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COAST AND GEODETIC SURVEY
ROBERT F. A. STUDDS, Director

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THE TSUNAMI OF NOVEMBER 4, 1952 AS RECORDED AT TIDE STATIONS

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PREFACE

The purpose of this publication is to present the factual record of the November 4, 1952 tsunami as shown by tide gage records and other data on file at the U.S.Coast and Geodetic Survey and to examine the record for certain features in order to provide answers to some frequently asked questions about such waves.

This publication was prepared by W. B. Zerbe, Chief, Section of Oceanography, Division of Tides and Currents.

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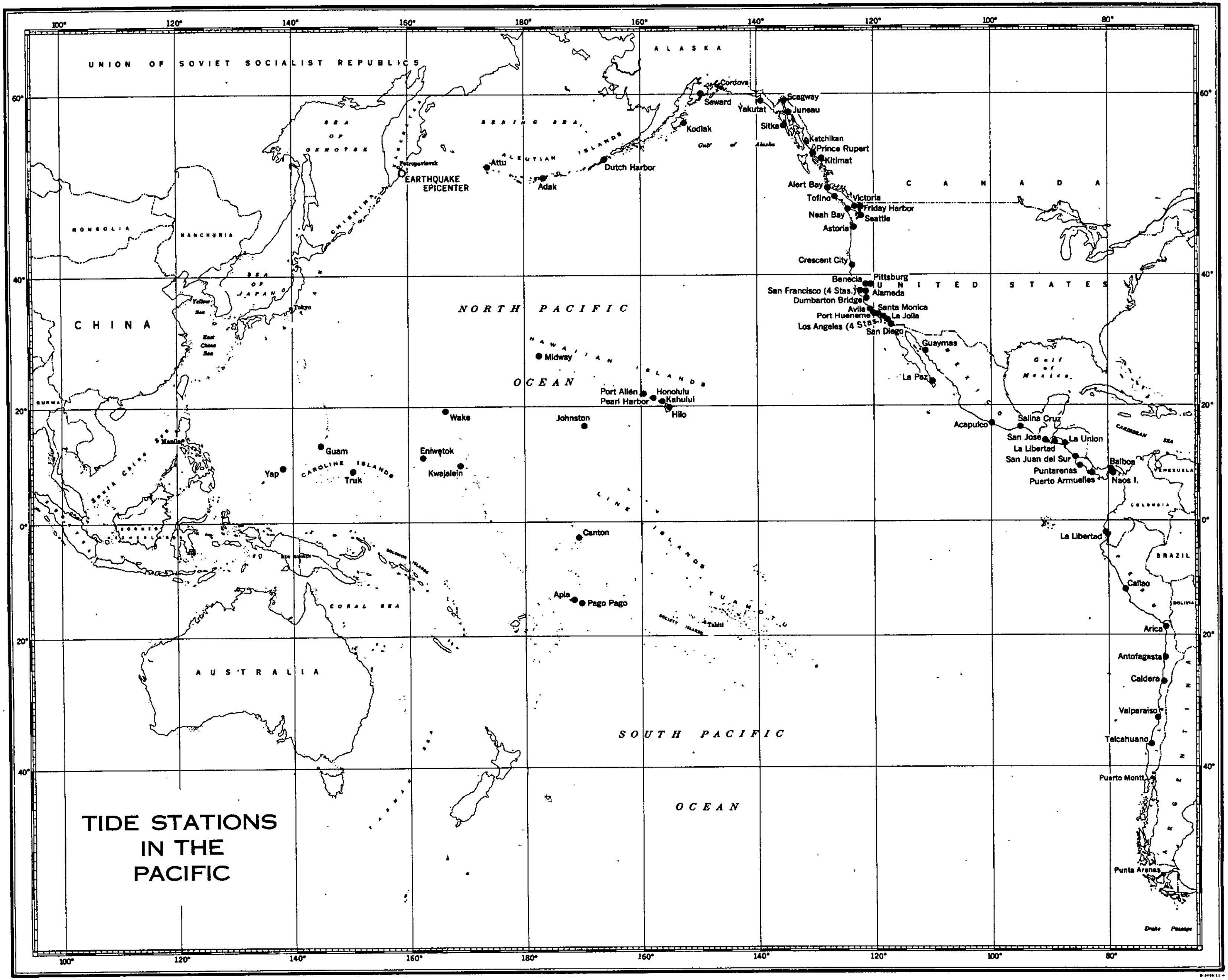
TIDE STATIONS IN THE PACIFIC
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CANADA
UNITED STATES
CHINA
MONGOLIA
MANCHURIA
AUSTRALIA
BRAZIL
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
SEA OF OKHOTSK
BERING SEA
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Eniwetok
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Yap
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Canton
Apia
Pago Pago
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Manila
100°
120°
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80°
60°
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0°
20°
40°

THE TSUNAMI OF NOVEMBER 4, 1952
AS RECORDED AT TIDE STATIONS

The Tsunami Record.

At 1658 Greenwich time on November 4, 1952, a series of sea waves was generated by a severe earthquake under the sea off the Kamchatka Peninsula. The earthquake was located at Lat. $52\frac{1}{2}$°N., Long. 159°E., and it had a magnitude of $8\frac{1}{4}$ to $8\frac{1}{2}$.* The seismic sea waves, often called "tidal waves" or now frequently by the Japanese term, "tsunami", were recorded by tide gages throughout the Pacific, and this report presents the record from tide gages in the Pacific islands and on the American continents.

This tsunami was probably recorded by more tide gages than any other before it. Even a few stations up tidal tributaries far from the sea recorded it (Kitimat, 50 miles up Douglas Channel, B. C., and Benecia and Pittsburg, about 30 and 45 miles respectively inside San Francisco Bay, Calif.). Tide stations that might have been expected to record it, but that did not, are Cordova and Ketchikan, Alaska, and Puerto Montt and Punta Arenas, Chile. At most places the waves were large enough to provide a clear, definite record.

The record is presented primarily by Table 1 and by the reproductions of portions of the gage records, supplemented by the following discussion. Both Table 1 and the figures are given at the end of the report. The height scales on the figures are placed for convenience in estimating heights and do not refer to any particular datum.

Comparison with the 1946 Tsunami.

It was the most severe tsunami to be recorded by Coast and Geodetic Survey gages since that of April 1, 1946. In fact, judging from many of the gage records alone, it was larger than that of 1946. But it was not as destructive, and we know from evidence other than that of the gages that nowhere did the waves roll or dash up to the great heights reached at some places by the great waves of 1946. In 1946, Scotch Cap Light, situated in the Aleutians on a promontory 57 feet above sea level, was obliterated. Nothing of this sort happened in 1952. In the Hawaiian Islands in 1946, 173 lives were lost and property damage amounted to $25,000,000. The 1952 tsunami caused property damage in the Hawaiian Islands estimated at $800,000 and no lives were lost. The fact that no lives were lost and that the loss of property was relatively small may be attributed in part to the successful operation of the seismic sea wave warning system that was organized after the 1946 catastrophe.

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* Preliminary Determination of Epicenter, U. S. Coast and Geodetic Survey, Washington, November 7, 1952.

For comparing wave data as recorded for the two tsunamis, Table 2 has been prepared for selected places at which gages were operating on both occasions. The pattern is mixed. Neither wave was consistently larger than the other at all places. The largest wave recorded on either occasion was 12 feet at Talcahuano, Chile in 1952. There is no gage record for that place for 1946.

TABLE 2. Maximum Recorded Rise or Fall

(This table lists only places at which gages were operating on both dates.)

Station	1946	1952
	Ft. *	Ft. **
Honolulu, T. H.	4.1	4.4
Sitka, Alaska	2.6	1.5
Clayoquot (Tofino), B. C.	1.9	2.0
Victoria, B. C.	0.7	1.4
Neah Bay, Wash.	1.2	1.5
Crescent City, Calif.	5.9	6.8
San Francisco (Presidio)	1.7	3.5
San Francisco (Hunters Point)	0.5	1.2
San Luis Obispo Bay (Avila)	8.5	9.5 +
Port Hueneme, Calif.	5.5	4.7
Los Angeles Hbr. (Berth 60)	2.5	2.0
Los Angeles Hbr. (Mormon I.)	2.2	3.6
La Jolla, Calif.	1.4	0.8
San Diego, Calif.	1.2	2.3
Antofagasta, Chile	5.9	4.7
Valparaiso, Chile	5.0 +	5.9 +

The 1946 maximum was 8.5 feet at Avila, Calif.
The 1952 max. was 12.0 ft. at Talcahuano, Chile.

* Seismic Sea Wave of April 1, 1946. Trans. Amer. Geophys. Union. v. 27, p. 453. 1946.

** For large waves not included in this table, see Table 1.

See also C.K. Green, Seismic Sea Wave of April 1, 1946 as Recorded on Tide Gages. Trans. Amer. Geophys. Union, v. 27, pp. 490-500, 1946.

Speed of Waves.

Much evidence of the speed of travel of seismic sea waves is already available, and data on the speed of the waves on this occasion merely confirm what is already known. The speed of such waves depends on depth and can be computed by the formula, $s = \sqrt{gd}$, where g is the acceleration of gravity and d is depth of water. For example in oceanic depths of 2000 and 5000 fathoms, they have speeds of about 370 and 580 knots respectively. In shoaler waters and in depths of the order found in bays and harbors, the speeds are considerably less, as indicated by Table 3.

TABLE 3. Computed Wave Speeds for Various Depths.

Depth	Speed	Depth	Speed
Fathoms	Knots	Fathoms	Knots
10	26	2000	368
100	82	3000	451
500	184	4000	521
1000	260	5000	582

Over great distances having varying depths, speed will vary, and the speed determined from observed travel time from epicenter to tide station will be an average for the whole distance. Table 4 shows observed average speeds for the 1952 wave to a few selected points. All but two of the stations chosen are ones to which the great circle course could be closely followed. The path followed by the initial wave may not always be the exact great circle path, of course, for at some places along the route adjacent paths may be deeper, an island may have to be skirted or the course changed to enter a harbor. But except for Kodiak and Acapulco, the speeds were determined by dividing the great circle distance from epicenter to tide station, as computed from latitude and longitude, by the observed wave travel time. For Kodiak and Acapulco, the distance was scaled from charts using the most probable path.

TABLE 4. Observed Average Wave Speed to Selected Stations.

Station	Distance	Travel Time	Speed
	Nautical miles	h. m.	Knots
Guam	2443	5 21	457
Canton I.	3633	8 02	452
Pago Pago	4304	9 43	443
Midway	1796	4 23	410
Honolulu	2724	6 16	434
Hilo	2893	6 37	437
Adak	893	2 29	360
Kodiak	1985	5 45	345
San Francisco (Presidio)	3265	8 40	377
Acapulco, Mexico	5101	12 37	404
Callao, Peru	7189	18 50	382
Valparaiso, Chile	8348	20 40	404

Wave Period.

The period of a seismic sea wave is difficult to determine accurately. The tide gage record can seldom be read accurately to the minute and in many cases the uncertainty covers several minutes. Moreover the waves set up reflections or interference as can be seen on the records shown herein. How early this effect occurs is uncertain. In a harbor or basin, the natural period of the basin should begin to assert itself with or soon after the arrival of the first wave. In some harbors and even at some stations on the open coast, an interference pattern is in evidence on the first wave. Nevertheless, the part of the gage record most likely to indicate the true wave period before interference is the record of the first oscillation, and this is recorded for each station in Table 1. The shortest recorded period of the initial wave is 8 minutes and the longest 100 minutes. The average for all stations listed is 38 minutes. The great diversity of periods is a confusing feature of this tsunami.

Wave Length.

In the open sea, the waves are much too long to be observed visually, but from the record of gages on shore we have data for computing wave length--the distance from crest to crest. For example, Table 4 shows that the average speed of the wave to Hilo was 437 nautical miles per hour. Table 1 shows that the second crest arrived 20 minutes (1/3 hour) after the first. Then roughly, the second crest must have been 1/3 of 437 or 146 nautical miles away when the first crest arrived. A similar computation for a few other places at which the first wave pattern is clear and apparently without interference gives the wave lengthsshown in Table 5.

TABLE 5. Wave Length.

Station	Wave length
	Nautical miles
Pago Pago	133
Canton I.	98
Honolulu	273
Hilo	146
Kodiak	356
Acapulco	215
Callao	153

Enough stations have been included in the table to show that the result is not consistent for all stations. It might be reasoned that the differences are due to the fact that the speeds used in the computation are averages that include the slow speeds in shoal water and the higher speeds in the open sea in different proportions. But an examination of the data used shows that the great differences in wave length are due primarily to differences in wave period rather than to differences in speed, and it is problematical as to what period is most nearly representative of the wave in the open sea.

Kodiak was included to represent one of the long durations in the Gulf of Alaska. Omitting it, the average wave length for the other six stations is 170 nautical miles which is consistent with their average period of about 25 minutes and speed of 425 knots.

Duration of the Oscillations.

At most places where the tsunami effect was definite, the oscillations continued for several days, but at many stations it is difficult to determine when they ceased. At some stations there is normally a seiche pattern on the record, and as the tsunami oscillations became small, it is difficult to determine when they stopped and the normal seiche began. Reasonably good durations could be determined for the sample places shown in Table 6 and they are listed to the nearest one-fourth day.

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TABLE 6. Duration of Tsunami Oscillations.

Station	Duration
	Days
Pago Pago	4 ½
Honolulu	4 3/4
Hilo	4 3/4
Adak	4
Crescent City	3 3/4
Avila	4 ½
Callao	5 ½

Reports of Observers.

Though the press as well as trained observers reported waves larger than those shown by the tide records, it does not mean that the reports are in error. The gages were seldom located where the waves were largest. In the case of the island of Oahu, the Honolulu record shows a maximum of about 4½ feet as against a reported 13 feet on the northwest coast. The waves were probably much larger at places on the exposed northwest coast than on the sheltered side of the island where Honolulu is located. Moreover, the small intake to the tide gage float wells, designed to dampen wind waves in the well, does not permit the tide gage to record the full amplitude of seismic sea waves. For example, considering waves of the size and period of the maximum shown in Table 1, it can be computed that dampening due to a 1-inch intake in a 12-inch well would be about 1/3 foot at Honolulu, but a foot or more at Midway and Attu.

Following are some excerpts of reports on file that add to the data in the tables or provide interesting sidelight information.

Apia, Western Samoa. The Observer-in-Charge, Apia Observatory reported: At 1 p.m. local time a further cable was received indicating that the wave had passed Midway Island with an amplitude of approximately 5.8 feet. No further information was on hand when the first signs of a disturbance were noticed in Apia harbour at about 3:45 p.m.

The harbor was alternately drained to below low tide level exposing all the inner reef, and filled to over highest tide level at intervals of approximately 15 minutes. The rise (and fall) of water was approximately 4.5 feet at Apia wharf although at the Observatory's tide gage in the lagoon, this was reduced to only 1.1 feet. The first indications on the tide gage were recorded at 3:35 local time when the water level began to rise.

The oscillations of the lagoon were visible for several hours and disturbances on the tide gage record at 10:00 a.m. the following morning still maintained the same periodicity. The highest water level was at 8:50 p.m. when the oscillations were still quite large and the tide was at its maximum height.

Some property damage was reported from Fagaloa Bay near the eastern end of Upolu where the wave built up into a 5 foot wall of water. A school and some other Samoan buildings were completely lost. No other extensive damage was reported and there was no loss of life.

Hawaiian Islands. The Supervisor, Pacific District, USC&GS, reported: A seismic sea wave struck the Hawaiian Islands at 1300 Hawaiian Standard Time on 4 November. The military authorities and the Honolulu Police Department were alerted at 0840 by the Honolulu Magnetic Observatory, and advisory information was issued throughout the emergency period. No lives were lost in the Hawaiian Islands, however, it is estimated that property damage may reach a total of $800,000.

A series of excellent photographs supplied by the Chief, Civil Works Branch, U. S. Engineers Department, Honolulu Area, shows boats moved onto the land, houses moved and collided with other houses, piers destroyed, beaches scoured, road pavement moved, etc.

An Associated Press report stated: Warning messages crackled through the air. Low-lying islands and coastal cities across 5,000 miles of ocean were put on the alert. Apparently not a single life was lost. Damage was remarkably light. A 13-foot wave knocked down telephone lines on Oahu, marooned automobiles and flooded yards. A farmer reported six cows killed. In Honolulu Harbor, waves tore a cement barge from moorings and hurled it against the freighter Hawaiian Packer. At Hilo a $13,000 boathouse was demolished. Twelve-ton Coast Guard buoys were ripped loose from their moorings. The waves caused much excitement but little panic. Sightseers stampeded toward the beach instead of away from it.

Pearl Harbor. The Chief of the USC&GS Pacific Tide Party reported: I arrived at the gage about a minute after the tsunami began. The rise and fall of the water was quite evident on the marigram, but observation of the waters around the dock area gave no indication of anything unusual. During the period of greatest activity there was a noticeable surface current past the piling under the dock near the gage.

Hilo, Hawaii. A representative of the U. S. Engineers who made an inspection of the Hilo area reported that the sea wave high water mark at the tide station was 1.5 feet above the deck of the pier that is 9.42 feet above mean lower low water. He estimated that the water receded 7 to 9 feet below normal tide level at the time of the wave.

The tide observer was on the pier and reported: At 1:35 p.m. considerable rising water movement was noticable and the seismic sea wave detector set off the alarm, and the Police Department in turn alerted the public by means of their sirens. The largest wave occurred about 1:45 p.m. which did considerable damage around the dock area. For a moment I thought the tide house would go with the wave, but fortunately it is still up.

The Volcanologist-in-Charge, Hawaiian Volcano Observatory, reported: At Hilo, except for one area, the heights reached were very much lower than in 1946, and instead of rolling in with a steep front and forceful impact, the November 4 wave was mostly just a gentle rise of the water. In a single area, that around the head of Reed's Bay ("Radio Bay"), the water heights closely approached those of 1946. Heights elsewhere on the island of Hawaii were distinctly lower than in 1946.

Attu, Alaska. The Officer-in-Charge, Attu Fuel Annex reported: The tide observer reported tide gage not operating correctly, but that he placed it in operation at about 2015Z. Thus it is not known exactly at what time the first signs of unusual tidal activity occurred. It is strongly suspected from high water mark inspection that the initial high tide occurred very close to 2000Z. Tide staff readings at 2005Z showed drop of 9 feet in 5 minutes. Observing the tide after discovery of the unusual activity until many hours later, no pronounced bore effect was noted. The water in the harbor simply receded rapidly (about 10 minutes in the beginning between high to high cycles) and then rose rapidly, spilling over onto the low areas adjacent to the harbor. What damage was suffered was due to flooding and not bore action.

Adak, Alaska. The tide observer reported: The tides fluctuated from approximately one foot below normal to a maximum of seven and one-half feet above normal over a period of approximately six hours. The fluctuation was relatively rapid, but very gentle, with no washing effect and no damage to installations, equipment or personnel. The water level simply rose, overflowed the banks of the harbor slightly in some areas (on three separate occasions) and receded.

Dutch Harbor, Alaska. The Officer-in-Charge, Navy Aero Unit, Dutch Harbor, reported: The maximum crest was 9.8 feet on the tide staff, or about 3 feet above normal. The waves came in intervals of from thirty to forty-five minutes. There was no damage recorded in the area. The town of Unalaska, across the bay from Dutch Harbor, closed down the schools and evacuated everyone into the mountains. On my request, Com Seventeen informed the Commissioner there was no danger, and they returned to their homes.

Canada. The District Engineer, Canadian Hydrographic Service, Victoria, B. C. reported: This wave was of somewhat greater amplitude on our coast than the one of 1946 and continued to oscillate for a considerably longer time. It was noticed by shipping in Victoria Harbor but there was no damage of any kind. Although greatly diminished, it was also recorded by our Kitimat gage at the head of Douglas Channel which is more than 50 miles from the open water of Hecate Strait.

Oregon and California. The Supervisor, Midwestern District, USC&GS, supplied the following account from the Portland, Oregon JOURNAL: The tidal wave missed most of the Oregon coast, but wrought havoc in the harbor at Crescent City, California. At least three fishing boats were wrecked, one was overturned but righted, heavy concrete moorage anchors were ripped loose and strewn around the harbor and the bulk of boats saved only by being taken out to sea for 24 hours. Terrific surges of water would rush into the basin, then recede every few minutes, buffeting anything in their path.

Peru. The U. S. Naval Attache at Lima reported the following information obtained from the press and from Peruvian Naval Officers: At Callao, the first wave caused a drop in the water level of almost 9 feet. The abrupt changes in the water level resulted in currents and whirlpools, particularly within the area enclosed by the breakwaters of the Maritime Terminal where currents reached a velocity of 10 knots. Damage at Callao was light. A navy dredge snapped five or six cables and almost collided with another vessel. More than thirty yachts and small boats were damaged and large vessels were unable to leave the terminal on schedule on the 5th or during the morning of the 6th. Aside from damage to vessels in the bay itself, a few houses in La Punta were inundated on the evening of the 5th. At Zorritos, a 120 meter section of the pier was destroyed and the pier put out of operation. In the vicinity of Callao, the currents and whirlpools stirred up a great deal of mud with the result that a large number of fish apparently were asphyxiated and thrown up on the beach.

Chile. The Departamento de Navigacion e Hidrografia supplied a copy of LA UNION of November 6, 1952 from which the following has been extracted: At Los Vilos, from 10 o'clock yesterday, the sea was abnormal with highs and lows every 15 minutes. The Captain of the Port estimated the crests between 2 and 3 meters, and warnings were broadcast to fishermen. At Valparaiso warnings were immediately radioed to all ships in the bay. At Talcahuano there was widespread alarm as the water rose an estimated 3 meters to the top of the mole. At Concon there was veritable panic along the coastal areas. According to fishermen, nothing of this nature had been seen for the past 30 years. At Iquique the waves reached a magnitude of 1.40 meters. The sea there receded several meters causing the grounding of various small vessels. At Coquimbo the phenomenon caused alarm. At about 15 hours the pier and new Custom House were flooded; parts of the market place were below water and 150 meters of the railroad line was flooded. The high tides also affected Dichato, Penco, and San Vincents. There was no loss of life and little damage to property.

The Seismic Sea Wave Warning System.

Following the 1946 seismic sea wave, a system was organized for detecting such waves soon after their inception and reporting them to Pacific area military and civil authorities. It is a cooperative undertaking involving seismological observatories for detecting and reporting large earthquakes in the Pacific area, tide stations located throughout the Pacific for detecting and reporting the resulting sea waves, a central station in Honolulu for receiving and evaluating the reports and alerting the central military and civil agencies, and rapid communication service between all stations and Honolulu. When the central military and civil agencies are informed that there is a wave, they put into operation their previously made plans for warning the civil communities, shipping, and military bases.

The warning system functioned satisfactorily at this time. How it operated can be seen from the following statements taken from the Preliminary Report submitted at the time supplemented by the Observatory's detailed log submitted later by the Observer-in-Charge, U. S. Coast and Geodetic Survey Magnetic and Seismological Observatory near Honolulu, which is the central station of the warning system. The times are Greenwich.

The seismograph alarm sounded at the Observatory at 1707 Nov. 4, 1952. Received data from Coast and Geodetic Survey observatories at Fairbanks, Alaska at 1728, Tucson, Arizona at 1753, and Sitka, Alaska at 1755. Data arrived from Berkeley (University of California) at 1807 and from Pasadena (Seismological Laboratory) at 1819. At 1815 the earthquake epicenter had been located (preliminary) at 51°N., 158°E.

The indicated arrival times for possible sea waves from this epicenter were then as follows: Attu 1900, Adak 1930, Tokyo and Dutch Harbor 2100, Wake and Midway 2130, Guam, Kwajalein, and Eniwetok 2230, Johnston 2300, and Honolulu 2330. Notified Attu to inspect tide record for wave between 1830 and 2000, and Adak between 1830 and 2130.

Sent all available readings to Tokyo Central Meteorological Observatory at 1834, and at 1840 advised CINCPAC of earthquake time, location, and possibility of a sea wave arriving at Honolulu at 2330. Gave 31st Air Weather Wing and Honolulu Police the same data.

Received further data from Tokyo at 1916 and at their request provided them with the estimated epicenter (51°N., 158°E.). At 2107 received tide staff readings from Attu showing 9-foot drop of water level in 5 minutes at 2005. Advised CINCPAC, Air Weather, and the Police. Adak furnished readings at 2120. At 2050 requested Wake and Dutch Harbor to inspect their gages between 2030 and 2230. At 2126 Midway reported a 1.5-foot rise and at 2149 Wake reported a 1-foot wave. At 2205 Dutch Harbor reported a high wave at 2100. By 2226 Midway had reported three waves, one of 5.8 feet with tide station and pier under water. At 2158 Johnston Island requested estimated arrival and all clear times. At 2256 Wake reported no sea wave damage. Midway reported 9 feet of water over the island. All wave reports were passed to CINCPAC, Air Weather Service, and the Police as they were received. At 2136 the Police were alerted to prepare for wave at 2315 (1315 Hawaiian time). Information was received at 0535 on the 5th that CINCPAC had ended the Military alert at 0502.

List of Waves, 1946 - 1952.

For a number of years, tide records in the Coast and Geodetic Survey have been examined systematically for evidence of waves from every earthquake in the Atlantic and Pacific areas that could have caused a wave. Table 7 lists the 16 earthquakes beginning in 1946 that produced waves or disturbances on Coast and Geodetic Survey tide records. It also shows the number of tide stations that recorded each disturbance and the greatest wave recorded. There are a number of lists available for tsunamis prior to 1946*; the present table is intended merely to bring the record up-to-date.

TABLE 7. Tsunamis Recorded at USC&GS Tide Stations, 1946 - 1952.

Earthquake**			Tide stations that recorded wave	Largest wave recorded (approx)
Date	Epicenter near	Magnitude	No.	Feet
1 Apr. 1946	Aleutian Is.	$7\frac{1}{4}$	33	8.5
4 Aug. 1946	Dominican Republic	8.1	4	1.0
8 Aug. 1946	Dominican Republic	7.6	4	1.1
20 Dec. 1946	Japan	$8\frac{1}{4}$	4	1.7
1947	-----	--	None	---
8 Sept.1948	Tonga Is.	7.8	4	0.7
22 Aug. 1949	Queen Charlotte Is.	8.1	1	0.3
27 Sept.1949	S. Coast Alaska	7	1	Seward gage shaken.
19 Oct. 1949	Solomon Is.	$7\frac{1}{4}$	2	1 to 2
5 Oct. 1950	Costa Rica	7.7	3	0.5
23 Oct. 1950	Guatemala	7.3	2	0.9
14 Dec. 1950	Mexico	7.3	1	2.0
21 Aug. 1951	Hawaii	6 3/4-7	2	0.3
4 Mar. 1952	Hokkaido	$8 - 8\frac{1}{4}$	23	1.7
19 Mar. 1952	Mindanao	$7\frac{1}{2}$ -7 3/4	4	2.2
13 July 1952	New Hebrides	7	1	0.1
4 Nov. 1952	Kamchatka	$8\frac{1}{4} - 8\frac{1}{2}$	71	12.0

** Earthquake data are from "Preliminary Determination of Epicenter" issued by the C&GS for each earthquake, "United States Earthquakes" issued annually by the C&GS, "Earthquake Notes" Vol. XVIII, No. 1 and 2, 1946, issued by the Eastern Section, Seismological Society of America, and "Seismological Laboratory Bulletin, 1946" issued by the California Institute of Technology.

* Heck, N. H. List of seismic sea waves. Bulletin of the Seismological Society of America, v. 37, no. 4, pp. 269-286, 1947.

Shepard, MacDonald and Cox. The tsunami of April 1, 1946. Bulletin of the Scripps Institution of Oceanography, Univ. of Calif. Press, Berkeley and Los Angeles, 1950.

Zetler, Bernard D. Travel times of seismic sea waves to Honolulu. Pacific Science, v. 1, no. 3, pp. 185-188, 1947.

Cuellar, M. P. Annotated bibliography on tsunamis. Tech. Memo. No. 30, Beach Erosion Board, Corps of Engineers, Washington, Feb. 1953.

Acknowledgement.

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Apia Observatory, Apia, Western Samoa.
Canadian Hydrographic Service, Victoria, B.C.
Departamento de Navegacion e Hidrografia, Valparaiso, Chile.
The Meteorological and Hydrographic Branch, The Panama Canal Co., Balboa, C.Z.
Inter-American Geodetic Survey, Balboa Heights, C.Z.

as well as to the organizations in various countries that supplied information through the Inter-American Geodetic Survey.

TABLE 1. The Tsunami of November 4, 1952 as Recorded on Tide Gages

(All times are Greenwich)

Waves originated at earthquake epicenter near Kamchatka (52½°N., 159°E.) at 1658 November 4, 1952.

TIDE STATION	LAT.	LONG.	INITIAL WAVE: TIME OF ARRIVAL	INITIAL WAVE: PERIOD 1st to 2nd CREST	INITIAL WAVE: INITIAL RISE (a)	INITIAL WAVE: FOLLOWING FALL (a)	MAXIMUM RISE OR FALL: TIME OF BEGINNING	MAXIMUM RISE OR FALL: DURATION	MAXIMUM RISE OR FALL: HEIGHT
	° ' N	° ' E	d. h.m.	min.	feet	feet	d. h.m.	min.	feet
1. Yap I.	9 30	138 08	4 23 05	55	0.2	0.4	4 23 30	35 F	0.4 F
2. Port Apra, Guam	13 26	144 39	4 22 19	53	0.5	0.9	4 22 28	25 F	0.9 F
3. Truk I.	7 22	151 53	4 22 46	(b)	0.4	(b)	5 01 35	23 R	0.8 R
4. Eniwetok	11 21	162 21	4 22 23	48 c	0.8	1.2	4 23 42	16 R	1.4 R
5. Wake I.	19 17	166 37	4 21 07	12	1.2	1.6	5 03 07	1 R	1.7 R
6. Kwajalein I.	8 44	167 44	4 22 56	32 c	0.8	1.6	4 23 17	17 F	1.6 F
	S	W							
7. Canton I.	2 48	171 43	5 01 00	13	0.3	0.4	5 06 03	1 R	0.7 R
8. Apia, Samoa	13 48	171 46	5 02 35 d	(d)	(d)	---	- -- --	--	(d)
9. Pago Pago, Samoa	14 17	170 41	5 02 41	18	0.9	2.0	5 03 32	11 F	6.0 F
	N	W							
10. Johnston I.	16 45	169 31	4 23 00	29	1.2	1.4	4 23 25	17 F	1.4 F
11. Midway I.	28 13	177 22	4 21 21	8	1.9	1.9	4 21 46	4 R	6.6 R
12. Port Allen, Kauai, T.H.	21 54	159 35	4 23 00	27	0.2	0.2	5 00 02	5 F	0.8 F
13. Pearl Harbor, Oahu, T.H.	21 21	157 57	4 23 22	18 c	0.3	0.3	5 00 45	7 F	1.2 F
14. Honolulu, Oahu, T.H.	21 18	157 52	4 23 14	38	1.1	3.0 e	5 00 26	9 R	4.4 R,e
15. Kahului, Maui, T.H.	20 54	156 28	4 23 20	(g)	(g)	(g)	(g)	(g)	(g)
16. Hilo, Hawaii, T.H.	19 44	155 03	4 23 35	20	4.0	7.9	4 23 48	12 F	7.9 F
17. Massacre B., Attu, Alaska	52 50	186 48	(h)	(h)	(h)	(h)	(h)	4 R	8.0 R
18. Sweeper Cove, Adak, Alaska	51 51	176 39	4 19 27	46	1.4	3.2	5 00 25	17 R	6.9 R,i
19. Dutch Harbor, Alaska	53 54	166 32	4 20 25	58 i	2.0 i	3.8 i	4 21 07	30 F	3.8 F,i
20. Womens B., Kodiak, Alaska	57 43	152 31	4 22 43	62	0.3	0.7	5 (j)	--	2.0 j
21. Seward, Alaska	60 06	149 27	4 23 15 k	60	0.3	0.5	5 18 55	24 R	1.0 R
22. Yakutat, Alaska	59 33	139 44	4 23 20 k	50 k	0.2	0.3	5 07 14	5 R	1.8 R
23. Juneau, Alaska	58 18	134 25	(m)	(m)	(m)	(m)	(m)	(m)	0.7 j
24. Skagway, Alaska	59 27	135 19	5 00 40 k	--	---	---	- -- --	--	---
25. Sitka, Alaska	57 03	135 20	4 23 13	90	0.4	0.8	5 06 15	4 R	1.5 R
26. Prince Rupert, B.C.	54 19	130 20	5 02 20	100 k	---	---	- -- --	--	---
27. Alert Bay, B.C.	50 35	126 56	5 01 18	70 k	0.4	0.8	5 07 03	15 R	1.0 R
28. Kitimat, B.C.	53 58	128 42	(n)	(n)	(n)	(n)	(n)	(n)	(n)
29. Tofino, B.C.	49 09	125 55	5 00 42	28	0.6	1.3	(j)	--	2.0 j
30. Neah Bay, Wash.	48 22	124 37	5 01 00	30	0.5	0.8	5 08 11	17 R	1.5 R
31. Victoria, B.C.	48 26	123 23	5 01 40	55	0.4	1.0	(j)	--	1.4 R
32. Friday Harbor, Wash.	48 33	123 00	(o)	(o)	(o)	(o)	(j)	--	0.4 j
33. Seattle, Wash.	47 36	122 20	(p)	(p)	(p)	(p)	(p)	(p)	(p)
34. Astoria, Oregon	46 13	123 46	(o)	(o)	(o)	(o)	5 08 02	34 R	0.8 R
35. Crescent City, Calif.	41 45	124 12	5 00 55	25	1.7	3.0	5 05 39	10 R	6.8 R
36. San Francisco (outer coast), Calif.	37 46	122 31	5 01 50	25 c	2.2	4.3	5 02 53	16 R	8.1 R,q
37. San Francisco (Presidio) Calif.	37 48	122 28	5 01 38	36 c	1.2	2.1	5 02 48	15 R	3.5 R
38. Alameda, San Francisco Bay, Calif.	37 47	122 16	5 02 09	31 c	0.7	1.2	5 03 13	14 R	2.5 R
39. Hunters Pt., San Francisco Bay, Calif.	37 44	122 22	5 02 05	42 c	0.3	0.5	5 03 13	24 R	1.2 R
40. Dumbarton Bridge, San Francisco Bay, Calif.	37 30	122 07	(p)	(p)	(p)	(p)	(p)	(p)	(p)
41. Sausalito, San Francisco Bay, Calif.	37 51	122 29	(s)	(s)	(s)	(s)	(s)	(s)	(s)

See footnotes at end of table.

