

THE TSUNAMI OF NOVEMBER 29, 1975 IN HAWAII

By

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DECEMBER 1975

HAWAII INSTITUTE OF GEOPHYSICS
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and

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HAWAII INSTITUTE OF GEOPHYSICS
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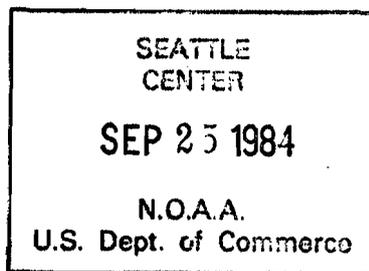
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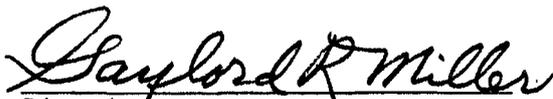
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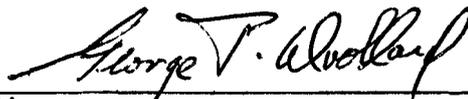
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ABSTRACT

*Wave runup heights for the tsunami of
November 29, 1975 are reported for locations
on the Island of Hawaii.*

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1. Description

At 0448 Hawaii standard time on November 29, 1975, an earthquake of magnitude 7.2 on the Richter scale with epicenter at lat. $19^{\circ}20'$ N., long. $155^{\circ}01'45''$ W. generated a tsunami that did considerable damage in shoreline areas of the southern two-thirds of the Island of Hawaii (Fig. 1). The damage from the earthquake and tsunami combined was estimated by Hawaii County to be \$3-3/4 million; of that, about \$1-1/2 million damage could be ascribed to the tsunami alone. About a dozen dwellings were totally or partially destroyed, and a dozen boats were severely damaged.

The largest wave was 20 feet high and overran the shoreline just seconds after the earthquake at locations near the epicenter, which was 2-1/2 miles southwest of Kalapana or right at the shoreline at an unpopulated location called Kupaalu. In spite of the fact that the coastline was well populated with fishermen, campers, and surfers (it was the Saturday morning of Thanksgiving weekend), only two persons were killed. One of the victims was killed by a rockslide; because the body of the other has not been recovered, cause of death is unknown. These fatalities were from among a group of 36 campers at Halape in the Hawaii Volcanoes National Park. Most of the campers were caught

in the incoming wave but survived the ordeal and managed to scramble to higher ground.

The small number of fatalities was due mainly to two factors. The earthquake awakened everyone and many people were aware that a tsunami might occur. Also, the first wave was smaller than the second and was not breaking, so the initial flooding was a clear warning of other waves to come. The second wave, which followed in minutes and was the largest wave, formed a bore. There were five or six, or more, discernible waves.

Persons farther from the epicenter had more time to escape the tsunami.

I talked to about two dozen people who "witnessed" the tsunami, insofar as one can see at 5 a.m. with a clear sky and the light from a sliver of waning moon. The sea was relatively calm and the tide was about midtide on the ebb. Along the coast near the epicenter the sea appeared to be agitated or choppy. Initial high water was observed immediately after the earthquake. At Kalapana this initial rise of water was about 3 feet and at Halape, 6 feet or more. I attribute this to the subsidence of the ground as well as to the short period waves caused by the earth's shaking. The longer period waves (i.e., 2 to 3 minutes crest-to-crest) followed at times that were appropriate to the distance from the area of generation.

Several people reported that their first indication of a tsunami was a severe recession of the water accompanied by an absence of normal wave noise and a rushing sound like that of the wind. I believe this was the sound of water draining out of rock crevices

after the ocean had receded. At Hilo, the recession was reported by two observers aboard boats in Radio Bay to be -5 feet, followed by a rise in water to +3 feet above the normal level. Many people heard a rumbling noise as a large number of stones were moved about by the rushing water and deposited throughout the inundation area. Also, the stones carried by the water scarred trees and undoubtedly added to the damaging force of the water.

This tsunami was similar to, but smaller than, that of 1868 when waves of 60 feet occurred and was of the type that represents a particular danger to Hawaii since it is not possible to give advance warning to persons near the source of the wave.

On Sunday, November 30, I began a careful survey of the affected coast, measuring the elevation of high-water marks with a level and staff, beginning at Hilo and working around the southern part of the island to Kawaihae (Fig. 2). In addition, I took photographs and talked to everyone I could locate who had firsthand experience of the tsunami. This work took five days and established the importance of *actual* measurements, since guesses of observers and even my own estimates of wave heights proved upon measurement to be very wrong at times.

The measurements were always taken to sea level and were then corrected for the tide, so that wave heights at the time of the tsunami are reported here. In some cases the elevation was found from a topographic map by identifying limits of inundation. This method was used at Punaluu, where the contractor's elevation maps were used; at

Kamoamoia campground¹ in the National Park, where the cliffs were too high to allow me to get down to sea level; and at the painted church at Kalapana, where the distance from the high-water mark to the water's edge was rather great and the elevation could be taken more accurately from a map. At Kaimu Beach, Kalapana, Kamoamoia, and Halape there is a problem in that it is not certain whether the wave hit before or after the subsidence of the land. I am reporting high-water marks at elevations above sea level as they existed on the date taken. I believe that for the most part the land subsided at the time of the earthquake and the reported wave heights are accurate.

2. Runup Measurements

All wave heights are corrected to actual wave height at the time of the tsunami. The information is presented in Tables 1-6 and with reference to figures. Figure 2 shows what was measured. Figure 1 and Figures 3-5 show locations of measurements. Tide gage records from Hilo, Honolulu, Kahului, and Nawiliwili are shown in Figures 6 and 7.

