 135 miles. | |
| #63 Jan. 18 | 1P 1S F | 14:49:42 14:50:12 14:52 | | | | Approximate distance 145 miles. | |
| #64 Jan. 19 | 1P 1S F | 09:53:42 09:54:11 09:57 | | | | Approximate distance 140 miles. | |
| #65 Jan. 20 | 1P eS F | 08:08:58 08:10:06 08:14 | | | | Approximate distance 415 miles. | |
| #66 Jan. 20 | e F | 13:14:56 13:17 | | | | Faint. Distant. | |
| #67 Jan. 21 | 1P 1S F | 07:52:10 07:52:40 07:55 | | | | Approximate distance 145 miles. | |
| #68 Jan. 21 | 1P 1S F | 15:22:28 15:22:58 15:25 | | | | Approximate distance 145 miles. | |
| #69 Jan. 21 | 1P 1S F | 23:55:35 23:56:05 23:59 | | | | Approximate distance 145 miles. | |
| #70 Jan. 22 | eP 1S F | 12:46:37 12:47:17 12:50 | | | | Approximate distance 190 miles. | |
| #71 Jan. 25 | 1P 1S F | 14:39:27 14:39:57 14:42 | | | | Approximate distance 145 miles. | |
| #63 X Jan. 19 | e F | 01:43:05 01:49 | | | | Distant. | |

G. E. MATTHEW
Chief Hydrographer

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SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

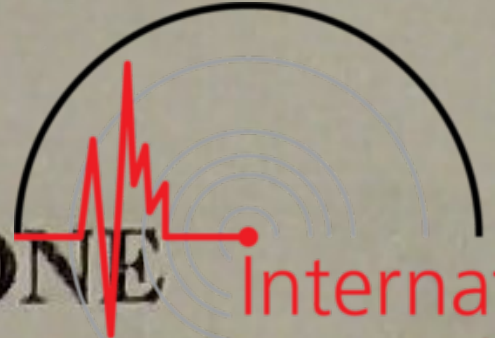
Lat. 8° 57' 39" N.

Long. 79° 33' 29" W.

h = 36 meters.

Lithologic foundation: Basalt.

Time Correction: Within 1.0 sec.



International
Seismological
Centre

INSTRUMENTS—FIXED CONSTANTS

| INSTRUMENTS | SYMBOL | REGISTRATION | DAMPING | PAPER SPEED | MASS |
|---------------|--------|--------------|----------|-----------------|---------|
| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | 1.3 gr. |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | 100 kg. |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T ₀ | V | G | DETERMINED |
|---------------|-----------|----------------|--------|---------|---------------|
| Wood-Anderson | N-S | 1.0 | 1370 | 14 to 1 | June 30, 1947 |
| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori |)) |)) |)) |)) |)) |
| Bosch-Omori | | | | | |

Month FEBRUARY 1951Page No. 29

| No. and Date | Phase | Time G. M. T. | | | Period | AMPLI- TUDE mm | REMARKS |
|----------------|---------------|-------------------------------|---|---|--------|----------------------|-----------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #72 Feb. 2 | 1P 1S F | 07:01:15 07:01:24 07:04 | | | | 5.5N 7.5E | Approximate distance 45 miles. |
| #73 Feb. 2 | 1P 1S F | 17:59:00 17:59:26 18:01 | | | | | Weak Approximate distance 125 miles. |
| #74 Feb. 5 | eP 1S F | 02:37:15 02:37:45 02:37 | | | | | Weak Approximate distance 145 miles. |
| #75 Feb. 7 | 1P 1S F | 22:54:38 22:54:56 22:59 | | | | 24.0N 18.5E | Approximate distance 85 miles. |
| #76 Feb. 9 | 1P 1S F | 20:53:40 20:53:48 20:57 | | | | 19.0N 14.5E | Approximate distance 40 miles. |
| #77 Feb. 13 | 1P 1S F | 12:48:35 12:49:03 12:51 | | | | | Weak Approximate distance 135 miles. |
| #78 Feb. 13 | eP eS F | 22:24:56 22:34:50 22:45 | | | | | U.S.C. & G.S. reports epicenter near 56°N. Lat., 155-1/2° W. long. Approximate distance 5200 miles. |
| #79 Feb. 14 | 1P 1S F | 01:54:45 01:55:20 01:58 | | | | | Approximate distance 170 miles. |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month FEBRUARY 1951Page No. 30