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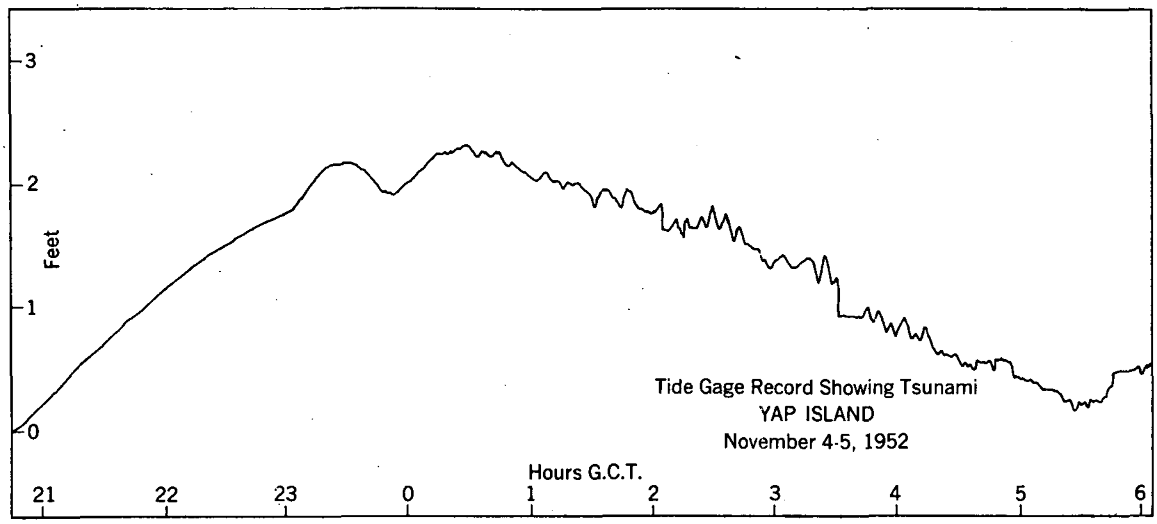
TABLE 1. The Tsunami of November 4, 1952 as Recorded on Tide Gages -- Continued

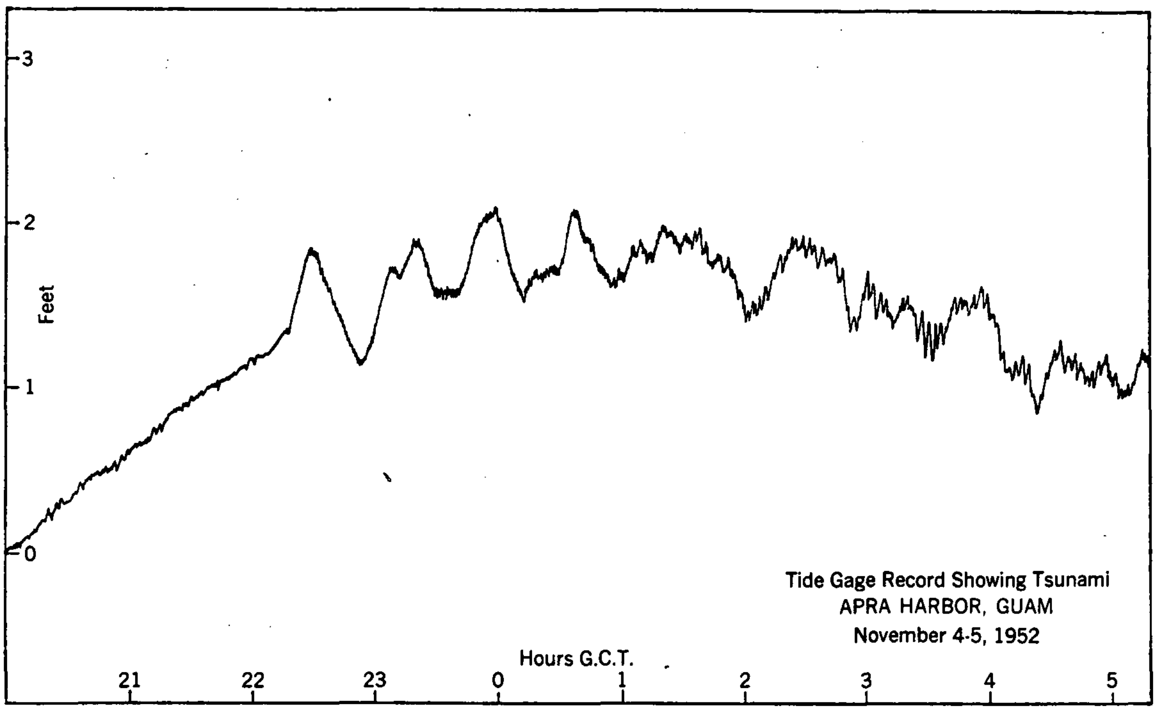
TIDE STATION	LAT.	LONG.	INITIAL WAVE				MAXIMUM RISE OR FALL		
			TIME OF ARRIVAL	PERIOD 1st to 2nd CREST	INITIAL RISE (a)	FOLLOWING FALL (a)	TIME OF BEGINNING	DURATION	HEIGHT
	° ' N	° ' W	d. h.m.	min.	feet	feet	d. h.m.	min.	feet
42. Benecia, Carquinez Strait, Calif.	38 03	122 08	5 (t)	85	0.1	0.3	- -- --	--	---
43. Pittsburg, Calif.	38 02	121 53	(p)	(p)	(p)	(p)	(p)	(p)	(p)
44. Avila, Calif.	35 10	120 44	5 01 35	20	1.4	(u)	(u)	(u)	9.5 R,u
45. Port Hueneme, Calif.	34 09	119 12	5 01 59 k	13	0.5	0.7	5 17 11	6 R	4.7 R
46. Santa Monica, Calif.	34 00	118 30	5 02 08	28	0.9	1.8	5 17 38	14 R	3.6 R
47. San Pedro, Los Angeles Harbor Light, Calif.	33 42	118 15	5 (o)	(o)	(o)	(o)	5 09 10	10	1.7 F
48. Los Angeles, Terminal I. Naval Reservation	33 45	118 14	5 02 08	45	0.7	1.9	5 08 41	15	2.7 F
49. Los Angeles Hbr., Berth 60, Calif.	33 43	118 16	5 02 17 k	30	0.2	0.2	5 09 11	16 F	2.0 F
50. Los Angeles Hbr., Berth 174, Mormon I., Calif.	33 45	118 16	5 02 33 k	55	0.4	3.2	5 14 58	25 R	3.6 R
51. La Jolla, Calif.	32 52	117 15	5 02 13	32	0.6	0.7	5 15 11	8 R	0.8 R
52. San Diego, Calif.	32 42	117 14	5 02 32	52 k	0.3	0.7	5 07 00	23 F	2.3 F
53. La Paz, Mexico	24 10	110 19	5 04 55	38	0.2	0.4	6 08 08	19 R	1.6 R
54. Guaymas, Mexico	27 55	110 55	(p)	(p)	(p)	(p)	(j)	--	0.2 j
55. Acapulco, Mexico	16 51	99 55	5 05 35	32	0.5	0.8	5 15 40 v	15 F,v	3.7 F,v
56. Salina Cruz, Mexico	16 10	95 12	5 06 40 k	35	0.3	0.2	5 21 21	25 R	4.0 R
57. San Jose, Guatemala	13 55	90 50	(o)	(o)	(o)	(o)	(j)	--	1.5 j
58. La Libertad, El Salvador	13 29	89 19	(o)	(o)	(o)	(o)	5 19 20	8 R	1.9 R
59. La Union, El Salvador	13 20	87 49	(o)	(o)	(o)	(o)	(j)	--	0.4 j
60. San Juan del Sur, Nicaragua	11 15	85 53	(o)	(o)	(o)	(o)	(j)	--	1.0 j
61. Puntarenas, Costa Rica	9 58	84 50	5 09 10	25	0.2	0.3	5 17 33	12 F	2.2 F
62. Puerto Armuelles, Panama	8 16	82 52	5 09 05	32	0.1	0.2	5 11 30	6 F	0.9 F
63. Naos I., Canal Zone	8 55	79 32	(o)	(o)	(o)	(o)	5 22 51	13 R	0.7 R
64. Balboa, Canal Zone	8 57	79 34	(o)	(o)	(o)	(o)	(j)	--	0.7 j
	S	W							
65. La Libertad, Ecuador	2 13	80 55	5 10 47	33	1.5	2.2	5 12 43 w	14 F	6.2 F
66. Callao, Peru	12 03	77 09	5 11 48	24	1.8	2.7	5 19 05	29 R	6.4 R
67. Arica, Chile	18 29	70 20	5 12 46	52 c	1.3	1.6	5 21 50	11	7.6 R
68. Antofagasta, Chile	23 39	70 25	5 12 56	17	1.3	1.9	5 15 03	5	4.7 F
69. Caldera, Chile	27 04	70 50	5 13 25	20	2.0	4.6	5 22 32	20	9.3 R
70. Valparaiso, Chile	33 02	71 38	5 13 38	20	1.9	2.5	5 14 20	26	5.9 R,x
71. Talcahuano, Chile	36 41	73 06	5 14 20	27	1.8	1.8	5 -- --	--	12.0 y

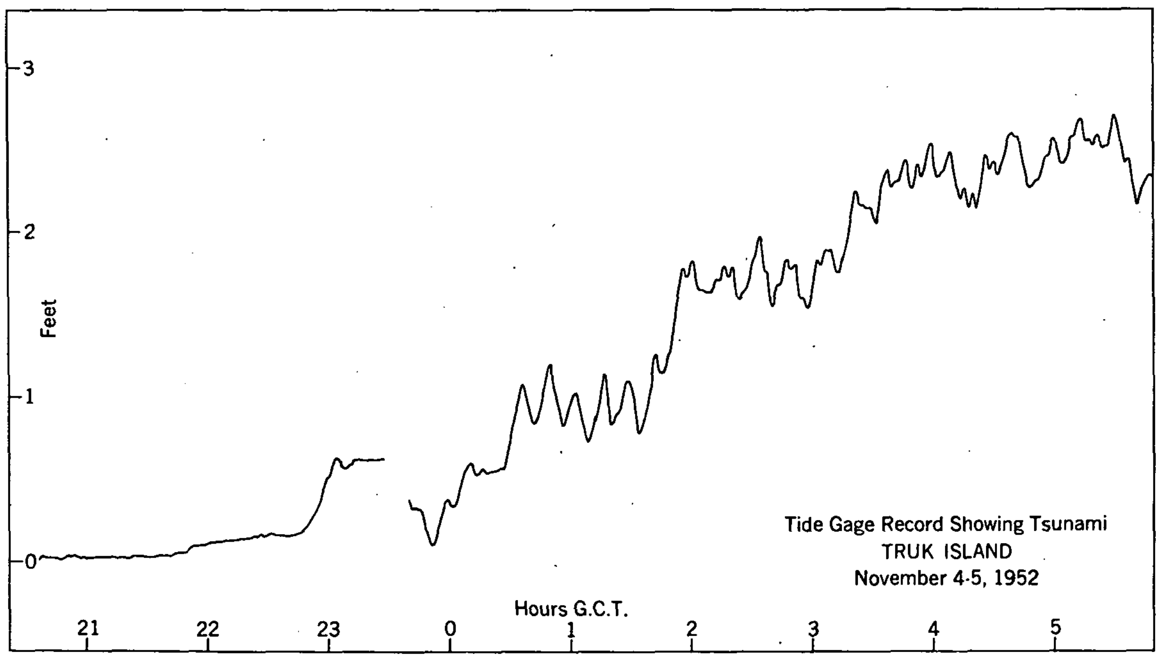
a. Initial motion was a rise at all places. The figures in this column represent wave rise or fall only, with the tide eliminated.
b. 18 minutes of record lost after first rise due to changing of record.
c. Period of first major oscillation. See curve.
d. From report of Apia observer. See text.
e. Includes estimate for trough that fell below limit of record. See curve.
F. Fall of wave. Tide eliminated approximately.
g. First rise went beyond limit of record and stopped gage.
h. Gage not operating when wave arrived. Motor clock (but not time clock) started between 2000Z and 2100Z.
i. Includes estimate for crest that went beyond limit of record. See curve.
j. At various times.
k. Approximate.
m. Small wave obscured by rapidly falling or rising tide of large (20 ft.) range.
n. Canadian Hydrographic Service reported oscillations were noticeable but small.
o. First oscillations were small or indefinite.

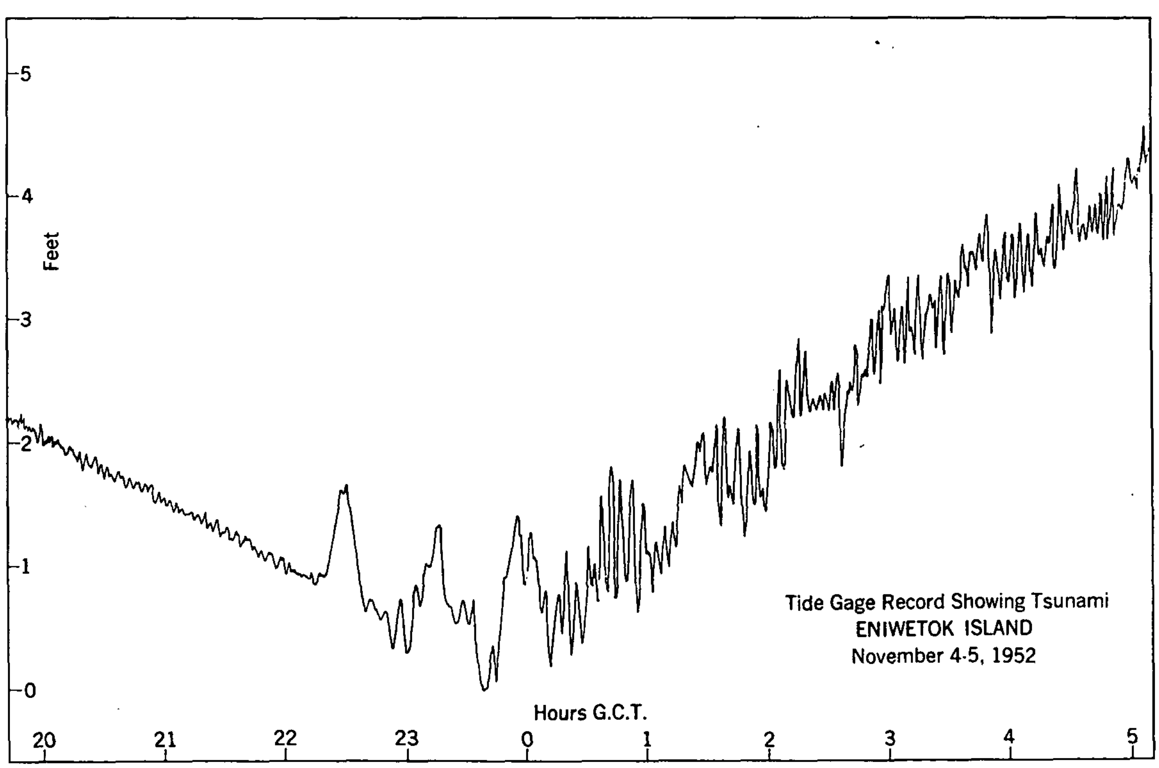
TABLE 1. The Tsunami of November 4, 1952 as Recorded on Tide Gages -- Continued

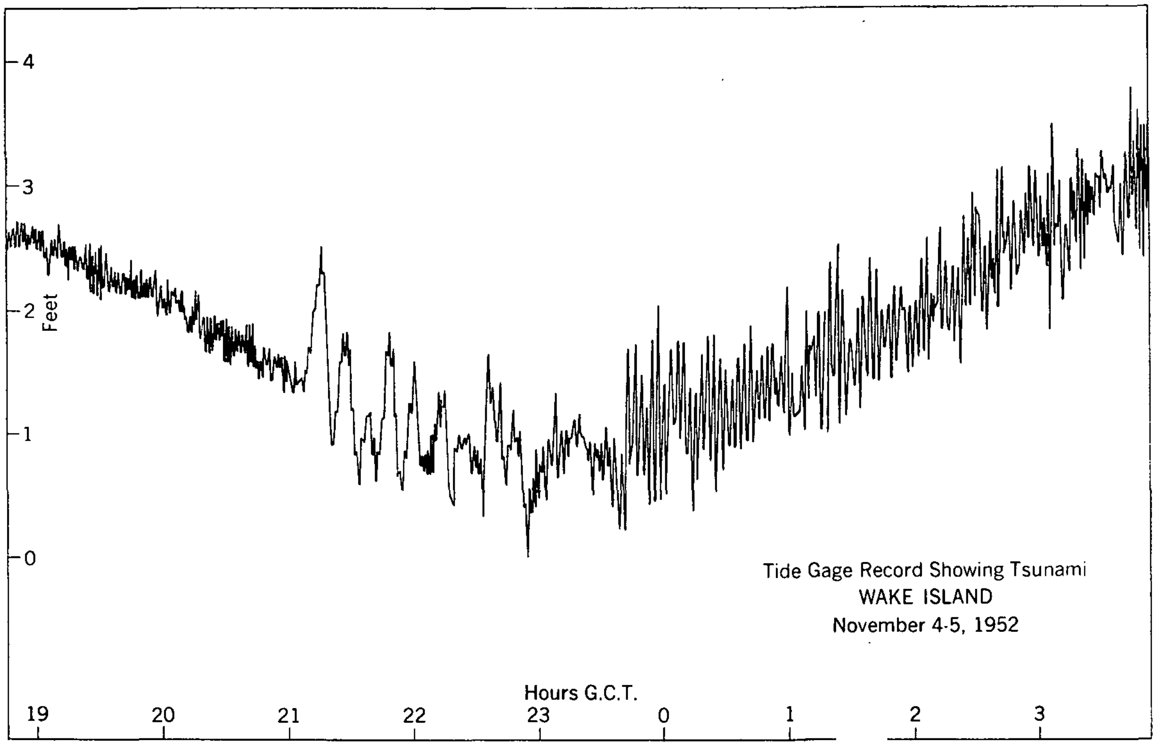
p. Oscillations were noticeable but small.
q. Includes minor oscillations. See curve.
R. Rise of wave. Tide eliminated approximately.
s. Gage operating intermittently. Oscillations of ½ to 2 feet were recorded 0900Z to 1800Z Nov. 5.
t. Indefinite.
u. Wave troughs went below limit of gage. Maximum rise probably 9½ feet. See curve.
v. Gage stopped after this wave.
w. Gage stopped about 3 hours later.
x. May have been exceded on several occasions when troughs fell below limit of gage.
y. Estimated. Several crests and troughs exceeded limit of gage.


3
2
1
0
Feet
Tide Gage Record Showing Tsunami
YAP ISLAND
November 4-5, 1952
Hours G.C.T.
21
22
23
0
1
2
3
4
5
6

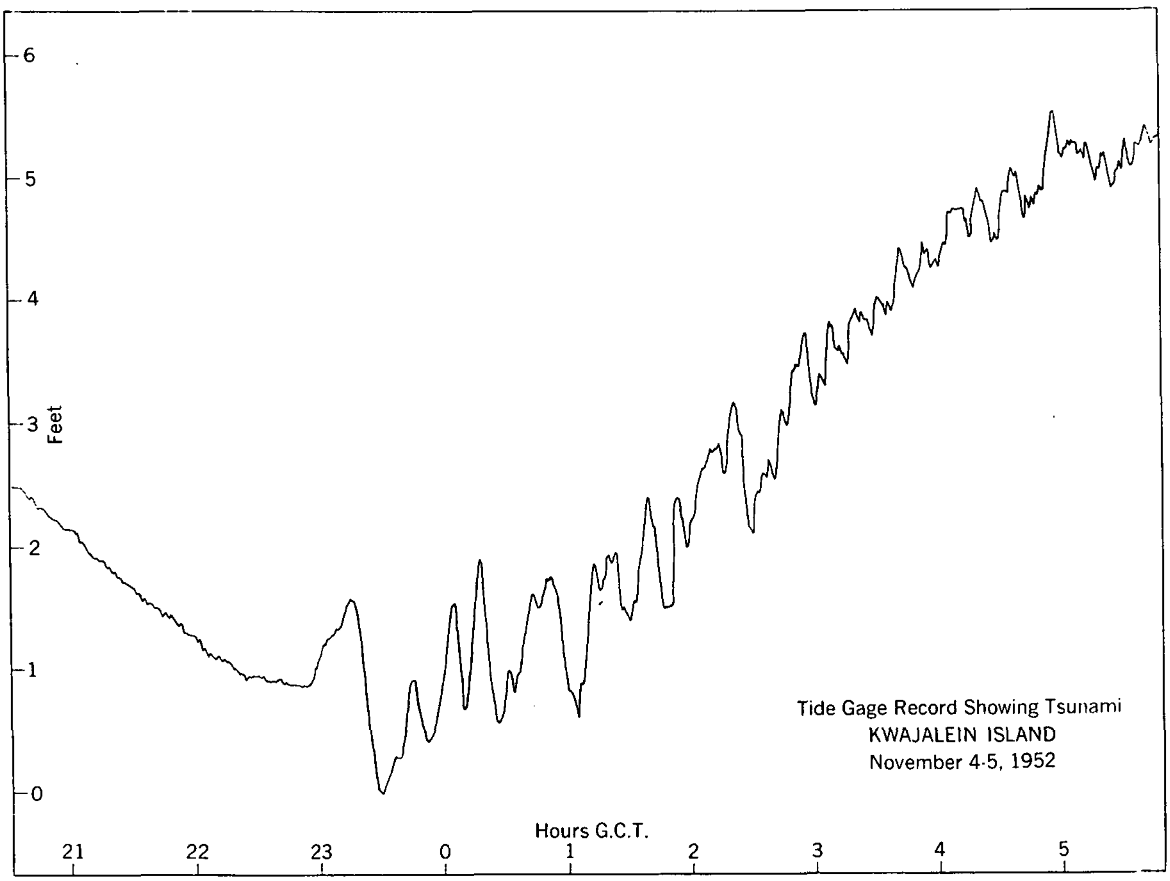

3
2
1
0
Feet
Tide Gage Record Showing Tsunami
APRA HARBOR, GUAM
November 4-5, 1952
Hours G.C.T.
21
22
23
0
1
2
3
4
5


3
2
1
0
Feet
Tide Gage Record Showing Tsunami
TRUK ISLAND
November 4-5, 1952
Hours G.C.T.
21
22
23
0
1
2
3
4
5

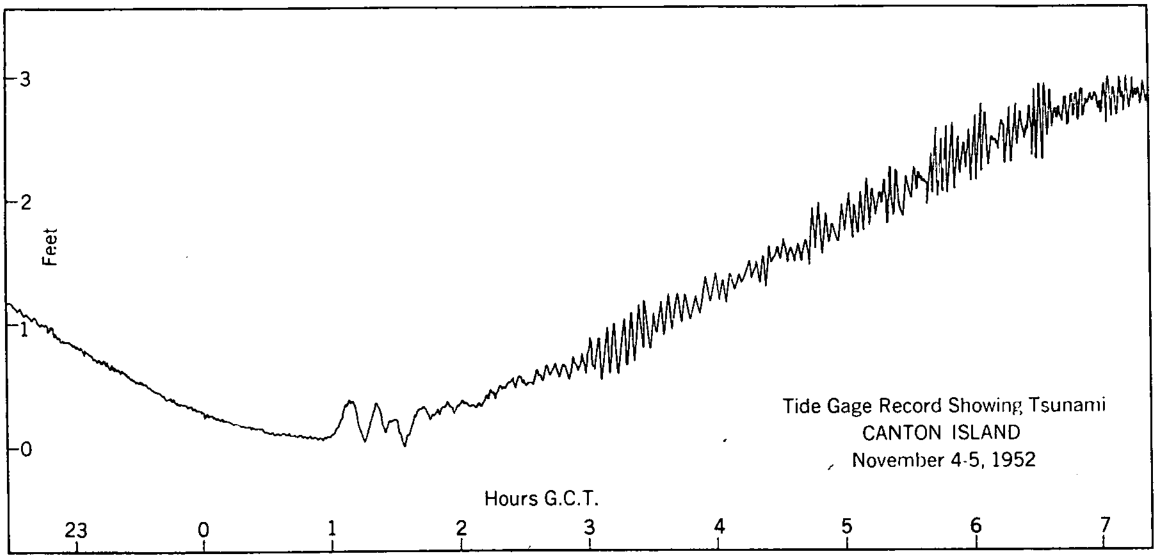

5
4
3
2
1
0
Feet
Tide Gage Record Showing Tsunami
ENIWETOK ISLAND
November 4-5, 1952
Hours G.C.T.
20
21
22
23
0
1
2
3
4
5



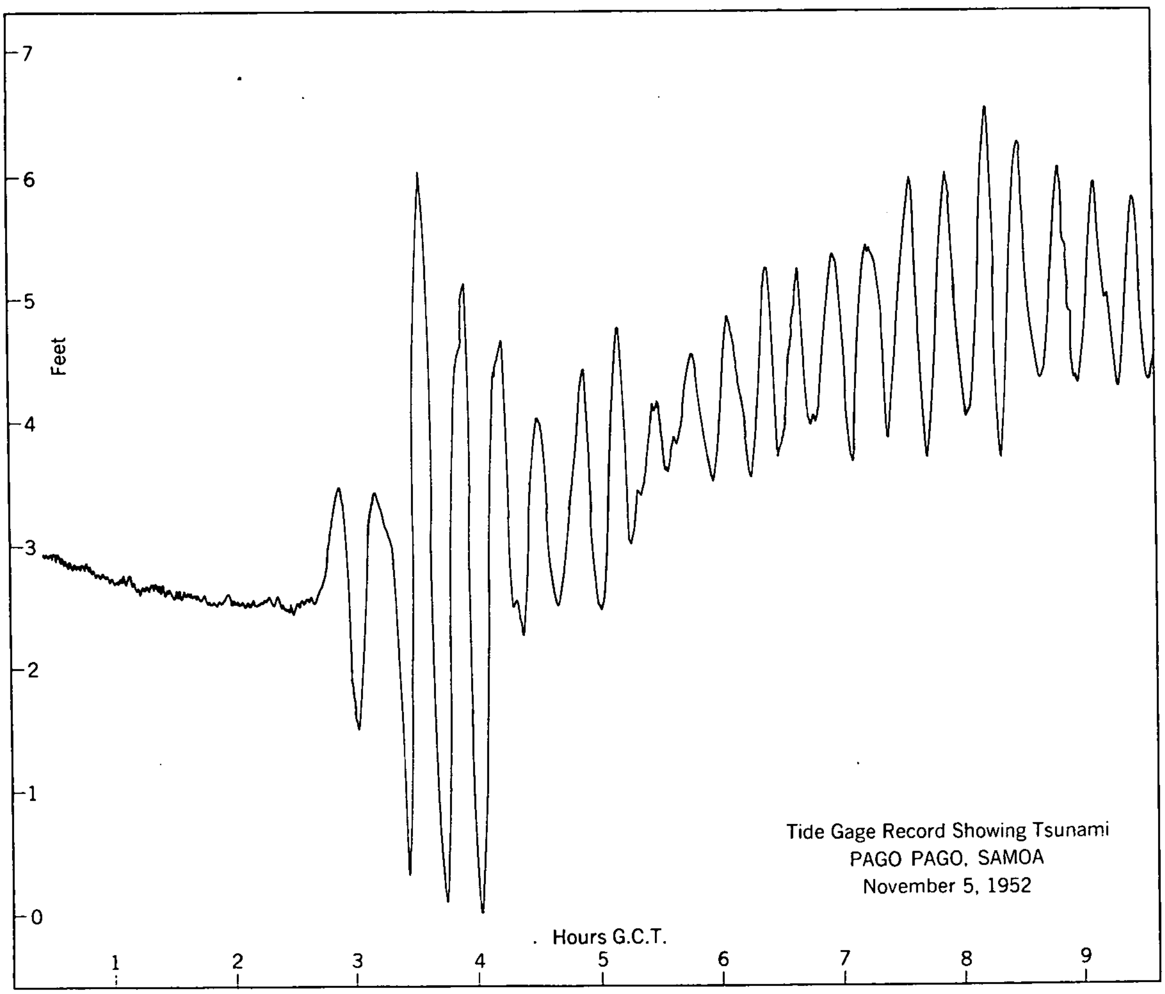
Tide Gage Record Showing Tsunami
WAKE ISLAND
November 4-5, 1952



