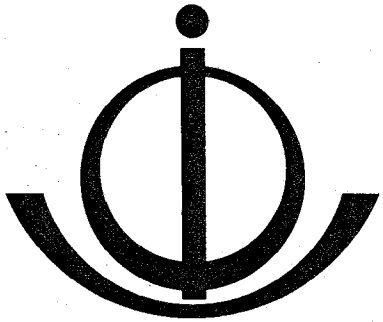

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
COMMISSION OCEANOGRAPHIQUE INTERGOUVERNEMENTALE
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МЕЖПРАВИТЕЛЬСТВЕННАЯ ОКЕАНОГРАФИЧЕСКАЯ КОМИССИЯ
اللجنة الدولية الحكومية لعلم المحيطات

TSUNAMI NEWSLETTER

INTERNATIONAL TSUNAMI INFORMATION CENTER
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Dr. George Pararas-Carayannis
Director

TSUNAMI NEWSLETTER is published by the International Tsunami Information Center to bring news and information to scientists, engineers, educators, community protection agencies and governments throughout the world.

We welcome contributions from our readers.

The International Tsunami Information Center is maintained by the U.S. National Oceanic and Atmospheric Administration for the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization. The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.

MEMBER STATES

Present membership of the International Coordination Group for the Tsunami Warning System in the Pacific comprises of the following States:

CANADA
CHILE
CHINA
COOK ISLANDS
ECUADOR
FIJI
FRANCE
GUATEMALA
INDONESIA
JAPAN
KOREA (REPUBLIC OF)
MEXICO
NEW ZEALAND
PERU
PHILIPPINES
SINGAPORE
THAILAND
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USA
USSR
WESTERN SAMOA

NEWS EVENTS

EARTHQUAKE AND TSUNAMI OF 12 DECEMBER 1979 IN COLOMBIA

by

George Pararas-Carayannis
Director
International Tsunami Information Center

INTRODUCTION: A major earthquake measuring 7.9 occurred at 07:59:4.3(UT) on 12 December 1979 along the Pacific Coast of Colombia. The 12 December 1979 earthquake and tsunami associated with it, were responsible for the destruction of at least six fishing villages and the death of hundreds of people in the Narino State of Colombia. The earthquake was felt in Bogota, Cali, Popayan, Buenaventura and other major cities and villages in Colombia, and in Guayaquil, Esmeraldas, Quito and other parts of Ecuador.

An investigation of the effects of the earthquake and tsunami was undertaken by ITIC. Tumaco and San Juan Island -- two of the areas that were most affected by the earthquake and tsunami were visited and surveyed. Because of the inaccessibility of the area destroyed by the earthquake and tsunami, all of the coastal villages were not visited. However, reports of earthquake and tsunami effects, as well as casualty and damage figures, were compiled from Civil Defense records and eyewitness accounts. The following is a preliminary account of the ITIC investigation.

THE EARTHQUAKE: The earthquake measured 7.9 on the Richter scale (MS) and occurred at exactly 07:59:4.3 (UT) on 12 December 1979. The epicenter of the earthquake was in the ocean at 1.584° North Latitude and 79.386° West Longitude. The origin time, magnitude and epicenter location have been reported by the U.S. National Earthquake Service (NEIS) in the preliminary report (PDE #50-79, 9 Jan 1980) and are based on the averages reported from 171 seismic stations around the world. The standard deviation in epicenter determination of the 12 December event given by NEIS is 1.1 seconds which translated into distance it means that the epicenter could be within a circle of approximately 8 nautical miles, as given in Figure 1. This epicenter is a refinement of the preliminary epicenter which had been given as 2.4 North and 79.0 West, immediately following the event. The refined epicenter is considerably further to the south and to the west than that given earlier and it is nearer the Colombian-Ecuadorian border.

It is a little difficult to explain the earthquake effects in the State of Narino, Colombia and the absence of considerable damage in Esmeraldas, and other cities and villages of Ecuador which were fairly close or even closer to the new epicenter. One would have to examine carefully the structural geology of the area to determine why the earthquake had far more severe effects in Colombia than it had in Ecuador. For example, the presence of an offshore ridge was determined by the preliminary examination of a small scale bathymetric chart of the area. This ridge is in the

