

THE PANAMA CANAL
DEPARTMENT OF OPERATION AND MAINTENANCE
SECTION OF SURVEYS

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Lat. 8° 57' 39" N.

Long. 79° 33' 29" W.

h = 36 meters.

Lithologic foundation: Basalt.

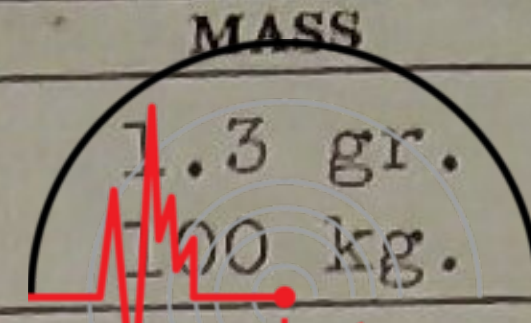
Time Correction: Within 0.5 sec.

INSTRUMENTS—FIXED CONSTANTS

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

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T. | V | h | DETERMINED |
|------------------------------------|-------------------------|----|----|----------|---------------|
| Wood-Anderson) Wood-Anderson) | Not In Operation | | | | |
| Bosch-Omori | E - W | 20 | 35 | Critical | July 27, 1932 |
| Bosch-Omori | N - S | 20 | 35 | Critical | July 27, 1932 |



International
Seismological
Centre

Month JANUARY 1933

Page No. 1

| No. and Date | Phase | Time G. M. T. h m s | Period s | Amplitude | | REMARKS |
|----------------------|---------------------|----------------------------------|-------------|-----------|---------|--|
| | | | | E mm | N mm | |
| II 806 Jan. 10 | e P E S E F E | 23:08:54 23:09:25 23:14:00 | | | | Phase very faint. Distance 180 miles. N-S clock stopped. |
| II 807 Jan. 12 | | 01:20 to 01:26 | | | | Very faint trace of short period waves. |

R. Z. KIRKPATRICK,
Chief of Surveys.

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|---------------|--------|--------------|----------|-----------------|-----------------|--------------------|
| | | | | 60 mm. per min. | 15 mm. per min. | 1.3 gr. 100 kg. |
| Wood-Anderson | I | Photographic | Magnetic | | | |
| Bosch-Omori | II | Smoked Sheet | Air | | | |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T _c | V | h | DETERMINED |
|---------------|-----------|----------------|----|----------|---------------|
| | | | | | |
| Wood-Anderson | | | | | |
| Wood-Anderson | | | | | |
| Bosch-Omori | E - W | 20 | 35 | Critical | July 27, 1932 |
| Bosch-Omori | N - S | 20 | 35 | Critical | July 27, 1932 |

International
Seismological
Centre

Month February, 1933.Page No. 2

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|----------------------|--|--|----|--------|-------------|-----------|-----|--|
| | | h | m | s | | E | N | |
| | | | | | | mm | mm | |
| II 808 Feb. 3 | | 8 | 37 | | | | | Very faint but rapid vibrations. |
| II 809 Feb. 12 | | 8 | 18 | | | | | Very faint but rapid vibrations. |
| II 810 Feb. 14 | e P E e L E F E | 17:01:00 17:01:26 17:03:00 | | | | | | S- waves doubtful distance about 75 miles N-S Faint and indistinct |
| II 811 Feb. 18 | | 19 : 50 to 19 : 56 | | | | | | Faint irregular, low amplitude waves. |
| II 812 Feb. 19 | i PNE i SNE i LNE M N M E C N C F FNE | 23:27:45 23:28:05 23:28:09 23:28:12 23:28:12 23:29:27 23:29:28 23:34:00 | | 2 4 | | 3.5 | 1.3 | Distance 120 miles Reported felt by a few people in Balboa, C. Z. |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month February, 1933Page No. 3

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|----------------------|-------|------------------|----|----|-------------|-----------|---------|--|
| | | h | m | s | | E mm | N mm | |
| II 813 Feb. 21 | i P N | 16 | 44 | 59 | 4 3 | 5.0 | 1.0 | Distance 130 miles reported felt by a few people in Balboa, C. Z. |
| | i P E | 16 | 44 | 57 | | | | |
| | i S N | 16 | 45 | 24 | | | | |
| | i S E | 16 | 45 | 19 | | | | |
| | M N | 16 | 45 | 28 | | | | |
| | M E | 16 | 45 | 23 | | | | |
| | C M | 16 | 46 | 41 | | | | |
| C E | 16 | 46 | 49 | | | | | |
| | FME | 16 | 51 | 00 | | | | |
| II 814 Feb. 23 | i P N | 8 | 15 | 41 | 14 | | 0.6 | Distance 2100 miles. Cable reports number of buildings damaged in Iquique, Chile. E-W trace irregular, no identifiable phases. |
| | i S N | 8 | 20 | 36 | | | | |
| | e L N | 8 | 23 | 28 | | | | |
| | M N | 8 | 29 | 11 | | | | |
| | C N | 8 | 34 | 14 | | | | |
| | F N | 8 | 44 | 00 | | | | |
| II 815 Feb. 23 | | 13 | : | 39 | | | | Very faint trace of irregular waves. |
| | | | to | | | | | |
| | | 13 | : | 41 | | | | |