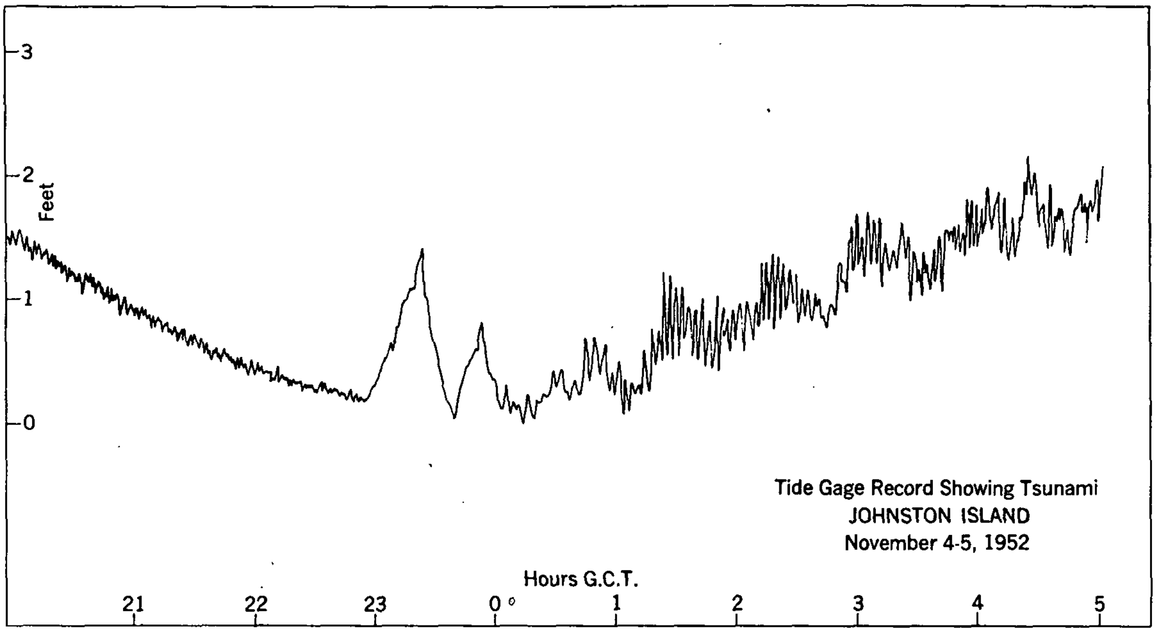
Tide Gage Record Showing Tsunami
KWAJALEIN ISLAND
November 4-5, 1952

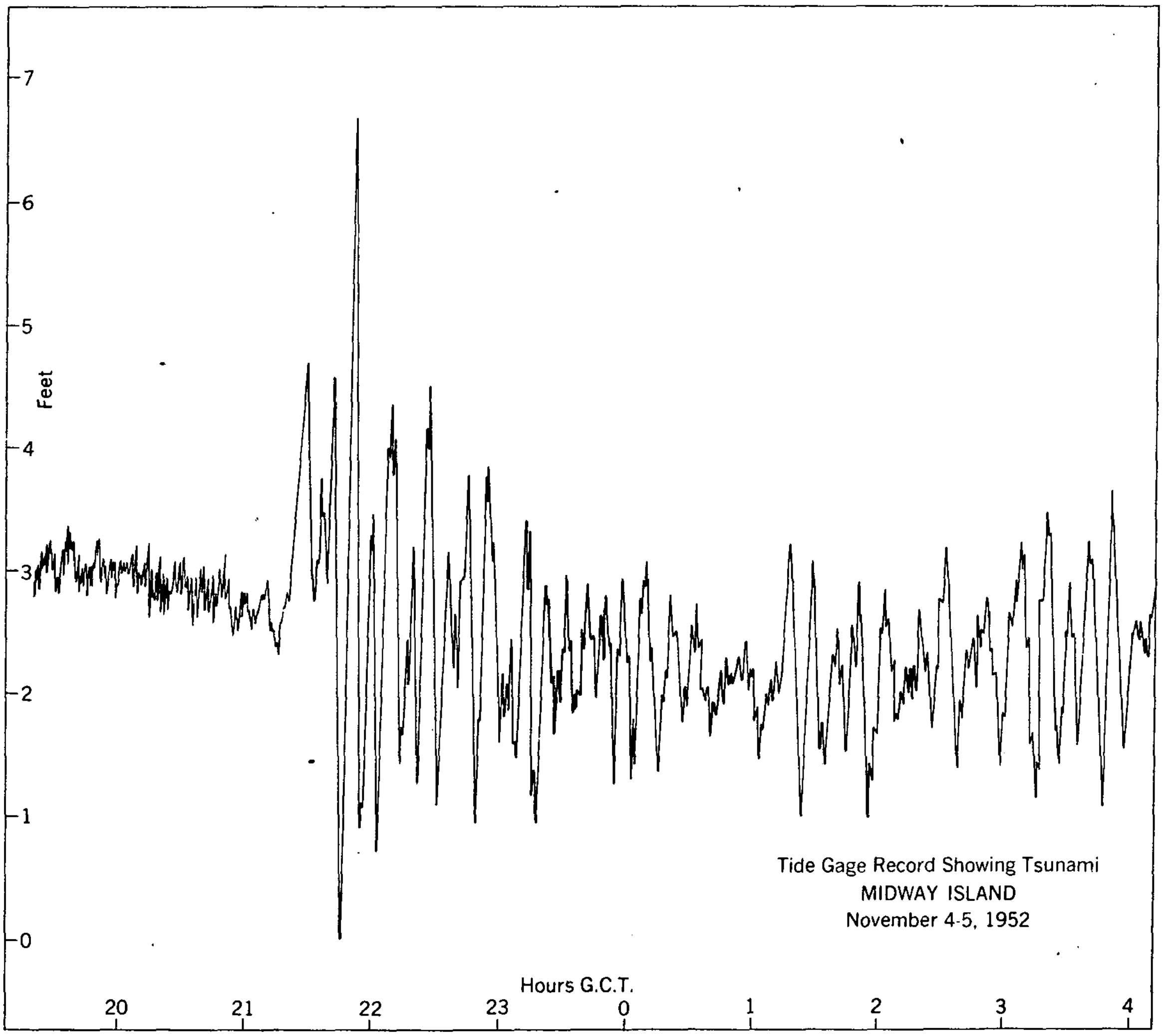


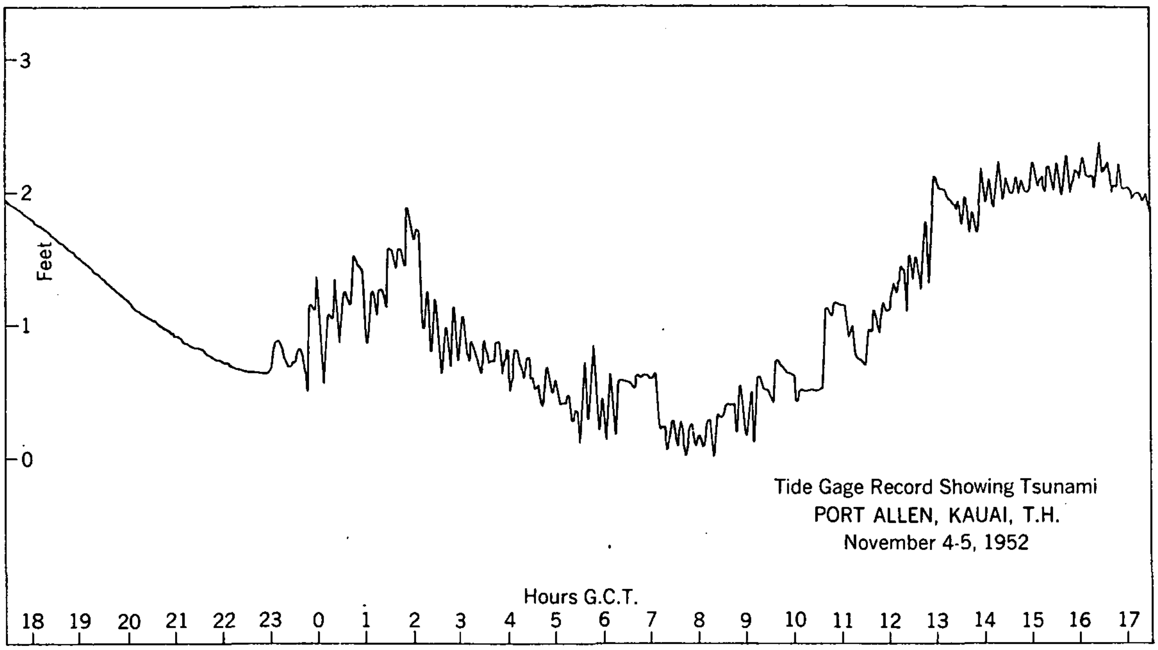
3
2
1
0
Feet
Tide Gage Record Showing Tsunami
CANTON ISLAND
November 4-5, 1952
Hours G.C.T.
23
0
1
2
3
4
5
6
7

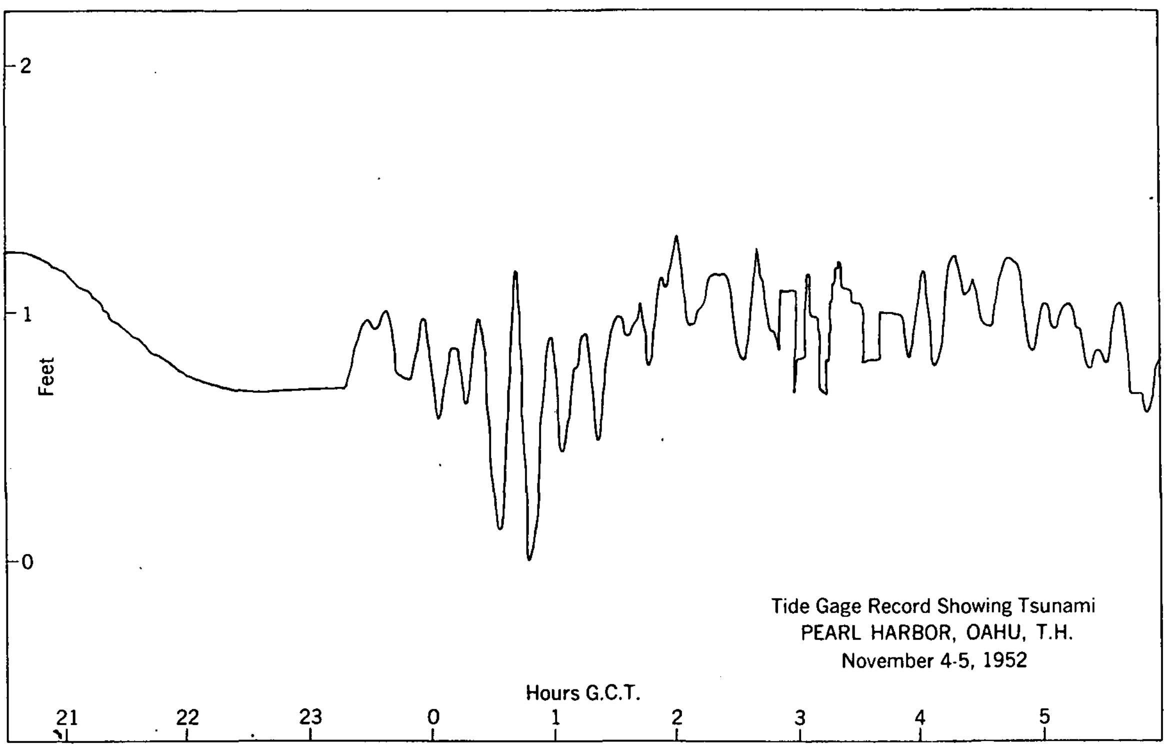


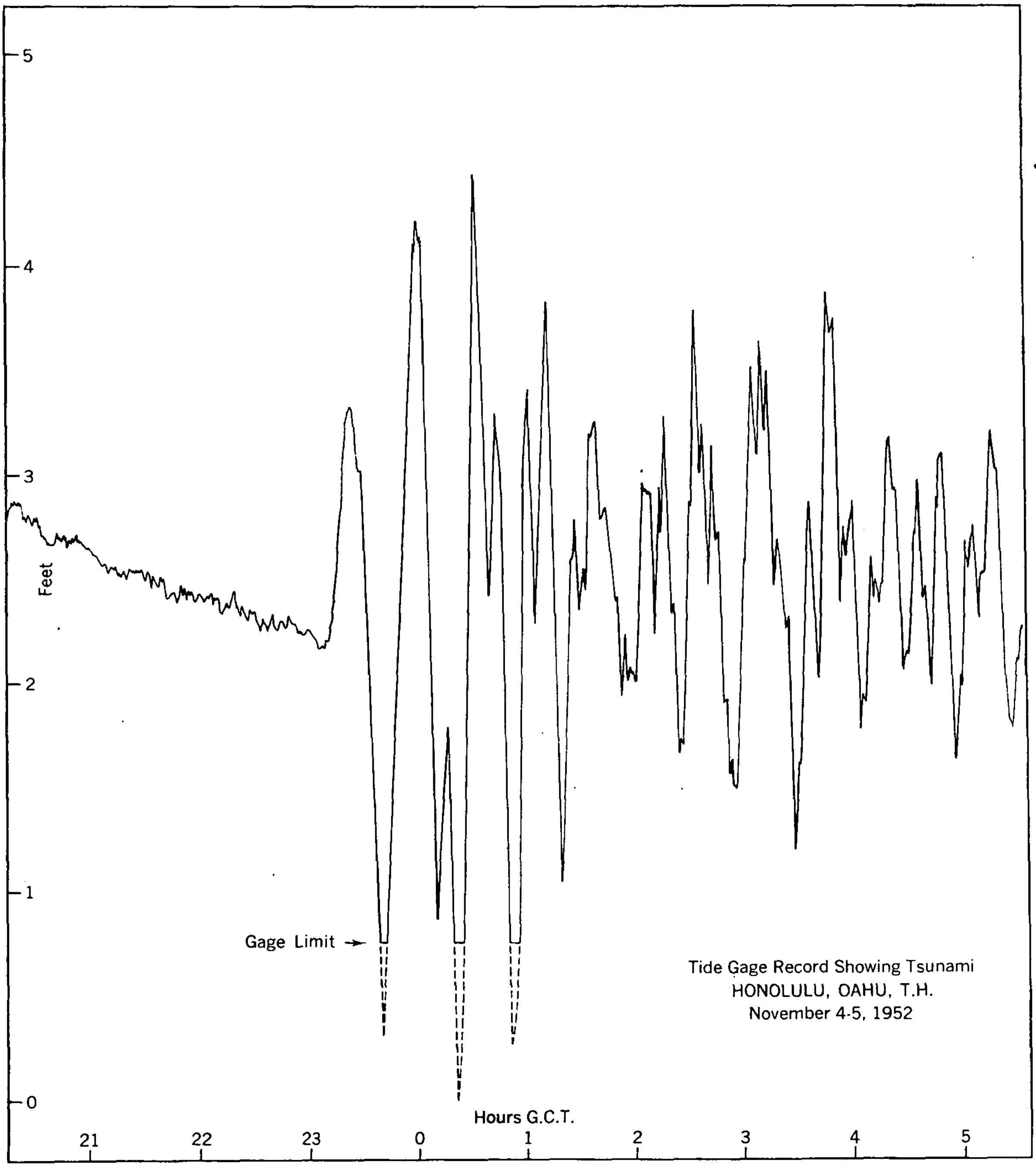
7
6
5
4
3
2
1
0
Feet
Tide Gage Record Showing Tsunami
PAGO PAGO, SAMOA
November 5, 1952
Hours G.C.T.
1
2
3
4
5
6
7
8
9


Feet
3
2
1
0
Tide Gage Record Showing Tsunami
JOHNSTON ISLAND
November 4-5, 1952
Hours G.C.T.
21
22
23
0
1
2
3
4
5

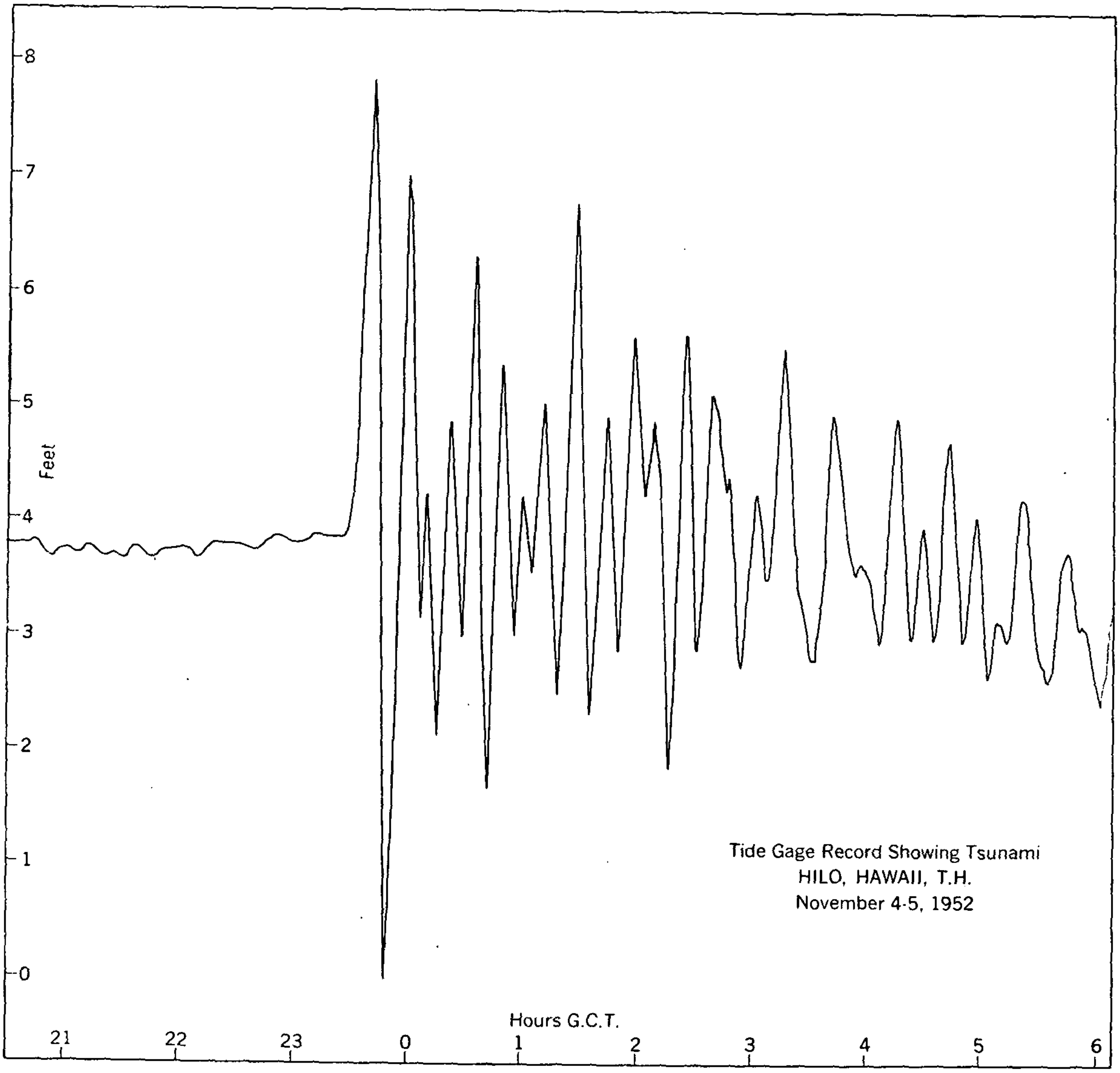

Feet
7
6
5
4
3
2
1
0
Tide Gage Record Showing Tsunami
MIDWAY ISLAND
November 4-5, 1952
Hours G.C.T.
20
21
22
23
0
1
2
3
4

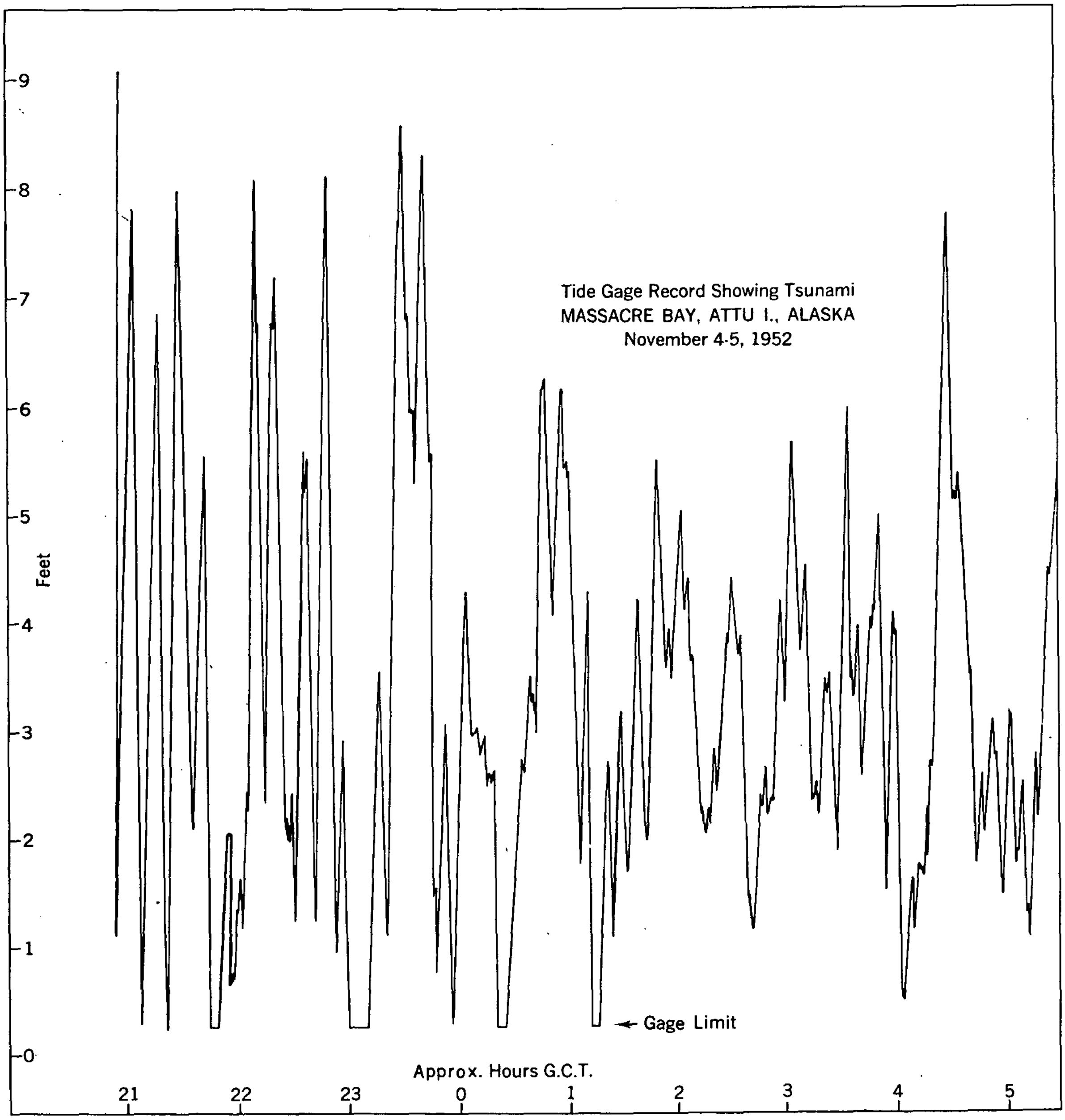

3
2
1
0
Feet
Tide Gage Record Showing Tsunami
PORT ALLEN, KAUAI, T.H.
November 4-5, 1952
Hours G.C.T.
18 19 20 21 22 23 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

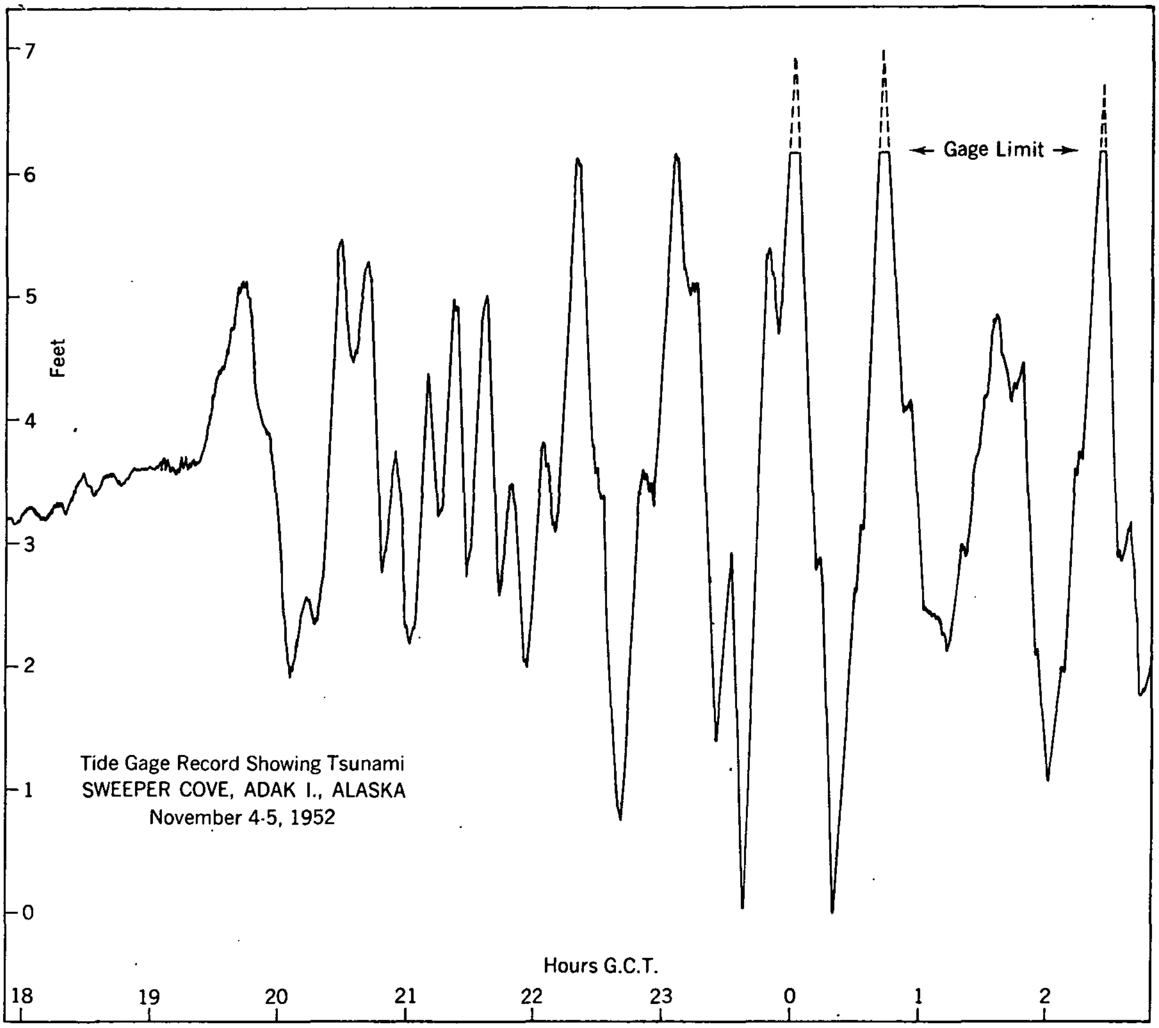

2
1
0
Feet
Tide Gage Record Showing Tsunami
PEARL HARBOR, OAHU, T.H.
November 4-5, 1952
Hours G.C.T.
21 22 23 0 1 2 3 4 5

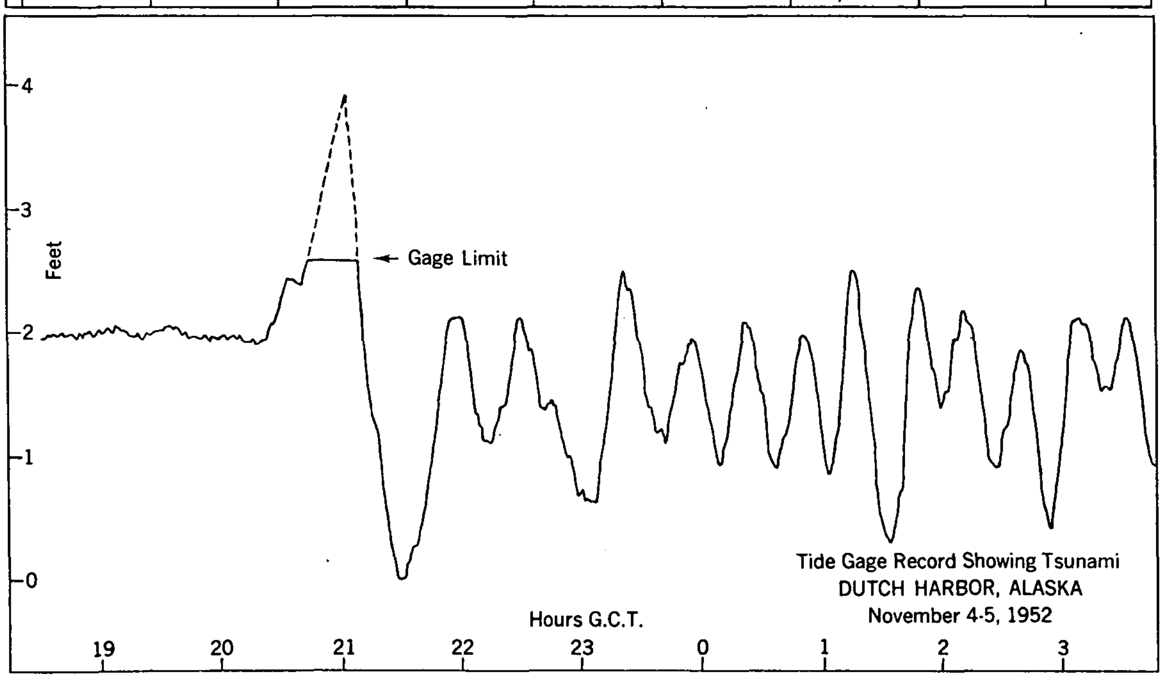


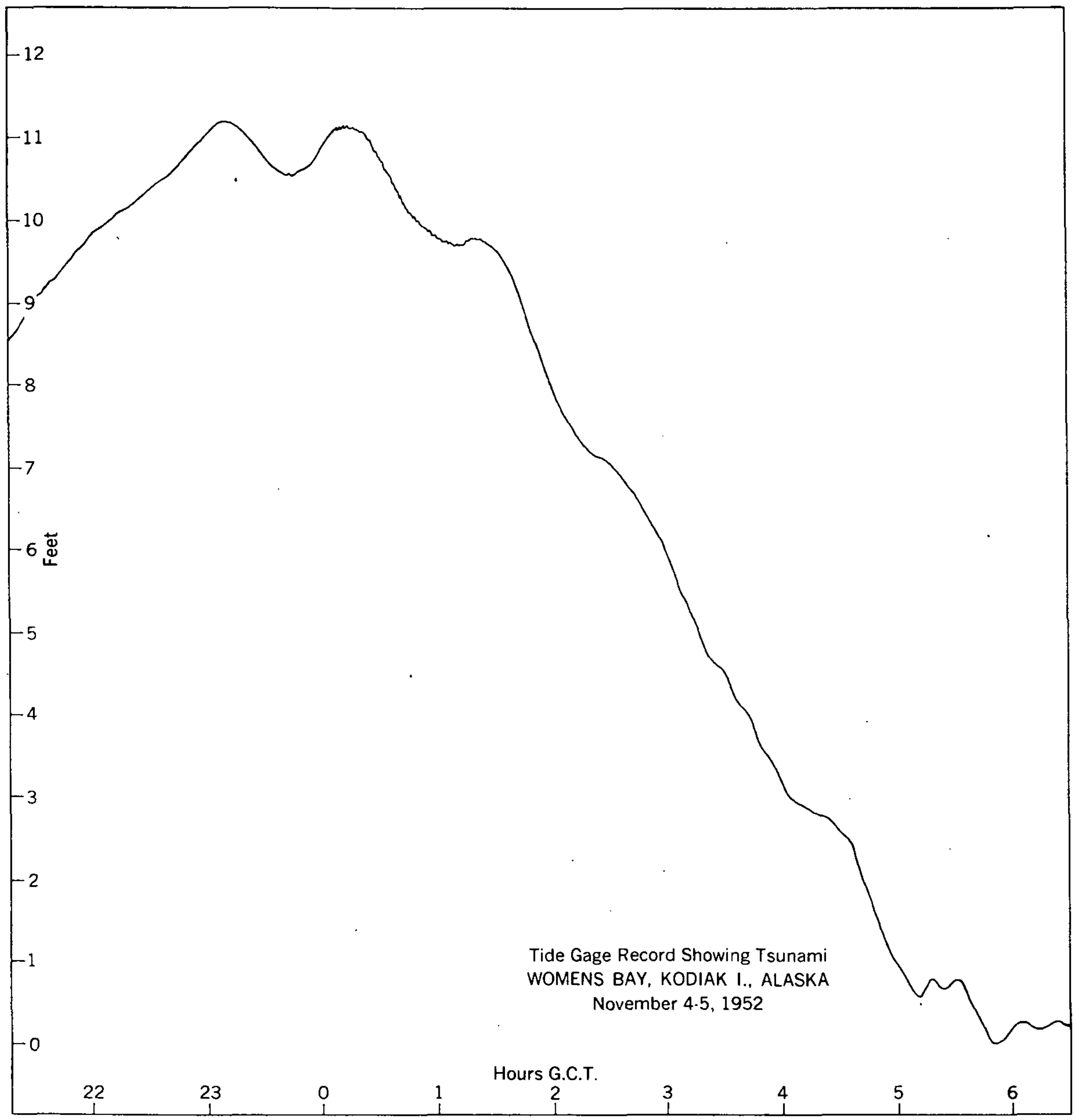
Tide Gage Record Showing Tsunami
HONOLULU, OAHU, T.H.
November 4-5, 1952