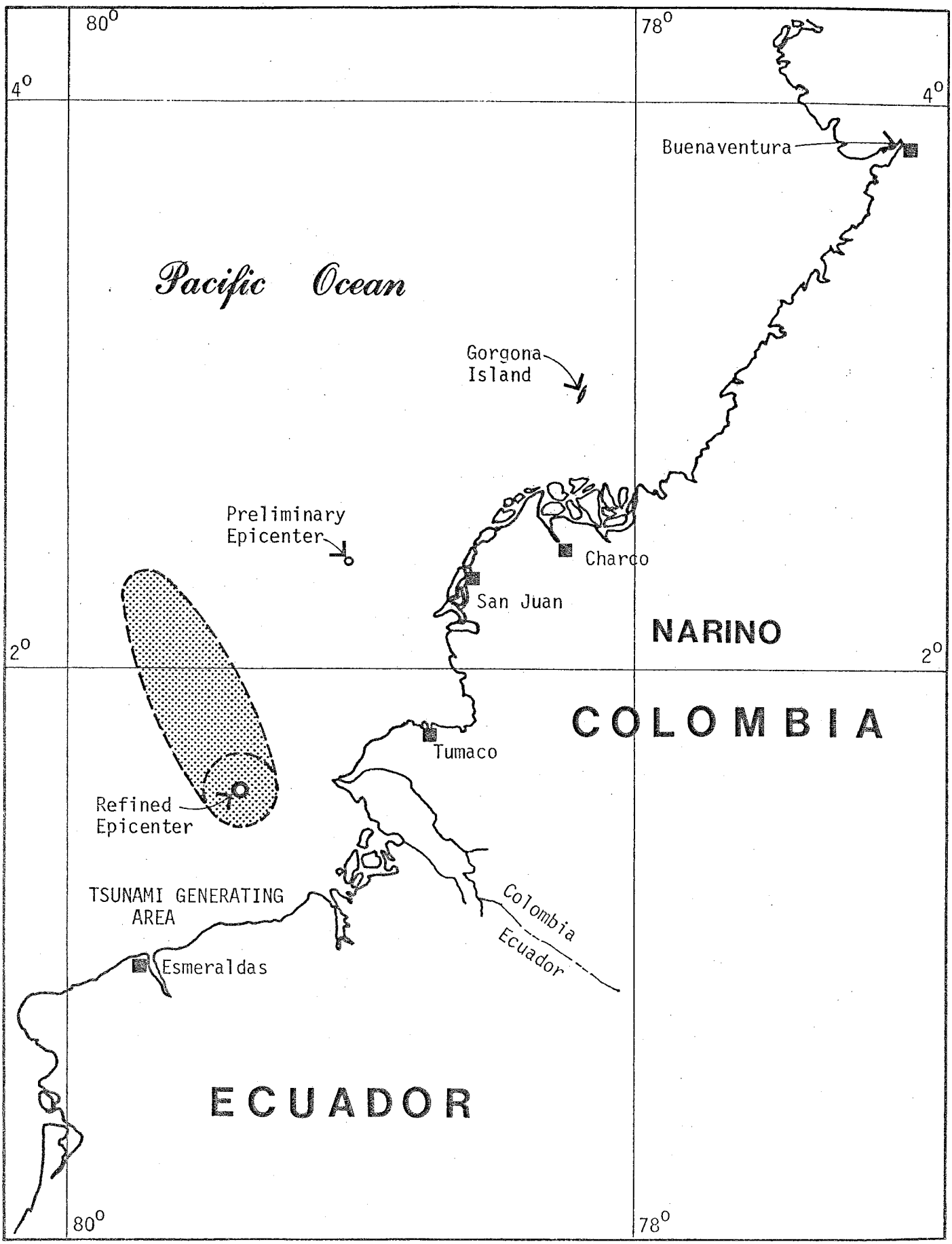


Figure 1 Tsunami Generating Area of the 12 December 1979 Earthquake in Colombia

vicinity of the epicenter and has an orientation in a northwest southeast direction. The ridge may be in fact part of an extensive fault line along which many historical earthquakes may have occurred. Other underwater ridges exist offshore from Tumaco, indicating a complex system of geological structures in the area. In the absence of comprehensive geological information for the area it is not possible to speculate on the source mechanism of the earthquake at this time. However, an attempt is made to partly explain the characteristics of the tsunami generating area on the basis of scant field evidence and observations made during the ITIC survey.

EARTHQUAKE EFFECTS: The earthquake of 12 December 1979 centered in the State of Narino in the southwest corner of Colombia, bordered to the south by Ecuador and to the west by the Pacific Ocean. The shock was felt over a wide area ranging from Bogota to the north to Quito and Guayaquil to the South. The quake had three major shock waves which according to reports lasted from 2:59 AM until 3:04 AM, local time (0759 to 0804 UT). This was the strongest earthquake in that part of Colombia since 19 January 1958 when an event of 7.8 in magnitude occurred. It was the second large earthquake to occur in Colombia within a month. An earthquake of magnitude 6.7 on the Richter scale occurred further north of the State of Narino in Colombia on 23 November 1979, killing 44 persons, injuring hundreds and causing extensive damage.

According to the Geophysical Institute of Javeriana University, there were at least 10 major aftershocks lasting for several days following the major event of 12 December. The violent quake left numerous dead and injured and destroyed thousands of buildings principally in the State of Narino, Colombia. In Bogota and other major cities in Colombia, tall buildings swayed, but damage was not significant. The shock was felt throughout Ecuador and caused some damage in villages and towns near the Colombian border, but no casualties were reported from that country.