3. Qualitative Impressions

I talked with dozens of eyewitnesses, most of whom reported that the second wave was about one-third larger than the first. In Hilo and on the Kona coast a big draw-down was reported; some reported that it was the first thing noticed and others reported a big recession

¹The *Hawaii Natural History Association Guide 1* notes that the Kamoamoia campground was the site of an ancient village that was destroyed by the 1868 tsunami.

between first and second waves. Successive crests were reported as being 2-3 minutes apart. Campers at Halape reported wave after wave in quick succession at 10-15 second intervals, each larger than the preceding.

Many people were kind enough to help with measurements, including Charles Garcia, Masaichi Iyo, and Henry A. Keliikoa. I interviewed the following eyewitnesses: From Hilo: Steven Hammeken, U.S. Coast Guard; Mr. and Mrs. Roger Anderson, sailboat *Valkyrie*; Mr. Morales, sampan fisherman; Bob Lee and Cliff Collins, pilots who flew over the coast immediately after the tsunami; Charles Garcia, tsunami observer; Mr. Thibadeau, Hilo Terminal and Transit Company.

From Kapoho: Bernard Mendonca; Mr. Gibson. From Kalapana: the duty ranger and the tide gage technician; Steve Garcia, surfer. From Punaluu: Joe Wood, contractor; Ed Crook, Jim Reed, and Doug Evans, C. Brewer Co.; Ernest Kalani, camper; "Honey Chile," resident; Mr. Cachaloe, resident; some fishermen at South Point; Tad Hashimoto, who was at Kaalualu. From Halape: Brad Jones, Keith Stratton, and Beverly Wellman, campers.

From Milolii: Mr. Kaupiko, resident; two other groups of residents who were at their boats during the tsunami. From Napoopoo: Bill Hodgens, resident; Mrs. Kahele, resident; two other residents. From Keauhou Bay: Bill Cuccaro, dive shop owner; Burt Lang, sailboat *The Est.* From Kailua-Kona: harbormaster and one boat captain. From Honokohau: Captain Parker, skipper; two other boat owners. From Kawaihae: Curt Shoemaker, boat owner. From the Volcano Observatory: Dr. Robert Tilling.

I also talked to numerous others, and occasionally requested strangers to hold a staff for measurements. Cliff Collins of Hilo was pilot for a visual and photographic aerial survey of the coastline. I thank them all, and especially Louise Lembeck, who assisted with this report.

Table 1. Wave runup heights at Hilo

Location	Symbol ¹	Measurement		Approximate distance from water's edge	Runup measurement		Correction		Evidence
		Date	Time		Yards	Feet	Feet	Feet	
Light at Wailuku River	a	11/30	1720	10	9.1	-0.6	8.5	Debris on ground	
Start of guard rail at intersection	b	11/30	1713	10	8.8	-0.6	8.2	Do.	
At canoe clubs	c	11/30	1635	20	7.9	-0.4	7.5	Do.	
100 yards east of symbol c	d	11/30	1640	20	7.9	-0.4	7.5	Do.	
Left bank entrance to Wailoa River	e	11/30	1705	20	8.8	-0.4	8.4	Do.	
Inside entrance, above parking lot	f	11/30	1655	20	8.3	-0.5	7.8	Do.	
At telephone stand, dock area, same level along docks	g	11/30	1615	5	5.5	-0.4	5.1	Silt on cement base of telephone stand	
Marine railway by Suisan	h	12/1	0950	15	7.7	-0.7	7.0	Debris on tree	
Rock wall toward river, inside at Suisan	i	12/1	1000	5	5.8	-0.7	5.1	Debris in rock wall	
Rock wall by Liliuokalani Garden	j	12/1	0930	10	5.1	-0.8	4.3	Debris	
To left of road leading to Coconut I.	k	12/1	1710	30	4.6	+0.2	4.8	Debris, log	
Coconut I. bridge	l	12/1	1735	40	5.0	0	5.0	Debris, seaweed	
Seaward side of comfort station	m	12/1	0740	8	7.4	0	7.4	Seaweed in trees	
Seaward right side of Coconut I.	n	12/1	0745	10	6.6	0	6.6	Debris on grass	
Water just tops wall	o	12/1	0750	1	6.1	0	6.1	Debris	
Right of road to Coconut I.	p	12/1	0725	20	5.5	0	5.5	Debris, seaweed	
Front of Hilo Lagoon Hotel	q	12/1	0630	5	4.1	+0.4	4.5	Debris	

Table 1. Wave runup heights at Hilo (cont'd.)