Feet
8
7
6
5
4
3
2
1
0
Hours G.C.T.
21
22
23
0
1
2
3
4
5
6
Tide Gage Record Showing Tsunami
HILO, HAWAII, T.H.
November 4-5, 1952


Tide Gage Record Showing Tsunami
MASSACRE BAY, ATTU I., ALASKA
November 4-5, 1952
Feet
9
8
7
6
5
4
3
2
1
0
Gage Limit
Approx. Hours G.C.T.
21
22
23
0
1
2
3
4
5


7
6
5
4
3
2
1
0
Feet
Gage Limit
Tide Gage Record Showing Tsunami
SWEEPER COVE, ADAK I., ALASKA
November 4-5, 1952
Hours G.C.T.
18
19
20
21
22
23
0
1
2


4
3
2
1
0
Feet
Gage Limit
Tide Gage Record Showing Tsunami
DUTCH HARBOR, ALASKA
November 4-5, 1952
Hours G.C.T.
19
20
21
22
23
0
1
2
3


12
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Feet
Tide Gage Record Showing Tsunami
WOMENS BAY, KODIAK I., ALASKA
November 4-5, 1952
Hours G.C.T.
22
23
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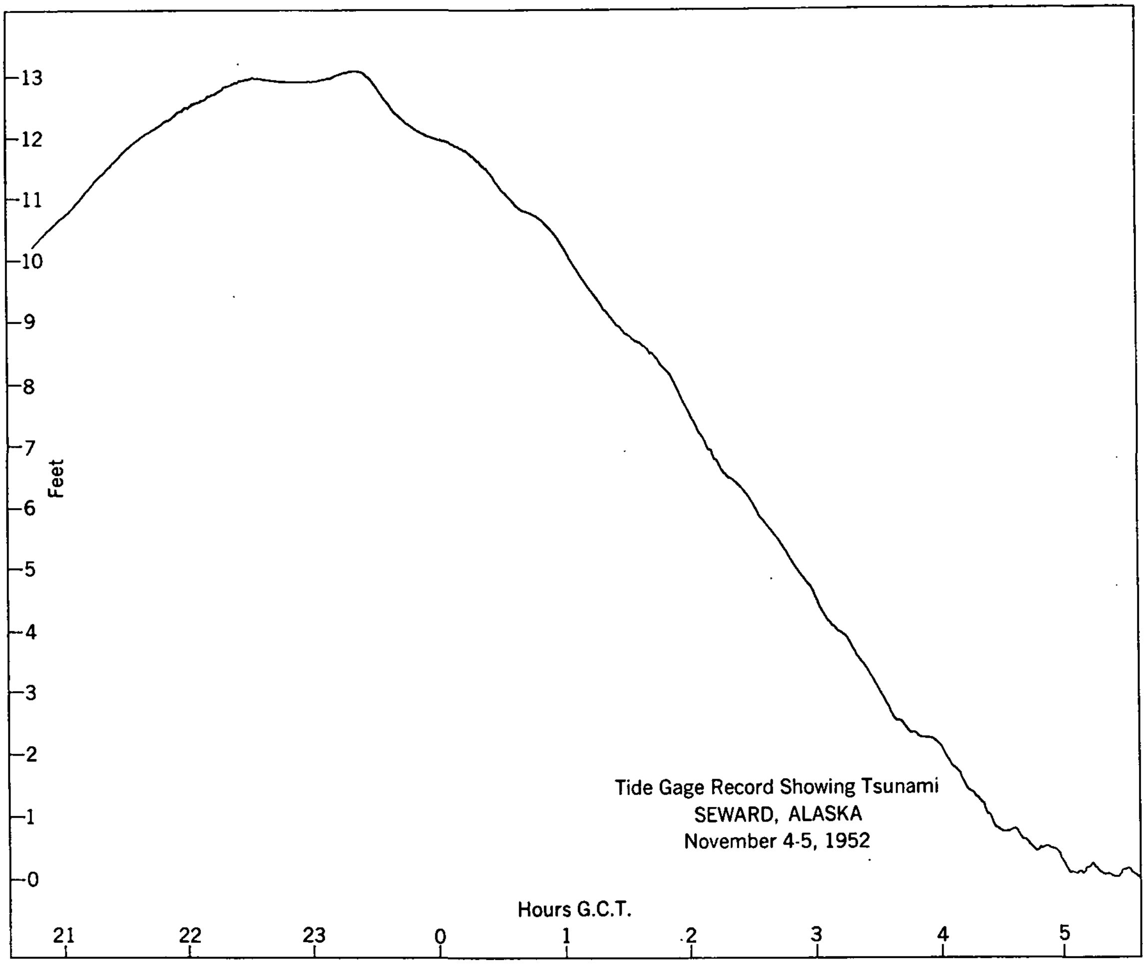

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Feet
Tide Gage Record Showing Tsunami
SEWARD, ALASKA
November 4-5, 1952
Hours G.C.T.
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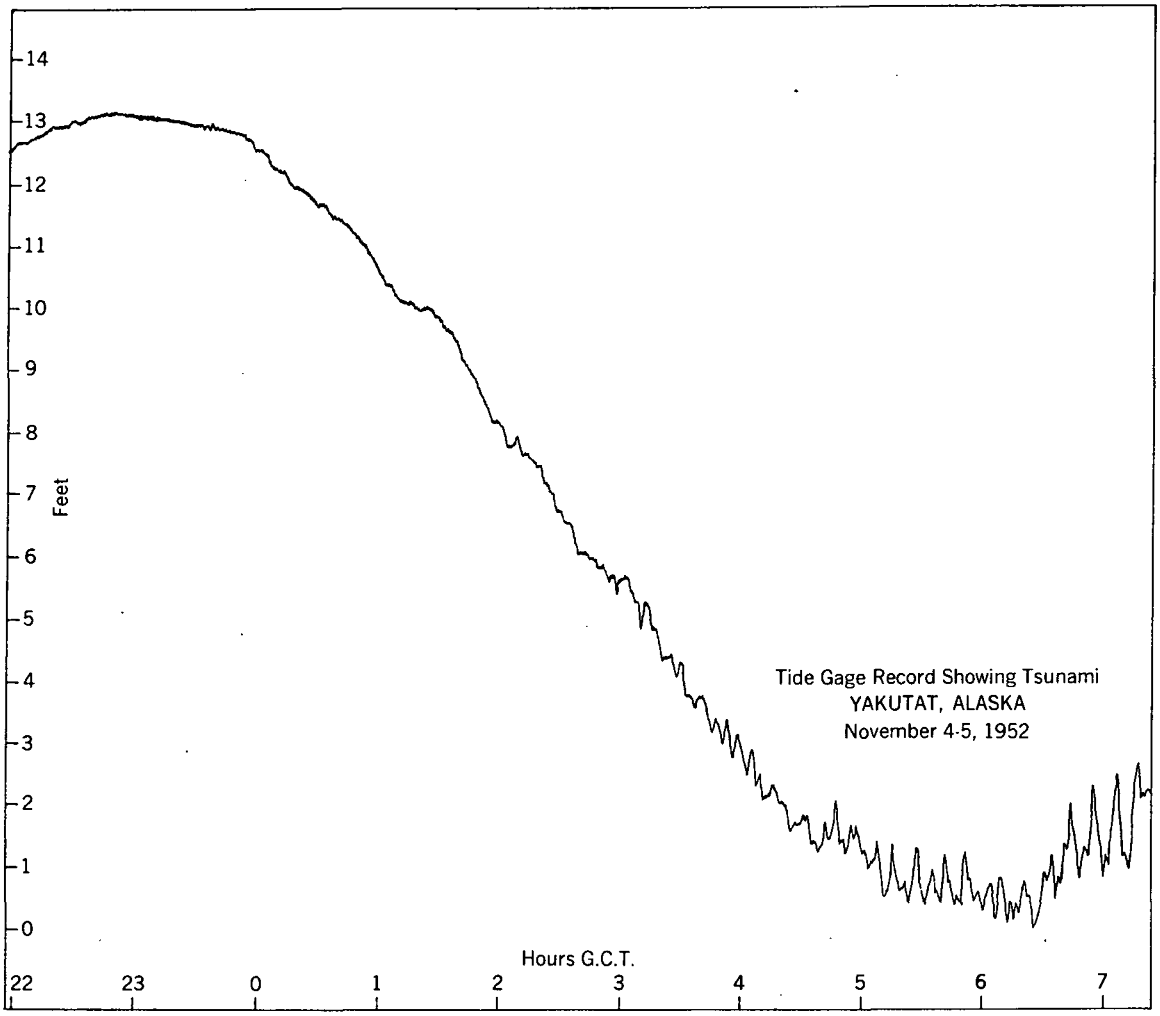
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Feet
Tide Gage Record Showing Tsunami
YAKUTAT, ALASKA
November 4-5, 1952
Hours G.C.T.
22
23
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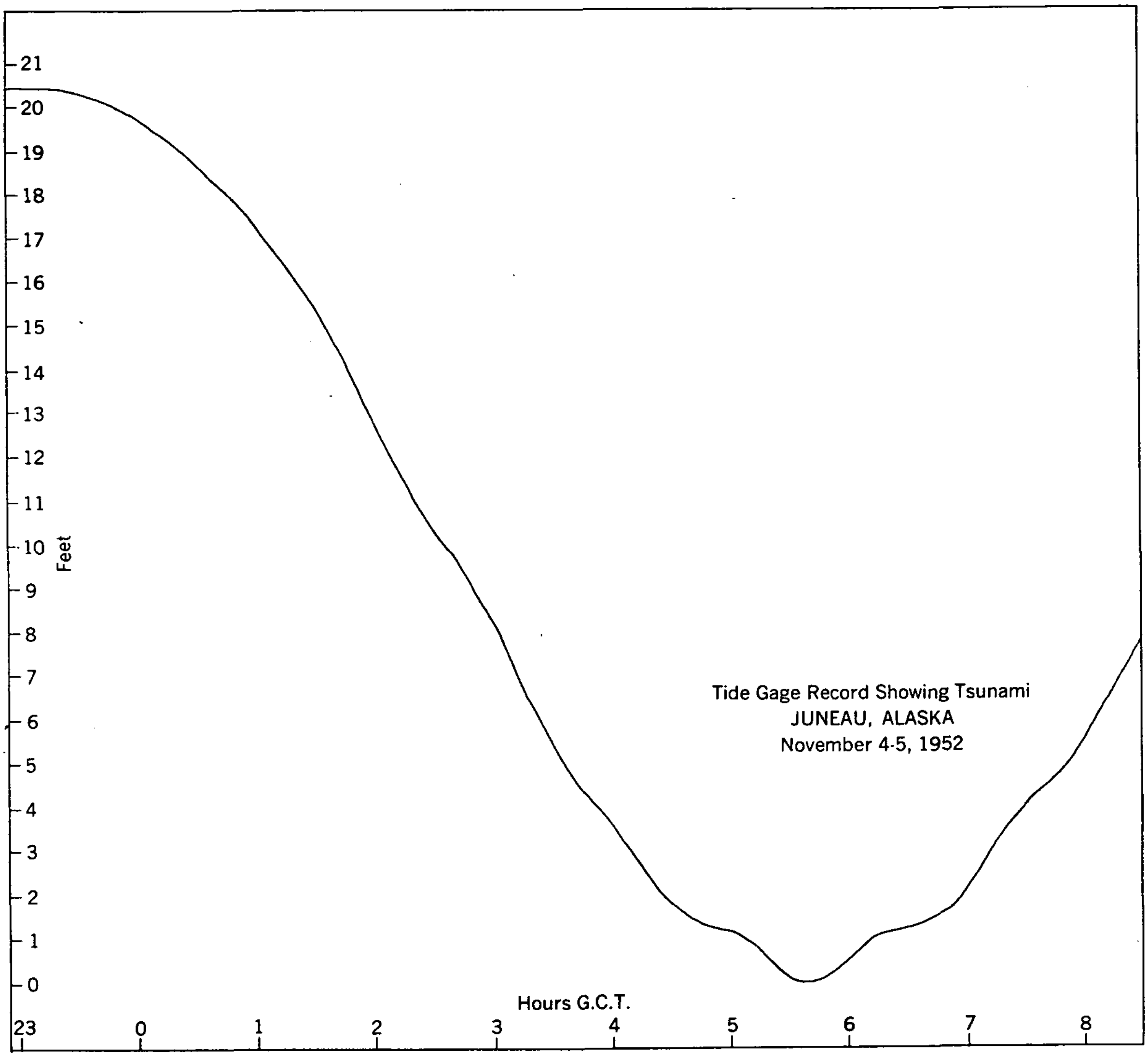
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0
Feet
Tide Gage Record Showing Tsunami
JUNEAU, ALASKA
November 4-5, 1952
Hours G.C.T.
23
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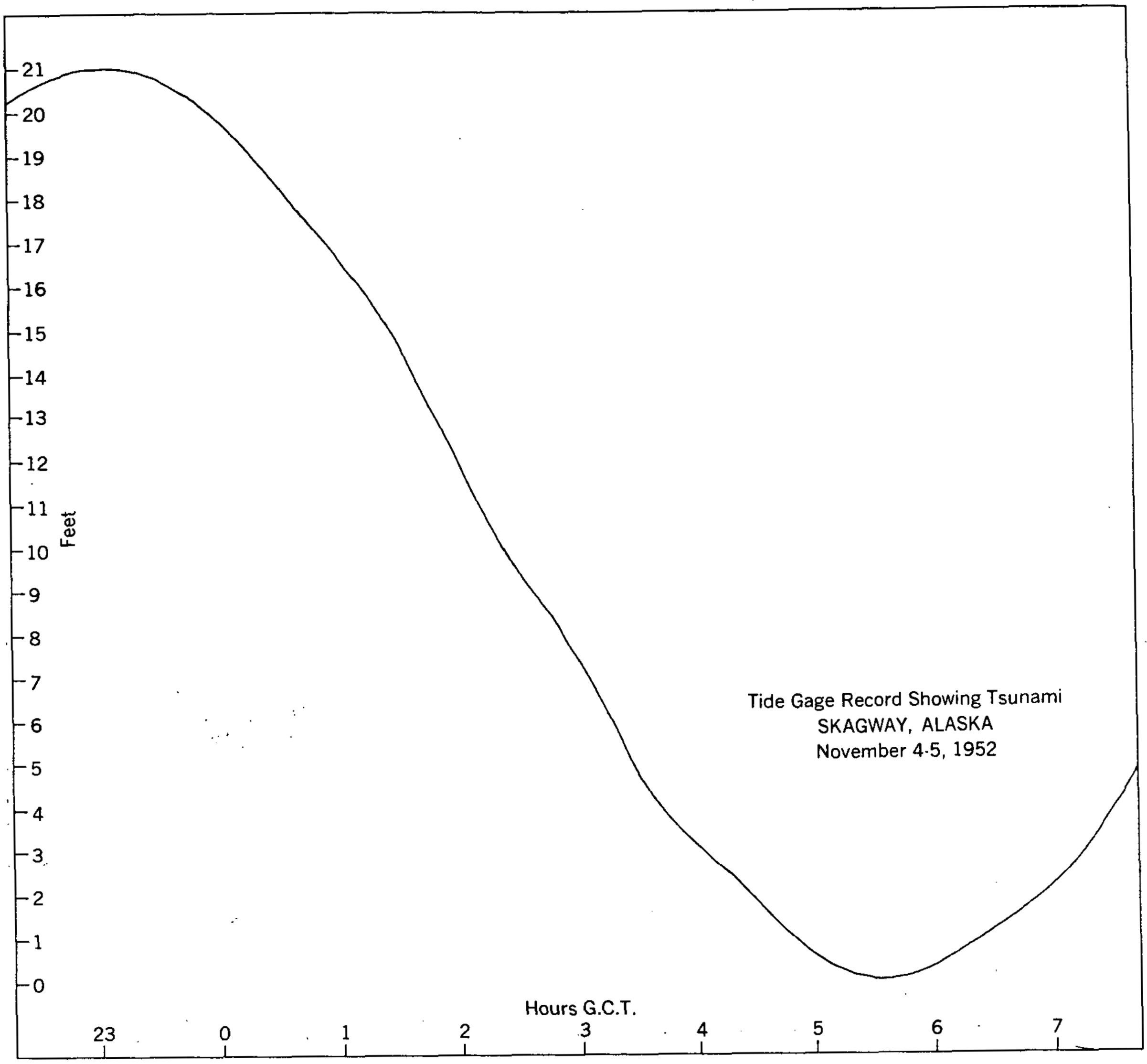
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2
1
0
Feet
Tide Gage Record Showing Tsunami
SKAGWAY, ALASKA
November 4-5, 1952
Hours G.C.T.
23
0
1
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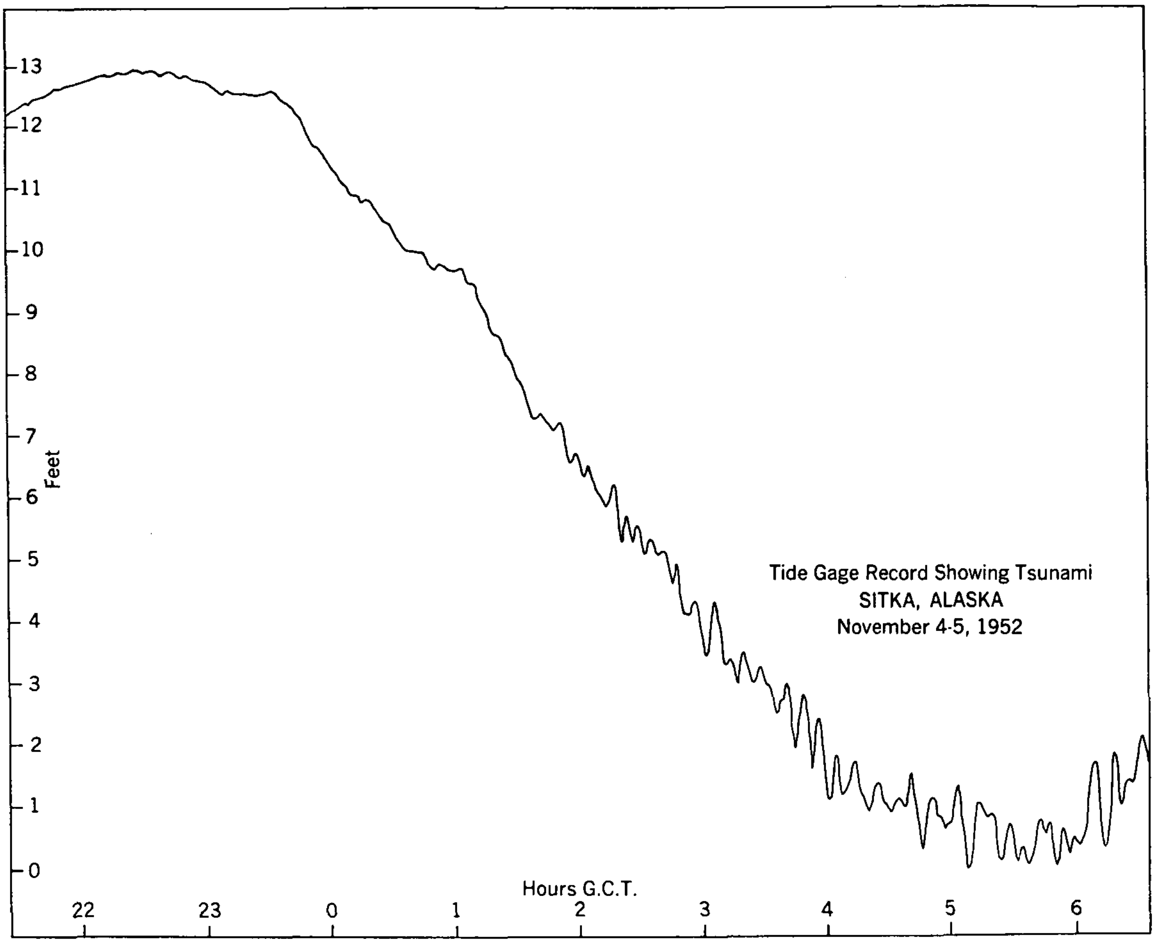
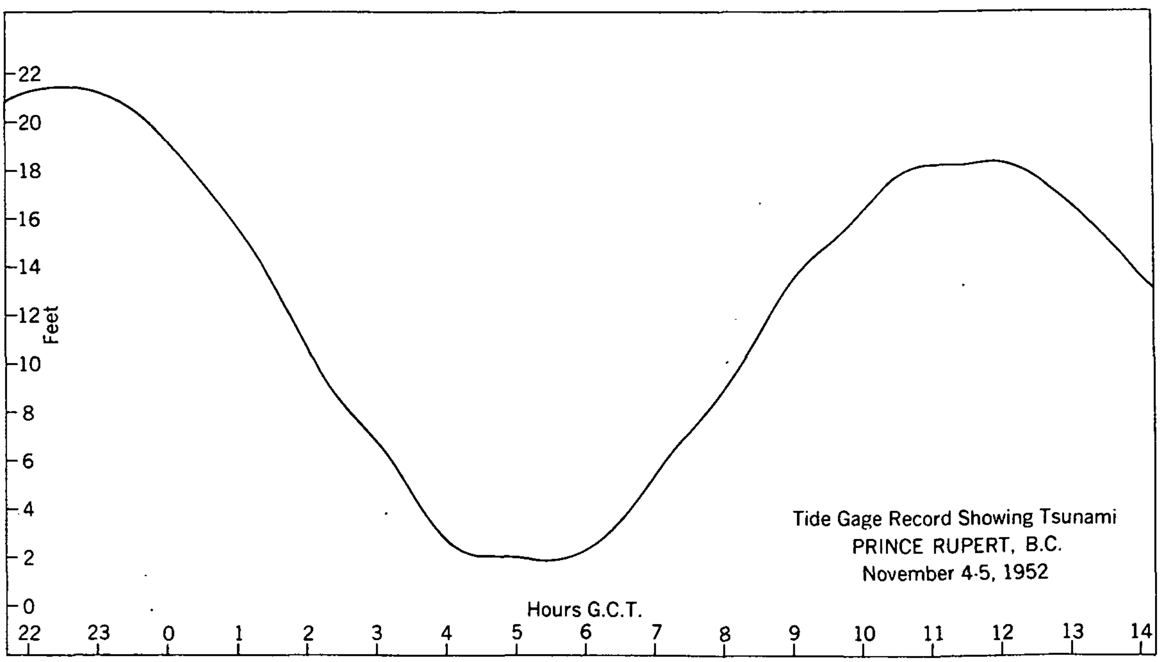
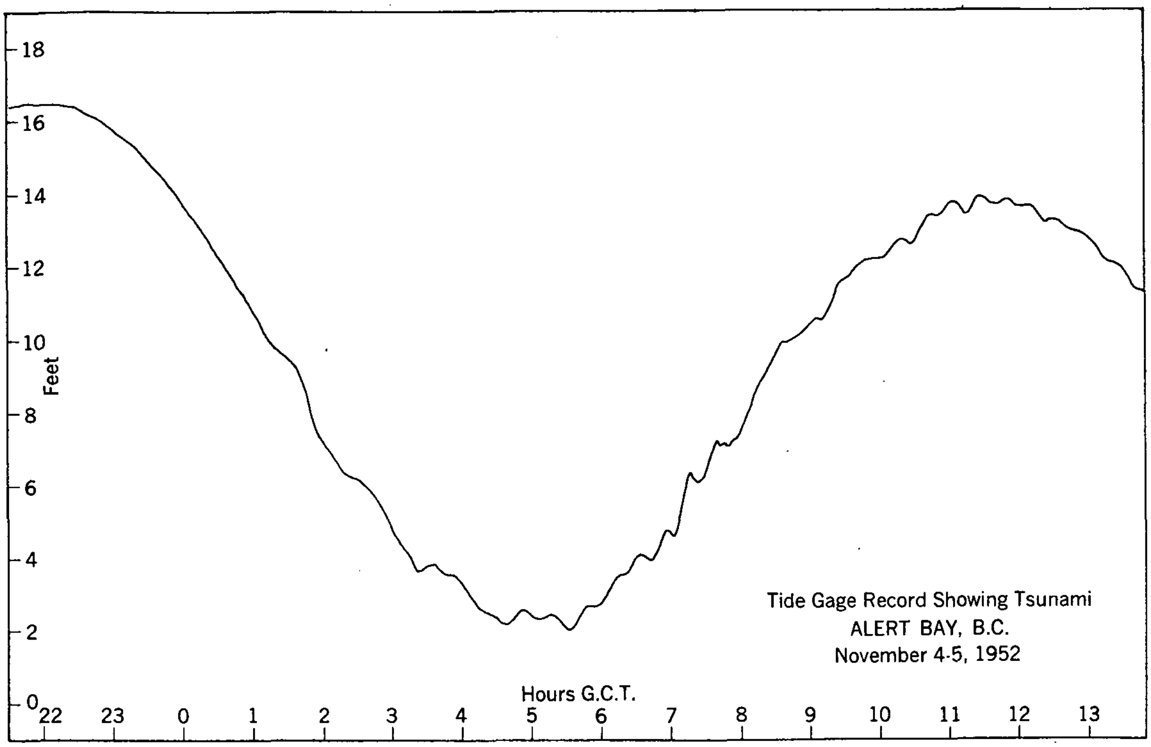
7



