



# TSUNAMI REPORTS

No 1977-12



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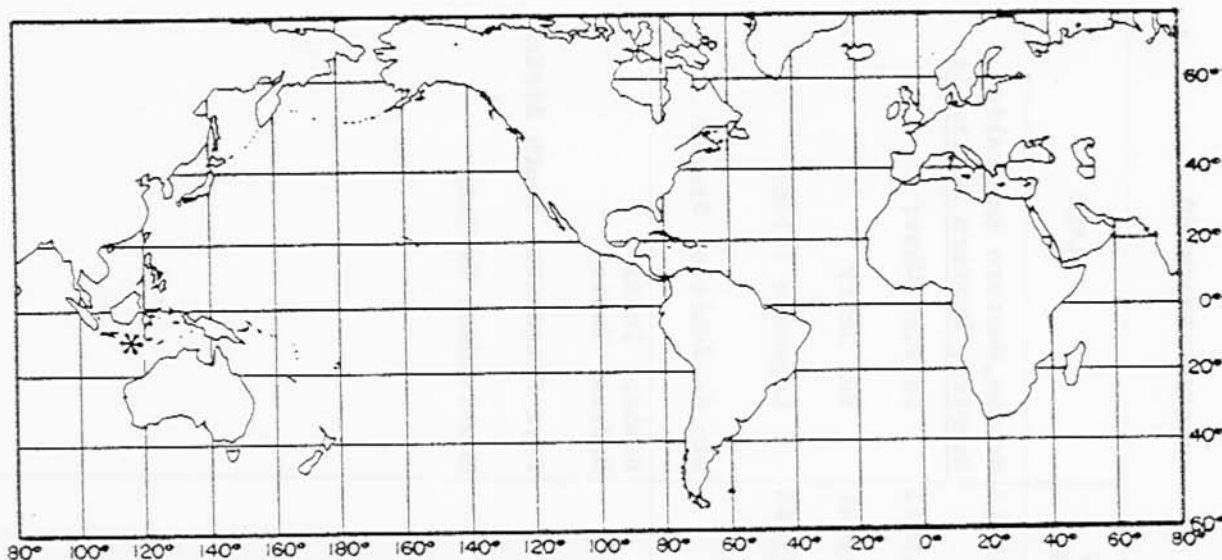
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## SUMMARY OF EVENT

Tsunami generated which caused many deaths in Indonesia and was experienced on the coast of Western Australia.

## EARTHQUAKE DATA

ORIGIN DATE (UT): August 19, 1977  
TIME (UT): 0609  
POSITION: Latitude: 10.5 S  
Longitude: 118.8 E  
REGION: Lesser Sunda Islands, Indonesia  
MAGNITUDE: 7.7  
FOCAL DEPTH (KM): 33 +



DATE OF ISSUE APRIL 1978

\*EARTHQUAKE EPICENTER

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From "The Establishment of a Tsunami Working Group in Indonesia" - an information paper presented at the 6th session of ICG/ITSU, Manila, Philippines, 20 - 26 February 1978. Paper was prepared by National Institute of Oceanography, Jalan Pasir Putih 1, Ancol Timur; P.O. Box 580/Dak; Jakarta Utara, Indonesia.

"The latest one (tsunami) occurred on August 19, 1977 which struck the south coast of the islands of Lombok and Sumbawa in the Lesser Sunda Islands. Almost 150 people have died or are missing, more than 1,000 people suffered and losses amounted up to one million dollars including houses, boats and fishing gear"

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Report by Captain J.D. Holden MRIN M(US) NAV.INST. F.R.M.S. , Pilbara Harbour Services Pty Ltd., P.O. Box 178, Dampier 6713, Western Australia

N.B. All times reported in Western Standard Time (Time meridian 120°E)

## Preceding Swell

At 1140 hours on Friday 19th August, the Harbourmaster, Captain D.W. Nielson observed from the service wharf, the beginning of a distant northerly swell of between 10 and 15 centimetres in height. Prior to this time there was no evidence of swell. The sea condition at the time was slight and little more than rippled by a westerly wind of 10 knots.

## Earth Temors

Earth temors were felt at Dampier at approximately 1420 hrs. They lasted for approximately 3-4 minutes.

## General Locality of Epicentre

At 1445 hours the public information service of the Bickerly Observatory advised earthquake activity of approximately 7.0 - 7.5 magnitude had occurred north of Australia in the general locality of the Indonesian Island of Bali; later estimated to be 300 km S.W. of Sumba Island.

An amended position based on other observations reported the epicentre to be in position 10.8°S 118.3°E and the time of the occurrence was given as 1408 and 51 seconds.

This position is 008°T, distance 598 nautical miles from Dampier.