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| | | | | 60 mm. per min. | 15 mm. per min. | 1.3 gr. 100 kg. |
| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | | |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | | |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T ₀ | V | h | DETERMINED |
|---------------|-----------|----------------|----|----------|--------------------------------|
| | | | | | July 27, 1932 July 27, 1932 |
| Wood-Anderson | | | | | |
| Wood-Anderson | | | | | |
| Bosch-Omori | E-W | 20 | 35 | critical | July 27, 1932 |
| Bosch-Omori | N-S | 20 | 35 | critical | July 27, 1932 |

Month March, 1933Page No. 4

| No. and Date | Phase | Time | | | Period | Amplitude | | REMARKS |
|----------------------|--|----------|----|----|--------|-----------|----|--|
| | | G. M. T. | | | | E | N | |
| | | h | m | s | | mm | mm | |
| II 816 March 1 | ePE eSE FE | 23 | 14 | 17 | | | | Distance 150 miles N-S faint and indistinct. |
| II 817 March 2 | PE eE eSE eLE ME CE FE | | ? | | | | | Destructive in Japan. N-S very faint. U.S.C.G.S. epicenter. 39.5° N. Lat., 143.5° E. Long. O = 17 h. 31. 0 m Distance from Balboa 8100 miles. |
| II 818 March 3 | ePE iSE FE | 6 | 03 | 58 | | | | Distance 130 miles. N-S phases indistinct. |
| II 819 March 3 | ePE iSE FE | 8 | 26 | 16 | | | | Distance 130 miles. N-S phases indistinct. |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month March, 1933

Page No. 5

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|-----------------------|--------------------|------------------|----|----|-------------|-----------|---------|---|
| | | h | m | s | | E mm | N mm | |
| II 820 March 12 | oPNE iSNE FE | 7 | 42 | 32 | | | | Distance 50 miles. Felt by one person. |
| II 821 March 18 | | 23 | 38 | | | | | Very faint low amplitude waves. |
| | | | to | | | | | |
| | | 23 | 44 | | | | | |
| II 822 March 28 | | 22 | 05 | | | | | Very faint trace of short period waves. |
| | | | to | | | | | |
| | | 22 | 05 | | | | | |



R. Z. KIRKPATRICK,
Chief of Surveys.

RZK*cc

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| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T _c | v | h | DETERMINED |
|---------------|-----------|----------------|------|----------|---------------|
| Wood-Anderson | E - W | 0.8 | 1370 | Critical | May 10, 1933 |
| Wood-Anderson | N - S | 0.8 | 1370 | " | " " |
| Bosch-Omori | E - W | 20.0 | 35 | " | July 27, 1932 |
| Bosch-Omori | N - S | 20.0 | 35 | " | " " |

Month May, 1933Page No. 7

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|--------------------|---------|------------------|---|---|-------------|-----------|---------|---|
| | | h | m | s | | E mm | N mm | |
| II 825 May 3 | 1PNE | 8:38:04 | | | | | | Distance 215 miles. |
| | 1S N | 8:38:47 | | | | | | |
| | 0S NE | 8:38:46 | | | | | | |
| | 0L N | 8:38:59 | | | | | | |
| | 0L E | 8:38:51 | | | | | | |
| | M N | 8:39:01 | | | | | 1.8 | |
| | M E | 8:38:59 | | | | 2.0 | | |
| FNE | 8:42:00 | | | | | | | |
| II 826 May 6 | 1P N | 5:34:35 | | | | | | Intensity III (Modified Mercalli Intensity scale of 1931) Distance 300 miles. |
| | 1P E | 5:34:37 | | | | | | |
| | 1S N | 5:35:30 | | | 2.0 | | | |
| | 1S E | 5:35:29 | | | 2.7 | | | |
| | 1 L N | 5:35:49 | | | 3.0 | | | |
| | 1L E | 5:35:50 | | | 4.0 | | | |
| | M N | 5:36:05 | | | 8.0 | | 4.1 | |
| | M E | 5:36:07 | | | 7.0 | 27.6 | | |
| | C N | 5:41:46 | | | | | | |
| C E | 5:42:00 | | | | | | | |
| FNE | 5:44:00 | | | | | | | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month May, 1933

Page No. 8

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|--------------------|-------|------------------|----|----|-------------|-----------|---------|--|
| | | h | m | s | | E mm | N mm | |
| II 827 May 6 | ● P N | 20 | 31 | 43 | | | | Faint shock. Distance 300 miles Apparently from same origin as preceding shock. |
| | ● P E | 20 | 31 | 42 | | | | |
| | 1 S N | 20 | 32 | 36 | | | | |
| | 1 S E | 20 | 32 | 33 | | | | |
| | 1 L N | 20 | 32 | 59 | | | | |
| | 1 L E | 20 | 32 | 55 | | | | |
| | M N | 20 | 33 | 07 | 3.0 | | 1.1 | |
| | M E | 20 | 33 | 09 | 3.0 | 3.1 | | |
| | F N E | 20 | 42 | 00 | | | | |



Wood-Andersons now in operation.
Bosch-Omoris dismantled.