Location	Symbol ¹	Measurement		Approximate distance from water's edge	Runup measurement		Correction		Corrected measurement		Evidence
		Date	Time		Yards	Feet	Feet	Feet	Feet	Feet	
Front of Hilo Lagoon Hotel	r	12/1	0815	5	4.3	0	4.3	0	4.3	Debris	
Front of Hilo Lagoon Hotel	s	12/1	0815	5	4.3	0	4.3	0	4.3	Do.	
Naniloa Hotel	t	12/1	0832	5	4.0	-0.3	3.7	-0.3	3.7	Do.	
Naniloa Hotel	u	12/1	0845	5	4.7	-0.4	4.3	-0.4	4.3	Do.	
Naniloa Hotel	v	12/1	0850	5	2.8	-0.4	2.4	-0.4	2.4	Do.	
Reeds Bay, by road	w	12/1	0910	10	4.3	-0.7	3.6	-0.7	3.6	Do.	
West of pier 2, 50 yards	x	12/1	1120	5	3.6	-1.2	2.4	-1.2	2.4	Do.	
Radio Bay at Coast Guard Cutter	y	11/30	1343	0	3.5	-0.4	3.1	-0.4	3.1	Testimony followed by measurements. "Boats bottomed during wave."	
East end of Radio Bay	z	11/30	1400	10	3.3	-0.4	2.9	-0.4	2.9	Debris on grass. Pine needle swash marks.	
Just outside breakwater	aa	11/30	1415	10	6.9	-0.4	6.5	-0.4	6.5	Do.	
Outside breakwater, 100 yards east	bb	11/30	1430	10	6.7	-0.4	6.3	-0.4	6.3	Do.	
Outside breakwater, 200 yards east	cc	11/30	1435	10	6.8	-0.4	6.4	-0.4	6.4	Do.	
James Kealoha Park	dd	11/30	1352	5	4.7	-0.4	4.3	-0.4	4.3	Bagasse, flattened grass	
Leleiwi Park	ee	11/30	1530	20	5.5	-0.4	5.1	-0.4	5.1	Swash in pine needles	
End of road, 4 miles	ff	11/30	1520	30	6.0	-0.4	5.6	-0.4	5.6	Do.	

¹ Symbol notations correspond to those on Figure 3.

Table 2. Wave runup heights along Puna coast

Location	Measurement		Approximate distance from water's edge		Runup measurement		Correction		Corrected measurement		Evidence
	Date	Time	Yards	Feet	Feet	Feet	Feet	Feet	Feet		
Cape Kumukahi 300 yards southwest of light	12/1	1255	10	11.5	-0.5	11.0				Swash marks on sand beach	
Isaac Hale County Park behind launch ramp	12/1	1340	50	7.0	-0.4	6.6				Debris on grass	
1 mile south McKenzie County Park	12/1	1403	10	12.0	-0.4	11.6				Swash marks in pine needles	
Kaimu Beach, northeast end	12/1	1445	10	12.5	-0.4	12.1				Marks in trees	
Kaimu Beach, northeast end	12/1	1445	30	12.5	-0.4	12.1				Mud across road	
Kaimu Beach, 100 yards from south-west end	12/1	1500	50	9.0	-0.4	8.6				Debris	
Kaimu Beach, 50 yards from south-west end	12/1	1500	20	8.0	-0.4	7.6				Swash in sand	
Kalapana, painted church and canoe landing, water to road	12/1	1800	100	¹ -	-	17.0				Debris in grass	
Kamoamo Campground	12/1	1600	70	¹ -	-	20.0				Debris and stones on grass along length of reconstructed ruins	

¹ From map.

Table 3. Wave runup heights on Kau coast from Hawaii Volcanoes National Park to South Point

Location	Measurement		Approximate distance from water's edge	Runup measurement		Correction		Corrected measurement		Evidence
	Date	Time		Yards	Feet	Feet	Feet	Feet	Feet	
Keauhou Landing, Hawaii Volcanoes National Park								+20 and under	Measured by observers from U.S. Geological Survey Volcano Observatory	
Halape, Hawaii Volcanoes National Park								¹ +20-26	Do.	
Punaluu ²	12/2	0930						³ +18	Seven houses destroyed, debris line all around cove, restaurant severely damaged, many high watermarks, County pavilion damaged, 2 cars destroyed, lei stand destroyed, 2 small pavilions destroyed. Water came to seaward corner of golf shop.	
Honuapo	12/2	1145	30	22.5	-0.9	21.6			All County buildings, pavilions, showers in park destroyed; house destroyed, moved 40 yards; corrugated shed destroyed.	
Honuapo	12/2	1145	30	22.5	-0.9	21.6			Debris beyond wharf.	
Honuapo	12/2	1200	50	20.0	-0.9	19.1			Debris on cliff behind shower.	
Kaalualu ⁴	12/3	0800-1200	-	-	-	16.0			Debris all around cove.	

Table 3. Wave runup heights on Kau coast from Hawaii Volcanoes National Park to South Point (cont'd.)

Location	Measurement		Approximate distance from water's edge	Runup measurement		Corrected measurement	Evidence
	Date	Time		Yards	Feet		
East 100 yards of South Point light and range marker	12/2	1315	40	-	-	14.0	Debris and stones on grass
East of light 500 yards	12/2	1320	40	-	-	16.5	Debris and log
East of light 550 yards	12/2	1330	40	-	-	16.5	Debris
East of light 600 yards	12/2	1340	70	-	-	17.0	Do.
East of light 700 yards	12/2	1345	50	-	-	16.0	Do.
Northeast 1 mile of light at launching ramp	12/2	1445	70	-	-	16.5	Debris, logs
Northeast 50 yards of launching ramp	12/2	1500	60	-	-	18.5	Debris
Northeast 50 yards of launching ramp	12/2	1500	200	-	-	20.0 estimated	Debris and 3 foot log
Northeast 400 yards of fishing camp, two coves up the coast	12/2	1440	130	-	-	18.5	Logs, debris

¹Along pali at Halape it was estimated by Volcano Observatory people that water splashed up to about 30 feet.
²See Figure 4.

³Wave height taken from contractor's elevation plan. Almost uniformly 18-foot contour. Marks on pavilion near water's edge were 18 feet also.

⁴See Table 4 and Figure 5.