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|----------------|-------|------------------|----|----|-------------|--------------------------------------------------------------------------------------------------------------------------------|---------|
| | | h | m | s | | | |
| #80 Feb. 17 | 1P | 21 | 26 | 11 | | U.S.C. & G.S. reports epicenter near 7°S.Lat., 146°E.Long. (Southeastern New Guinea) Approximate distance 9600 miles. | |
| | e | 21 | 28 | 45 | | | |
| | e | 21 | 29 | 40 | | | |
| | F | 21 | 37 | | | | |
| #81 Feb. 18 | 1P | 07 | 11 | 47 | | U.S.C & G.S. reports epicenter near 1-1/2°N.Lat., 82°W.Long. Approximate distance 525 miles. | |
| | 1S | 07 | 13 | 15 | | | |
| | F | 07 | 16 | | | | |

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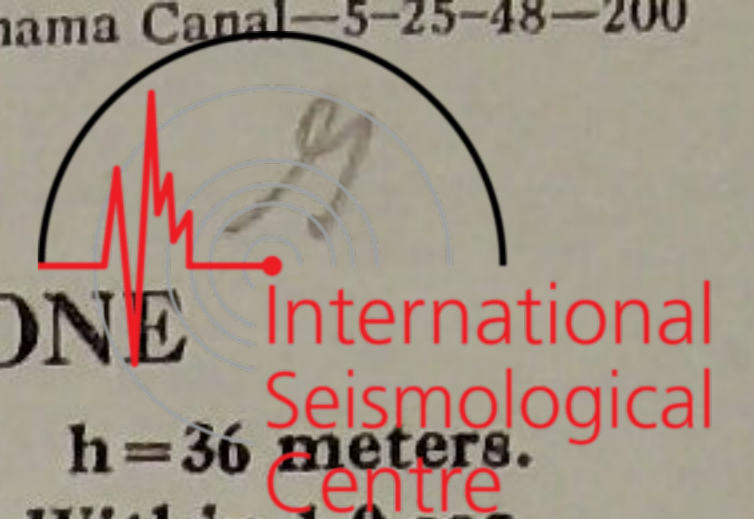
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| Bosch-Omori | | | | | |
| Bosch-Omori | | | | | |

Month MARCH 1951Page No. 31

| No. and Date | Phase | Time | Period | AMPLI- | REMARKS |
|--------------------|---------------|-------------------------------|--------|--------|--------------------------------------------------------------------------------------------------------------------------------|
| | | G. M. T. | | TUDE | |
| | | h m s | | mm | |
| #82 Mar. 4 | 1P eS F | 11:22:49 11:28:14 11:37 | | | U.S.C. & G.S. reports epicenter near 16° S.Lat., 74° W.Long. (near coast of Southern Peru) Approximate distance 2350 miles. |
| #83 Mar. 9 | 1P 1S F | 02:03:09 02:03:22 02:06 | | | Approximate distance 65 miles. |
| #84 Mar. 10 | 1P 1S F | 09:44:58 09:45:21 09:48 | | | Approximate distance 110 miles. |
| #85 Mar. 15 | 1P 1S F | 04:35:47 04:36:08 04:38 | | | Approximate distance 100 miles. |
| #86 Mar. 18 | 1P 1S F | 21:22:23 21:22:53 21:26 | | | Approximate distance 145 miles. |
| #87 Mar. 21 | 1P eS F | 20:03:08 20:03:52 20:06 | | | Weak Approximate distance 210 miles. |
| #88 #38 Mar. 24 | 1P F | 20:54:57 21:10 | | | Distant |

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| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori | NOT IN OPERATION | | | | |
| Bosch-Omori | | | | | |