The State of Narino is one of the least developed areas of Colombia, and there is a lack of roads and runways making it one of the most inaccessible areas of the country. Most of the inhabitants live in villages and towns on the coast or near waterways as the area is mostly jungle. Preliminary reports estimated the number of persons killed in the hundreds with up to 2,000 people missing. The area was declared a disaster area, and Army, Navy, and Civil Defense officials began rescue and supply operations quickly after the disaster struck. Electrical power and telephone lines were knocked out in several areas of the State of Narino, but were quickly restored a few days later. At the time of the ITIC survey in the last week of December, there was still lack of potable water in the area.

Hardest hit by the earthquake and the tsunami was Charco, a Colombian fishing village of 4,000 persons -- about 300 kilometers north of the Ecuadorian border, where 100% of all the houses were either seriously damaged or totally destroyed. Most of the houses at Charco were built on stilts over a lake. It is not known at this time whether the houses were destroyed by the earthquake or by wave action. Numerous deaths and injuries were reported from this area. Most of the victims were women and children. Hundreds of people at Charco had to sleep on the ground

following the disaster, and had to go without food and drinking water for several days. The landing strip at Charco was inundated, becoming unusable for relief operations. Most of the supplies had to be flown to the airport in Guapi, about 30 kilometers from Charco.

The second populated area that was hardest hit by the earthquake was the seaport of Tumaco, only about 80 kilometers from the earthquake epicenter. At least 40 persons were killed and 750 injured by the earthquake, which destroyed approximately 10% of the houses and other buildings in the town of 80,000. Included in the buildings that were destroyed was the four-story Las Americas Hotel.

Tumaco is built on an island made up of alluvial deposits of Rio Mira and Rio Caunapi. In fact the whole area appears to have formed from deltaic deposits. Evidence of liquifaction was evident in many areas of the city of Tumaco where structures failed and it was particularly evident along sections of the waterfront. Evidence of subsidence was found on either side of the bridge connecting the island where Tumaco is situated to the island where the airport is located. It appeared that the island dropped by as much as 60 centimeters. Evidence of subsidence of about 60 centimeters also was reported from the island of Rompido, offshore from Tumaco, and a good portion of that island was under water. Subsidence of approximately 50 centimeters was reported from Cascajal Island. Other fishing villages in the State of Narino that were destroyed were Curval, Timiti, San Juan, Mulatos and Iscuande. Most of the damage and deaths in these villages, however, were the result of the tsunami.

TSUNAMI EFFECTS: The 12 December 1979 earthquake resulted in a tsunami that practically wiped out six of the coastal fishing villages along Colombia's southwest Pacific coast, and left several hundred persons dead or missing. At least 15 other coastal towns in the area were rocked by the earthquake and were damaged by the waves. Waves measuring anywhere from 2-5 meters destroyed many of these coastal villages. People along the coast, who survived the earthquake by running outside their homes were carried away a few minutes later by the large tsunami waves generated by the earthquake. Six fishing boats, one with 40 men aboard, were lost. A pier on the prison island of Gorgona was destroyed, however, no injuries from either the earthquake or the tsunami were reported from there. Most of the houses at Charco, a village of 4,000, which were built on stilts over a lake were knocked into the water. Waves sent the Iscuande River out of its banks along the Pacific coast. The wall of water reportedly in the village of Iscuande caused extensive damages. At least one person was reported dead from that area.

Hardest hit of all the coastal villages was the fishing village of San Juan, where the waves completely overran the island destroying just about everything in their path. Numerous deaths were reported from San Juan which was totally devastated and is in the process of being relocated further inland at the present time. According to eyewitness reports, 3 to 4 waves were observed, the first wave arriving approximately 10 minutes after the main earthquake. The water recessed first to about 3 meters below the level of the sea. The first wave arrived minutes later. The third wave was the largest, and at San Juan Island it was approximately

5 meters above the level of the tide, which fortunately, was at its lowest at that time.

The maximum difference between low and high tide in the region for that time of the year was approximately 1.3 meters, thus, the maximum wave could have been that much more, if it had arrived at high tide, and numerous more deaths could have resulted. Considering that the mean elevation of the coastal islands is approximately 2 - 2 1/2 meters above high tide, it would mean that maximum waves would have completely overrun all of the coastal islands in the area. Approximately 30-35 kilometers of the coast were hardest hit by the tsunami, while the length of the area hardest hit by the earthquake was approximately 225 kilometers in length, from Guapi to Tumaco.