Table 4. Details of Kaalualu cove on southwest Kau coast

Location	Symbol ¹	Measurement		Approximate distance from water's edge	Runup measurement		Correction		Corrected measurement		Evidence
		Date	Time		Yards	Feet	Feet	Feet	Feet	Feet	
Kaalualu	a	12/3	0950	80	15.0	-0.6	14.4	Debris			
Kaalualu	b	12/3	0940	50	14.3	-0.5	13.8	Keawe tree marks			
Kaalualu	c	12/3	0935	40	16.4	-0.4	16.0	Do.			
Kaalualu	d	12/3	0930	20	14.8	-0.4	14.4	Do.			
Kaalualu	e	12/3	0932	10	14.9	-0.4	14.5	Do.			
Kaalualu	f	12/3	1002	2	12.0	-0.6	11.4	Do.			
Kaalualu	g	12/3	1010	5	13.2	-0.6	12.6	Do.			
Kaalualu	h	12/3	1018	5	13.5	-0.7	12.8	Do. (near wrecked boat)			
Kaalualu	i	12/3	1027	5	9.8	-0.8	9.0	Keawe tree marks			
Kaalualu	j	12/3	1036	40	11.8	-0.8	11.0	Do.			
Kaalualu	k	12/3	1146	60	11.1	-0.9	10.2	Do.			
Kaalualu	l	-	-	200				Stone wall knocked down			
Kaalualu	m	12/3	1125	5	15.2	-0.8	14.4	Keawe tree marks			
Kaalualu	n	12/3	1133	80	16.0	-11.0	15.0	Debris on grass			

¹ Symbol notations correspond to those on Figure 5.

Table 5. Wave runoff heights on Kona coast from South Point to Kawaihae

Location	Measurement		Approximate distance from water's edge	Runup measurement		Correction	Corrected measurement		Evidence
	Date	Time		Yards	Feet		Feet	Feet	
Milolii ¹									
Hookena, 100 yards to right of pavilion	12/3	1355	30	6.7	-0.6	6.1	6.1	Debris in grass	
Hookena, 50 yards to left of pavilion	12/3	1400	20	5.8	-0.6	5.2	5.2	High-water marks on sand beach	
Napoopoo, 50 yards south of wharf at Kahele home	12/3	1700	20	11.5	-0.3	11.2	11.2	Debris on grass, and testimony	
Napoopoo at old wharf	12/3	1715	10	12.6	-0.3	12.3	12.3	Debris on grass and in bushes	
Napoopoo, 200 yards south of pier on point	12/3	1745	20	11.5	-0.3	11.2	11.2	Shed carried 50 yards seaward. Two canoes destroyed. Marks in tree.	
Keauhou Bay ⁴	12/4	0930	-	9.2	+0.4	9.6	9.6	Debris, watermarks	
Kahaluu Beach Park to left of pavilion	12/4	1040	10	7.5	-0.5	7.0	7.0	Debris on grass	
Kahaluu Beach Park to right of pavilion	12/4	1050	25	9.8	-0.5	9.3	9.3	Debris and swash marks in sand	
1 mile north of n at 4-mile marker	12/4	1103	10	6.5	-0.5	6.0	6.0	Debris	
Kailua, Kona; parking lot of boat harbor	12/4	1125	10	6.5	-0.5	6.0	6.0	Sand on parking lot, testimony of harbormaster.	

Table 5. Wave runup heights on Kona coast from South Point to Kawaihae (cont'd.)

Location	Measurement		Approximate distance from water's edge		Runup measurement		Correction		Corrected measurement		Evidence
	Date	Time	Yards	Feet	Feet	Feet	Feet	Feet	Feet	Feet	
Honokohau Boat Harbor at launching ramp	12/4	1212	5	8.0	-0.8	7.2	Debris on rocks				
Honokohau Boat Harbor near harbor-master shed	12/4	1240	1	6.2	-0.8	5.4	Debris				
Fishing shacks just north of Honokohau ⁵	12/4	1235	10	4.0	-0.8	3.2	Swash marks in sand				
Anaehoomalu	12/4	1325	7	4.5	-0.7	3.8	Marks in sand				
Kawaihae, launching ramp ⁶	12/4	1430	5	(-3.5 withdrawal)		2.5	High-water mark				

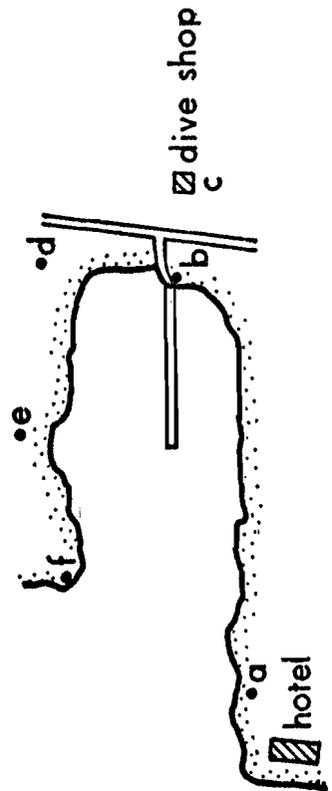
¹ Three different groups of fishermen who were at their canoes at expected arrival time report no wave.
² Steep bank.
³ Residents saw ocean floor between first and second wave. Water fell at least -6.5 feet.
⁴ See Table 6.
⁵ Two residents here reported nothing, then said it was like a high tide.
⁶ No high-water marks could be found on coral flat 5 feet above sea level.

Table 6. Detail runup at Keauhou Bay, Kona.