Month APRIL 1951Page No. 11

| No. and Date | Phase | Time G. M. T. | | | Period | AMPLI- TUDE mm | REMARKS |
|------------------------|--------------------|-------------------------------------------|---|---|--------------|----------------------------------------------------------------------------------------------------------------------------------|---------|
| | | h | m | s | | | |
| #89 Apr. 2 #112 | 1P e F | 00:16:27 00:19:32 00:51 | | | | U.S.C. & G.S. Reports epicenter near 13° N. Lat., 90° W. Long. (Off coast of El Salvador) Approximate distance 750 miles. | |
| #90 Apr. 2 | 1P 1B F | 01:28:34 01:29:22 01:34 | | | | U.S.C. & G.S. Reports epicenter in Pacific Ocean, off coast of Panama. Approximate distance 230 miles | |
| #91 Apr. 4 | 1P 1B F | 23:20:43 23:21:03 23:23 | | | 5.0B 4.5B | Approximate distance 95 miles | |
| #92 Apr. 8 | 1P 1B F | 11:04:43 11:05:14 11:07 | | | | Approximate distance 150 miles. | |
| #93 Apr. 12 | 1P eB F | 04:12:06 04:13:21 04:19 | | | | Approximate distance 450 miles | |
| #94 Apr. 14 #118 | 1P 1B e F | 00:52:06 00:57:25 01:02:06 01:10 | | | | U.S.C. & G.S. Reports epicenter near 24° S. Lat., 66-1/2° W. Long. (Northern Argentina) Approximate distance 2,300 miles | |
| #95 Apr. 15 | 1P 1B F | 20:15:07 20:15:34 20:17 | | | | Approximate distance 130 miles | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Seismological
CentreMonth APRIL 1951Page No. 12

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|----------------|-------|------------------|----|----|-------------|----------------------|----------------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #96 Apr. 16 | 1P | 22 | 48 | 07 | | | Approximate distance 300 miles |
| | eS | 22 | 49 | 11 | | | |
| | F | 22 | 53 | | | | |
| #97 Apr. 26 | 1P | 19 | 34 | 19 | | | Approximate distance 115 miles |
| | 1S | 19 | 34 | 43 | | | |
| | F | 19 | 37 | | | | |
| NOTE: | | | | | | | A short wave receiver was installed in the seismograph room during April to pick up the time signals from WWV. |
| | | | | | | | G. E. MATTHEW Chief Hydrographer |

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SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Lat. 8° 57' 39" N.

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INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T. | V | C | DETERMINED |
|---------------|------------------|-----|------|---------|---------------|
| Wood-Anderson | N-S | 1.0 | 1370 | 14 to 1 | June 30, 1947 |
| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori | | | | | |
| Bosch-Omori | Not in operation | | | | |

Month MAY, 1951Page No. 13

| No. and Date | Phase | Time G. M. T. | | | Period | AMPLI- TITUDE mm | REMARKS |
|----------------------|-------|------------------|----|----|--------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #98 #60 May 3 | E P | 04 | 13 | 06 | | | U.S.C. & G.S. reports epicenter near 15 1/2° N. Lat., 61° W. Long. (Leeward Islands) Approximate distance 1325 miles |
| | E S | 04 | 16 | 37 | | | |
| | F | 04 | 19 | | | | |
| #99 #62 May 6 | E P | 21 | 43 | 50 | | | U.S.C. & G.S. reports epicenter near 11° N. lat., 85 1/2° W. long. (near Northwest coast of Costa Rica. Approximate distance 650 miles |
| | E S | 21 | 45 | 41 | | | |
| | F | 21 | 53 | | | | |
| #100 #63 May 6 | I P | 23 | 05 | 47 | | | U.S.C. & G.S. reports epicenter near 13 1/2° N. lat., 88° W. long., (Eastern El Salvador) Many killed and extensive property damage. Approximate distance 650 miles |
| | F | 23 | 34 | | | | |
| | | | | | | | |
| #101 May 7 | I P | 11 | 04 | 49 | | | Approximate distance 210 miles |
| | I S | 11 | 05 | 33 | | | |
| | F | 11 | 08 | | | | |
| #102 May 7 | I P | 20 | 24 | 52 | | | Distant |
| | F | 20 | 37 | | | | |
| #103 May 8 | E P | 20 | 04 | 47 | | | U.S. Coast & Geodetic Survey reports epicenter near 7 1/2° S. lat., 80° W. long. (near coast of northern Peru) Approximate distance 1100 miles |
| | F | 20 | 10 | | | | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