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## Observations at Dampier

The first tsunami was observed at Dampier by Captain S. Roscoe, Master of the dredger "W.H. Resolution" at 1740 hours in the form of a pronounced wave travelling down Mermaid Sound. A second wave occurred at 1742 hours and a third and fourth wave in close proximity to each other at 1743 hours.

## Wave Height

Captain Roscoe in his report states the waves were observed to be travelling in perfectly straight lines heading 180°T. There were no broken "tops", the wave surface being perfectly smooth and ran from east to west across the harbour. Each wave was clearly defined by the dark shadow on the southern face. Estimated height of waves 6 - 8 feet, 1.83 - 2.44 metres. On sighting the waves the suction pipes were lifted and the ships head turned to the north. Vessel rode the waves easily and no damage was caused. Mr. F. Rothleitner, the dredging project manager, measured the waves against the service wharf structure and reported the maximum wave to be 8 feet, 2.44 metres from trough to crest; the wave had commenced to break.

## Speed of Travel

The first wave took 3 hours 31 minutes to reach Dampier, indicating it had travelled at a speed of 171 knots, 317 kilometres per hour.

## Effects at Dampier

No damage was reported at the wharf but a tug berthed at the service wharf broke mooring lines and a 165,000 DWT ore carrier nearly loaded, berthed at East Intercourse Island, ranged 40 feet, 12 metres controlled by her tension winches. Parker Point berth was empty as was the Dampier Salt berth.

## Tide Gauges

Two tide gauges are located at Dampier, one at the Service Wharf and the other at the tug jetty in the following respective positions:

Service Wharf:	Lat 20° 38' 21" S	Long 116° 43' 40" E
Tug Jetty:	Lat 20° 39' 50" S	Long 116° 41' 03" E

The latter gauge is within the sheltered and confined waters of Hampton Harbour whilst the Service Wharf is in an exposed position.

## Initial Surge

The service wharf gauge failed to record between the hours of approximately 1740 and 1745 for reasons unknown but probably due to the initial surge of water upsetting the instrument. The instrument was noted to have moved slightly.

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## Succeeding Surges

The recordings from both these gauges show no irregular movement in the water level before the first wave but pronounced surges for the three hours immediately after the event and hence at intervals through to and including the next high water.

Some surging effect is noted on the succeeding low and high waters on the 20th August 1977.

## Wave Rider Buoy

A wave rider buoy moored off Legendre Island in a water depth of 32 metres recorded the height of three distinct waves.

First wave: 1.0 metre in height  
Second wave: 0.5 metre in height  
Third wave: 0.5 metre in height

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From letter sent by Mr. K.R. Gammie, Acting Engineer & Construction Manager, Woodside Petroleum Development Pty. Ltd., Box D188, GPO, Perth, Western Australia 6001.

"We enclose a copy of a wave trace of August 19, 1977 for a position just north of Legendre Island, Western Australia. This trace shows three anomalous waves interpreted as tidal waves, resulting from an earthquake located approximately 300 km SW of Sumba Island, Indonesia.

The wave trace was obtained using a Datawell wave rider buoy, transmitting to a Datawell Warep receiver where the waves are recorded in analogue form on a moving strip chart. The technical specifications of the equipment are such that the wave measurement buoy responds to wave periods, large errors are introduced both in amplitude and phase.

Accordingly, the wave amplitudes shown on the trace are probable seriously in error. Because of the response characteristics of the wave measurement buoy, we are surprised that the instrument did actually record the event. We have visually examined the wave trace to 24 hours each side of the event and find no other anomalous waves.

The times of arrival of the event should be accurate. We believe the timing mechanism used on this instrument has a maximum error of plus or minus 30 seconds, as the time marks put on the chart by the operator are noted to the nearest minute. In addition, the paper feed speed controlled by the timing mechanism is checked each three months."



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## Preliminary Report on the Tsunami of August 19, 1977

by Sidney O. Wigen, and Dennis J. Sigrist

### BALI ISLAND

Kuta Beach: This beach faces westward, and is shielded by the southern peninsula of Bali. People with markets on the beach reported feeling the earthquake, but did not observe any unusual wave activity.

Ulu Watu: The coast rises in sheer cliffs from the water, and is inaccessible. Viewed from the top of the cliffs, there was no indication whether tsunami waves had reached this shore.

Nusa Dua: On the beach at the eastern extremity of the Bukit Badung Peninsula in a bay sheltered from the south by a rocky promontory, a beach cafe operator reported the first crest reached almost to the cafe, and this was the highest of 3 waves. Its maximum elevation was clearly visible in flotsam, and measured 2.8 meters above MSL. The tsunami did not reach the top of the beach, and no damage occurred. During the tsunami the water was reported to be very dirty. One kilometer south of the promontory, debris on a beach facing and exposed to the southeast showed the tsunami had crested over the top of the beach, and had run a few meters inland in a level area, before dissipating into the sand. Here the maximum elevation was 4.1 meters above MSL.