Table 1 was compiled from Civil Defense records, and gives casualties and damages from the combined effects of the earthquake and tsunami. These figures may be in actuality underestimates, and the earthquake and tsunami may have resulted in numerous more deaths than those given in the official estimates, since the census figures for the area are at least ten years old, and since final tabulation had not been made at the time of the ITIC survey. It is estimated also that the majority of casualties (at least 80%) were the result of the tsunami rather than of the earthquake. Because of the inaccuracy of the census figures, it may be difficult, even in the future, to determine with accuracy the number of people that lost their lives. It is also difficult to separate the deaths caused by the earthquake from those that were caused by the tsunami. An ITIC estimate based on informal reports is that 500-600 people may have been killed by the combined effects of the earthquake and tsunami with about 4,000 people injured. Homes of at least 10,000 persons were destroyed. Final and more accurate estimates will be provided at a later time.

Table 1. Casualties and Damage Estimates of Combined Effects of Earthquake and Tsunami of 12 December 1979 *

Municipality	Dead	Hurt	Missing	Houses Destroyed
Tumaco	38	400	7	1,280
El Charco	43	300	50	All
San Juan	161	70	38	All
Mosquera	4			
Majagual	12	28		20%
Salahonda	1	—	—	
TOTAL	259	798	95	

* As of 27 December 1979, compiled by local Civil Defense Authorities.

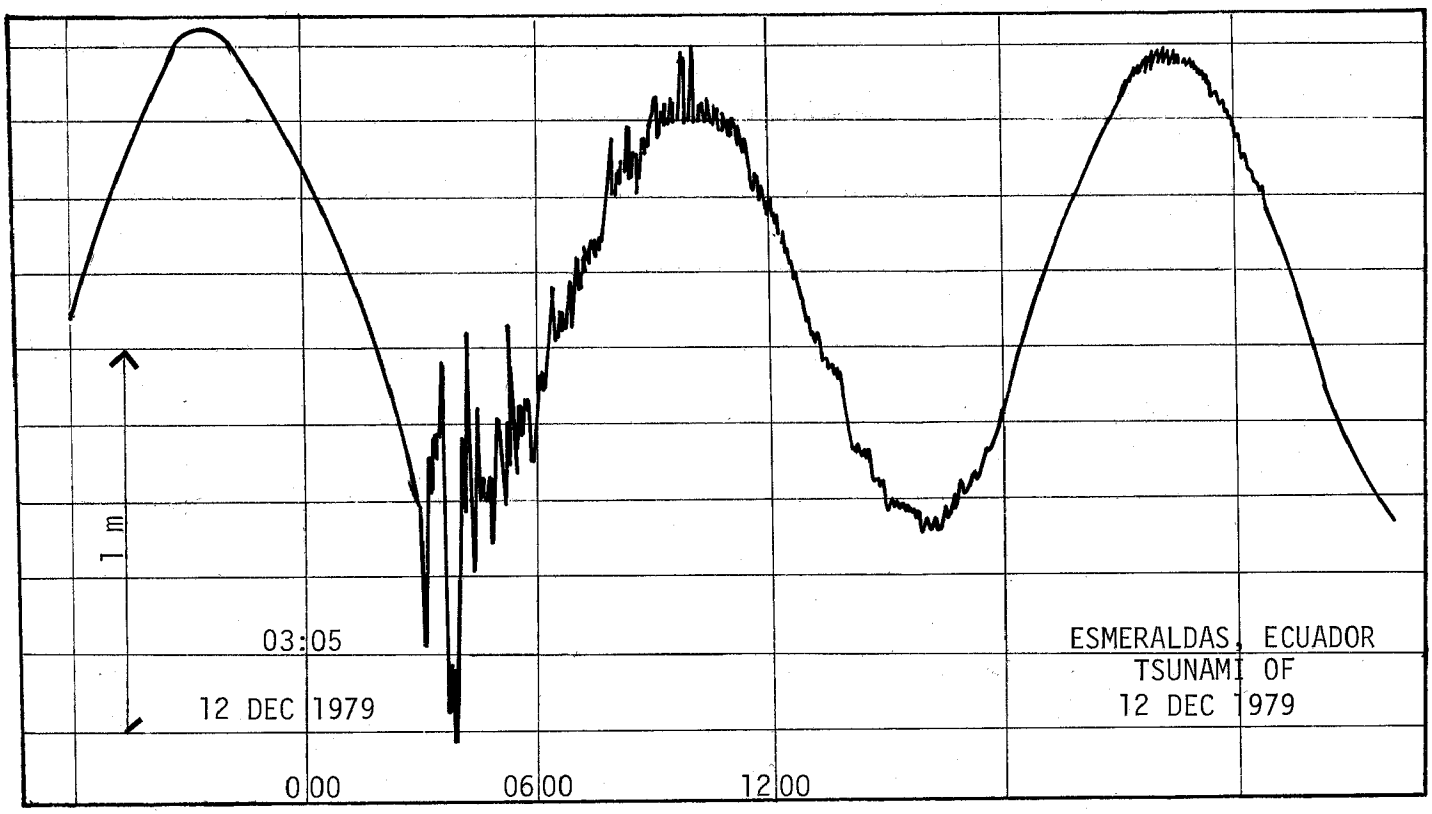


Figure 2. The Tsunami of 12 December 1979 earthquake as recorded in Esmeraldas, Ecuador.