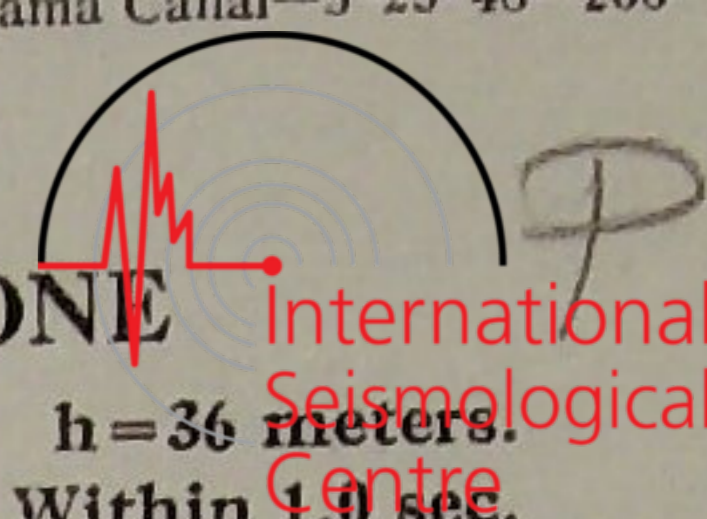
Month MAY, 1951

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|----------------|-----------------|-------------------------------|---|---|-------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #104 May 11 | E P F | 02:31:18 02:43 | | | | | U.S.C. and G. S. reports epicenter near 13° N., lat., 87 1/2° W. long. (Near coast of Nicaragua) Approximate distance 600 miles |
| #105 May 11 | I P I S F | 03:16:18 03:17:06 03:22 | | | | | U.S.C. & G.S. reports epicenter near 7° N. lat., 83° W. long. (Off coast of Panama) Approximate distance 230 miles |
| #106 May 14 | E P E S F | 13:04:12 13:05:26 13:14 | | | | | U.S.C. & G.S. reports epicenter near 9° N. lat., 86° W. long. (Off coast of Costa Rica) Approximate distance 450 miles |
| #107 May 19 | I P I S F | 16:19:15 16:19:37 16:22 | | | | | Approximate distance 110 miles |
| #108 May 20 | I P F | 04:04:25 04:11 | | | | | Distant |

G. E. Matthew
Chief Hydrographer

DEPARTMENT OF OPERATION AND MAINTENANCE
SECTION OF METEOROLOGY AND HYDROGRAPHY

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE



Lat. 8° 57' 39" N.

Long. 79° 33' 29" W.

h = 36 meters.

Lithologic foundation: Basalt.

Time Correction: Within 1.0 sec.

INSTRUMENTS—FIXED CONSTANTS

| INSTRUMENTS | SYMBOL | REGISTRATION | DAMPING | PAPER SPEED | MASS |
|---------------|--------|--------------|----------|-----------------|---------|
| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | 1.3 gr. |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | 100 kg. |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T. | V | G | DETERMINED |
|---------------|-------------------|-----|------|---------|---------------|
| Wood-Anderson | N-S | 1.0 | 1370 | 14 to 1 | June 30, 1947 |
| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori | Not in operation. | | | | |
| Bosch-Omori | Not in operation. | | | | |