| | | | | | | | |
|--------------------|-----------------------|----------------------------------|--|--|--|--|--|
| I 828 May 14 | ● PNE ● SNE FNE | 10:40:57 10:41:42 10:43:00 | | | | | Very faint tremors. Distance 250 miles. |
|--------------------|-----------------------|----------------------------------|--|--|--|--|--|

| | | | | | | | |
|--------------------|-----------------------|-------------------------------|--|--|--|--|--|
| I 829 May 25 | 1 P E 1 S E F E | 2:38:36 2:39:20 2:43:00 | | | | | N - S stopped. E - W light weak. Phases indistinct. Distance of 250 miles. |
|--------------------|-----------------------|-------------------------------|--|--|--|--|--|

| | | | | | | | |
|--------------------|--|----------------------------|--|--|--|--|--|
| I 830 May 30 | | 11:44:30 to 11:57:00 | | | | | E - W stopped. N - S light weak. Record blurred. Felt by a few people. |
|--------------------|--|----------------------------|--|--|--|--|--|

| | | | | | | | |
|--------------------|--|----------------------------|--|--|--|--|---|
| I 831 May 31 | | 10:55:51 to 10:57:00 | | | | | E - W stopped Very faint tremors from local disturbance |
|--------------------|--|----------------------------|--|--|--|--|---|

30
15
Correction given in
June 1933 report.

R. Z. KIRKPATRICK,
Chief of Surveys.

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| INSTRUMENTS | COMPONENT | T. | V | h | DETERMINED |
|---------------|-----------|-------------------------|------|----------|--------------|
| Wood-Anderson | E - W | 0.8 | 1370 | Critical | May 10, 1933 |
| Wood-Anderson | N - S | 0.8 | 1370 | Critical | May 10, 1933 |
| Bosch-Omori) | - - - - | Not Operating - - - - - | | | |
| Bosch-Omori) | - - - - | | | | |

Month JUNE 1933Page No. 8

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|---------------------|--|------------------|----|----|-------------|-----------|---------|---|
| | | h | m | s | | E mm | N mm | |
| I 832 June 2 | | 19 | 55 | 22 | | | | Faint trace of short period waves. E - W stopped |
| | | | to | | | | | |
| | | 19 | 56 | 30 | | | | |
| I 833 June 8 | | 18 | 12 | 29 | | | | Trace of waves from local disturbance. Main phases not recorded on account of weak light. |
| | | | to | | | | | |
| | | 18 | 18 | 00 | | | | |
| I 834 June 9 | | 13 | 51 | 00 | | | | Trace of waves from local disturbance. Main phases not recorded on account of weak light. |
| | | | to | | | | | |
| | | 13 | 56 | 00 | | | | |
| I 835 June 10 | | 21 | 26 | 34 | | | | Trace of short period waves. N - S stopped |
| | | | to | | | | | |
| | | 21 | 29 | 35 | | | | |
| I 836 June 19 | 1PNE S, L and M blurred; light. ePNE 1SNE L & M blurred; FNE | 9 | 47 | 42 | | | | Paper not sensitive enough to record fast moving Two quakes superposed. 1st quake stronger - Intensity IV (Modified Mercalli Scale) Distance of 2nd. quake 110 miles. Several people in Balboa alarmed by first quake |
| | | 9 | 51 | 19 | | | | |
| | | 9 | 51 | 39 | | | | |
| | | 9 | 57 | 00 | | | | |
| I 837 June 24 | | 22 | 16 | | | | | Faint trace of long distant waves. |
| | | | to | | | | | |
| | | 22 | 48 | | | | | |
| I 838 June 26 | 1PNE 1SNE L & M blurred FNE | 3 | 52 | 34 | | | | Distance 75 miles. Felt by a few people. Intensity II (Modified Mercalli Scale) |
| | | 3 | 52 | 48 | | | | |
| | | 3 | 55 | 00 | | | | |
| I 839 June 26 | 1PNE 1SNE MN ME FNE | 8 | 31 | 01 | | | | Distance 100 miles. L - uncertain. |
| | | 8 | 31 | 18 | | | | |
| | | 8 | 31 | 24 | | | | |
| | | 8 | 31 | 25 | 2.5 | 3.5 | | |
| | | 8 | 33 | 00 | | | | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month JUNE 1953

Page No. 9

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|---------------------|-------|------------------|----|----|-------------|-----------|---------|---|
| | | h | m | s | | E mm | N mm | |
| I 840 June 30 | oPNE | 15 | 36 | 29 | | | | Distance 50 miles. M - on E - W blurred. |
| | iSNE | 15 | 36 | 38 | | | | |
| | MN | 15 | 36 | 40 | | | 4.5 | |
| | FNE | 15 | 37 | 21 | | | | |



✓
CORRECTION: Quake No. 831 should be dated May 30 and the time should be 15 : 55 : 51 to 15 : 57 : 00

R. Z. KIRKPATRICK
Chief of Surveys.

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| | | | | | May 10, 1933 |
| Wood-Anderson | E - W | 0.8 | 1370 | Critical | May 10, 1933 |
| Wood-Anderson | N - S | 0.8 | 1370 | Critical | May 10, 1933 |
| Bosch-Omori | -- | Not operating | | | |
| Bosch-Omori | -- | Not operating | | | |