Benoa: This port serves the capital city of Denpasar, and shipping docks are located in a basin about 4 km x 6 km. The port entrance is about 1 km wide, with a maximum depth at low water of 5 meters. Because of the restricted entrance, normal tidal currents within Benoa Harbour are usually strong, and appear to be about 2 knots along the dock face. Port authorities reported that the tsunami caused the water level to rise and fall a maximum of 1.5 meters, and currents appeared to reach about 6 knots. Since Benoa has a tide range of about 2.5 meters no damage was done.

Sanur Beach: Mr. Wijaya, an employee of Bali Beach Hotel provided a specific account of the events of August 19. The earthquake had been felt for about 3 minutes, with motion in 2 directions, and was strong enough to crack some windows, and cause some guests to run out of the hotel.

An hour later, near low tide inside the lagoon in front of the hotel, he drove a jeep and trailer down the beach to load the hotel's motor boat. The sea started rising with suddenness and violence, but with no curling waves, and swept over the jeep and trailer. It rose almost to the top of the rock wall at the upper edge of the beach but did not overtop it. The wave receded, and was followed at intervals of about 5 minutes by two more large waves, and four more of diminishing size. Sailing boats with outriggers were picked up by the waves and smashed against the stone wall.

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Investigation showed no evidence of the tsunami overtopping the wall but several people who had seen the tsunami agreed closely on its maximum elevation. One observer reported that on the outgoing wave the water had receded until a wreck near the reef was fully exposed. Based on tide scale readings on the pier in front of the hotel, and a comparison with Benoa tide predictions, the maximum tsunami wave reached a level of + 2.5 meters, and the minimum - 2.3 meters.

Kusamba: This community fronts on Badung Strait. Residents reported no unusual sea disturbance, and did not feel the earthquake. The beach showed no evidence of tsunami waves.

## NUSA PENIDA

No tsunami investigation was conducted on this island. Southerly facing coasts are fronted by cliffs, and habitations are inland and on the northerly coasts.

## LOMBOK ISLAND

Ampenan: Two local observers reported that no unusual sea disturbances followed the earthquake. The beach area showed no evidence of a tsunami.

One of the observers reported that waves did come around the southwest peninsula of Lombok Island, and reached the coast at Paupau. There some people on the shore went down to take fish left by the receding waves, and one was drowned by incoming waves. He reported also that the south coast of the peninsula was hit by higher waves.

Kuta: This village is located at the head of a bay, and the homes are set back from the crest of the beach. The community is primarily engaged in agriculture and many of the homes are a considerable distance from the coast. Residents reported experiencing the earthquake for about 4 minutes. Some time after the quake 3 explosions or roars like thunder were heard. About 5 minutes after the explosions the water receded about 300 meters, and turned black. The following wave topped the beach by about 1 meter, and ran about 100 meters inland. One person was killed, and boats were damaged. The first incoming wave was the largest. Successive crests arrived at intervals of about 5-10 minutes, diminishing in size, and the fourth was small. Tsunami crest elevations were measured on the beach in front of Kuta and at points southward along the western boundary of the Bay. At the village the wave reached 4.3 above MSL.

At the southernmost point of inspection the maximum elevation was 5.5 meters above MSL. This position has little or no shelter against waves from the southeast whereas the village is somewhat sheltered, and has a reef in front.

Awang: This village, in a large bay on the south shore of Lombok Island, is primarily a fishing community. It may have received limited protection from the southeast, but it was severely struck by the tsunami. Most homes located behind the beach were destroyed, and preliminary report indicated 24 people were

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killed and 51 injured. Many boats with outriggers were damaged or reported missing.

Shortly after the earthquake, residents heard 3 explosions within seconds of each other, somewhat like the sound of bombs. The bay waters receded almost immediately following the earthquake, leaving an additional 200 meters of beach exposed. Many people went out on the beach. The wave followed in 3 to 5 minutes, cresting about 2 meters above the top of the beach. The water was reported to be very hot with a chemical odor and black in color. Trees were broken or uprooted, houses near the foreshore were destroyed, and fishing boats were smashed. The front columns on the mosque were destroyed, but the main core of the building withstood the waves. The tsunami left a clearly defined line on the walls of the mosque. Several homes on posts near the beach were not destroyed.

The tsunami reached a crest on the mosque, of 4.3 meters above MSL, and had an excursion inland of 200 meters beyond high water on the beach.

Access to Awang was by ferry from Batunampar, about 5 kilometers northward toward the head of the bay. This harbour was shielded by the outer point of the bay, and by extensive shallow water and reef areas; the maximum wave rose only about 0.6 meters above normal high tide, or about 2 meters above MSL. Here also the residents reported the water as hot.