Month JUNE 1951Page No. 15

| No. and Date | Phase | Time G. M. T. | | | Period | AMPLI- TUDE mm | REMARKS |
|------------------------|--------------------|-------------------------------------------|---|---|--------|-------------------------------------------------------------------------------------------------------------------------------------------|---------|
| | | h | m | s | | | |
| #109 June 4 | eP F | 17:51:38 17:57 | | | | Distant | |
| #110 June 5 #86 | eP F | 01:35:54 01:47 | | | | U.S.C. & G.S. reports epicenter near 9 1/2° N. Lat., 85° W. Long. (near coast of Costa Rica) Approximate distance 400 miles | |
| #111 June 14 | 1P 1S P | 06:52:56 06:53:25 06:57 | | | | Approximate distance 140 miles | |
| #112 June 18 #91 | 1P eS e F | 17:45:48 17:46:48 17:48:02 17:56 | | | | U.S.C. & G.S. reports epicenter near 11° N. Lat., 85° W. Long. (Costa Rica- Nicaragua Border) Approximate distance 435 miles | |
| #113 June 21 | 1P 1S F | 08:02:58 08:03:34 08:06 | | | | Approximate distance 175 miles | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month JUNE 1951Page No. 16

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|-----------------|-------------------------|-------------------------------------------------------|---|---|----------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #114 June 21 | 1P 1S F | 12:01:22 12:01:58 12:03 | | | | | Approximate distance 175 miles |
| #115 June 22 | 1P 1S F | 11:32:21 11:32:45 11:35 | | | | | Approximate distance 115 miles |
| #116 June 24 | 1P 1S F | 15:38:06 15:38:31 15:40 | | | | | Approximate distance 120 miles |
| #117 June 25 | 1P eS e e F | 20:18:46 20:21:25 20:32:37 20:41:28 20:47 | | | | | V.S.C. & G.S. reports epicenter near 1° N. lat., 85° W. long. (about 300 miles off coast of Ecuador) Approximate distance 680 miles |
| #118 June 29 | 1P 1S F | 11:42:34 11:42:52 11:46 | | | 10.0W 10.0E | | Approximate distance 85 miles |
| #119 June 29 | 1P 1S F | 18:35:18 18:36:26 18:45 | | | | | Approximate distance 400 miles |
| | | | | | | | G. E. MATTHEW Chief Hydrographer |

DEPARTMENT OF OPERATION AND MAINTENANCE
SECTION OF METEOROLOGY AND HYDROGRAPHY

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Lat. 8° 57' 39" N.

Long. 79° 33' 29" W.

h = 36 meters.

Lithologic foundation: Basalt.

Time Correction: Within 1.0 sec.

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INSTRUMENTS—FIXED CONSTANTS

| INSTRUMENTS | SYMBOL | REGISTRATION | DAMPING | PAPER SPEED | MASS |
|---------------|--------|--------------|----------|-----------------|---------|
| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | 1.3 gr. |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | 100 kg. |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T. | V | (| DETERMINED |
|---------------|------------------|-----|------|---------|---------------|
| Wood-Anderson | E-W | 1.0 | 1370 | 14 to 1 | June 30, 1947 |
| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori | Not in operation | | | | |
| Bosch-Omori | | | | | |

Month JULY 1951Page No. 17

| No. and Date | Phase | Time G. M. T. | | | Period | AMPLI- TUDE mm | REMARKS |
|----------------|-------|------------------|----|----|--------|----------------------|-------------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #120 July 2 | 1P | 06 | 58 | 33 | | | U.S.C. & G.S. reports epicenter near 40° N. Lat., 92 1/2° W. Long. (about 300 miles) South of Panama. |
| | eP | 06 | 59 | 39 | | | |
| | P | 07 | 05 | | | | Approximate distance 625 miles |
| #121 July 2 | 1P | 07 | 37 | 47 | | | |
| | eP | 07 | 38 | 51 | | | |
| | P | 07 | 46 | | | | Approximate distance 625 miles |
| #122 July 8 | 1P | 11 | 02 | 11 | | | |
| | P | 11 | 07 | | | | Distant |
| #123 July 9 | eP | 00 | 08 | 05 | | | U.S.C. & G.S. reports epicenter near 16° N. Lat., 96° W. Long. (near coast of Mexico, Mexico). |
| | P | 00 | 19 | | | | Distant |
| #124 July 9 | eP | 21 | 18 | 42 | | | U.S.C. & G.S. reports epicenter near 11° N. Lat., 85° W. Long. (near coast of Costa Rica.) |
| | eP | 21 | 19 | 48 | | | |
| | P | 21 | 24 | | | | Approximate distance 115 miles |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month JULY 1951Page No. 10