Location	Symbol ¹	Measurement		Approximate distance from water's edge		Correction		Evidence	
		Date	Time	Yards	Feet	Feet	Feet	Yards	Feet
Kona Surf Hotel, 50 yards inside south point of cove	a	12/4	1012	30	8.5	-0.2	8.3	Debris on grass	
Telephone pole at left side of parking lot	b	12/4	0910	3	7.8	+0.3	8.1	Paint marks high water on pole	
Dive shop and behind	c	12/4	0850	30	8.0	+0.4	8.4	Debris, high-water marks on building	
To right of cove, canoe storage behind wall	d	12/4	0930	50	9.2	+0.4	9.6	Debris	
Empty lot right side of cave	e	12/4	0930	30	8.6	+0.4	9.0	Do.	
North point of cove near Doc Hill's old house	f	12/4	0942	10	9.0	0	9.0	Debris on grass	

¹Symbol notations correspond to the sketch below.

Note: Boat at pier bottomed between first and second wave. One 20-foot boat was deposited on parking lot. A 36-40 foot boat was sunk. Other boats sustained minor damage.



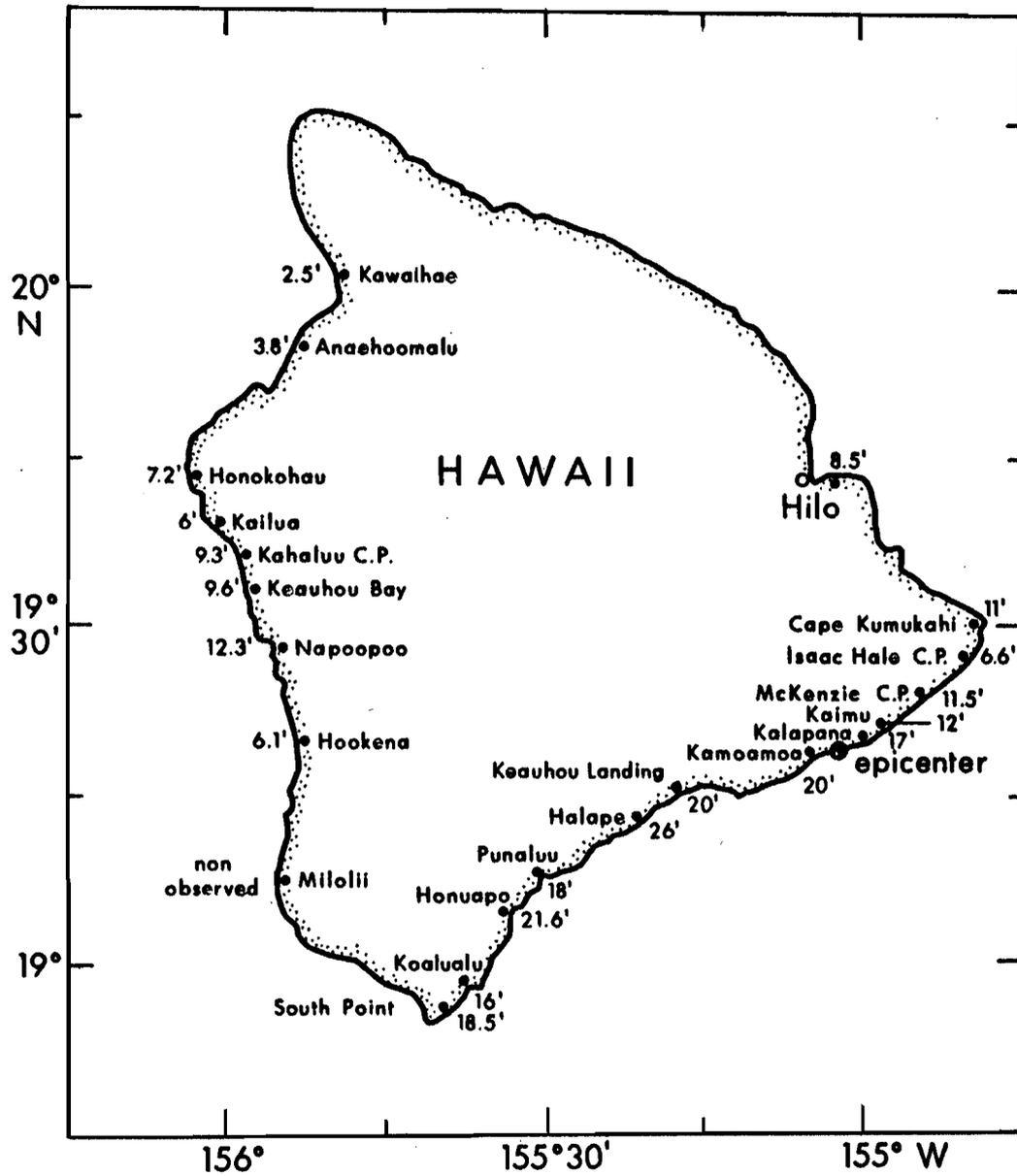


Figure 1. Maximum measured wave heights on the Island of Hawaii.