Tide Gage Record Showing Tsunami
SITKA, ALASKA
November 4-5, 1952



Tide Gage Record Showing Tsunami
PRINCE RUPERT, B.C.
November 4-5, 1952


18
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Feet
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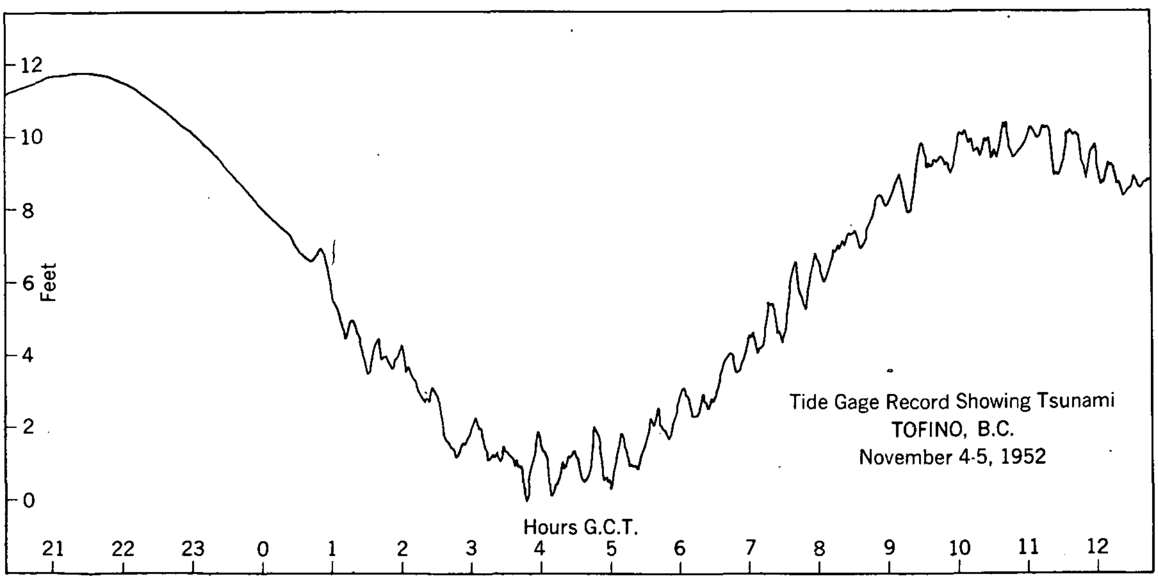
Tide Gage Record Showing Tsunami
ALERT BAY, B.C.
November 4-5, 1952
Hours G.C.T.
22 23 0 1 2 3 4 5 6 7 8 9 10 11 12 13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Feet
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Tide Gage Record Showing Tsunami
TOFINO, B.C.
November 4-5, 1952
Hours G.C.T.
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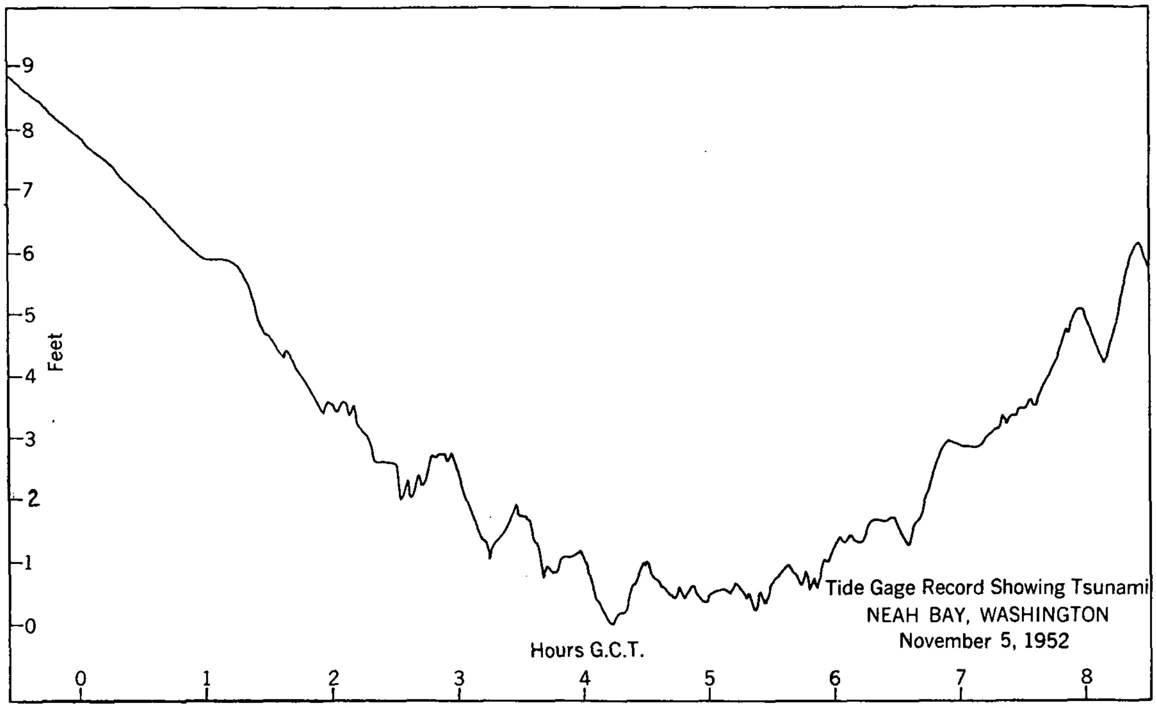
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Hours G.C.T.
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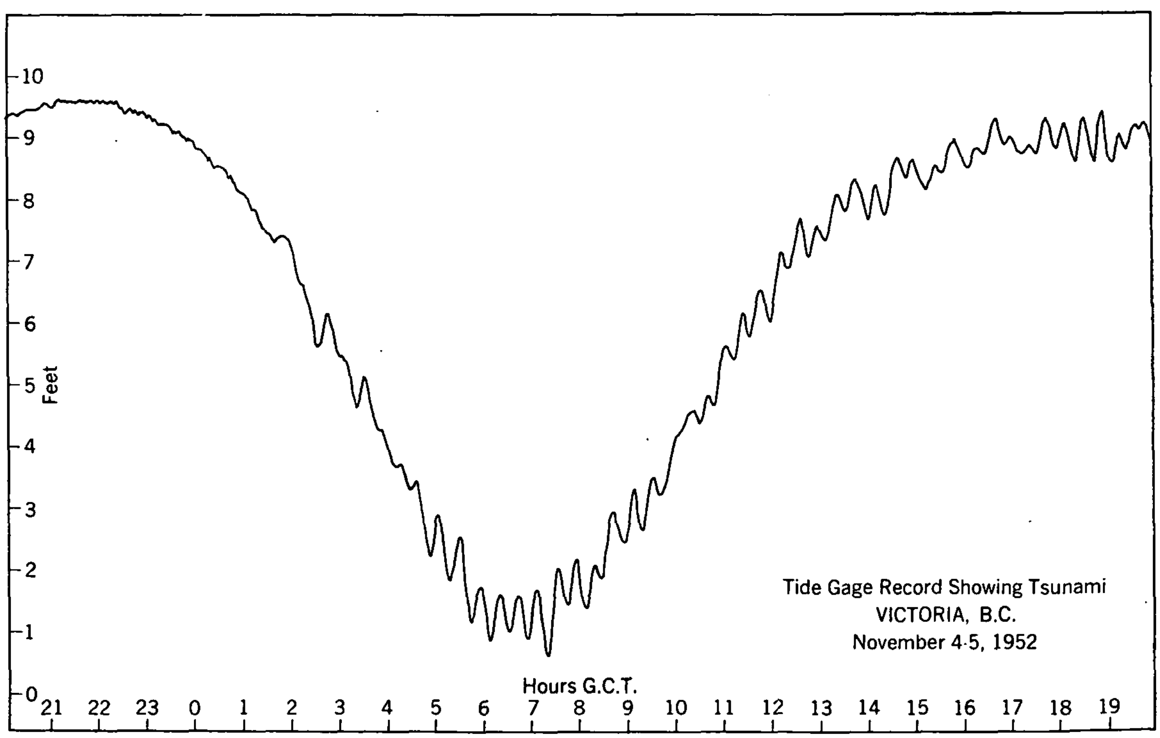
Tide Gage Record Showing Tsunami
NEAH BAY, WASHINGTON
November 5, 1952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Hours G.C.T.
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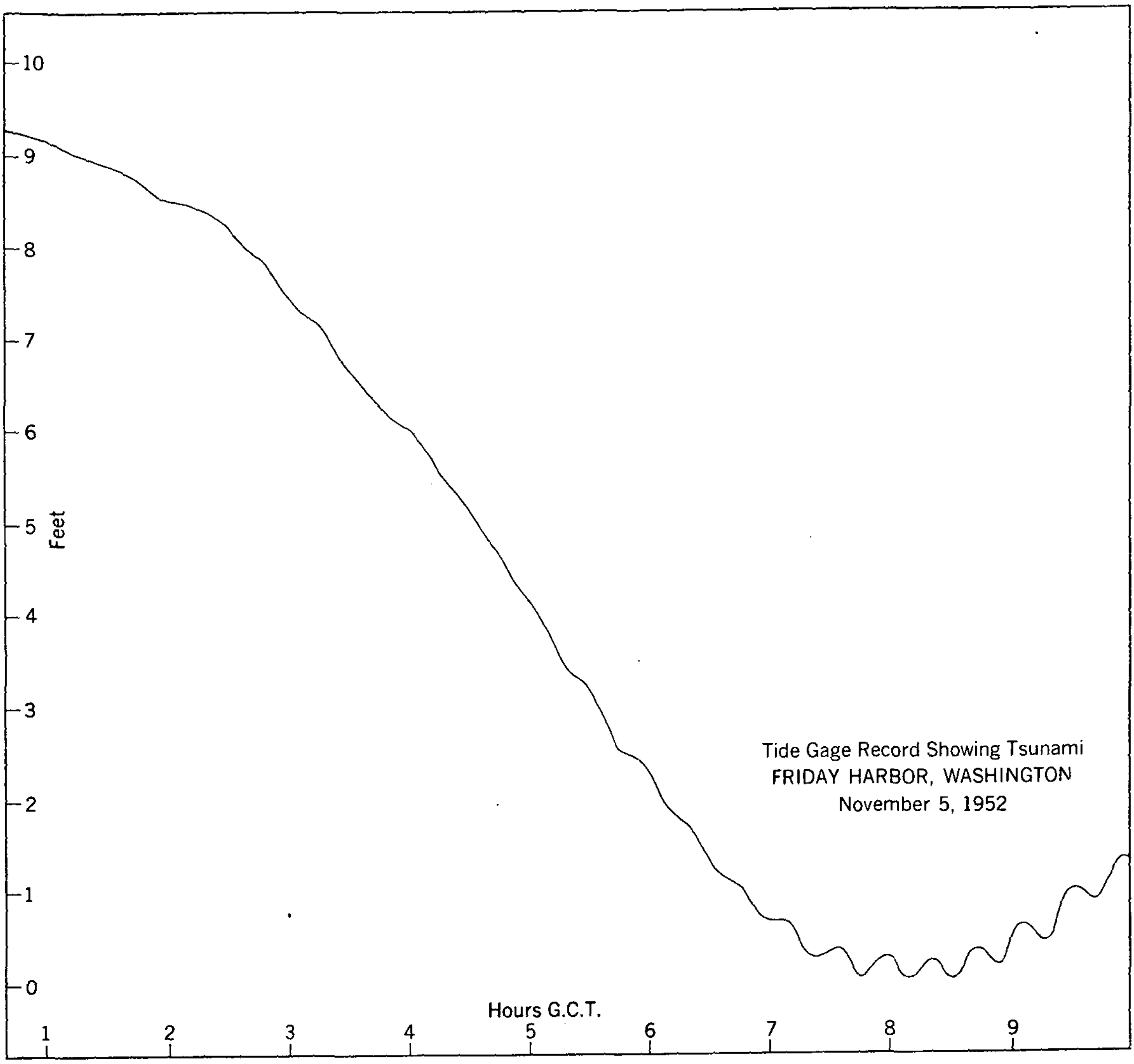
Tide Gage Record Showing Tsunami
VICTORIA, B.C.
November 4-5, 1952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Feet
Tide Gage Record Showing Tsunami
FRIDAY HARBOR, WASHINGTON
November 5, 1952
Hours G.C.T.
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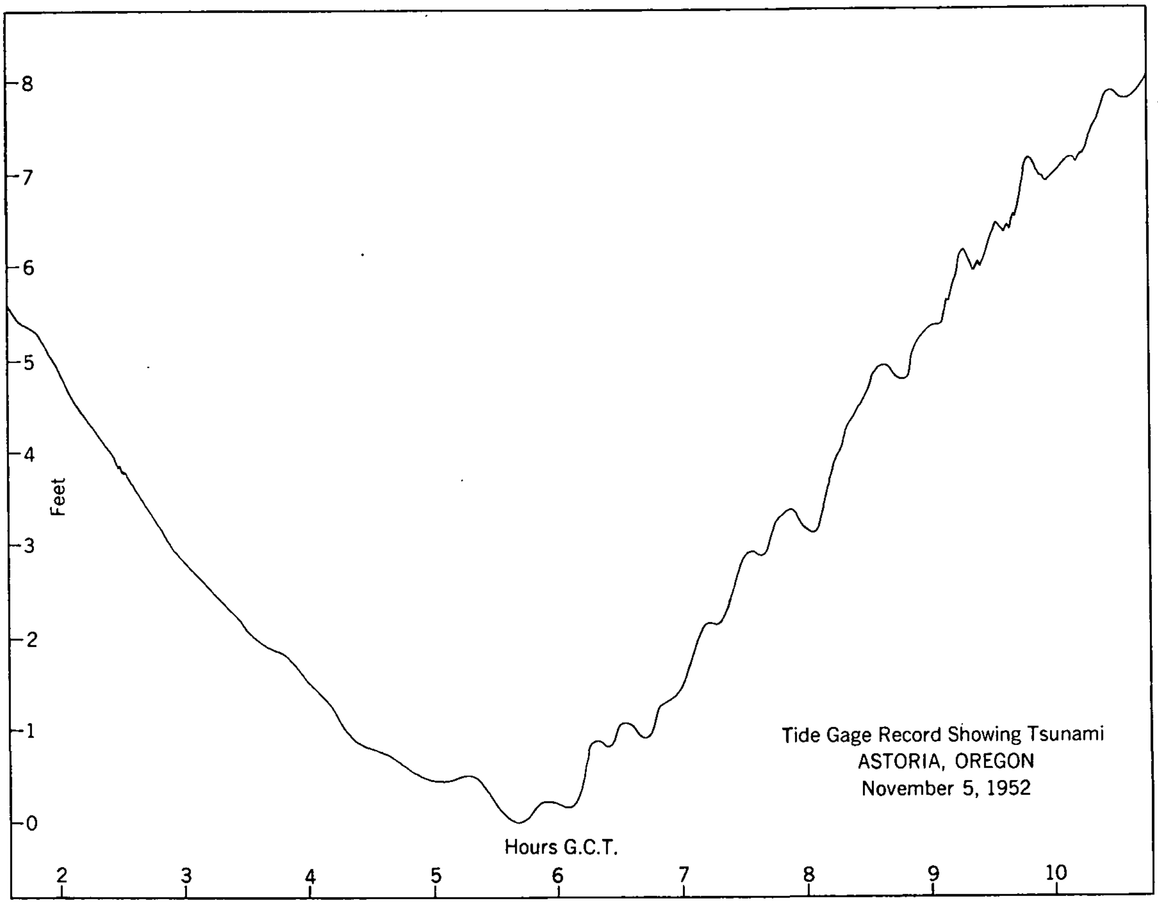

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Hours G.C.T.
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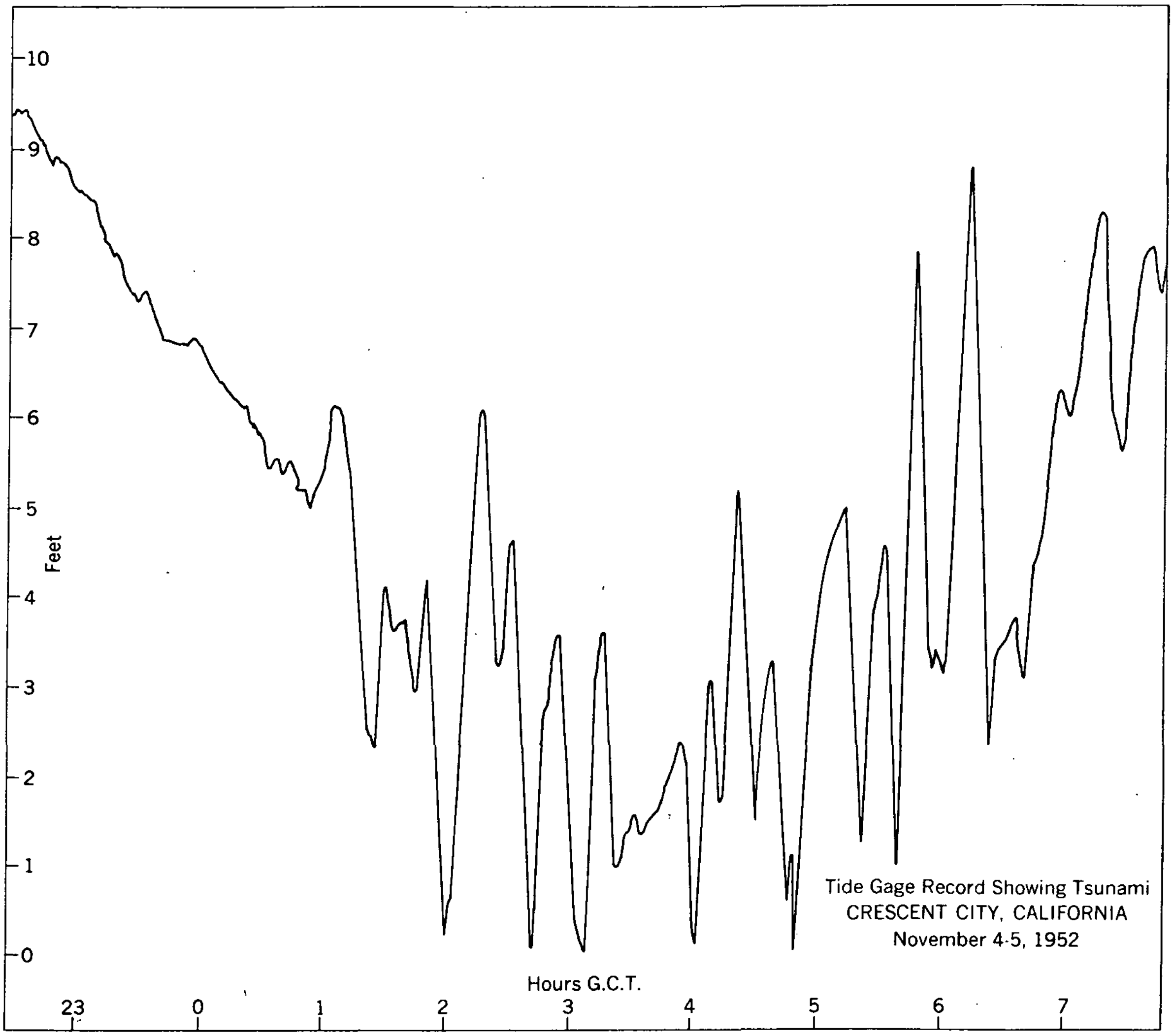
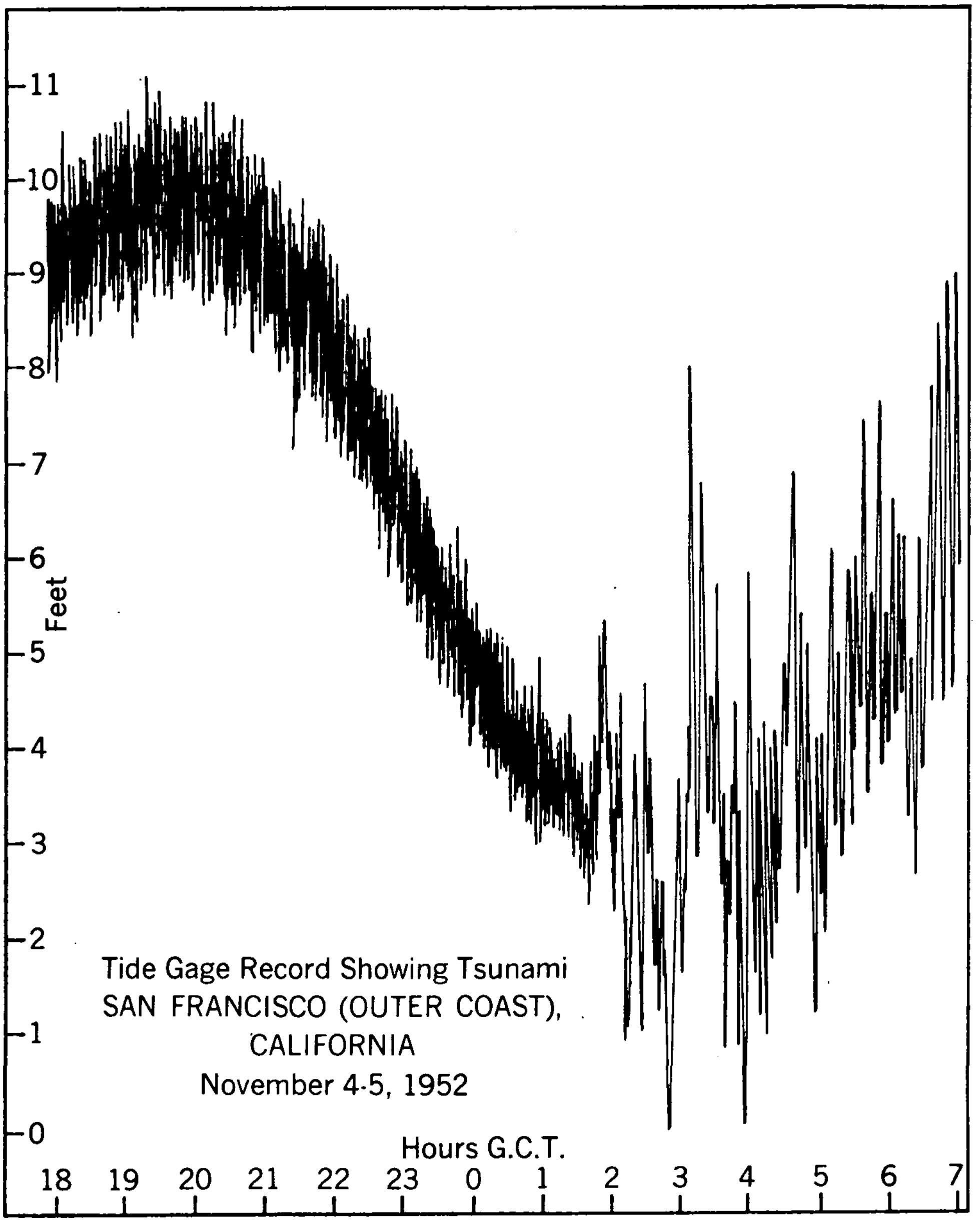
Tide Gage Record Showing Tsunami
ASTORIA, OREGON
November 5, 1952



Tide Gage Record Showing Tsunami
CRESCENT CITY, CALIFORNIA
November 4-5, 1952


11
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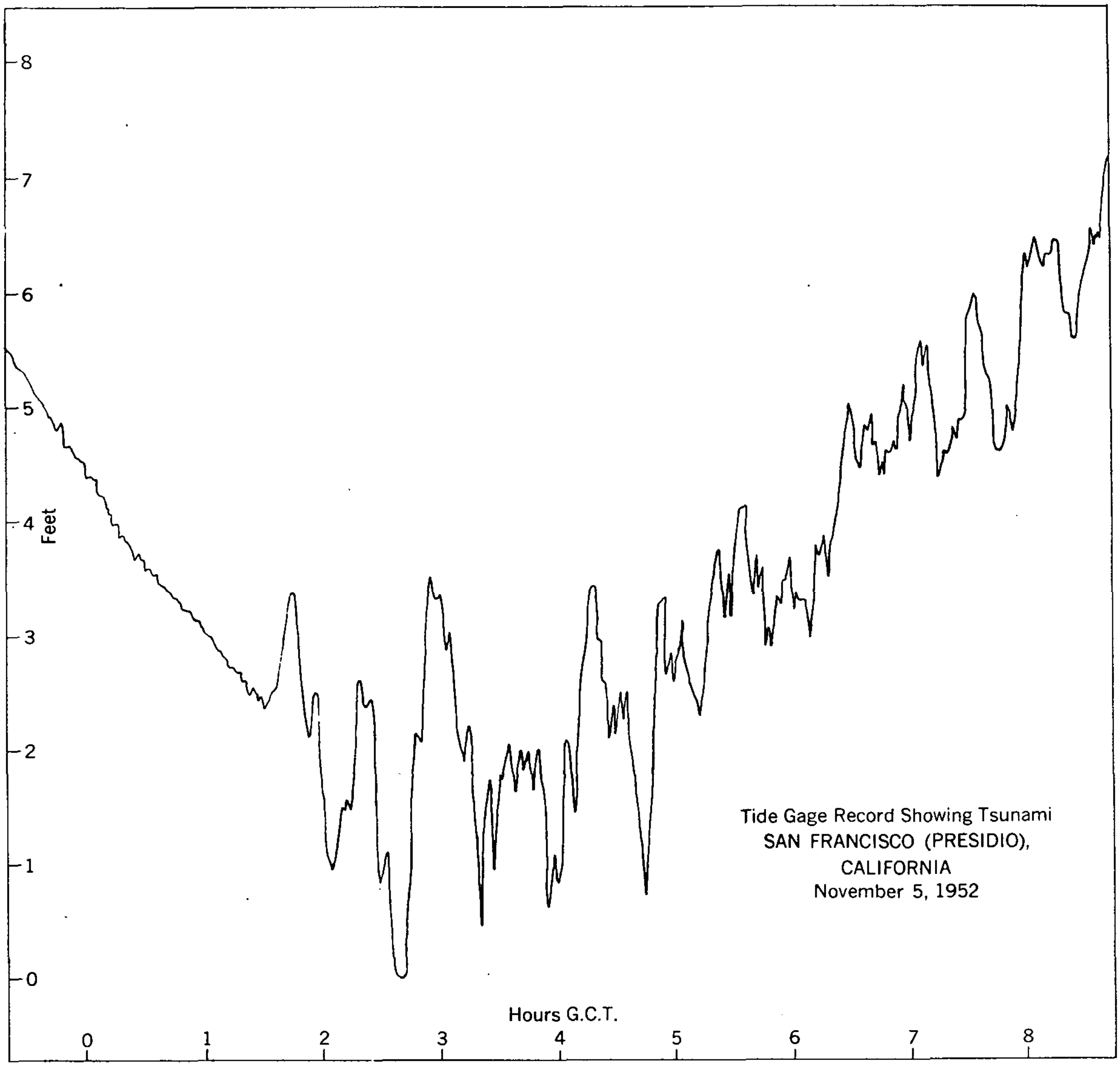
Tide Gage Record Showing Tsunami
SAN FRANCISCO (OUTER COAST),
CALIFORNIA
November 4-5, 1952
Hours G.C.T.
18 19 20 21 22 23 0 1 2 3 4 5 6 7



Feet
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Hours G.C.T.
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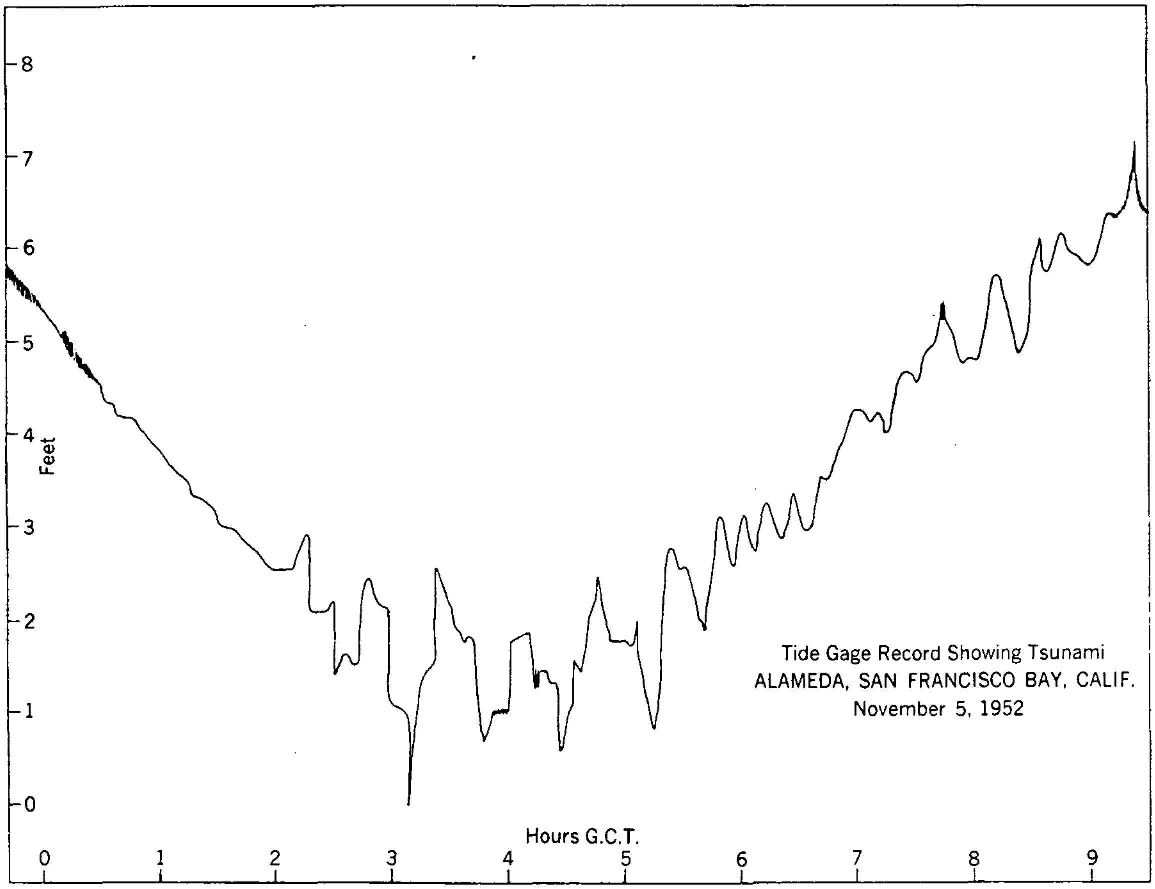
Tide Gage Record Showing Tsunami
SAN FRANCISCO (PRESIDIO),
CALIFORNIA
November 5, 1952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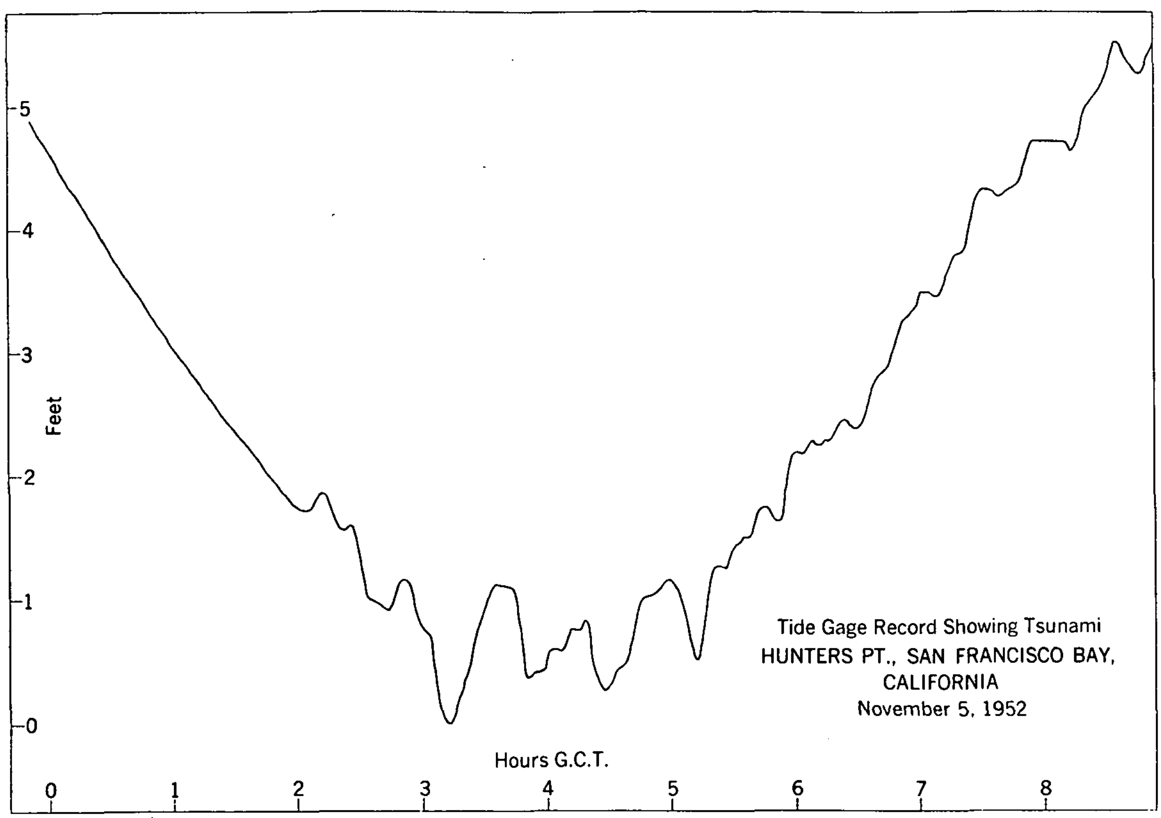
Tide Gage Record Showing Tsunami
ALAMEDA, SAN FRANCISCO BAY, CALIF.
November 5, 1952
Hours G.C.T.
0 1 2 3 4 5 6 7 8 9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Feet
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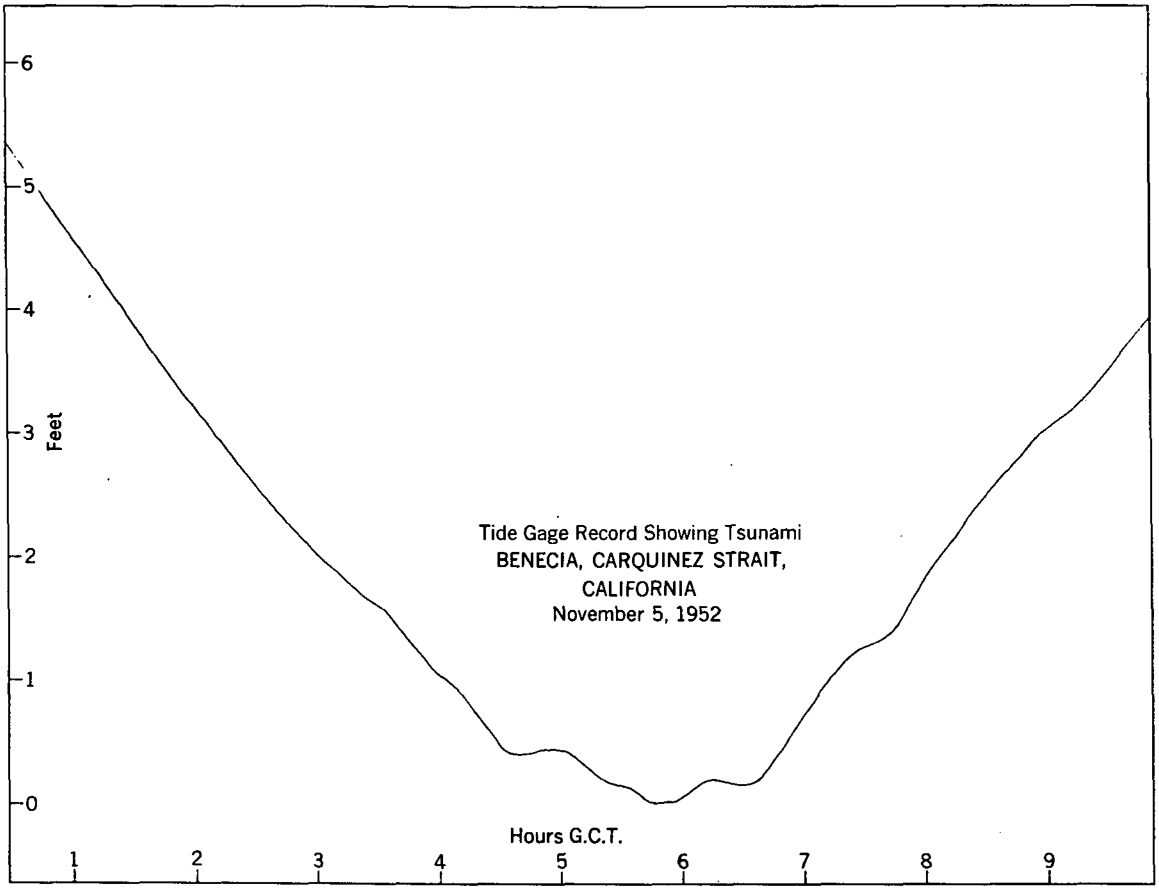
Tide Gage Record Showing Tsunami
HUNTERS PT., SAN FRANCISCO BAY, CALIFORNIA
November 5, 1952
Hours G.C.T.
0 1 2 3 4 5 6 7 8