Figure 2 is a tsunami record obtained from the port of Esmeraldas in Ecuador, approximately 95 nautical miles to the south of the epicenter. It is confirmed from this record that the tsunami occurred at the lowest possible tide, that the first wave activity was a recession followed by approximately 3 to 4 waves. No tsunami damage occurred in Tumaco (Colombia) or Esmeraldas (Ecuador), but had the wave occurred at high tide, it is believed that flooding and considerable tsunami damage would have occurred at these two cities. For example, if the wave had occurred at high tide, its elevation would have been 1.3 meters higher than the 2 meter wave observed in Tumaco, and could have resulted in extensive tsunami damage of that city.

TSUNAMI GENERATING AREA: Preliminary assessment of the tsunami generating area indicated that the orientation of the generating area was an ellipse with the major axis being in a northwest/southeast direction (Figure 1). Because of the orientation of the generating area, it appears that coastal areas to the south and to the north of the generating area were not affected greatly by the tsunami. Minimum tsunami energy was propagated to the north or to the south of the generating area explaining, for example, why Tumaco experienced relatively small tsunami waves although so close to the generating area. At San Juan Island, where maximum waves were observed, the direction of approach of the waves was from the southwest, rather than from the west. The direction of wave approach was obtained

by observing fallen palm trees, detritus material wrapped around objects and the way buildings had moved or structurally failed. If mareographic records from Buenaventura and Tumaco become available, it would be easier to reconstruct the generating area of the tsunami. Based on the record obtained from Esmeraldas, it appears that the travel time to that tide station was only 5-6 minutes after the quake.

The tsunami generated in Colombia was also observed in many places of the Pacific including the Hawaiian Islands. At Hilo and at Kahului, maximum wave observed (trough to crest) was approximately 40 centimeters. At Nawiliwili the wave was only 10 cm. At Johnston Island the wave was only 8 cm. A deep water gauge off the coast near Tokyo, Japan did not record any wave activity. Figure 3 is a computer-generated tsunami refraction diagram and travel time chart for the 12 December 1979 tsunami across the Pacific Ocean (Steve Poole, Personal Communication).