International
Seismological
Centre

Month July 1933.Page No. 10

| No. and Date | Phase | Time | | | Period | Amplitude | | REMARKS |
|---------------------|-------|----------|----|----|--------|-----------|--|---------|
| | | G. M. T. | | | | E | N | |
| | | h | m | s | | mm | mm | |
| I 841 July 7 | | 21 | 10 | 44 | | | Very abrupt. No P waves recorded. Felt by a few people. Origin doubtful; may be dynamite explosion. | |
| | | 21 | 11 | 20 | | | | |
| I 842 July 9 | | 22 | 12 | 40 | | | Similar to preceding quake. Shock very sharp and rapid, lasting about 2 seconds. Felt by observer at Balboa Heights. | |
| | | 22 | 13 | 30 | | | | |
| I 843 July 25 | | 12 | 50 | 16 | | | Light tremors of 0.5 seconds period. | |
| | | 12 | 53 | 30 | | | | |
| I 844 July 26 | ePNE | 18 | 47 | 12 | | | Very slight tremors. Distance about 220 miles. | |
| | eSNE | 18 | 47 | 50 | | | | |
| | MN | 18 | 47 | 57 | | 1.4 | | |
| | ME | 18 | 47 | 53 | 1.3 | | | |
| | FNE | 18 | 50 | 00 | | | | |

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| INSTRUMENTS | COMPONENT | T _c | V | h | DETERMINED |
|---------------|----------------------|----------------|----|----------|--------------|
| Wood-Anderson | Not Operating | | | | |
| Wood-Anderson | E - W | 20 | 35 | Critical | Aug. 1, 1933 |
| Bosch-Omori | N - S | 20 | 35 | Critical | Aug. 1, 1933 |

Month AUGUST, 1933.Page No. 11

| No. and Date | Phase | Time G. M. T. | | | Period | Amplitude | | REMARKS |
|--------------|-------|---------------|---|---|--------|-----------|---|---------|
| | | h | m | s | | E | N | |

Wood-Anderson seismographs discontinued August 1, 1933, due to lack of funds necessary for their operation.

II
845
Aug. 12

ePE
1SE
EEF

10:11:44
10:12:03
10:14:00

N-S stopped
E-W Record not clear

Quake felt by observer.
Distance 110 miles.

II
846
Aug. 28

22:53
to
23:34

Very faint

R. Z. KIRKPATRICK.
CHIEF OF SURVEYS.

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| INSTRUMENTS | COMPONENT | T. | V | h | DETERMINED |
|---------------|-----------|---------------|----|----------|----------------|
| Wood-Anderson | } ----- | Not Operating | | | ----- |
| Wood-Anderson | | | | | |
| Bosch-Omori | E-W | 20 | 35 | Critical | August 1, 1933 |
| Bosch-Omori | N-S | 20 | 35 | Critical | August 1, 1933 |

Month Sept. 1933

Page No.

| No. and Date | Phase | Time | | | Period | Amplitude | | REMARKS |
|--------------|-------|------|----|----|--------|-----------|-----|---------------------------------------|
| | | G. | M. | T. | | E | N | |
| | | h | m | s | s | mm | mm | |
| II | PN | 16 | 40 | 59 | | | | Distance approximately 30 miles. |
| 847 | PE | 16 | 40 | 54 | | | | Intensity IV on Modified Mercalli |
| Sept. 22 | SE | 16 | 41 | 01 | | | | Scale of 1931. |
| | MN | | | ? | | | 7.0 | Some people reported hearing a sharp |
| | ME | 16 | 41 | 04 | | 12.1 | | noise similar to an explosion; tremor |
| | FNE | 16 | 43 | 00 | | | | felt by many. |
| | | | | | | | | SN & MN blurred by short circuit in |
| | | | | | | | | time marker. |

R. Z. Kirkpatrick
R. Z. KIRKPATRICK,

Chief of Surveys.

1933 OCT 18 AM 9:33

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| INSTRUMENTS | COMPONENT | T ₀ | V | h | DETERMINED |
|-----------------|-----------|----------------|------------------|----------|----------------|
| Wood-Anderson) | ----- | NOT | OPERATING | ----- | |
| Wood-Anderson) | | | | | |
| Bosch-Omori | N-S | 20 | 35 | Critical | August 1, 1933 |
| Bosch-Omori | E-W | 20 | 35 | Critical | August 1, 1933 |

Month September 1933Page No. 12

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|-----------------------|-------|------------------|---|---|-------------|-----------|---------|---|
| | | h | m | s | | E mm | N mm | |
| II 847 Sept. 22 | i PH | 16:40:59 | | | | | | E picenter approximately 30 miles. |
| | i PE | 16:40:52 | | | | | | Intensity IV (Modified Mercalli Scale) |
| | i SE | 16:41:01 | | | | | | |
| | MN | ? | | | | 4.1 | | N-S phases obscured due to short circuit in time marker. |
| | ME | 16:41:05 | | | | 8.3 | | |
| | FNE | 16:44:00 | | | | | | Some people reported hearing sharp noise similar to an explosion. |

TO WHOM CONCERNED: Henceforth the Modified Mercalli Intensity scale of 1931 will be used at Balboa Heights.

R. Z. KIRKPATRICK,
Chief of Surveys.

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 0.5 sec.