Tide Gage Record Showing Tsunami
BENECIA, CARQUINEZ STRAIT,
CALIFORNIA
November 5, 1952
Feet
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Hours G.C.T.
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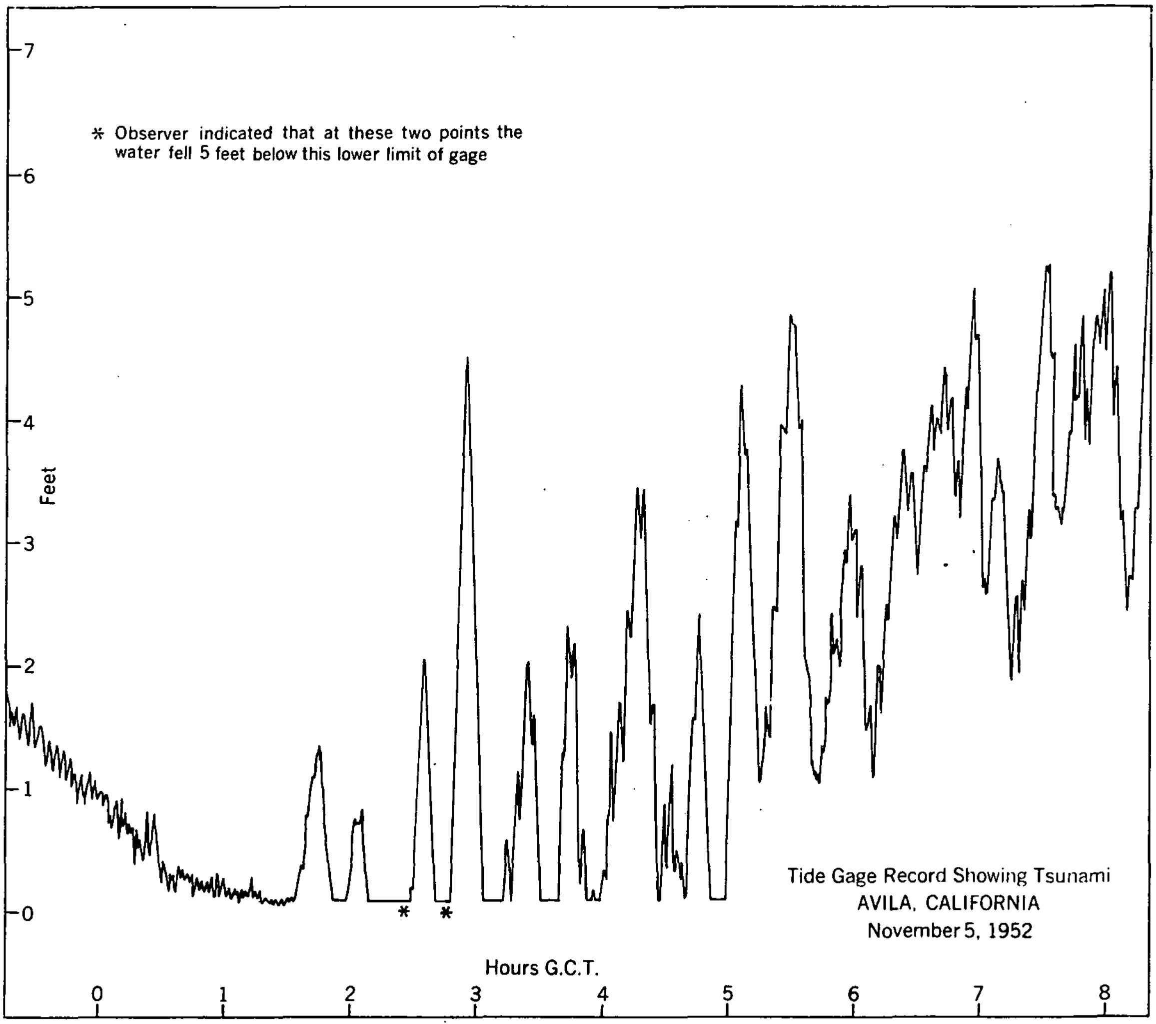
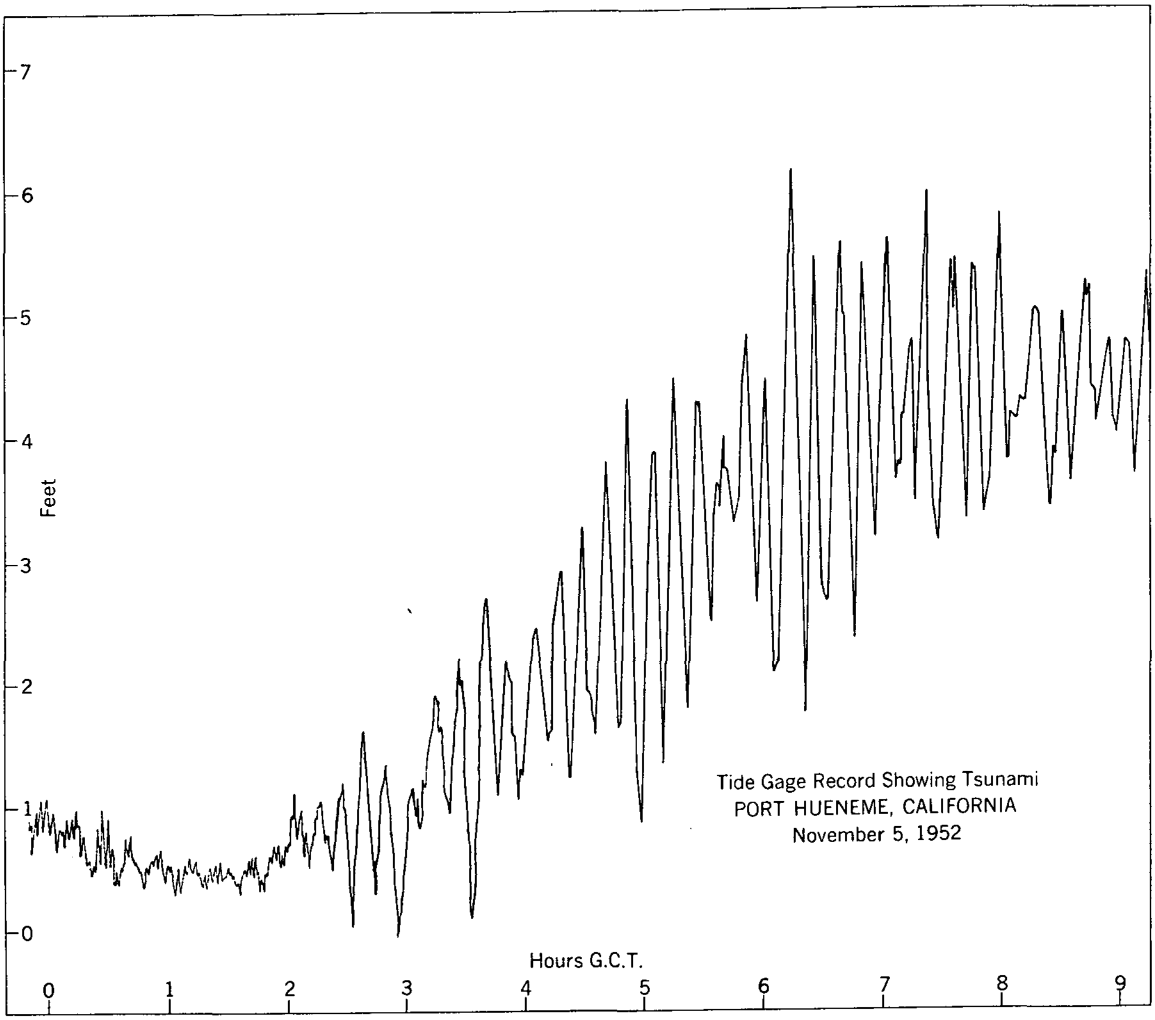


Tide Gage Record Showing Tsunami
AVILA, CALIFORNIA
November 5, 1952


Feet
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Tide Gage Record Showing Tsunami
PORT HUENEME, CALIFORNIA
November 5, 1952
Hours G.C.T.
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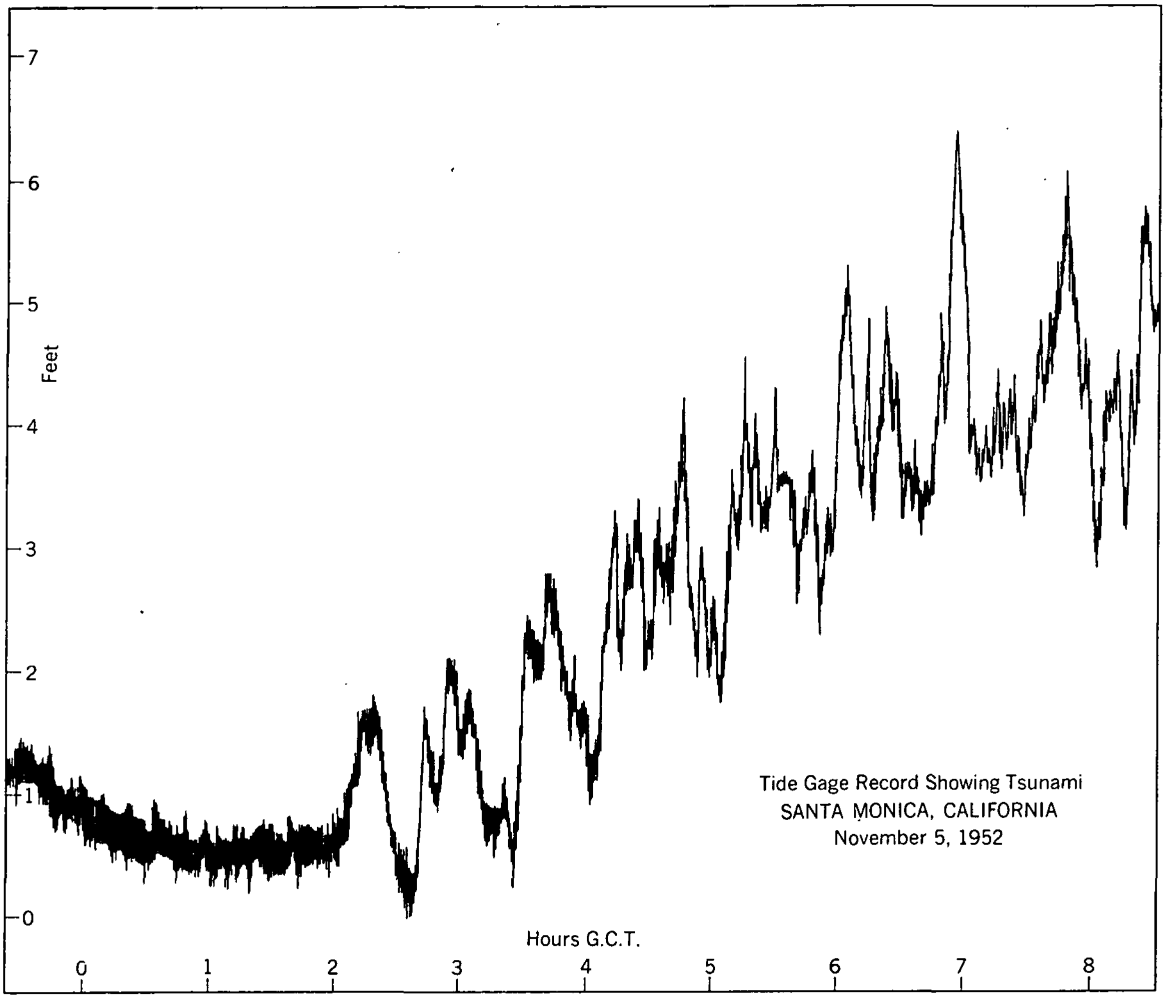
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Feet
Hours G.C.T.
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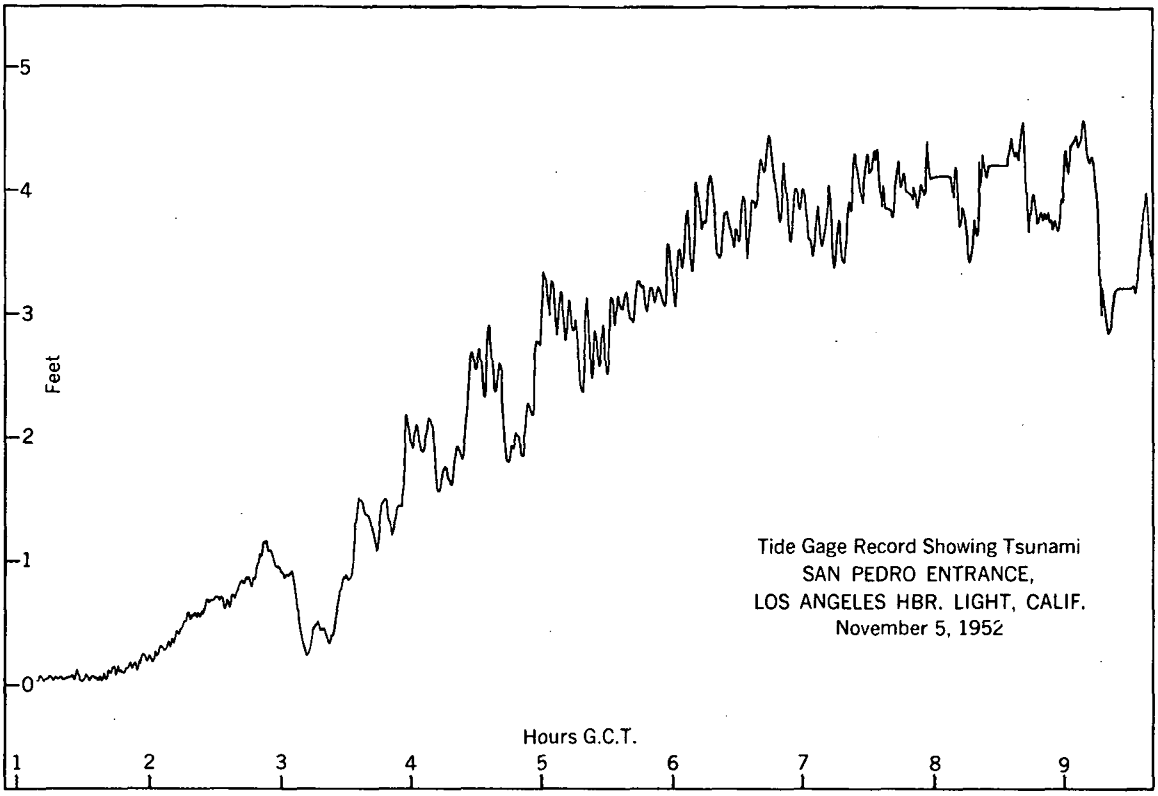
Tide Gage Record Showing Tsunami
SANTA MONICA, CALIFORNIA
November 5, 1952


Feet
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Tide Gage Record Showing Tsunami
SAN PEDRO ENTRANCE,
LOS ANGELES HBR. LIGHT, CALIF.
November 5, 1952
Hours G.C.T.
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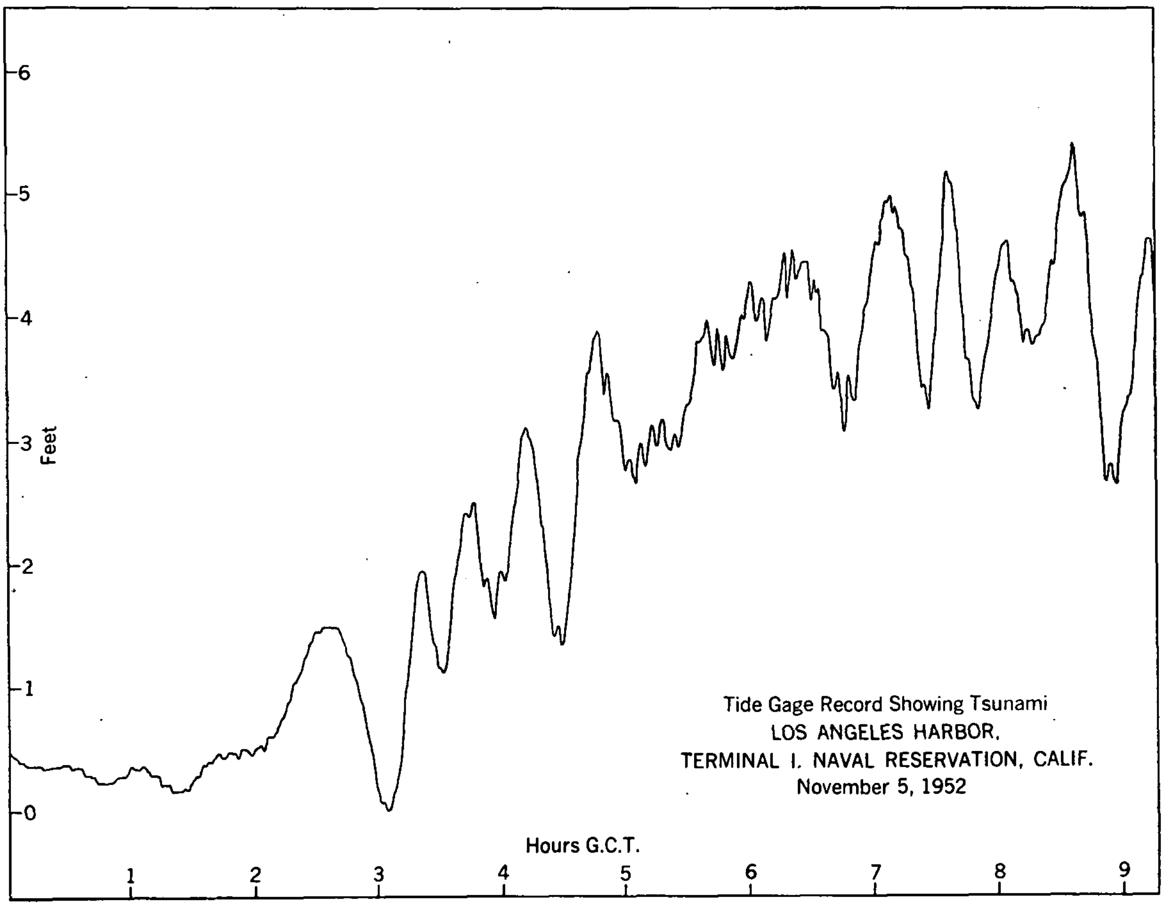
Feet
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Tide Gage Record Showing Tsunami
LOS ANGELES HARBOR,
TERMINAL I. NAVAL RESERVATION, CALIF.
November 5, 1952
Hours G.C.T.
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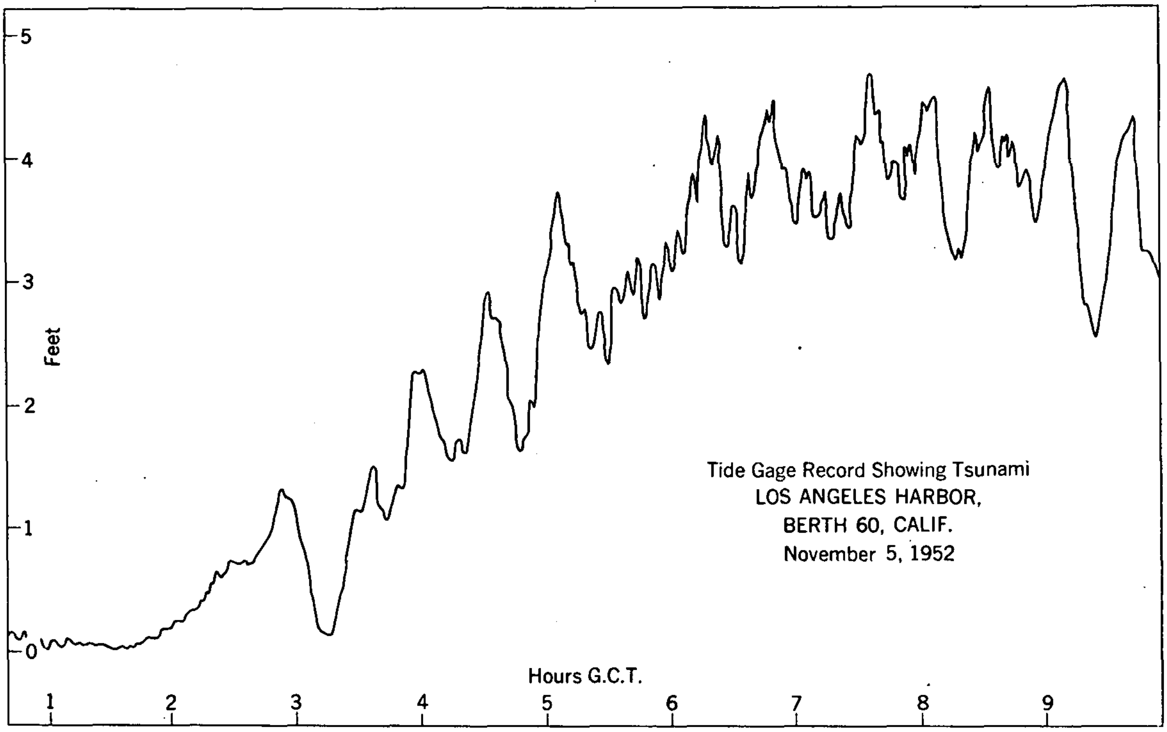
Tide Gage Record Showing Tsunami
LOS ANGELES HARBOR,
BERTH 60, CALIF.
November 5, 1952
Feet
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Hours G.C.T.
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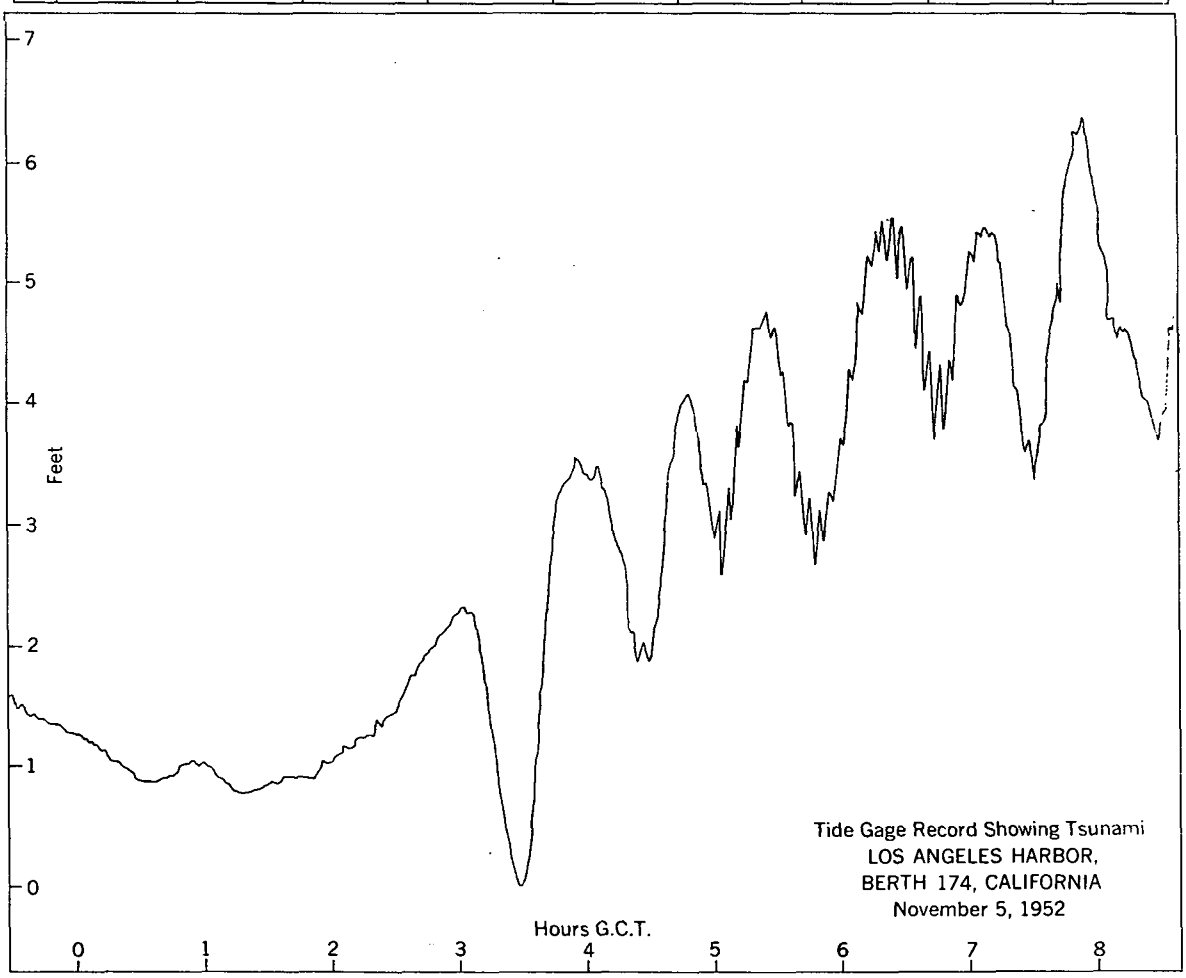
Tide Gage Record Showing Tsunami
LOS ANGELES HARBOR,
BERTH 174, CALIFORNIA
November 5, 1952
Feet
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Hours G.C.T.
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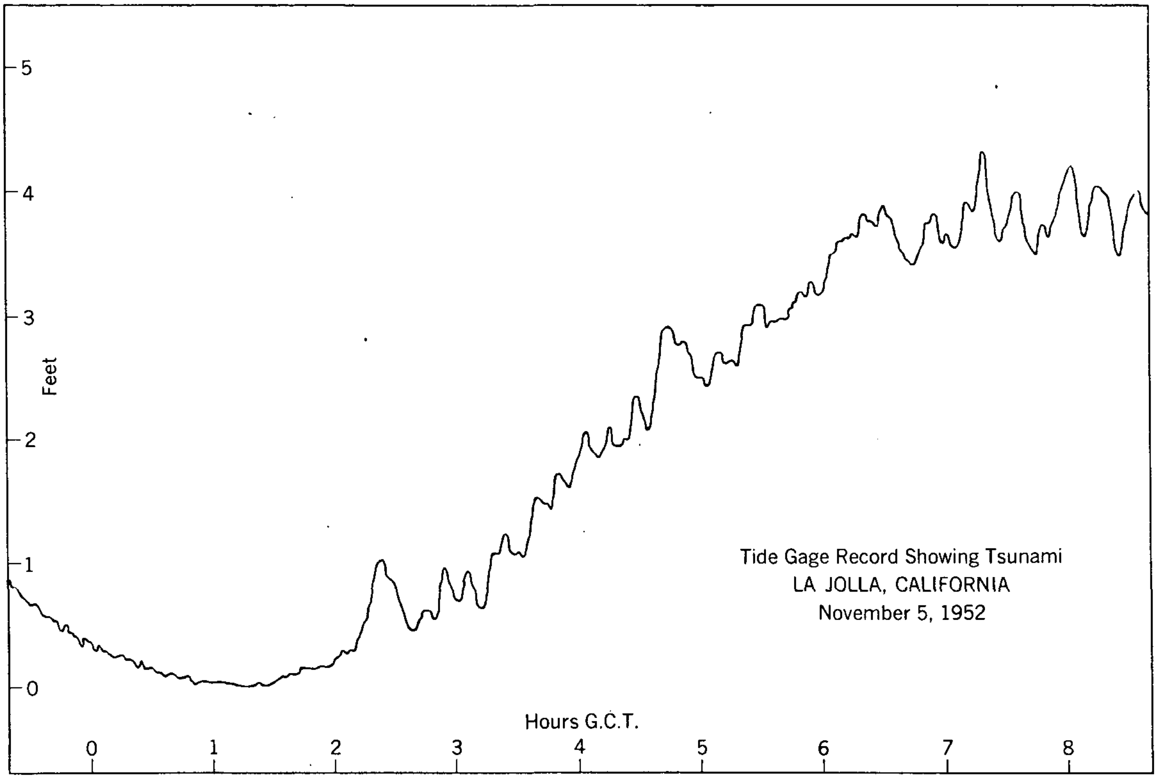
Feet
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Tide Gage Record Showing Tsunami
LA JOLLA, CALIFORNIA
November 5, 1952
Hours G.C.T.
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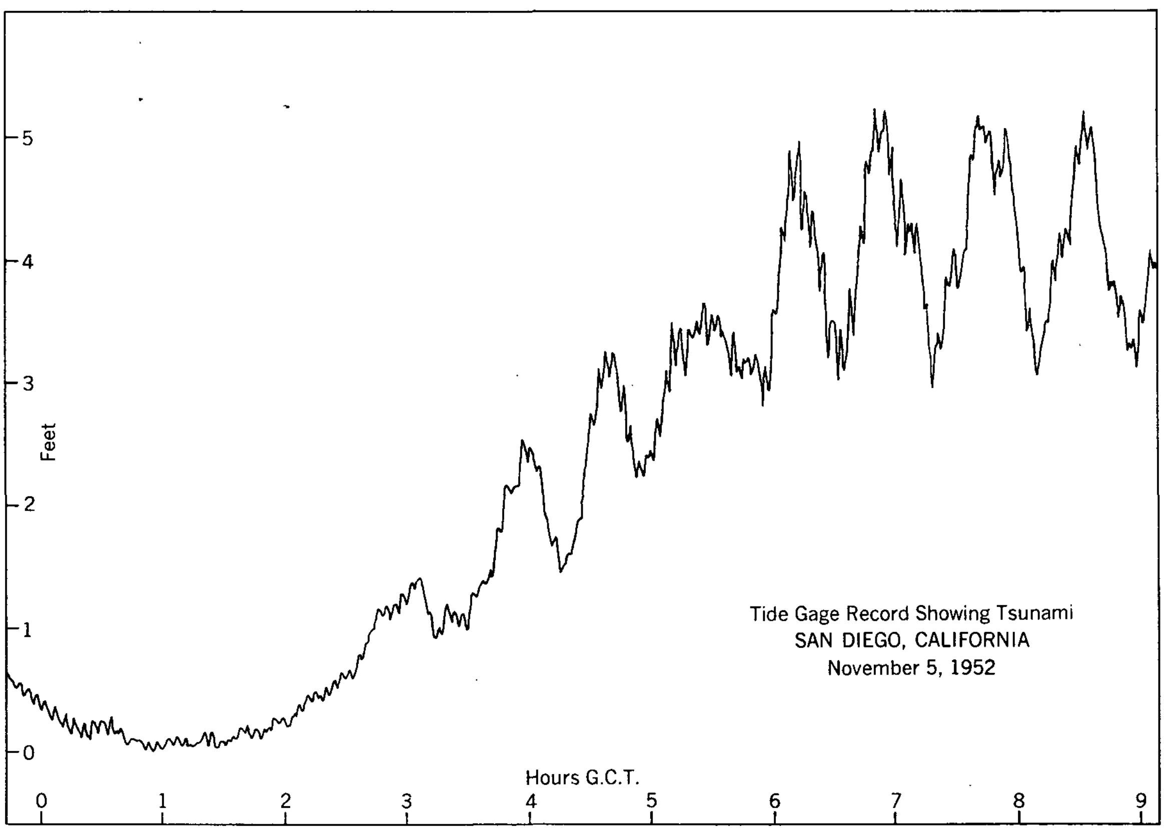
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Tide Gage Record Showing Tsunami
SAN DIEGO, CALIFORNIA
November 5, 1952
Hours G.C.T.
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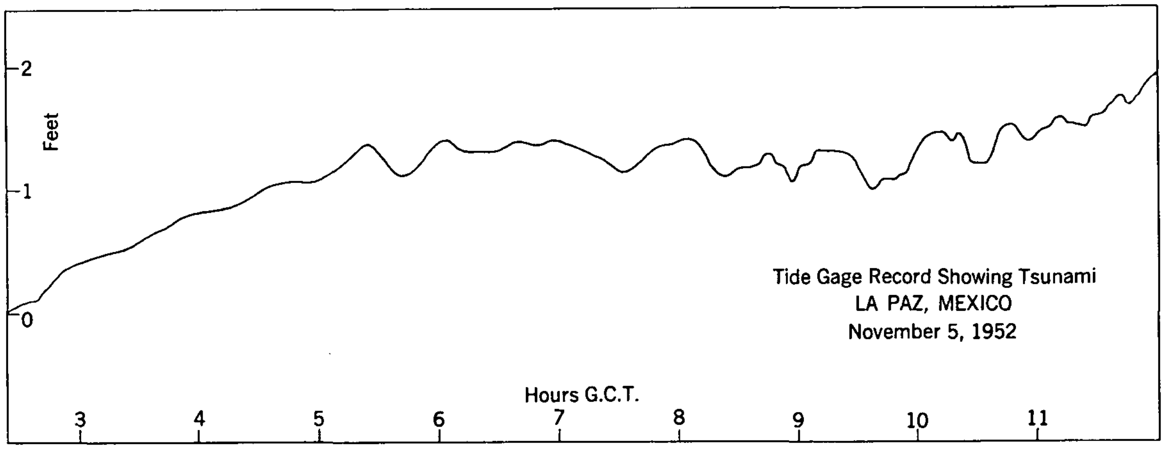
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Tide Gage Record Showing Tsunami
LA PAZ, MEXICO
November 5, 1952
Hours G.C.T.
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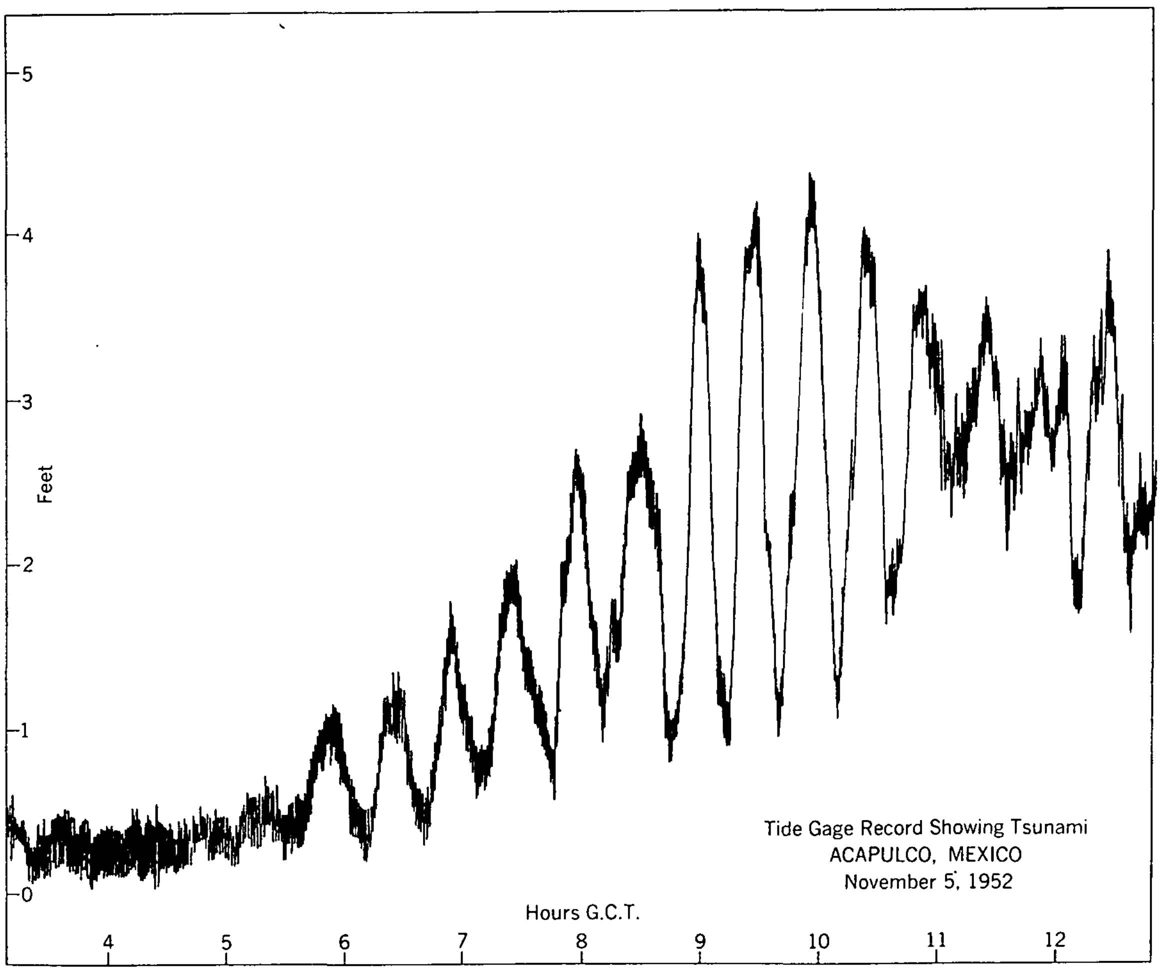
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Tide Gage Record Showing Tsunami
ACAPULCO, MEXICO
November 5, 1952
Hours G.C.T.
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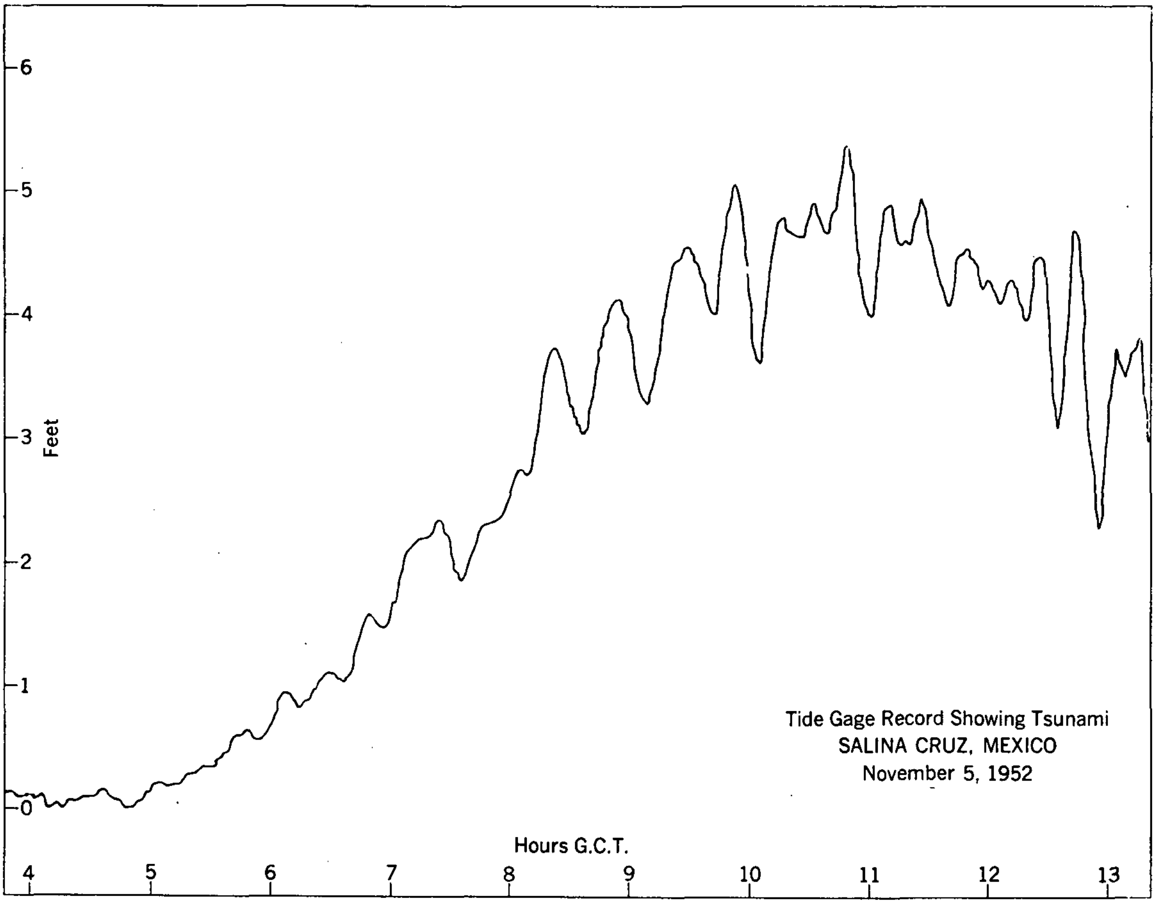
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Feet
Tide Gage Record Showing Tsunami
SALINA CRUZ, MEXICO
November 5, 1952
Hours G.C.T.
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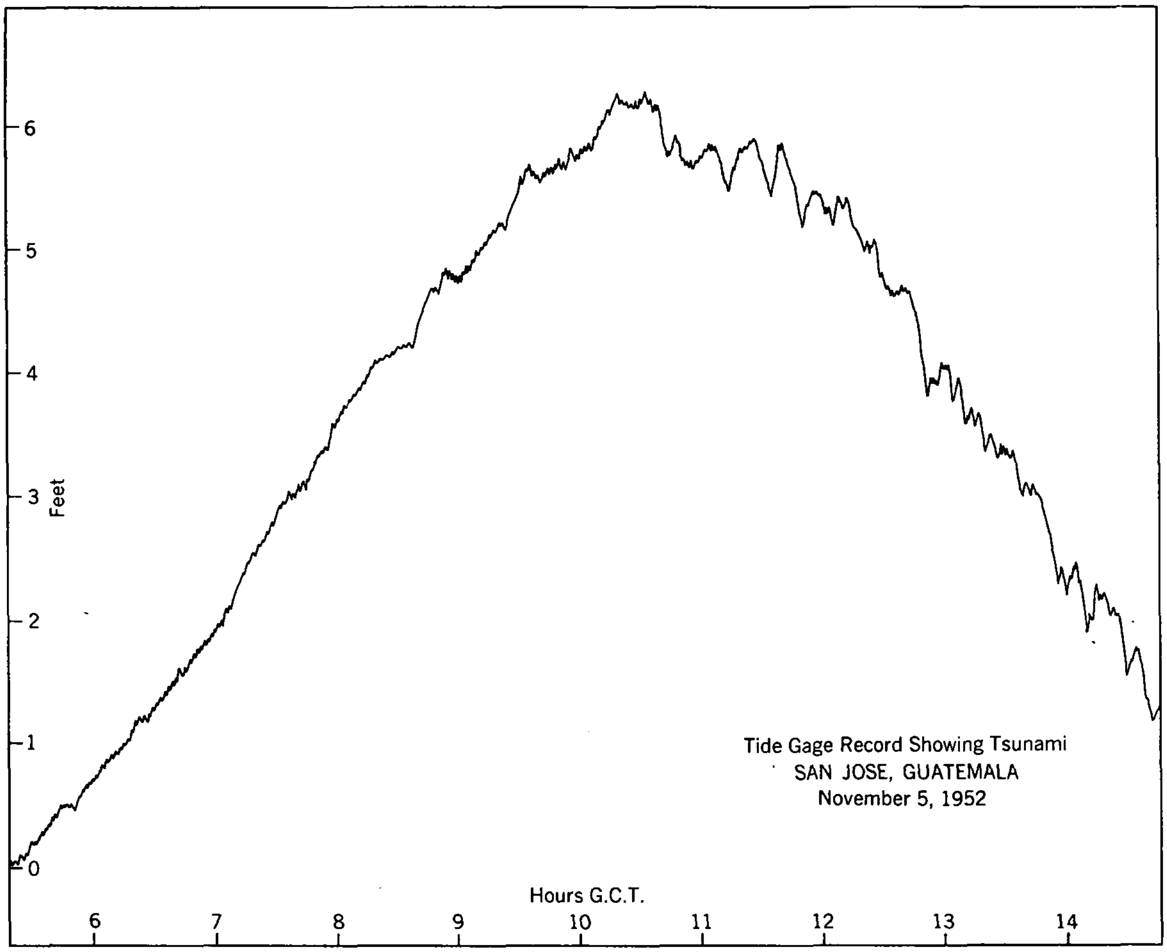
Tide Gage Record Showing Tsunami
SAN JOSE, GUATEMALA
November 5, 1952
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Hours G.C.T.
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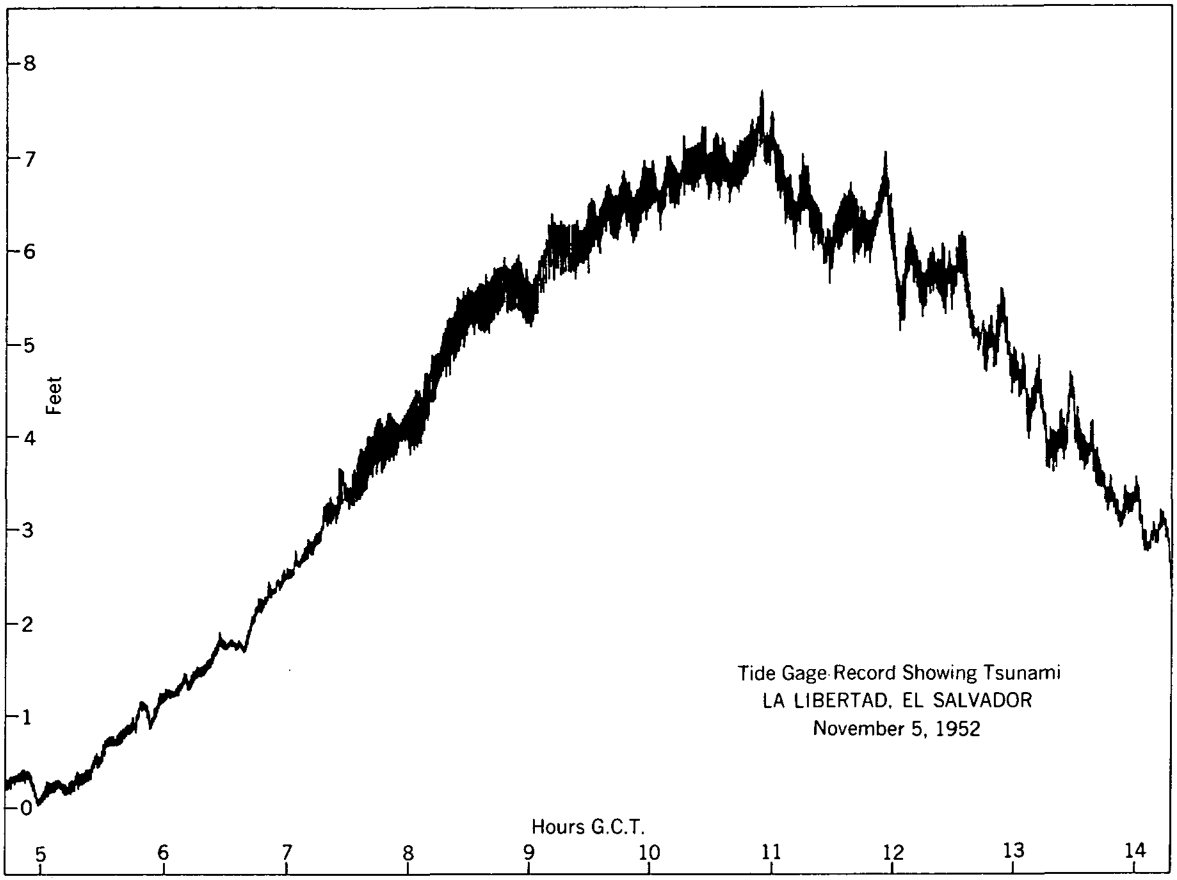