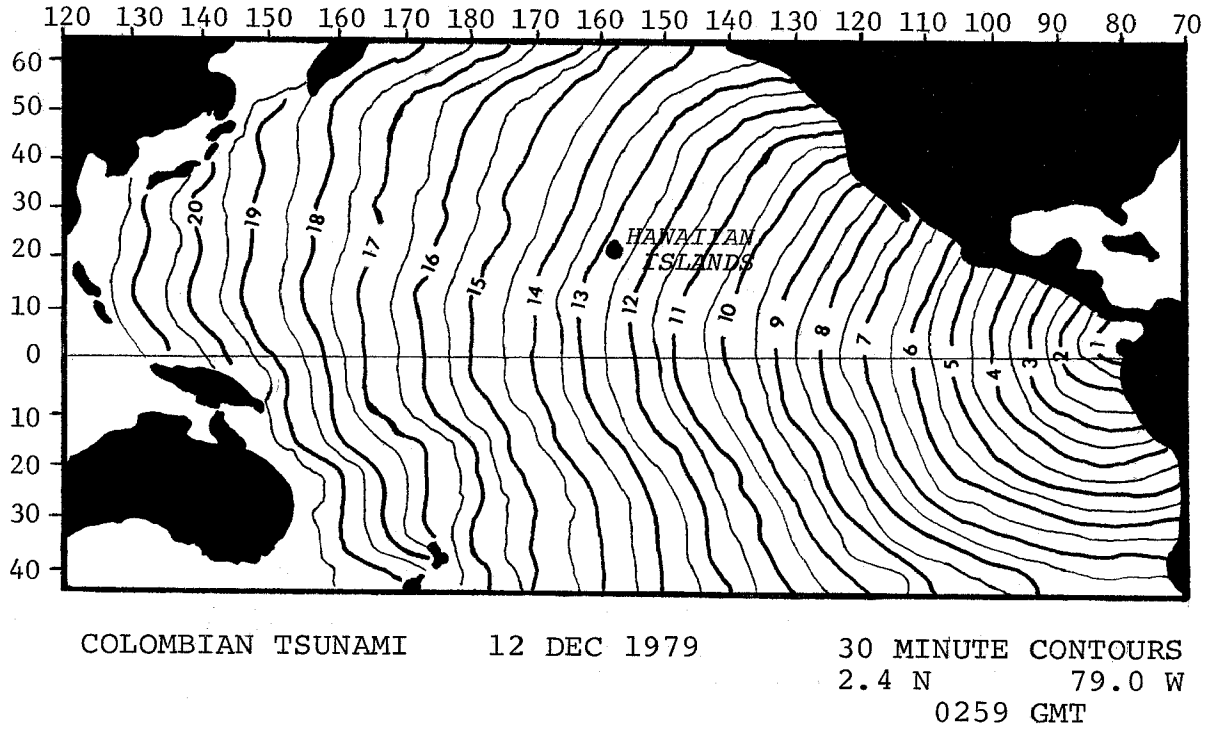
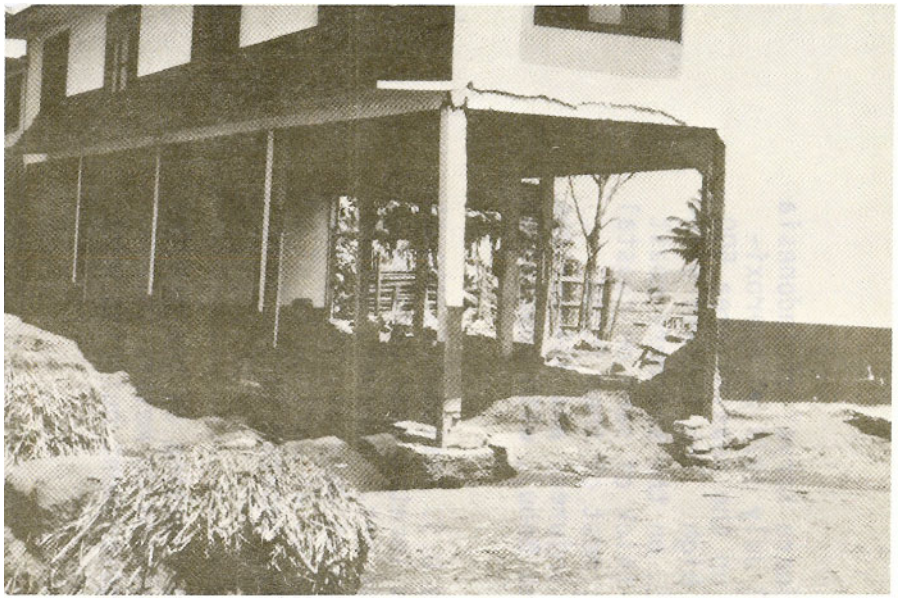
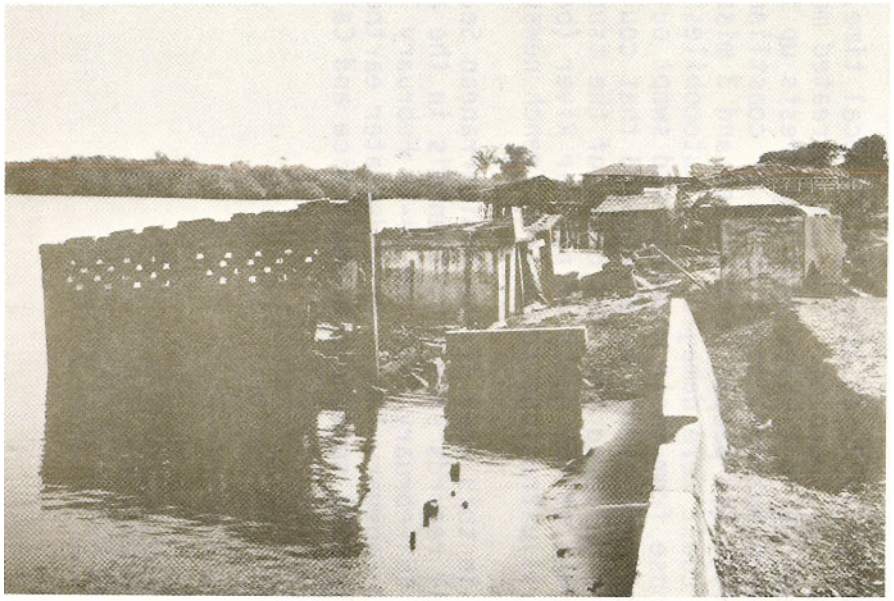


Figure 3. Refraction Diagram and Travel Time Chart of the 12 December 1979 Tsunami Across the Pacific Ocean (Steve Poole, Personal Communication)

Tsunami and Earthquake Damage at San Juan Island, State of Narino, Columbia, from the 12 Dec 1979 Earthquake





Update of the Tsunamis in Indonesia

Sources from the daily newspapers "Kompas" and "Suara Karya" of Indonesia stated that the tsunami waves that occurred on 18 July 1979 at approximately 1:00 A.M. (local time) in Indonesia swept up the coastal area 500 meters inland and over hills that were 10 meters high. The tsunami originated from an area which is at 8°32'S - 123°30'E, on the southern coast of Lembata Island. The waves deposited 2 meters thick of sand on coastal settlements. A total of 187 persons were killed, most of them found buried under the sand, 32 persons were seriously injured, and 364 persons were missing. The 3 villages (Labala, Waiteba and Bobu), with population totalling 3,422, were completely obliterated.