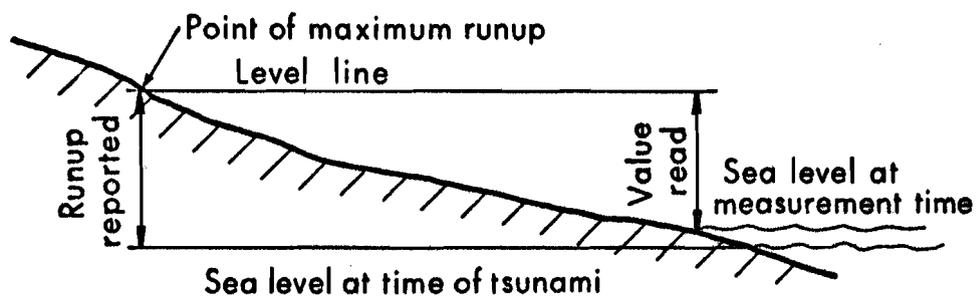


Figure 2. Diagram of runup measurement.

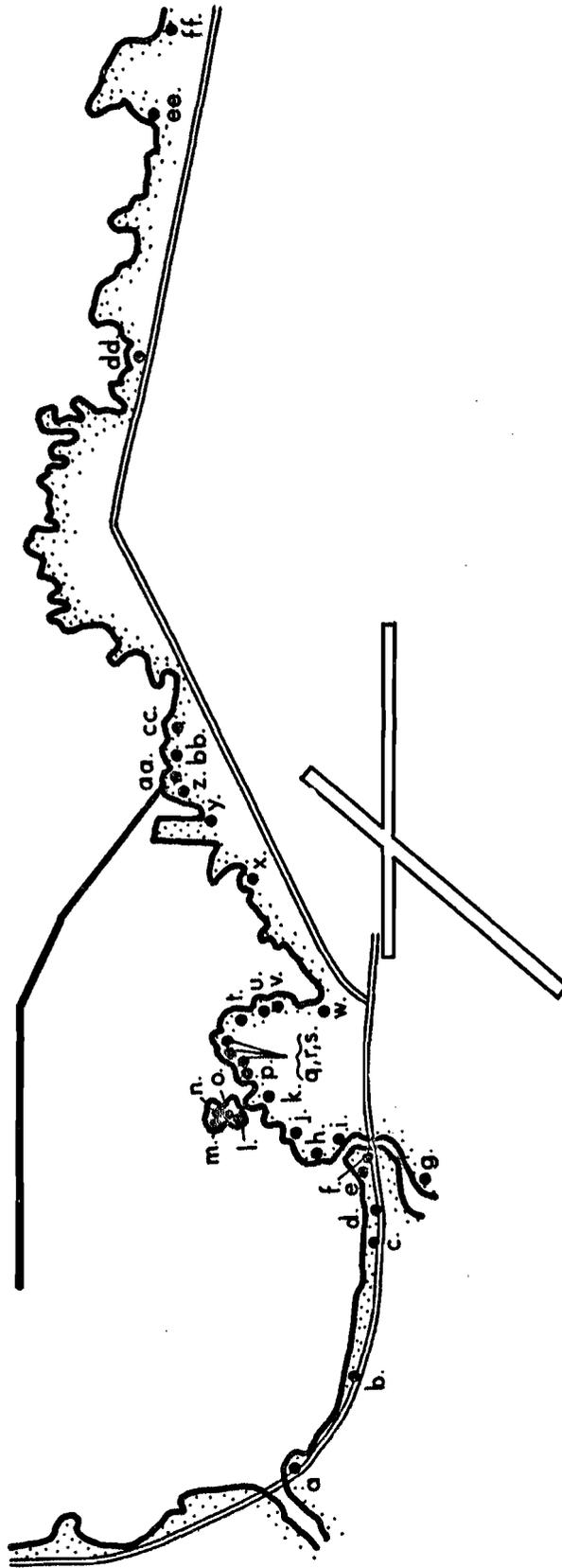
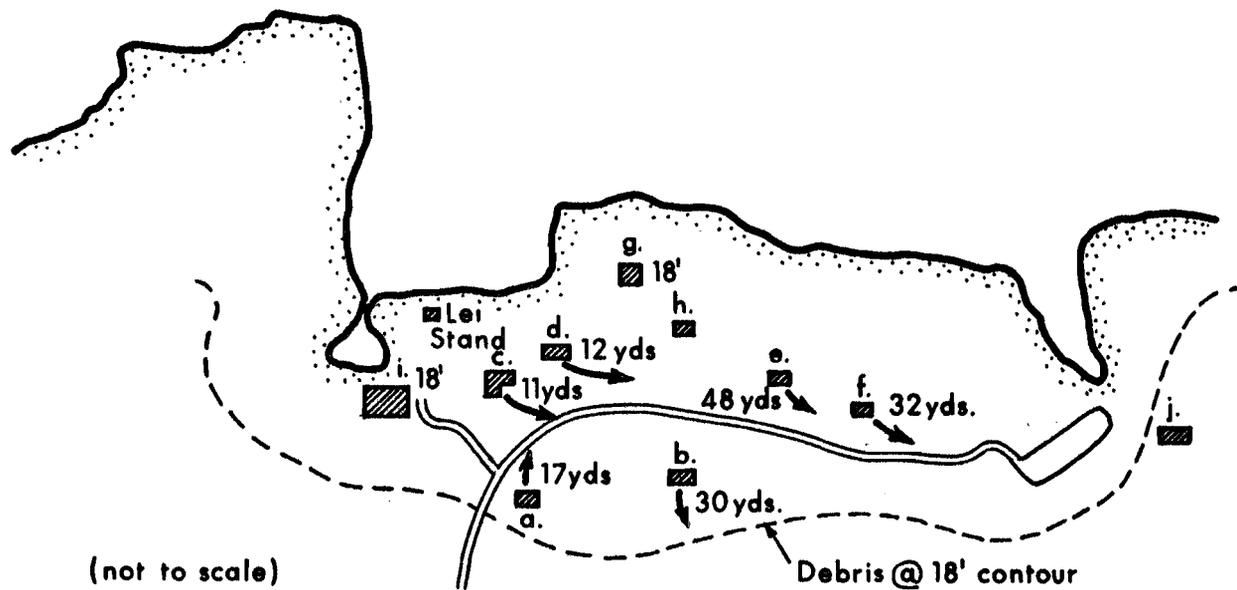


Figure 3. Location of measurements at Hilo; some symbols refer to Table 1.