INSTRUMENTS—FIXED CONSTANTS

| INSTRUMENTS | SYMBOL | REGISTRATION | DAMPING | PAPER SPEED | MASS |
|---------------|--------|--------------|----------|-----------------|-------------------|
| Wood-Anderson | I | Photographic | Magnetic | 60 mm. per min. | 13 gr. 100 kg. |
| Bosch-Omori | II | Smoked Sheet | Air | 15 mm. per min. | |

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T _c | V | h | DETERMINED |
|----------------|-----------|---------------------|----|----------|----------------|
| Wood-Anderson) | | -- Not operating -- | | | |
| Wood-Anderson) | | | | | |
| Bosch-Omori | E - W | 20 | 35 | Critical | August 1, 1933 |
| Bosch-Omori | N - S | 20 | 35 | Critical | August 1, 1933 |

Month October, 1933.Page No. 13

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|------------------------------|-------|------------------|----|----|-------------|-----------|---------|--|
| | | h | m | s | | E mm | N mm | |
| II 848 Oct. 2 | 1 PN | 15 | 32 | 05 | | | | Distance 650 miles. Felt in Ecuador. |
| | 1 PE | 15 | 32 | 12 | | | | |
| | 1 SN | 15 | 33 | 55 | | | | |
| | 1 SE | 15 | 34 | 02 | | | | |
| | LN | 15 | 34 | 55 | 6.0 | | | |
| | LE | 15 | 35 | 10 | 10.0 | | | |
| | MN | 15 | 36 | 39 | 11.0 | | 3.0 | |
| | ME | 15 | 35 | 12 | 10.0 | 19.4 | | |
| | CN | 15 | 43 | 55 | 10.0 | | | |
| | CE | 15 | 44 | 12 | 9.0 | | | |
| | FN | 16 | 10 | 00 | | | | |
| | FE | 16 | 19 | 00 | | | | |
| II 849 Oct. 4 | | 7 | 22 | | | | | Very faint. |
| | | to | | | | | | |
| | | 7 | 24 | | | | | |
| II 850 Oct. 6 | | 23 | 37 | | | | | Very faint but certainly seismic. |
| | | 23 | 39 | | | | | |
| II 851 Oct. 18 1933 | 1 PN | 14 | 44 | 52 | | | | Slight tremors. Distance about 150 miles. |
| | 1 PE | 14 | 44 | 54 | | | | |
| | 1 SN | 14 | 45 | 20 | | | | |
| | 1 SE | 14 | 45 | 18 | | | | |
| | LN | 14 | 45 | 28 | | | | |
| | LE | 14 | 45 | 30 | | | | |
| | MN | 14 | 45 | 34 | | | 1.6 | |
| | ME | 14 | 45 | 36 | | 1.4 | | |
| | CN | 14 | 46 | 04 | | | | |
| | CE | 14 | 46 | 10 | | | | |
| | FN | 14 | 47 | 20 | | | | |
| | FE | 14 | 47 | 30 | | | | |
| II 852 Oct. 18 1933 | | 16 | 46 | 24 | | | | Very faint tremors. |
| | | to | | | | | | |
| | | 16 | 47 | 20 | | | | |
| II 853 Oct. 25 1933 | | 23 | 34 | 52 | | | | Very faint tremors. |
| | | 23 | 37 | 34 | | | | |

R. Z. Kirkpatrick
R. Z. KIRKPATRICK,
Chief of Surveys.

43

EARTHQUAKE SHOCKS NOVEMBER 21 - 22, 1933

AS RECORDED BY SEISMOGRAPH SHEETS AT BALBOA HEIGHTS, CANAL ZONE.



| 75th Meridian Time | | Remarks |
|--------------------|------------|------------------|
| Began | Ended | |
| 6:50 p.m. | 7:01 p.m. | Heavy shock |
| 7:40 p.m. | 7:42 p.m. | Very light shock |
| 8:40 p.m. | 8:41 p.m. | Very light shock |
| 11:53 p.m. | 12:03 a.m. | Heavy shock |
| 12:08 a.m. | 12:16 a.m. | Medium shock |
| 12:23 a.m. | 12:24 a.m. | Very light shock |
| 1:15 a.m. | 1:16 a.m. | Very light shock |
| 1:19 a.m. | 1:21 a.m. | Very light shock |
| 1:59 a.m. | 2:03 a.m. | Light shock |
| 3:12 a.m. | 3:19 a.m. | Medium shock |
| 3:45 a.m. | 3:51 a.m. | Medium shock |
| 5:14 a.m. | 5:19 a.m. | Light shock |
| 5:33 a.m. | 5:34 a.m. | Very light shock |
| 6:32 a.m. | 6:33 a.m. | Very light shock |

Approximate distance of above disturbances from Balboa Heights, 250 miles.

Epicenter could be in the Province of Chiriqui or adjacent oceans.

1:00 P. M. - November 22nd: Since 9 o'clock this morning slight seismic tremors have been recorded at about 9:12 a.m., 9:50 a.m. and 11:45 p.m. presumably from the same source.

①
 C. G. Survey, Wash DC
 These shocks are said to have caused considerable damage and confusion at the Panama-Cost Rican west end of boundary line.
 R. K. S. P. A. M. S.
 Panama Canal
 12/1/33

THE PANAMA CANAL
DEPARTMENT OF OPERATION AND MAINTENANCE
SECTION OF SURVEYS

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 0.5 sec.