The cause of the tsunami is still uncertain. The U.S. National Earthquake Information Service reported that no large events located near Lomblem Island had been recorded by the world-wide seismic net. However, according to the Smithsonian Institution's SEAN Bulletin of July 31, 1979, the meteorology and geophysics station at Kupang recorded an earthquake of undetermined magnitude at 0042 local time on 18 July, located in the Sawu Sea (S of Lomblem).

Light rocks, dead fishes, and oil film were found floating on the coastal waters, days after the tsunami. The coastline shifted 20 meters inland. The sites where a school, a health centre and a government building were located, are now under the sea.

Tsunami Struck the French Riviera

On 16 October 1979, at about 14:00 local time, a tsunami struck the French Riviera without warning. The sea retreated more than 300 meters, then returned rapidly in 2 waves that had crests up to 10 meters high. From Menton SW to Antibes, about 60 km of coastline were hit by the tsunami (Figure 1). Six people were killed and 3 missing. Numerous buildings near the coast were damaged; many automobiles were destroyed and boats pulled loose from their moorings and swept out to sea. It is reported that no seismic events were recorded that could have triggered the tsunami. It is believed that the cause of the tsunami is submarine landsliding of sediments at the mouth of the Var River (between Antibes and Nice), as shown in illustrations taken from French newspapers (Nice-Matin).

Tsunamis in this area of the Mediterranean Sea are not uncommon. The historical records show that tsunamis in the area occurred on 27 July 1564, on 16 February 1752, on 24-25 February 1818, on 29 February 1854 and on 23 February 1887. An underwater earthquake occurred as recently as 19 July 1963 somewhere between Nice and Calvi.