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|-------------------------|---------------|-------------------------------|---|---|-------------|----------------------|------------------------------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #125 July 12 | LP LS F | 05:35:34 05:36:18 05:38 | | | | | Approximate distance ²¹⁵ 215 miles |
| #126 July 16 #123 | LP LS F | 09:13:35 09:23:08 10:02 | | | | | U.S.C. & U.S. reports epicenter near 1° N. Lat., 27° W. Long. (Mid Atlantic Ocean) Approximate distance 3,750 miles |
| #127 July 25 | LP LS F | 14:36:05 14:36:55 14:40 | | | | | Approximate distance 240 miles |
| #128 July 30 #133 | LP LS F | 16:52:51 16:54:11 16:58 | | | | | Approximate distance 500 miles |
| #129 | LP LS F | 23:02:43 23:03:24 23:07 | | | | | Approximate distance 195 miles |

G. E. MATHEW
Chief Hydrographer

THE PANAMA CANAL
DEPARTMENT OF OPERATION AND MAINTENANCE
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SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Lat. 8° 57' 39" N.

Long. 79° 33' 29" W.

Lithologic foundation: Basalt.

Time Correction: Within 1.0 sec.

h = 36 meters.

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Seismological
Centre

INSTRUMENTS—FIXED CONSTANTS

| INSTRUMENTS | SYMBOL | REGISTRATION | DAMPING | PAPER SPEED | MASS |
|---------------|--------|--------------|----------|-----------------|---------|
| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | 1.3 gr. |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | 100 kg. |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T _c | V | f | DETERMINED |
|---------------|------------------|----------------|------|---------|---------------|
| Wood-Anderson | N-S | 1.0 | 1370 | 14 to 1 | June 30, 1947 |
| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori | Not in operation | | | | |
| Bosch-Omori | | | | | |

Month AUGUST 1951Page No. 19

| No. and Date | Phase | Time G. M. T. | | | Period | AMPLI- TUDE mm | REMARKS |
|------------------------|-------------------|-------------------------------------------|---|---|--------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #130 #135 Aug. 1 | 1P P | 03:24:33 | | | | | U.S.C. & G.S. reports epicenter near 3° N. Lat., 84° W. Long. (off coast of Columbia Approximate distance 500 miles |
| #131 Aug. 2 | 1P e P | 20:32:26 20:34:26 20:44 | | | | | Distant |
| #132 Aug. 3 | 1P e P | 00:26:05 00:28:03 00:46 | | | | | U.S.C. & G.S. reports epicenter near 13° N. Lat., 87 1/2° W. Long. (near south coast of Nicaragua) Approximate distance 600 miles |
| #133 Aug. 3 | 1P P | 05:27:51 05:45 | | | | | Distant |
| #134 Aug. 3 | 1P P | 16:47:17 16:56 | | | | | Distant |
| #135 Aug. 6 | 1P e e P | 08:10:59 08:12:26 08:13:16 08:30 | | | | | U.S.C. & G.S. reports epicenter near 13° N. Lat., 87 1/2° W. Long. (near south coast of Nicaragua) Approximate distance 600 miles |
| #136 Aug. 7 | eP 1S P | 00:41:31 00:41:55 00:44 | | | | | Approximate distance 115 miles |
| #137 Aug. 14 | 1P 1S P | 20:02:32 20:03:28 20:08 | | | | | Approximate distance 270 miles |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month AUGUST 1951Page No. 20

| No. and Date | Phase | Time G. C. T. | | | Period s | AMPLI- TUDE mm | REMARKS |
|-----------------|---------------|-------------------------------|---|---|-------------|----------------------|--------------------------------|
| | | h | m | s | | | |
| #138 Aug. 22 | 1P 1S F | 05:42:31 05:43:22 05:48 | | | | 6.0M 6.5E | Approximate distance 245 miles |
| #139 Aug. 23 | 1P 1S F | 07:05:27 07:05:52 07:08 | | | | | Approximate distance 120 miles |
| #140 Aug. 26 | 1P 1S F | 09:31:42 09:31:59 09:34 | | | | | Approximate distance 80 miles |

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THE PANAMA CANAL
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SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

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Centre

Lat. 8° 57' 39" N.