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Tide Gage Record Showing Tsunami
LA LIBERTAD, EL SALVADOR
November 5, 1952
Hours G.C.T.
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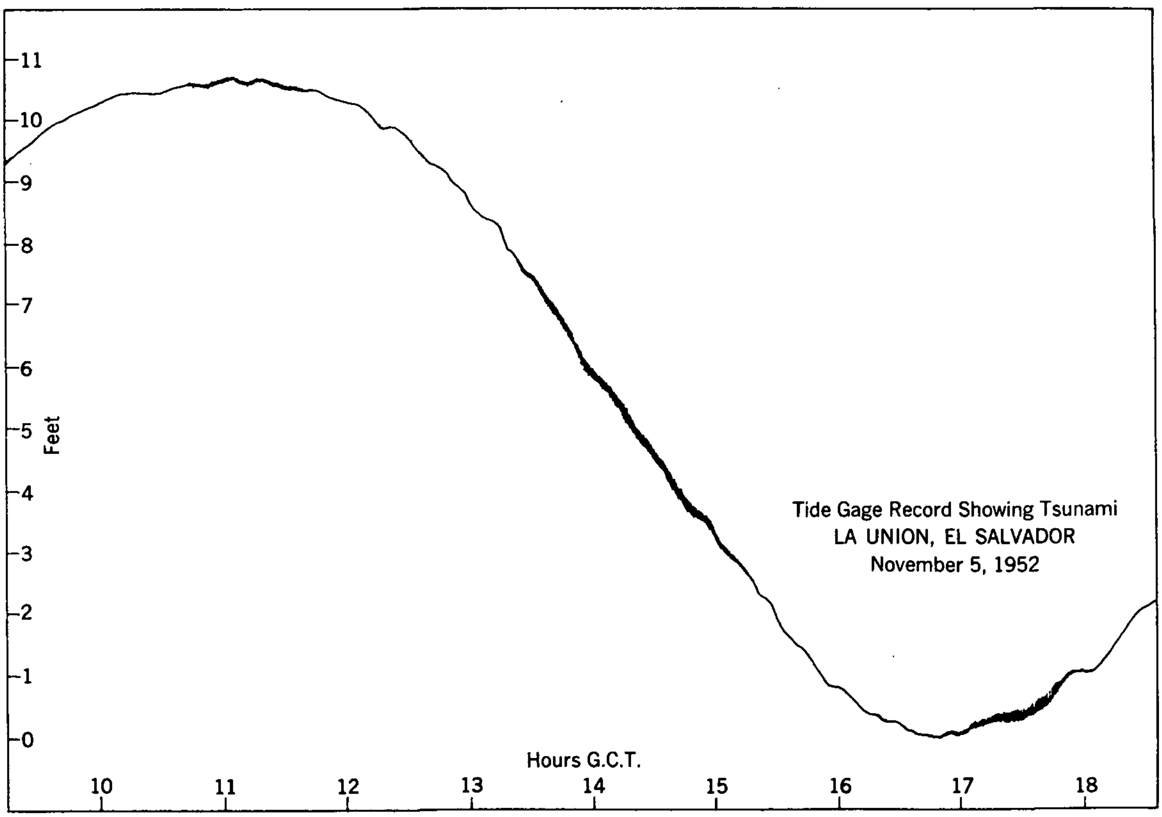

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Tide Gage Record Showing Tsunami
LA UNION, EL SALVADOR
November 5, 1952
Hours G.C.T.
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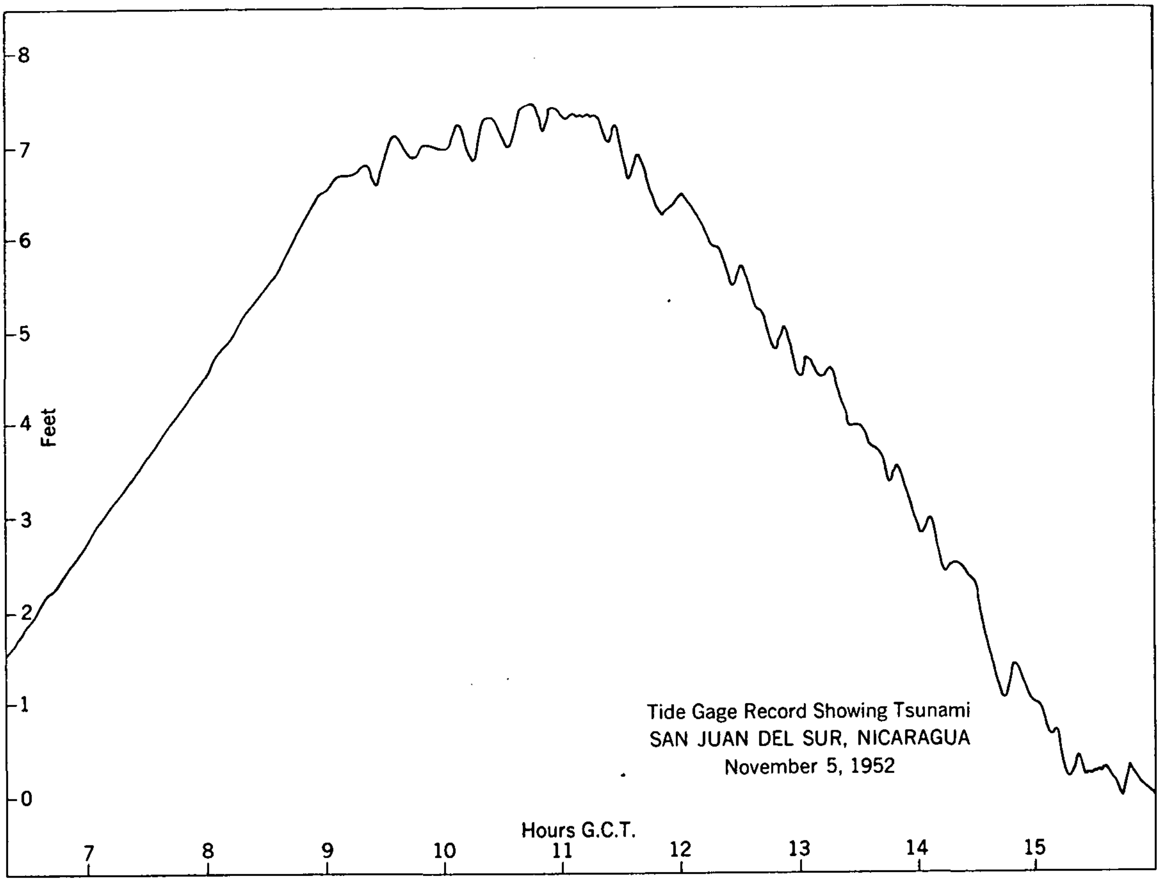
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Hours G.C.T.
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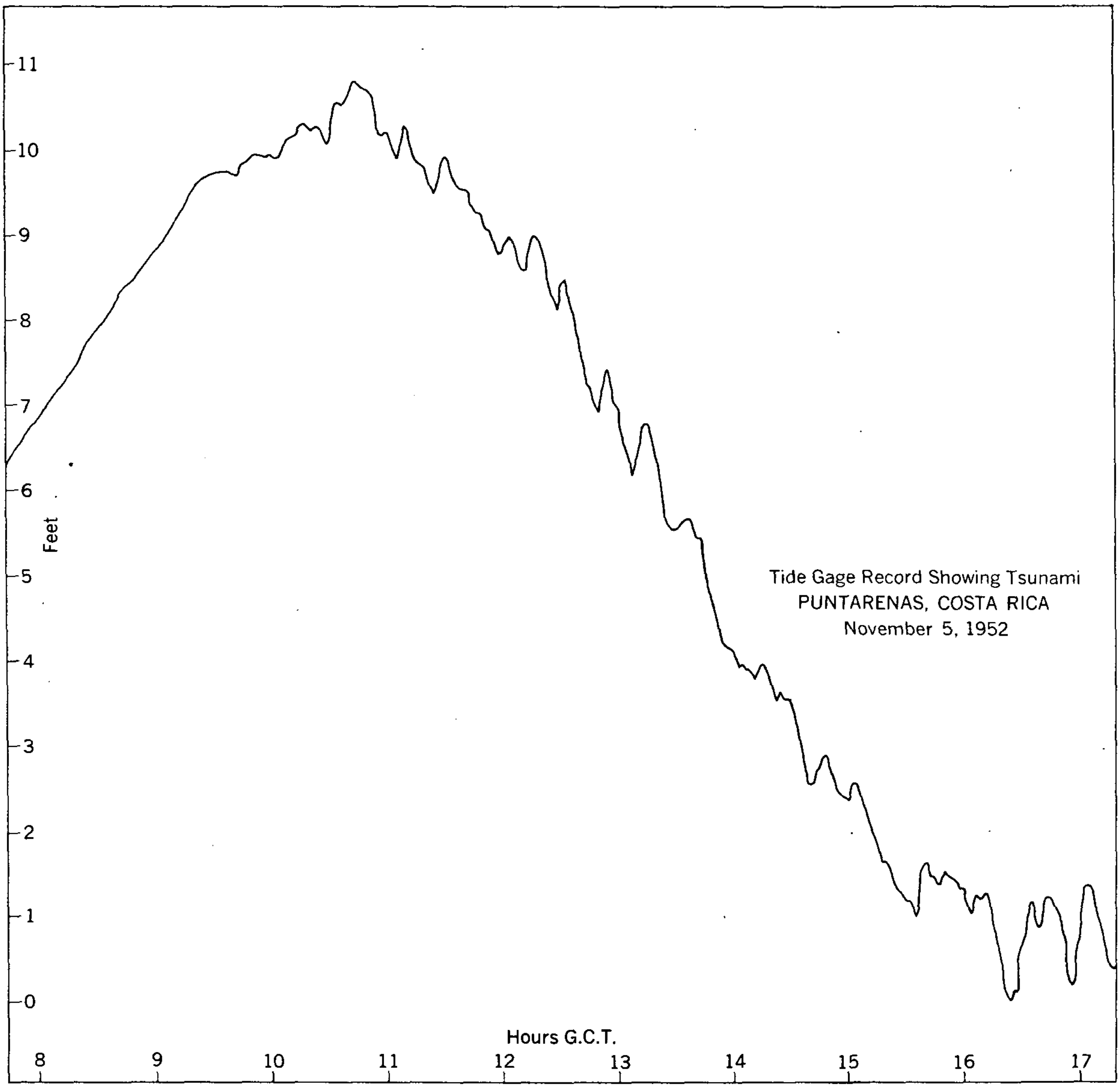
Tide Gage Record Showing Tsunami
SAN JUAN DEL SUR, NICARAGUA
November 5, 1952