INSTRUMENTS—FIXED CONSTANTS

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

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T ₀ | v | h | DETERMINED |
|------------------------------------|-----------|---------------------|----|----------|---------------|
| Wood-Anderson) Wood-Anderson) | | -- not operating -- | | | |
| Bosch-Omori | E - W | 20 | 35 | critical | Aug. 1, 1933. |
| Bosch-Omori | S - N | 20 | 35 | critical | Aug. 1, 1933. |

Month November 4, 1933Page No. 1

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS | |
|----------------------------|--|------------------|----|----|-------------|-----------|---------|---|--|
| | | h | m | s | | E mm | N mm | | |
| II 854 Nov. 4 | | 8 | 44 | 36 | | | | Very slight | |
| | | | to | | | | | | |
| | | 8 | 46 | 54 | | | | | |
| II 855 Nov. 4 | | 12 | 00 | 25 | | | | Very slight | |
| | | | to | | | | | | |
| | | 12 | 02 | 18 | | | | | |
| II 856 Nov. 17 | | 8 | 25 | 50 | | | | Faint trace | |
| | | | to | | | | | | |
| | | 8 | 27 | 26 | | | | | |
| II 857 Nov. 20 | | 11 | 54 | 00 | | | | slight seismic waves from distant disturbances. P + S + L not distinguishable/ | |
| | | | to | | | | | | |
| | | 12 | 08 | 54 | | | | | |
| II 858 Nov. 21 to | i-PN i-PE i-SN i-SE -LE -ME -CE -FE | 23 | 49 | 56 | 3.3 | 40 | | Pen thrown off - N-S Intensity I Distance about 250 miles, felt in Chiriqui and Bocas del Toro Provinces, Republic of Panama. | |
| | | 23 | 49 | 56 | | | | | |
| | | 23 | 50 | 44 | | | | | |
| | | 23 | 50 | 44 | | | | | |
| | | 23 | 51 | 08 | | | | | |
| | | 23 | 51 | 24 | | | | | |
| | | 23 | 53 | 08 | | | | | |
| | | 00 | 01 | 08 | | | | | |
| II 859 Nov. 22 | | 00 | 40 | 30 | | | | Very slight tremors | |
| | | | to | | | | | | |
| | | 00 | 41 | 40 | | | | | |
| II 860 Nov. 22 | | 1 | 40 | 08 | | | | Very slight tremors | |
| | | | to | | | | | | |
| | | 1 | 40 | 40 | | | | | |
| II 861 Nov. 22 | i-PE i-SE LE ME CE FE | 4 | 53 | 12 | 3.3 | 45 | | Intensity I Distance about 250 miles Felt in Chiriqui, R. P. | |
| | | 4 | 54 | 00 | | | | | |
| | | 4 | 54 | 24 | | | | | |
| | | 4 | 55 | 12 | | | | | |
| | | 4 | 57 | 12 | | | | | |
| | | 5 | 03 | 00 | | | | | |
| II 862 Nov. 22 | i-PE i-SE -LE -ME -CE -FE | 5 | 08 | 20 | 3.6 | 6 | | Intensity I Distance 250 miles Felt in Chiriqui, R. P. | |
| | | 5 | 09 | 08 | | | | | |
| | | 5 | 09 | 32 | | | | | |
| | | 5 | 10 | 08 | | | | | |
| | | 5 | 10 | 46 | | | | | |
| | | 5 | 15 | 36 | | | | | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month November, 1933