Long. 79° 33' 29" W.

h = 36 meters.

Lithologic foundation: Basalt.

Time Correction: Within 1.0 sec.

INSTRUMENTS—FIXED CONSTANTS

| INSTRUMENTS | SYMBOL | REGISTRATION | DAMPING | PAPER SPEED | MASS |
|---------------|--------|--------------|----------|-----------------|---------|
| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | 1.3 gr. |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | 100 kg. |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T ₀ | V | ε | DETERMINED |
|---------------|------------------|----------------|------|---------|---------------|
| Wood-Anderson | N-S | 1.0 | 1370 | 14 to 1 | June 30, 1947 |
| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori | Not in operation | | | | |
| Bosch-Omori | | | | | |

Month OCTOBER 1951Page No. 22

| No. and Date | Phase | Time G. C. T. | | | Period | AMPLI- TUDE mm | REMARKS |
|--------------------------------------------------------------------|---------------|-------------------------------|---|---|--------------|----------------------|--------------------------------|
| | | h | m | s | | | |
| #146 Oct. 2 | 1P 1S F | 21:41:56 21:42:40 21:45 | | | | | Approximate distance 210 miles |
| #147 Oct. 5 | eP 1S F | 12:55:08 12:55:48 12:59 | | | | | Approximate distance 210 miles |
| #148 Oct. 6 | 1P F | 00:13:06 00:17 | | | | | Distant |
| #149 Oct. 7 | 1P e F | 06:01:17 06:02:20 06:08 | | | | | Distant |
| NOTE: No record 16:23 G. C. T. October 9 to 12:30 GCT October 10 | | | | | | | |
| #150 Oct. 13 | 1P 1S F | 07:12:16 07:12:44 07:15 | | | 4.5B 4.0B | | Approximate distance 135 miles |
| #151 Oct. 13 | 1P 1S F | 20:21:27 20:21:54 20:24 | | | | | Approximate distance 130 miles |
| #152 Oct. 17 | 1P 1S F | 02:34:52 02:36:04 02:38 | | | | | Approximate distance 440 miles |
| #153 Oct. 18 | 1P 1S F | 10:12:15 10:12:44 10:16 | | | | | Approximate distance 140 miles |
| #154 Oct. 25 | 1P eS F | 06:09:47 06:10:58 06:12 | | | | | Approximate distance 435 miles |
| NOTE: No record 16:00 GCT October 26 to 12:54 GCT October 27, 1951 | | | | | | | |

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Lat. 8° 57' 39" N.

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h = 36 meters.

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INSTRUMENTS—FIXED CONSTANTS

| INSTRUMENTS | SYMBOL | REGISTRATION | DAMPING | PAPER SPEED | MASS |
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| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | 1.3 gr. |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | 100 kg. |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T ₀ | V | ε | DETERMINED |
|---------------|------------------|----------------|------|---------|---------------|
| Wood-Anderson | N-S | 1.0 | 1370 | 14 to 1 | June 30, 1947 |
| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori | Not in operation | | | | |
| Bosch-Omori | | | | | |