Legend:

- a. Ito house destroyed, moved 17 yards toward sea.
- b. House nearly intact, moved 30 yards inland.
- c. Dahlberg house, mostly destroyed, rotated 90° clockwise, moved 11 yards to right then seaward 5 yards.
- d. Carmichel A-frame house destroyed, moved 12 yards to right.
- e. Mizuno house shattered, moved 48 yards,
- f. Cacholoa house shattered, moved 32 yards.
- g. Pavilion fence down and roof lifted.
- h. Small tile buildings destroyed.
- i. C. Brewer restaurant gutted.
- j. Golf house basement filled, golf carts flooded.

Figure 4. Punaluu, Kau, Hawaii showing houses destroyed.

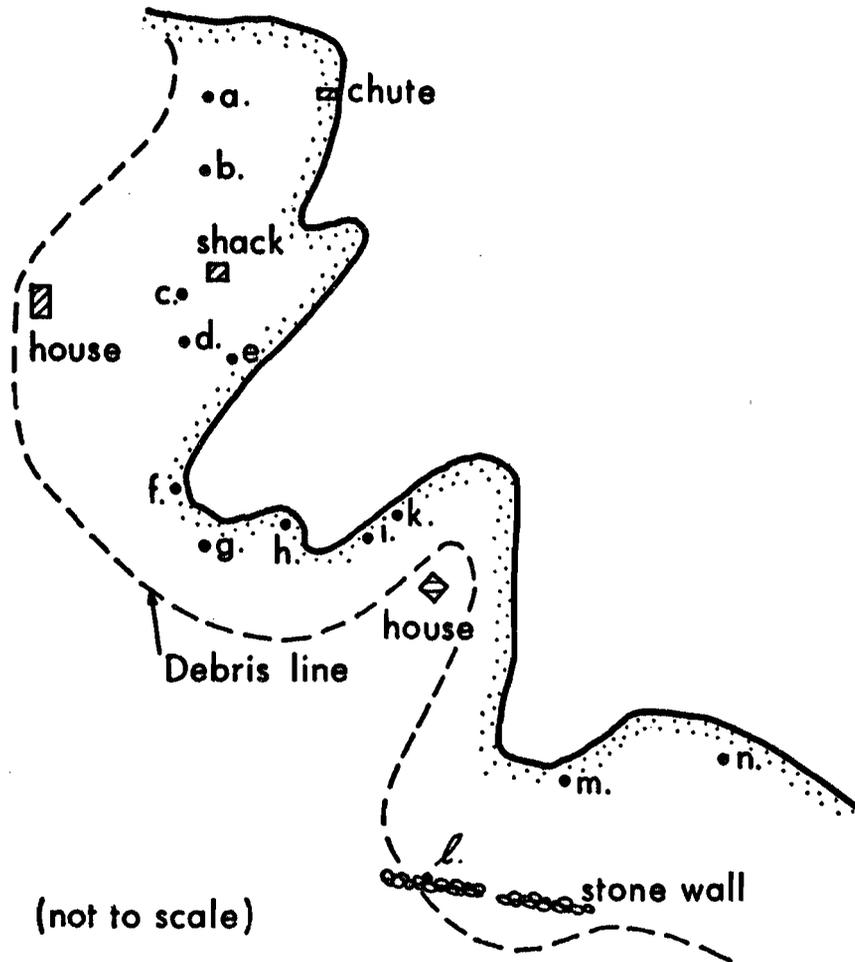
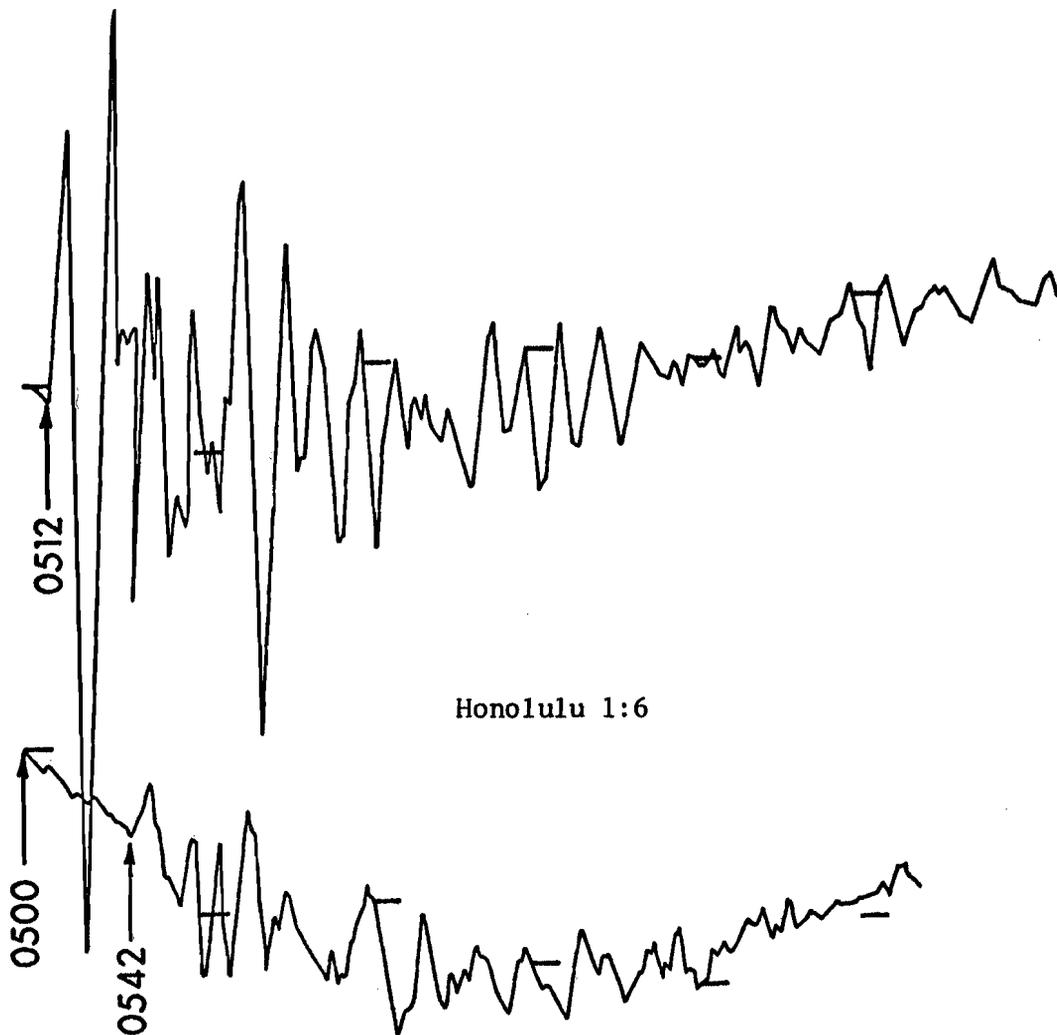