South of Awang, many stones were torn off the point at Tg Bariendi, and many stones appeared after the tsunami in the shallow water off Batunampar.

Labuhanhadji: Reports for this village were given primarily by Mr. A. St. Tomosoa, a fisheries official who was on the beach when the tsunami occurred. The earthquake was felt strongly for 3 minutes, and caused some walls to crack. Ten minutes later, three explosions were heard, like bombs or aircraft sonic booms. Eight minutes later the tsunami arrived. The water receded to below MSL, then rose and crested over the beach to 3.2 meters above MSL. People described the wave as approaching from the south, the sea looking normal when it was far out, but as it approached shore the wave appeared to reach the height of a coconut tree, and came in as a large curling, crashing wave. The water appeared black.

One kilometer to the north of the village, people described the wave as approaching at an angle to the beach, and the second wave coming in as the first was running out.

Two kilometers north of the village the first wave penetrated 100 kilometers into a coconut grove, and reached an elevation of +4.1 meters. One kilometer south of the village the wave reached + 3.8 meters.

Some boats were damaged at Labuhanhadji, but no lives were lost. In part this may have been due to the fisheries officer, who had experienced an earthquake and tsunami in the Banda Sea, in 1950, and was aware of what was occurring.



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## SUMBA ISLAND

### Leterua, (South coast, western end)

#### A. Observations

1. 0030 UTC, debris marks 5.5 meters above tide level at time of measurement
2. 0045 UTC, debris marks (evidence) in grove of coconut trees along small stream bed 4.8 meters above tide level at time of measurement.
3. 0125 UTC, marsh area above berm of beach, approximately 1200 meters from water line, 5.5 meters above tide level at time of measurement.

#### B. Casualties - none

#### C. First Hand Reports

According to eyewitness accounts from those residing at the village of Leterua, the tsunami wave (initial) arrived from the southeast, hit the shore, reflected off, and met with the second wave (coming in from the southeast, also). It was reported that the reflected second wave did not constructively combine with the incoming second wave. The tsunami occurred at near low tide. The tsunami followed the earthquake by five minutes (a reasonable approximation, but it was noted that the observer did not have a wrist watch).

Although the survey team did not inquire, the local villagers did not report any unusual explosion sounds following the earthquake.

The normal tidal range in this area appears to be about three to three and one-half meters as noted from observations of high tide water marks.

Observations 1 and 3 were made close to the village area while observation 2 was made about 0.8 kilometers southwest of Leterua.

Other reports indicated the maximum height of the tsunami was slightly greater than the normal tides in the area. No damage was reported in the immediate vicinity of Leterua.

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## Melolo, (East coast)

### A. Observations

1. 0610 UTC, line 1.5 meters above tide level at time of measurment

### B. Casualties - none

### C. First Hand Reports

Reports from local villagers indicated the tsunami occurred near low tide. Also, the tsunami rose to a height no greater than the normal high tide. Observation 1 was made during near high tide.

Since the tide was low when the tsunami occurred, its impact was much less than would be expected. The tsunami at Melolo was a rapid rise and fall of the water and was not accompanied by waves. The beach at Melolo is typically flat with a very gentle slope leading to the water.

Other residents living near the coast felt the earthquake, moderate shaking, but heard no explosive sounds following the quake.

Other reports on the earthquake revealed only very minor damage to buildings at Melolo. It was also reported motion was in the horizontal plane in the NE-SW direction.

## Waingapu (North coast, central portion)

### A. Observations

No runup measurements were made

### B. Casualties - none

### C. First Hand Reports

The survey team visited both the new and old port areas of Waingapu City.

One first hand report, a resident living near the water, reported the tsunami followed the earthquake by one hour, approximately. The resident reported no unusual explosive sounds following the quake. The tsunami itself rushed in and out of the harbour very rapidly.

At the old harbour facility, the harbour watch stander reported a period of about 2 - 3 minutes between the maximum/minimum oscillations of the water level in the harbour. He also reported the wave activity continued until 1230 UTC in the evening at a diminishing rate.

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At the new harbour area, presently under construction, a construction engineer on the site reported that the tsunami was, also, a rapid oscillation of the water level. The disturbance continued till the early evening hours. Another observer reported the tsunami followed the earthquake by only ten minutes and that the maximum water level reached was only slightly greater than normal high tide. No damage was reported to the facilities under construction. Both observers reported hearing no explosive sounds following the quake. The tsunami occurred at low tide in the harbour area.

An Australian, who proceeded to the old harbour area following the earthquake, reported he noticed unusual activity in the harbour. Specifically he said there was a oscillation of the water of about 1 meter. This continued for several hours following the quake and subsided during that period.