Tide Gage Record Showing Tsunami
PUNTARENAS, COSTA RICA
November 5, 1952
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Hours G.C.T.
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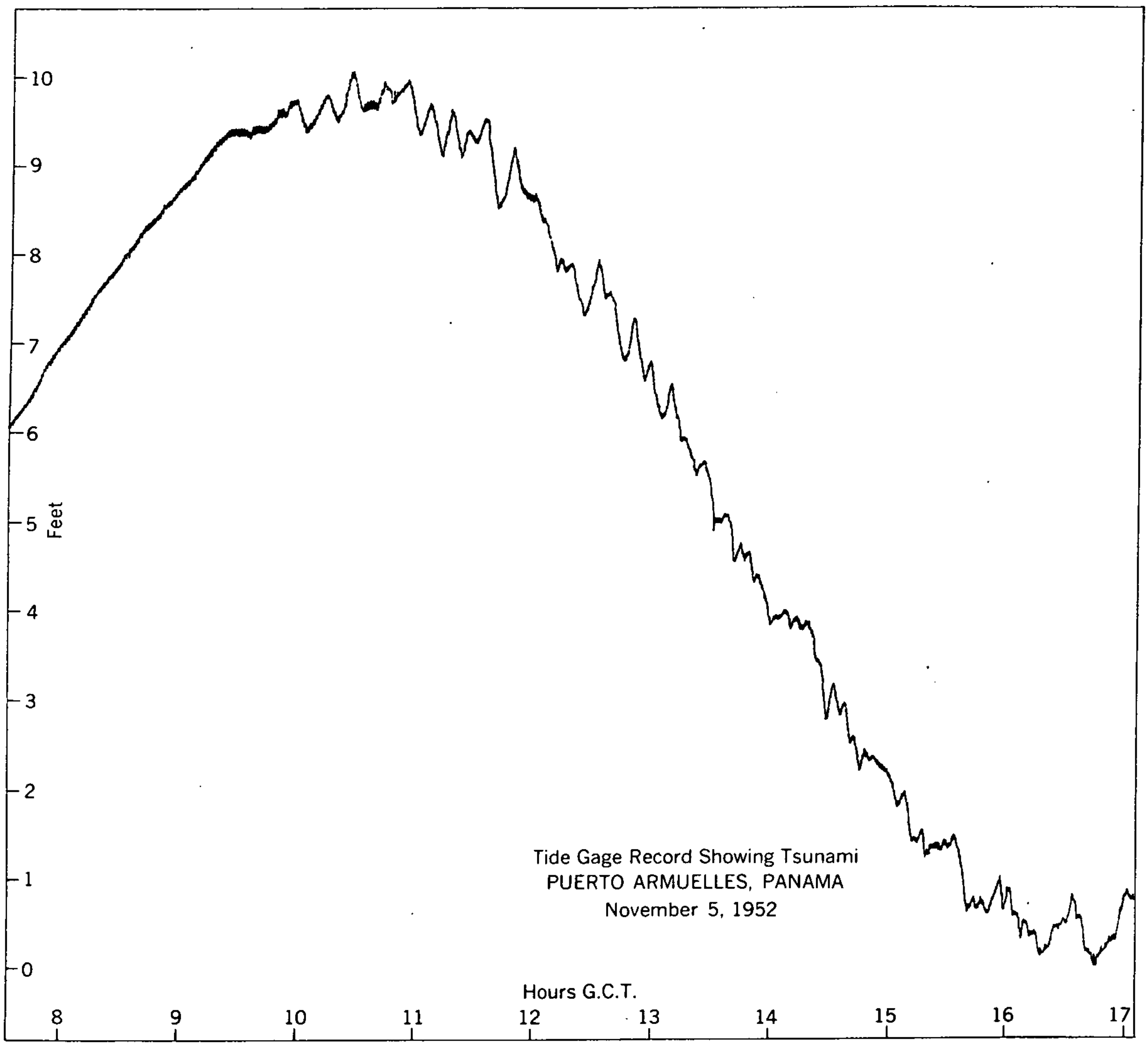
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Tide Gage Record Showing Tsunami
PUERTO ARMUELLES, PANAMA
November 5, 1952
Hours G.C.T.
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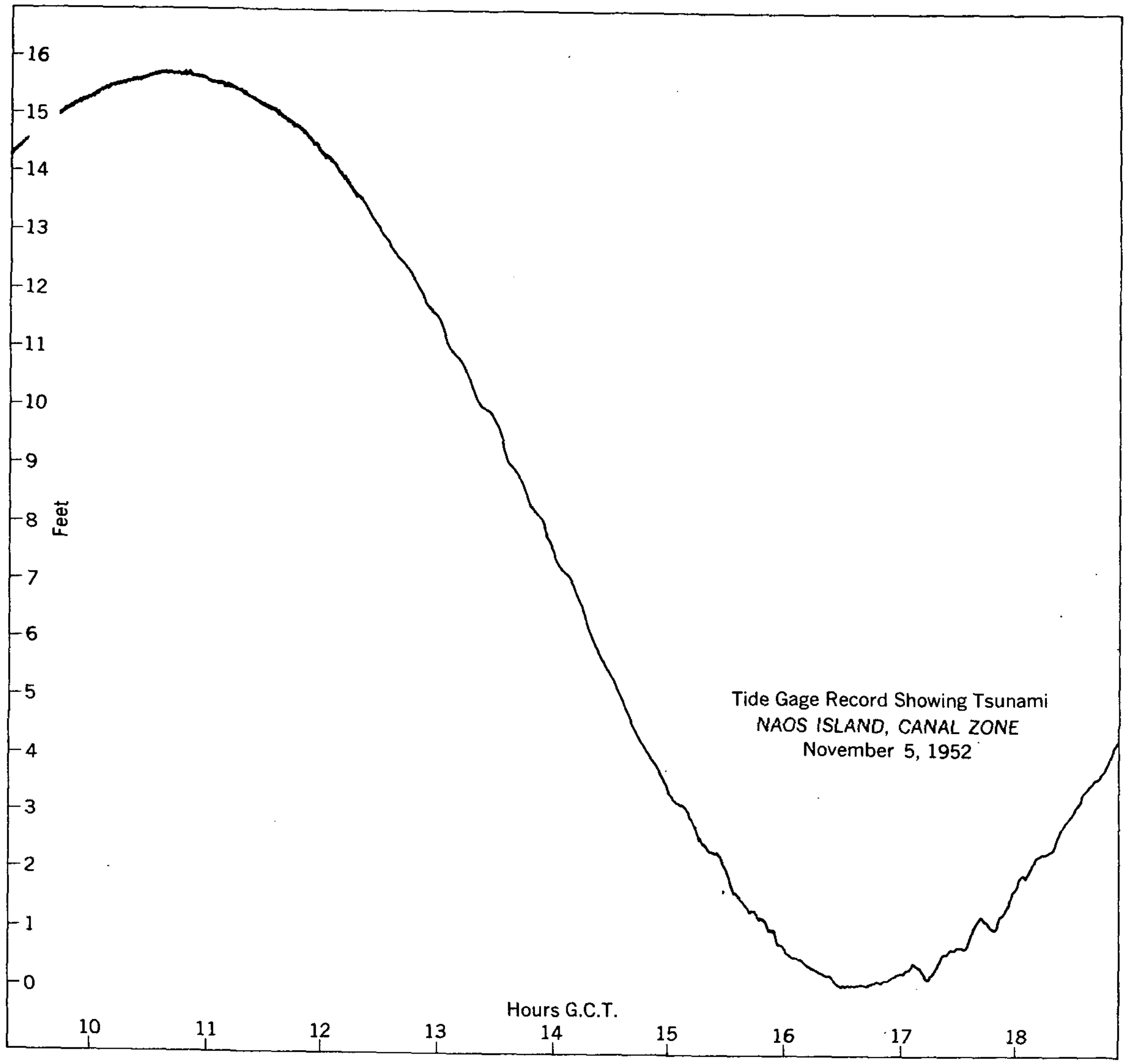
Tide Gage Record Showing Tsunami
NAOS ISLAND, CANAL ZONE
November 5, 1952
Feet
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Hours G.C.T.
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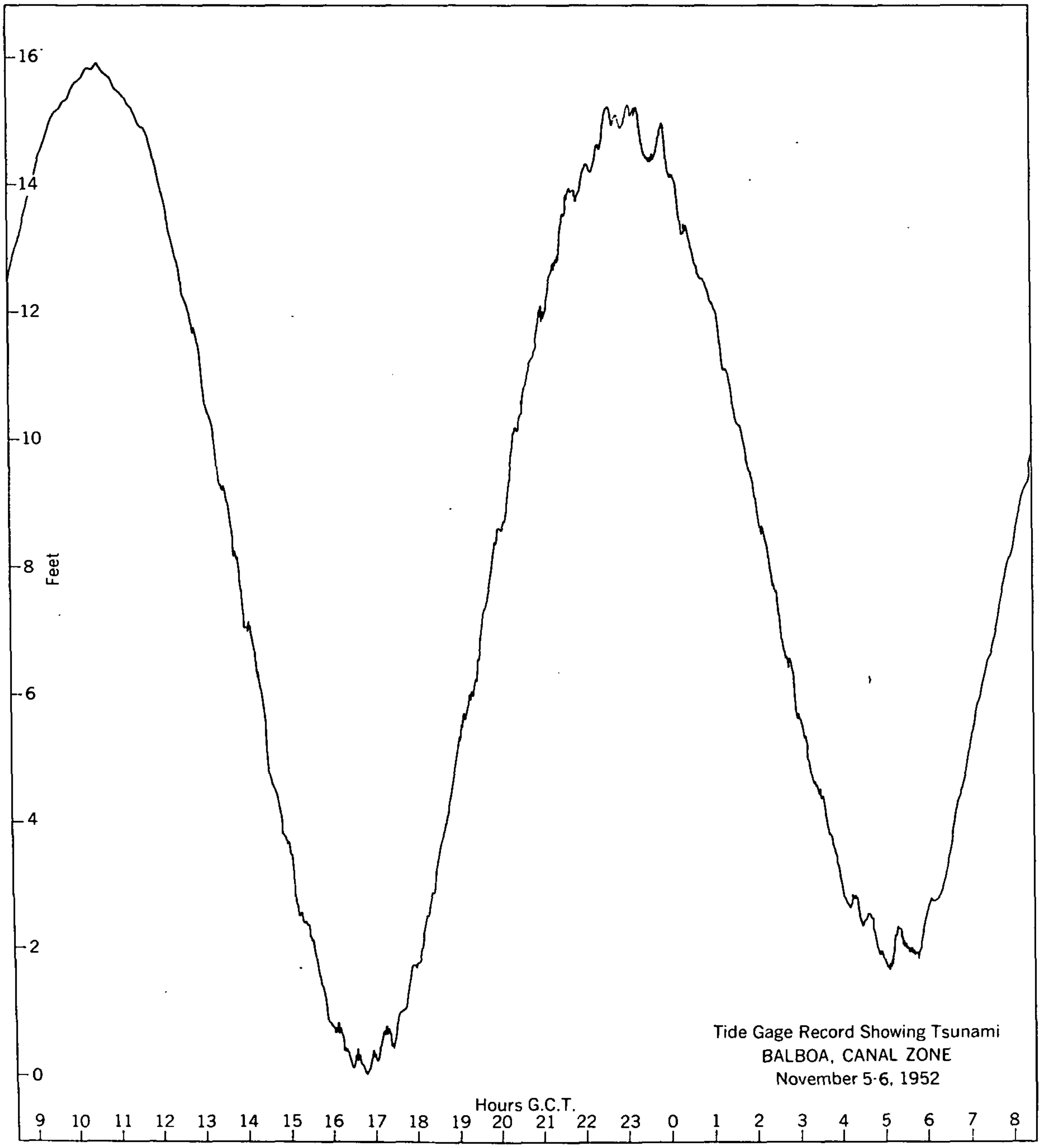
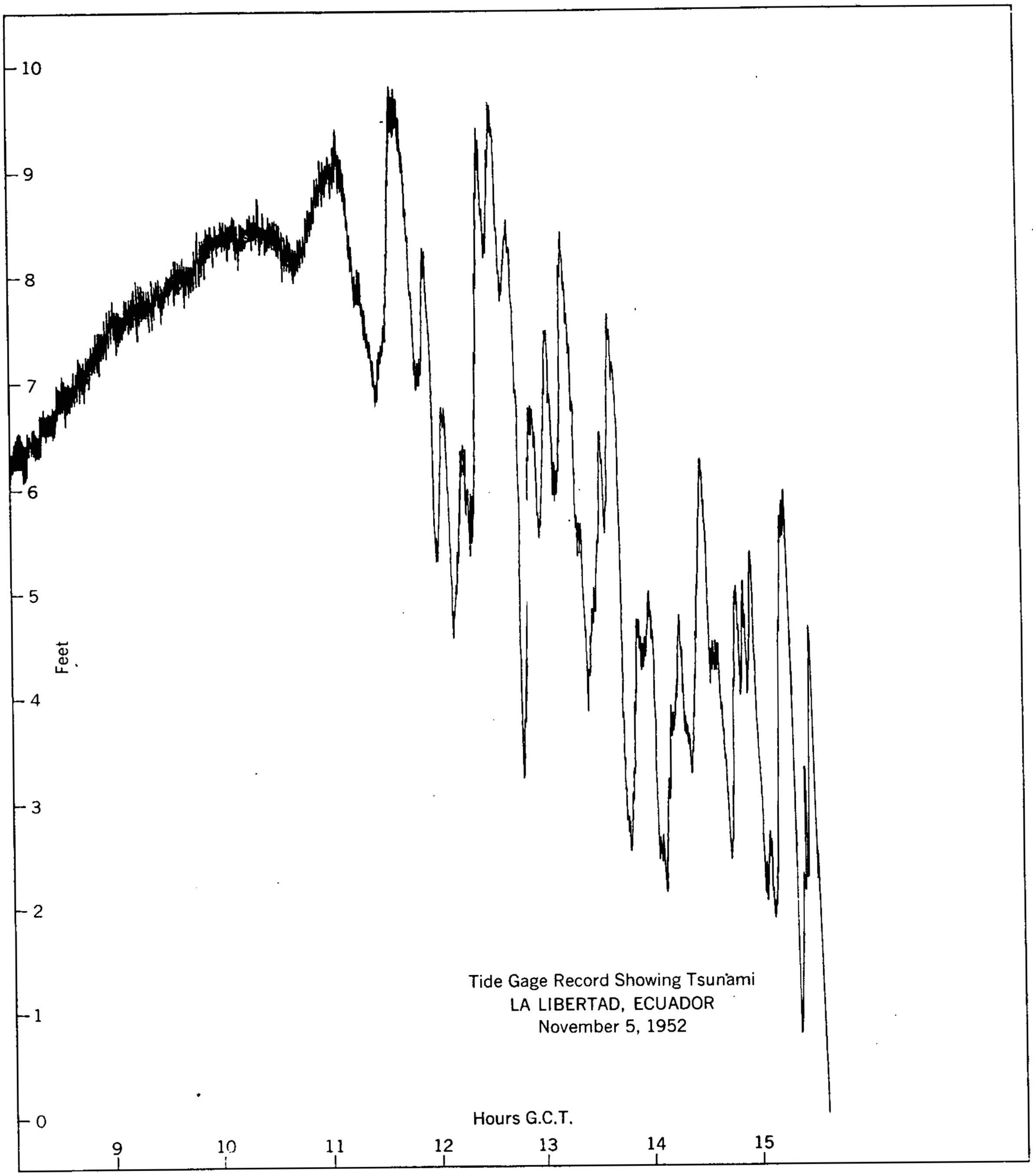


Tide Gage Record Showing Tsunami
BALBOA, CANAL ZONE
November 5-6, 1952



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Tide Gage Record Showing Tsunami
LA LIBERTAD, ECUADOR
November 5, 1952
Hours G.C.T.
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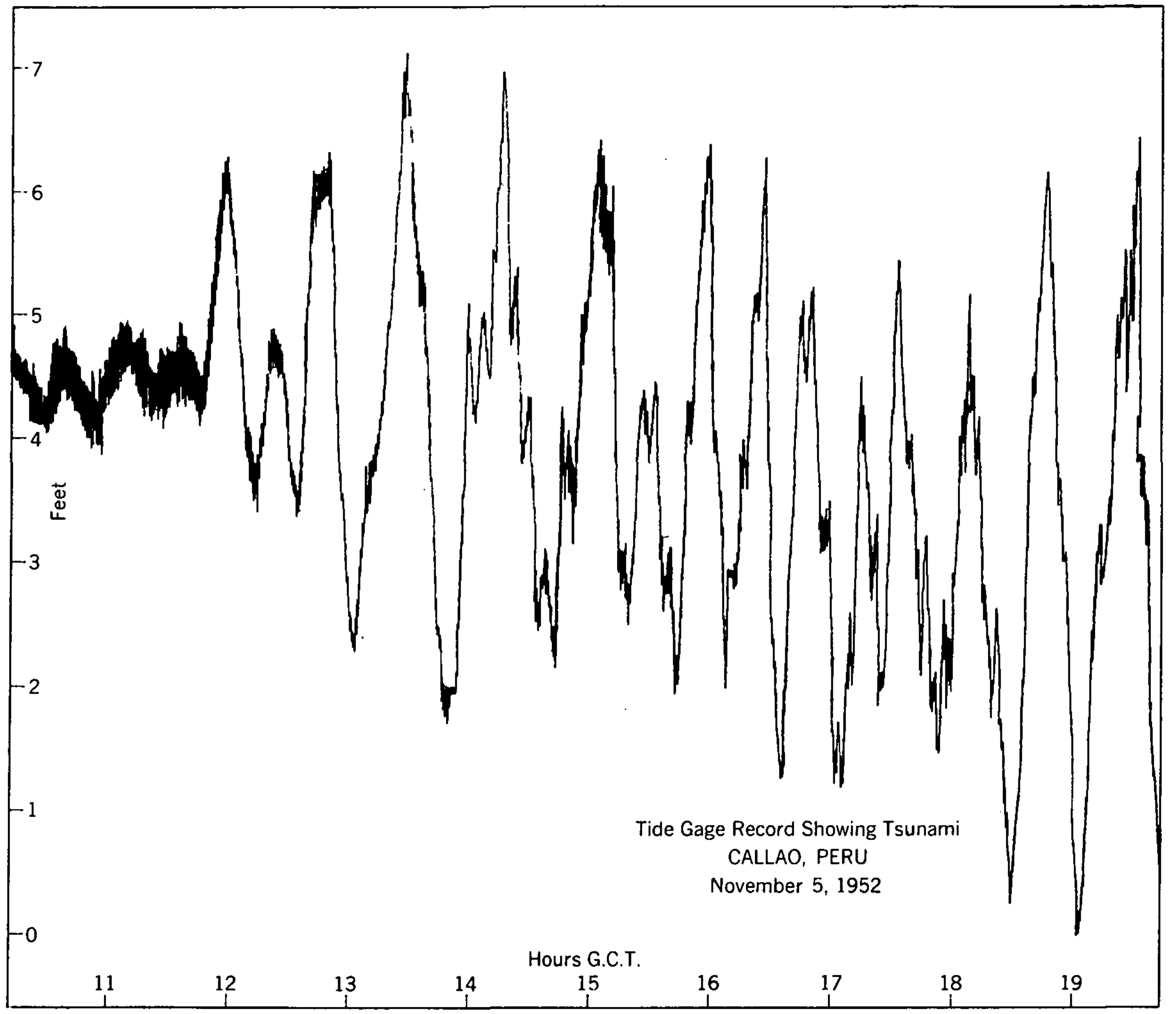
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Tide Gage Record Showing Tsunami
CALLAO, PERU
November 5, 1952
Hours G.C.T.
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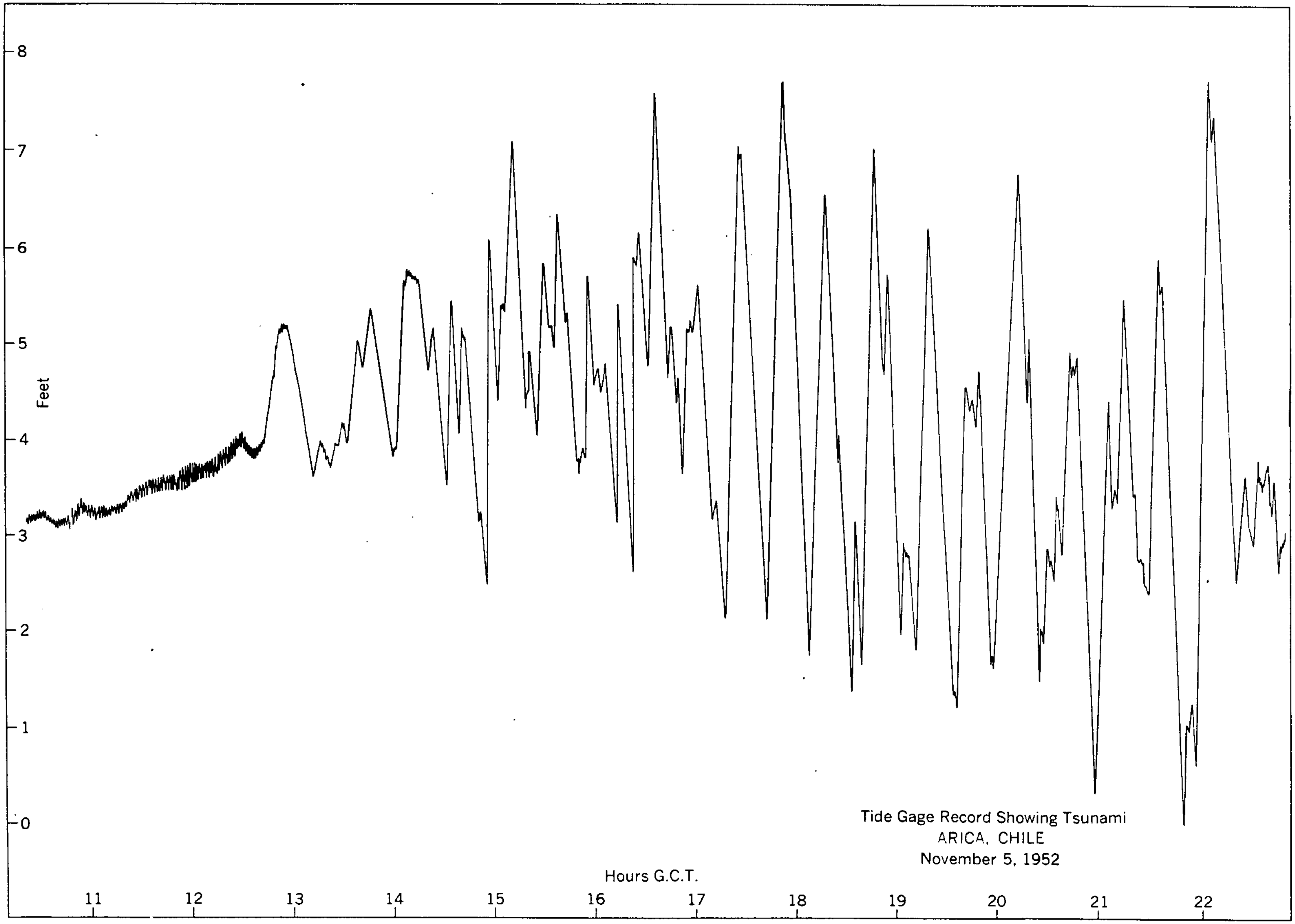
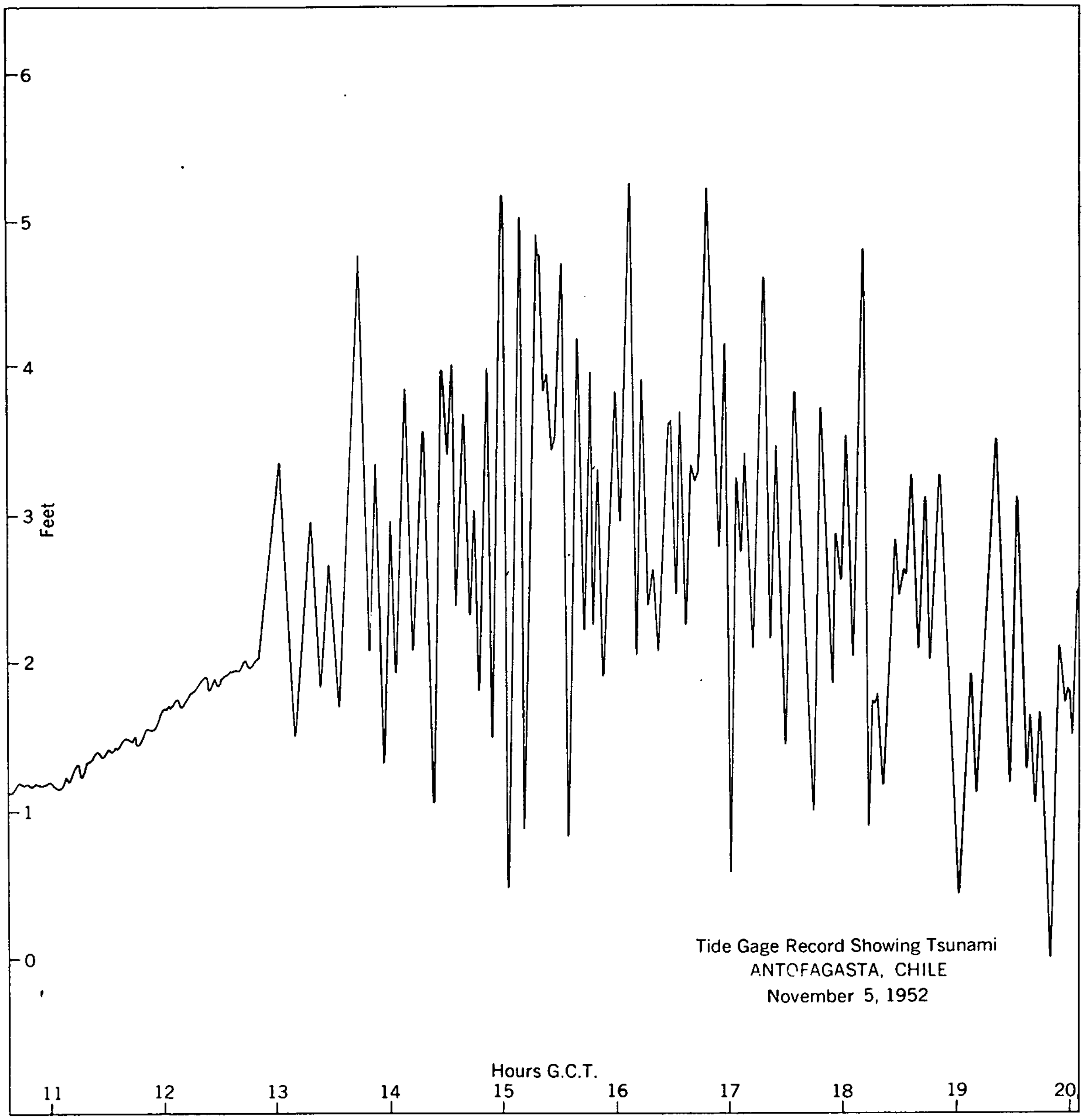


Tide Gage Record Showing Tsunami
ARICA, CHILE
November 5, 1952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Tide Gage Record Showing Tsunami
ANTOFAGASTA, CHILE
November 5, 1952
Hours G.C.T.
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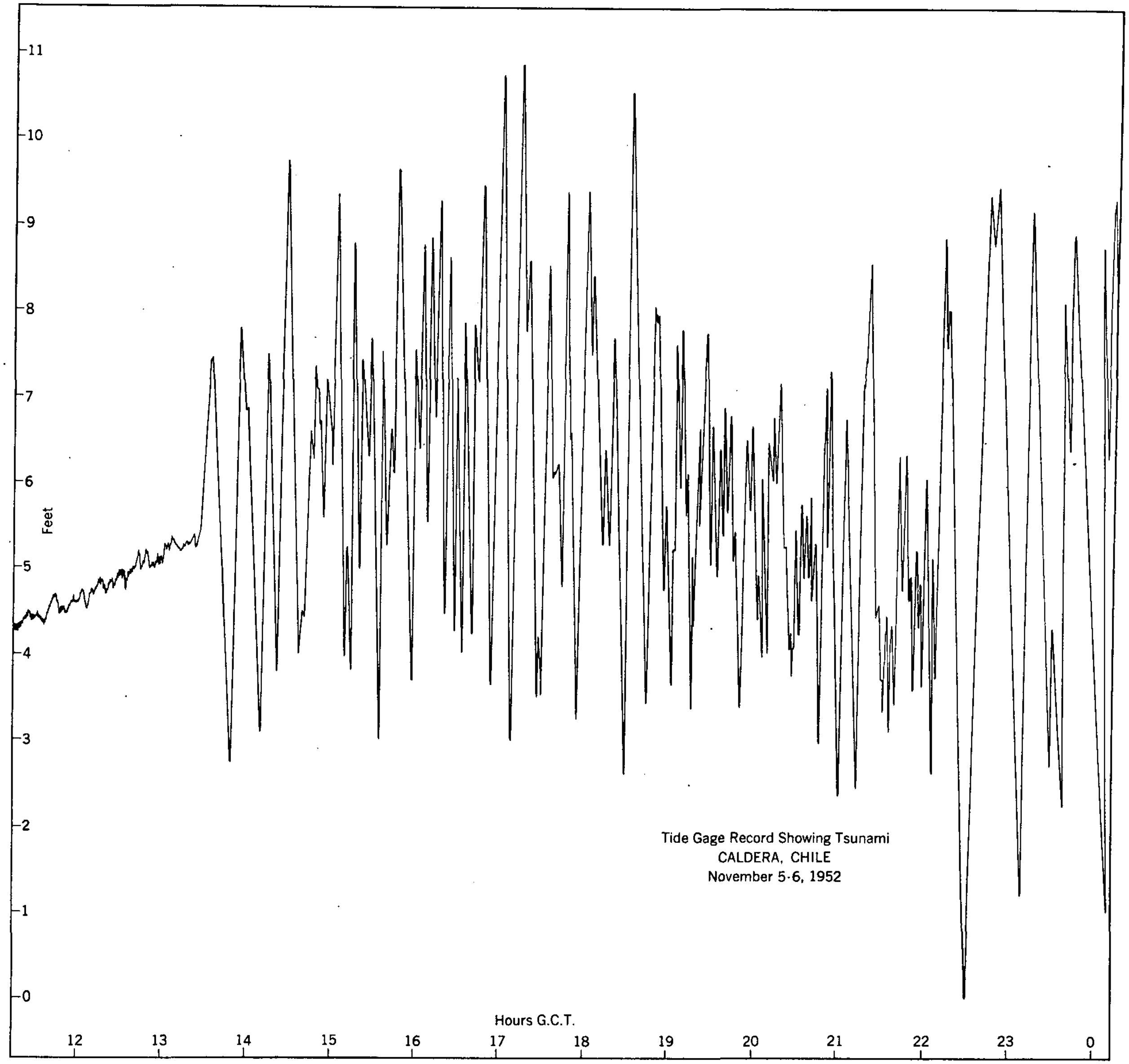
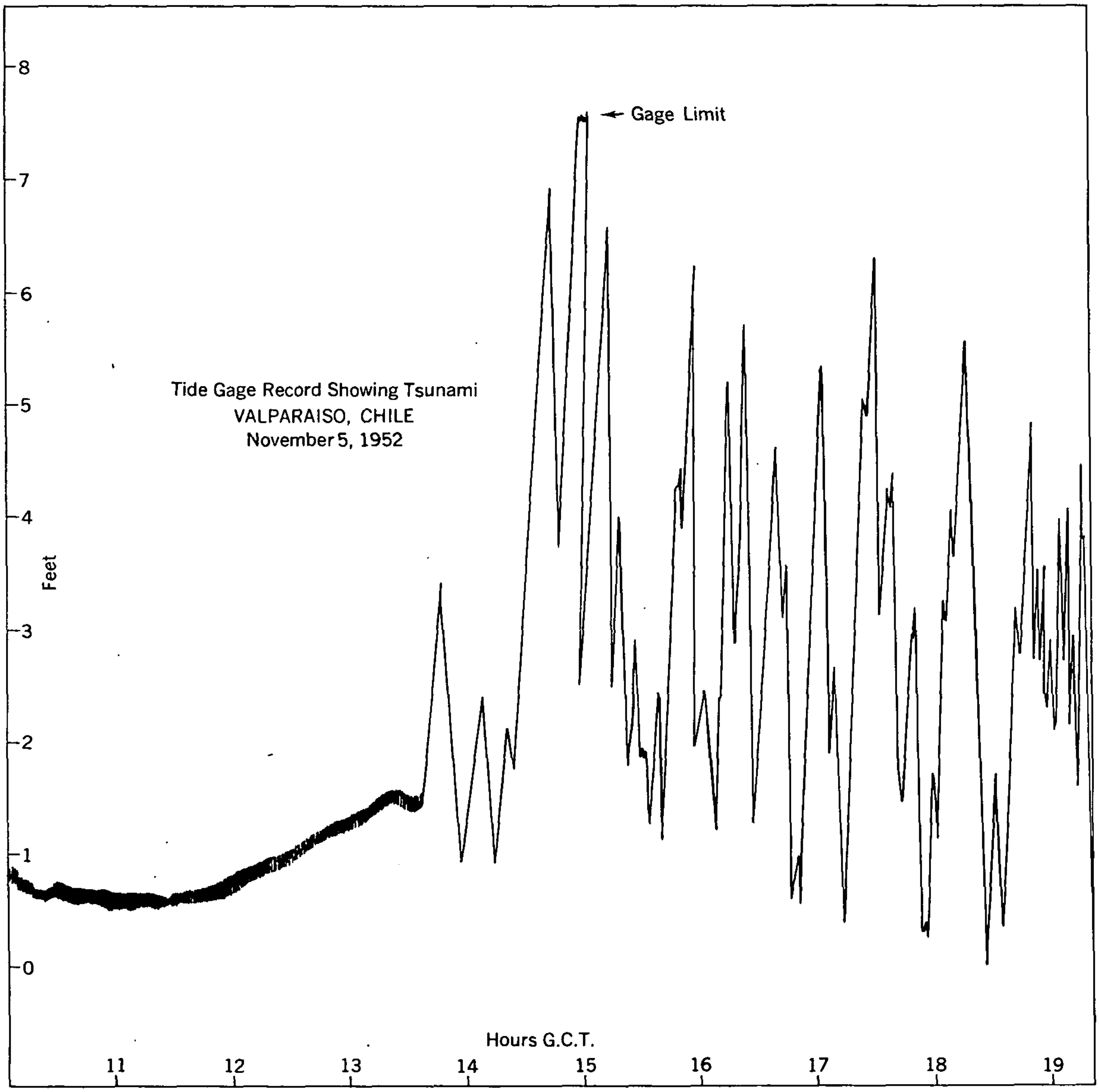


Tide Gage Record Showing Tsunami
CALDERA, CHILE
November 5-6, 1952



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Feet
Gage Limit
Tide Gage Record Showing Tsunami
VALPARAISO, CHILE
November 5, 1952
Hours G.C.T.
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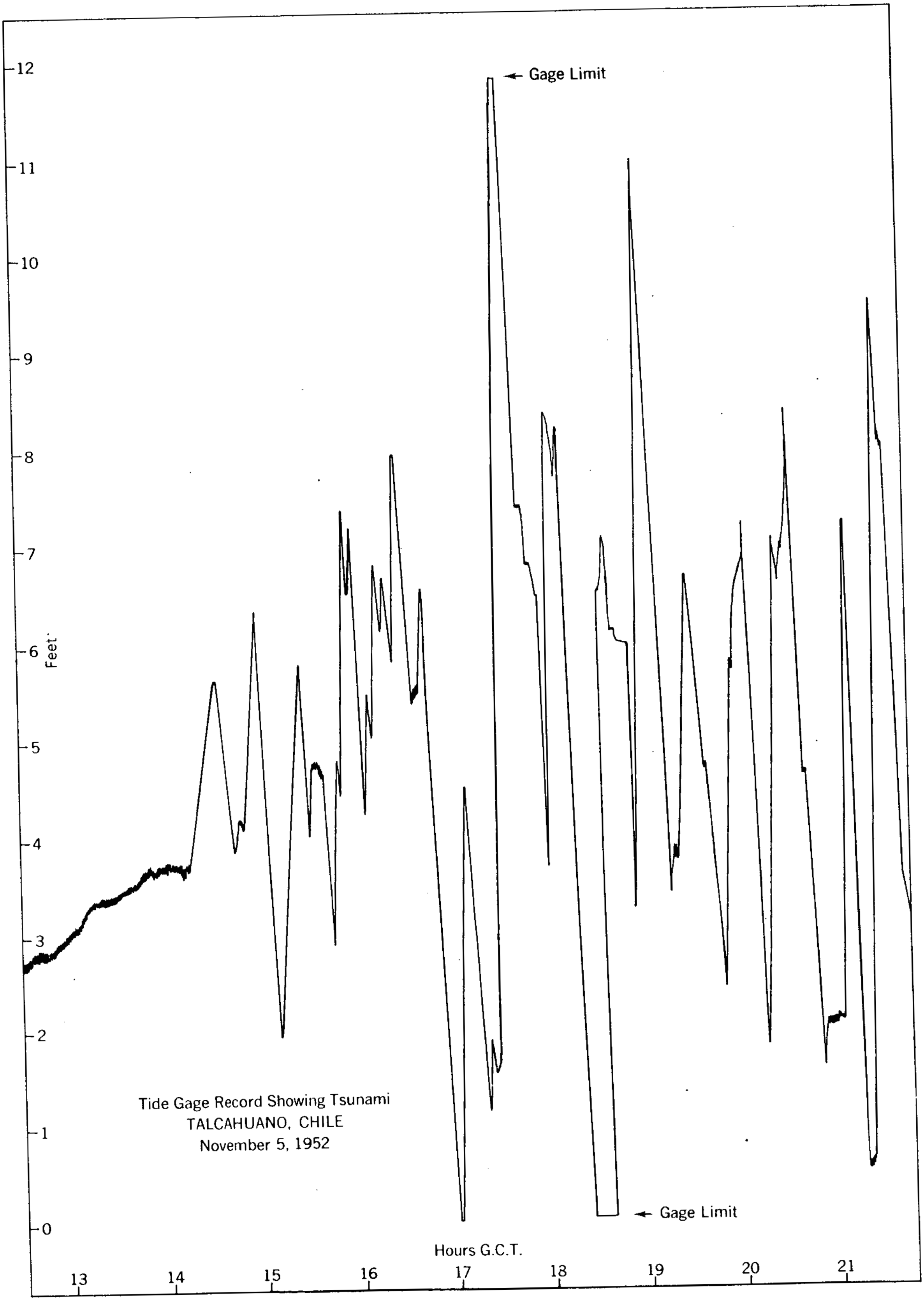

Tide Gage Record Showing Tsunami
TALCAHUANO, CHILE
November 5, 1952

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