Month ~~NOVEMBER~~ 1951

Page No. 23

| No. and Date | Phase | Time G. C. T. | | | Period | AMPLI- TUDE mm | REMARKS |
|-----------------|-------|------------------|----|----|--------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #155 Nov. 1 | 1P | 19 | 14 | 15 | | | U.S.C. & G.S. reports epicenter about 250 miles off coast of Ecuador Distant |
| | F | 19 | 19 | | | | |
| #156 Nov. 3 | 1P | 08 | 52 | 39 | | | U.S.C. & G.S. reports epicenter near southern coast of Colombia Approximate distance 350 miles |
| | 1S | 08 | 53 | 38 | | 10.0N 9.5E | |
| | F | 08 | 58 | | | | |
| #157 Nov. 9 | eP | 22 | 14 | 16 | | | Faint trace - Distant |
| | F | 22 | 24 | | | | |
| #158 Nov. 13 | 1P | 05 | 45 | 42 | | | NOTE: Time marker stopped 14:55 G.C.T., Nov. 12, 1951 to 12:50 G.C.T., Nov. 13, 1951 Time for quake #158 may be off 10-15 sec. Approximate distance 170 miles. |
| | 1S | 05 | 46 | 17 | | 8.0N | |
| | F | 05 | 51 | | | 6.5E | |
| #159 Nov. 28 | 1P | 20 | 12 | 47 | | | Approximate distance 125 miles. |
| | 1S | 20 | 13 | 13 | | | |
| | F | 20 | 16 | | | | |

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INSTRUMENTS—FIXED CONSTANTS

| INSTRUMENTS | SYMBOL | REGISTRATION | DAMPING | PAPER SPEED | MASS |
|---------------|--------|--------------|----------|-----------------|---------|
| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | 1.3 gr. |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | 100 kg. |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T. | V | C | DETERMINED |
|---------------|------------------|-----|------|---------|---------------|
| Wood-Anderson | N-S | 1.0 | 1370 | 14 to 1 | June 30, 1947 |
| Wood-Anderson | E-W | 1.0 | 1370 | 18 to 1 | June 30, 1947 |
| Bosch-Omori | Not in operation | | | | |
| Bosch-Omori | | | | | |

Month DECEMBER 1951Page No. No. 24

| No. and Date | Phase | Time G. C. T. | | | Period | AMPLI- TUDE mm | REMARKS |
|-----------------|-------|------------------|----|----|--------|----------------------|----------------------------------------------------------------------------------------------------------|
| | | h | m | s | | | |
| #160 Dec. 5 | 1P | 07 | 59 | 40 | | | |
| | 1S | 08 | 00 | 23 | | | |
| | F | 08 | 03 | | | | Approximate distance 205 miles |
| #161 Dec. 5 | 1P | 08 | 03 | 50 | | | |
| | 1S | 08 | 04 | 33 | | | |
| | F | 08 | 09 | | | | Approximate distance 205 miles |
| #162 Dec 6 | 1P | 14 | 30 | 20 | | | U.S.C. & G.S. reports epicenter near $5-1/2^{\circ}$ N. Lat. $77-1/2^{\circ}$ W. Long. |
| | 1S | 14 | 31 | 04 | | 5.5N | |
| | F | 14 | 47 | | | 7.5E | Approximate distance 210 miles |
| #163 Dec. 7 | eP | 22 | 10 | 35 | | | |
| | eS | 22 | 11 | 32 | | | |
| | F | 22 | 15 | | | | Approximate distance 275 miles |
| #164 Dec. 8 | eP | 04 | 33 | 38 | | | |
| | F | 05 | 50 | | | | Distant |
| #165 Dec. 12 | eP | 01 | 41 | 22 | | | U.S.C. & G.S. reports epicenter near 17° N. Lat., $94-1/2^{\circ}$ W. Long. (Oaxaca, Mexico) |
| | F | 02 | 05 | | | | Approximate distance 1300 miles |
| #166 Dec. 23 | 1P | 07 | 01 | 30 | | | |
| | F | 07 | 07 | | | | Distant |
| #167 Dec. 24 | 1P | 10 | 27 | 06 | | | |
| | F | 10 | 32 | | | | Distant |
| #168 Dec. 24 | 1P | 20 | 28 | 57 | | | |
| | 1S | 20 | 29 | 22 | | | |
| | F | 20 | 31 | | | | Approximate distance 125 miles |
| #169 Dec. 28 | 1P | 09 | 25 | 03 | | | |
| | eS | 09 | 29 | 02 | | | |
| | F | 10 | 00 | | | | Approximate distance 1500 miles |

G. E. MATTHEW
Chief Hydrographer