Page No. 3

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|--------------------------|---------------------------------------|------------------|----|----|-------------|-----------|---------|------------------------------------|
| | | h | m | s | | E mm | N mm | |
| II 863 Nov. 22 | | 5 | 23 | 20 | | | | Very slight tremors |
| | | | to | | | | | |
| | | 5 | 24 | 08 | | | | |
| II 864 Nov. 22 | | 6 | 14 | 48 | | | | Very slight tremors |
| | | | to | | | | | |
| | | 6 | 15 | 32 | | | | |
| II 864 Nov. 22 | | 6 | 14 | 48 | | | | Very slight tremors |
| | | | to | | | | | |
| | | 6 | 15 | 32 | | | | |
| II 865 November 22 | | 6 | 18 | 44 | | | | Very slight tremors |
| | | | to | | | | | |
| | | 6 | 21 | 06 | | | | |
| II 866 Nov. 22 | 1-PE 1-SE -LE ME CE FE | 6 | 58 | 38 | 3.2 | 3. | | Intensity I Distance, 250 miles |
| | | 6 | 59 | 16 | | | | |
| | | 6 | 59 | 40 | | | | |
| | | 6 | 59 | 50 | | | | |
| | | 7 | 00 | 02 | | | | |
| | | 7 | 02 | 56 | | | | |
| II 867 Nov. 22 | 1-PE 1-SE LE MF CE FE | 8 | 11 | 40 | 3.3 | 7 | | Intensity I 250 miles distance |
| | | 8 | 12 | 28 | | | | |
| | | 8 | 12 | 52 | | | | |
| | | 8 | 12 | 56 | | | | |
| | | 8 | 13 | 08 | | | | |
| | | 8 | 19 | 05 | | | | |
| II 868 Nov. 22 | 1-PE 1-SE -LE ME CE FE | 8 | 44 | 52 | 3.3 | 11.5 | | Intensity I 250 miles distance |
| | | 8 | 45 | 40 | | | | |
| | | 8 | 46 | 04 | | | | |
| | | 8 | 46 | 12 | | | | |
| | | 8 | 46 | 40 | | | | |
| | | 8 | 50 | 40 | | | | |
| II 869 Nov. 22 | e-PE e-SE LE ME CE FE | 10 | 14 | 04 | 2.2 | 3 | | Intensity I 250 miles distance |
| | | 10 | 14 | 52 | | | | |
| | | 10 | 14 | 56 | | | | |
| | | 10 | 15 | 04 | | | | |
| | | 10 | 15 | 30 | | | | |
| | | 10 | 19 | 00 | | | | |
| II 870 Nov. 22 | | 10 | 33 | 12 | | | | Very slight tremors |
| | | | to | | | | | |
| | | 10 | 34 | 08 | | | | |
| II 871 Nov. 22 | | 11 | 32 | 20 | | | | Very slight tremors |
| | | | to | | | | | |
| | | 11 | 33 | 20 | | | | |
| II 872 Nov. 22 | S-N P-M | 14 | 11 | 28 | | | | Very slight tremors |
| | | | to | | | | | |
| | | 14 | 13 | 34 | | | | |
| | | 14 | 11 | 18 | | | | |
| | | 14 | 12 | 24 | | | | |



SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month November, 1955Page No. 3

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|----------------------|-------|------------------|----|----|-------------|-----------|---------|---|
| | | h | m | s | | E mm | N mm | |
| II 873 Nov. 22 | S-N | 14 | 49 | 16 | | | | Very slight tremors |
| | | | to | | | | | |
| | B-W | 14 | 49 | 26 | | | | |
| | | | to | | | | | |
| | | 14 | 50 | 32 | | | | |
| II 874 Nov. 22 | S-N | 21 | 57 | 58 | | | | Very slight tremors |
| | | | to | | | | | |
| | EW | 21 | 58 | 04 | | | | |
| | | | to | | | | | |
| | | 21 | 59 | 44 | | | | |
| II 875 Nov. 25 | 1-PN | 18 | 59 | 20 | | 19 | 18 | Distance 250 miles felt in Chiriqui Intensity I |
| | 1-PE | 18 | 59 | 08 | | | | |
| | 1-SN | 18 | 59 | 52 | | | | |
| | 1-SE | 18 | 59 | 56 | | | | |
| | LN | 19 | 00 | 04 | | | | |
| | LE | 19 | 00 | 24 | | | | |
| | MN | 19 | 00 | 20 | | | | |
| | ME | 19 | 00 | 36 | | | | |
| | CN | 19 | 01 | 20 | | | | |
| | CE | 19 | 01 | 48 | | | | |
| FN | 19 | 11 | 56 | | | | | |
| FE | 19 | 11 | 04 | | | | | |
| II 876 Nov. 24 | PN | 8 | 28 | 00 | | | | Very slight tremors |
| | PE | 8 | 27 | 52 | | | | |
| | FN | 8 | 30 | 04 | | | | |
| | FE | 8 | 29 | 32 | | | | |
| II 877 Nov. 29 | 1-PN | 5 | 04 | 30 | 3.8 3.6 | 39 | 42 | Intensity I Distance about 250 miles. |
| | 1-PE | 5 | 04 | 30 | | | | |
| | 1-SN | 5 | 05 | 14 | | | | |
| | 1-SE | 5 | 05 | 14 | | | | |
| | LN | 5 | 05 | 18 | | | | |
| | LE | 5 | 05 | 42 | | | | |
| | MN | 5 | 05 | 20 | | | | |
| | ME | 5 | 05 | 56 | | | | |
| | CN | 5 | 06 | 18 | | | | |
| | CE | 5 | 07 | 54 | | | | |
| FN | 5 | 17 | 30 | | | | | |
| F.E | 5 | 17 | 10 | | | | | |



THE PANAMA CANAL
DEPARTMENT OF OPERATION AND MAINTENANCE
SECTION OF SURVEYS

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Lat. 8° 57' 39" N.

Long. 79° 33' 29" W.

h = 36 meters.

Lithologic foundation: Basalt.

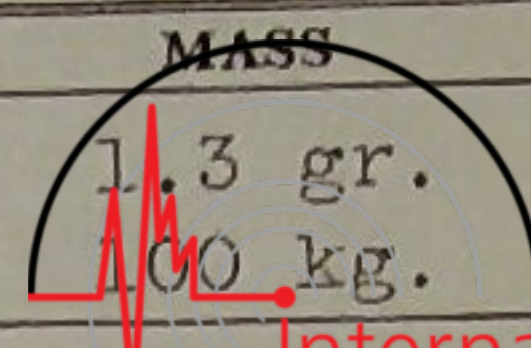
Time Correction: Within 0.5 sec.