Figure 5. Kaalualu, Kau, Hawaii showing locations of measurements.

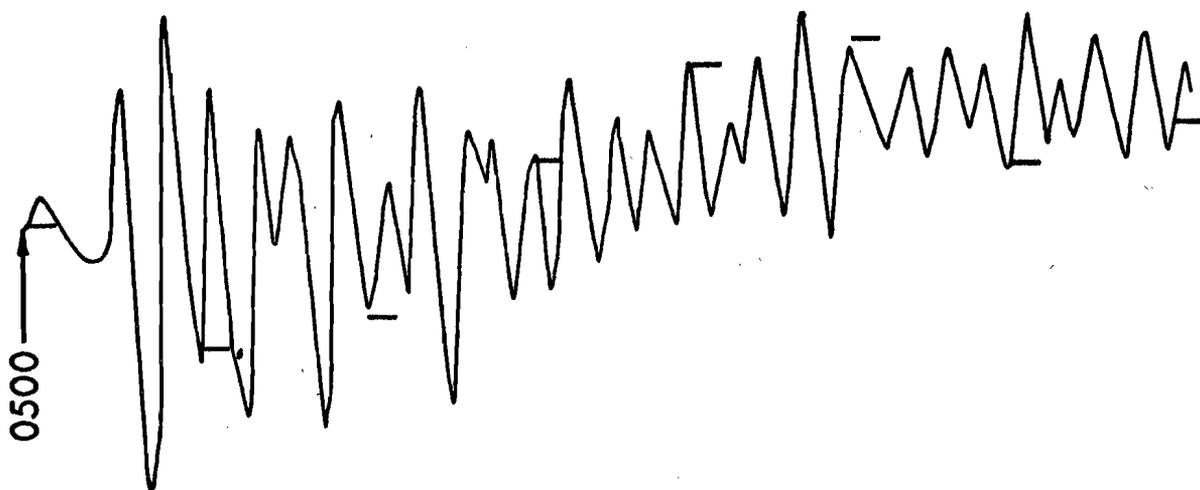
Hilo 1:12



Honolulu 1:6

Figure 6. Tide records of November 29, 1975 at Hilo and Honolulu.
(Horizontal bars are hour marks.)

Kahului 1:12



Nawiliwili 1:6

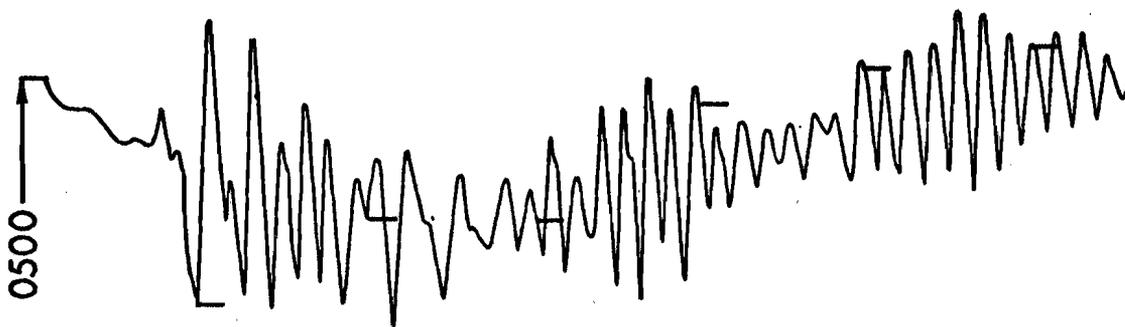


Figure 7. Tide records of November 29, 1975 at Kahului and Nawiliwili.