INSTRUMENTS—FIXED CONSTANTS

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

INSTRUMENTS—DETERMINED CONSTANTS

| INSTRUMENTS | COMPONENT | T ₀ | V | h | DETERMINED |
|---------------|-----------|----------------|----|----------|----------------|
| Wood-Anderson | | Not operating | | | |
| Wood-Anderson | | | | | |
| Bosch-Omori | E - W | 20 | 35 | Critical | August 1, 1933 |
| Bosch-Omori | S - N | 20 | 35 | Critical | August 1, 1933 |



International
Seismological
Centre

Month December 1933

Page No. 1

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|---------------------|--------|------------------|----|----|-------------|-----------|---------|---|
| | | h | m | s | | E mm | N mm | |
| II 878 Dec. 1 | i - PN | 16 | 29 | 12 | | | | Distance about 250 miles. <i>Intensity I</i> |
| | i - PE | 16 | 29 | 04 | | | | |
| | i - SN | 16 | 29 | 48 | | | | |
| | i - SE | 16 | 29 | 44 | | | | |
| | - LN | 16 | 29 | 54 | | | | |
| | LE | 16 | 29 | 54 | | | | |
| | MN | 16 | 29 | 58 | 3.5 | | 2 | |
| | ME | 16 | 29 | 56 | 3.5 | 2 | | |
| | LN | 16 | 29 | 58 | | | | |
| | CE | 16 | 30 | 20 | | | | |
| FN | 16 | 30 | 08 | | | | | |
| FE | 16 | 31 | 44 | | | | | |
| II 879 Dec. 2 | i - PN | 3 | 01 | 46 | | | | Distance about 250 miles. <i>Intensity II</i> |
| | i - PE | 3 | 01 | 32 | | | | |
| | i - SN | 3 | 02 | 16 | | | | |
| | i - SE | 3 | 02 | 12 | | | | |
| | LN | 3 | 02 | 34 | | | | |
| | LE | 3 | 02 | 22 | | | | |
| | MN | 3 | 02 | 44 | 4.5 | | 7 | |
| | ME | 3 | 02 | 26 | 3.0 | 5 | | |
| | CN | 3 | 02 | 50 | | | | |
| | CE | 3 | 03 | 14 | | | | |
| FN | 3 | 10 | 54 | | | | | |
| FE | 3 | 07 | 12 | | | | | |
| II 880 Dec. 6 | i - PN | 4 | 57 | 58 | | | | <i>Intensity IV</i> Distance about 145 miles. Felt locally by many |
| | i - PE | 4 | 57 | 58 | | | | |
| | i - SN | 4 | 58 | 24 | 2 | | | |
| | i - SE | 4 | 58 | 24 | 2 | | | |
| | LN | 4 | 58 | 34 | 6 | | | |
| | LE | 4 | 58 | 34 | 6 | | | |
| | MN | 4 | 58 | 28 | | | 11 | |
| | ME | 4 | 58 | 42 | | 8 | | |
| | CN | 4 | 59 | 00 | | | | |
| | CE | 4 | 59 | 06 | | | | |
| FN | 5 | 02 | 00 | | | | | |
| FE | 5 | 01 | 28 | | | | | |
| II 881 Dec. 6 | i - PN | 6 | 35 | 32 | | | | <i>Intensity III</i> Distance about 145 miles Felt locally by several |
| | i - PE | 6 | 35 | 48 | | | | |
| | i - SN | 6 | 35 | 58 | | | | |
| | i - SE | 6 | 36 | 14 | | | | |
| | MN | 6 | 36 | 02 | | | 6 | |
| | ME | 6 | 36 | 20 | | 2 | | |
| | LN | 6 | 36 | 08 | 2 | | | |
| | LE | 6 | 36 | 24 | 2 | | | |
| | CN | 6 | 36 | 26 | | | | |
| | CE | 6 | 36 | 42 | | | | |
| FN | 6 | 37 | 40 | | | | | |
| FE | 6 | 38 | 08 | | | | | |

SEISMOLOGICAL RECORD AT BALBOA HEIGHTS, CANAL ZONE

Month December 1933

Page No. 2

| No. and Date | Phase | Time G. M. T. | | | Period s | Amplitude | | REMARKS |
|---------------------|---------|------------------|----|----|-------------|-----------|---------|---|
| | | h | m | s | | E mm | N mm | |
| II 882 Dec. 6 | 1 - P N | 10 | 24 | 38 | | | | Distance about 145 miles. Intensity IV <i>Felt locally.</i> |
| | 1 - P E | 10 | 24 | 38 | | | | |
| | 1 - S N | 10 | 25 | 04 | 3 | | | |
| | 1 - S E | 10 | 25 | 04 | 2 | | 11 | |
| | M N | 10 | 25 | 08 | | | | |
| | M E | 10 | 25 | 08 | | 7 | | |
| | L N | 10 | 25 | 14 | 8 | | | |
| | L E | 10 | 25 | 14 | 7 | | | |
| | C N | 10 | 25 | 46 | | | | |
| C E | 10 | 25 | 54 | | | | | |
| | F N | 10 | 28 | 04 | | | | |
| | F E | 10 | 30 | 24 | | | | |
| II 883 Dec. 8 | | 21 | 30 | 52 | | | | Very slight tremors |
| | | | to | | | | | |
| | | 21 | 33 | 44 | | | | |