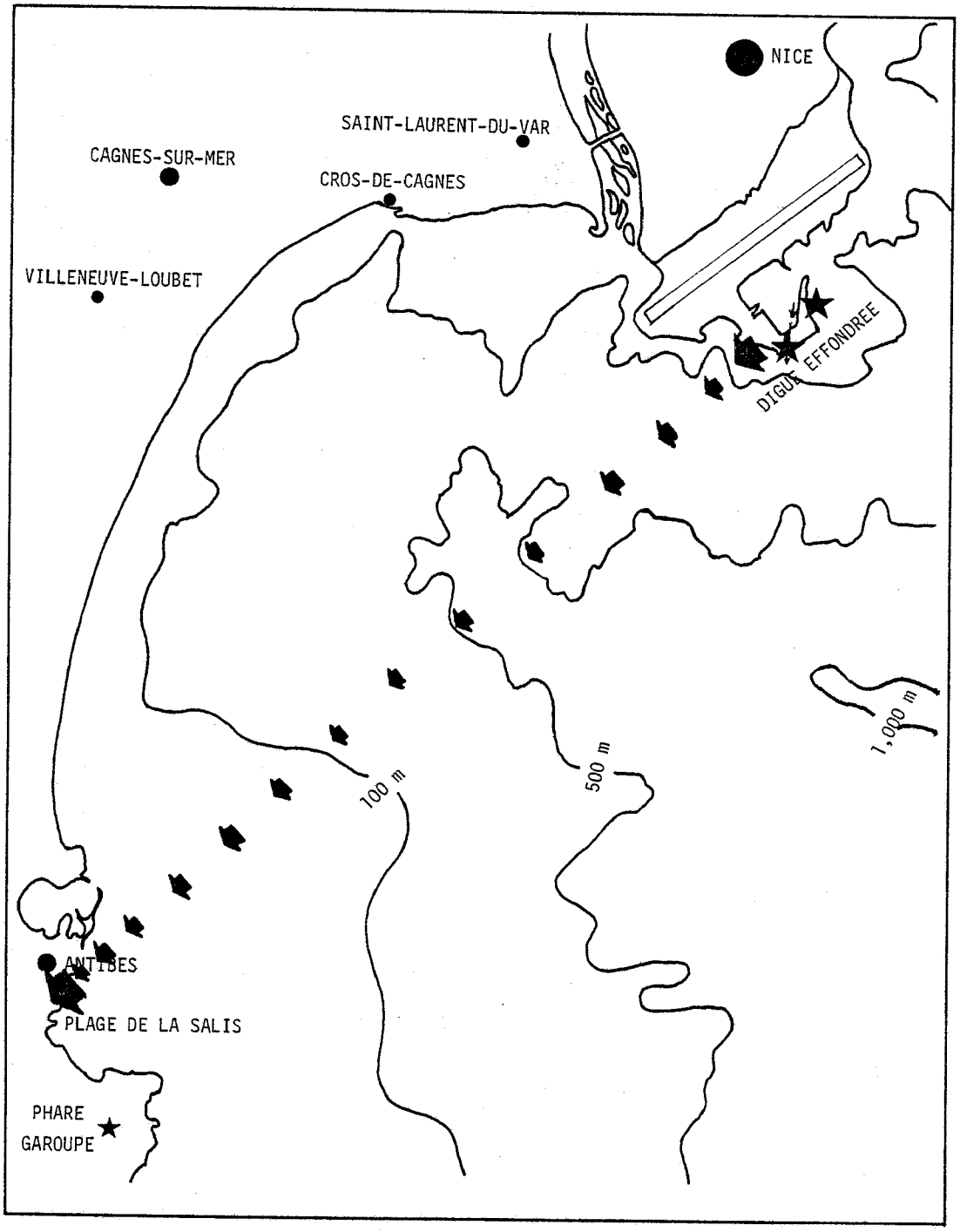
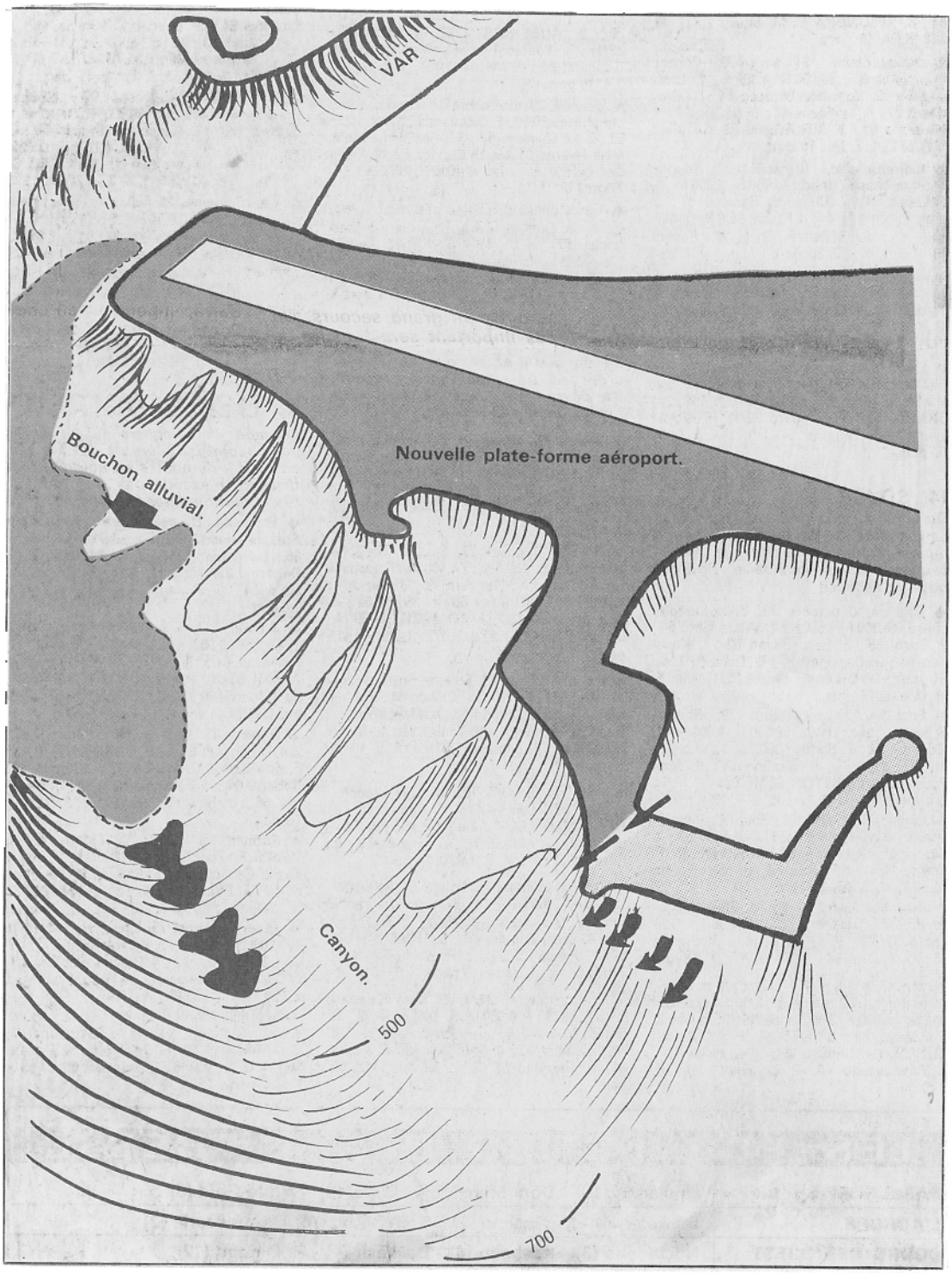
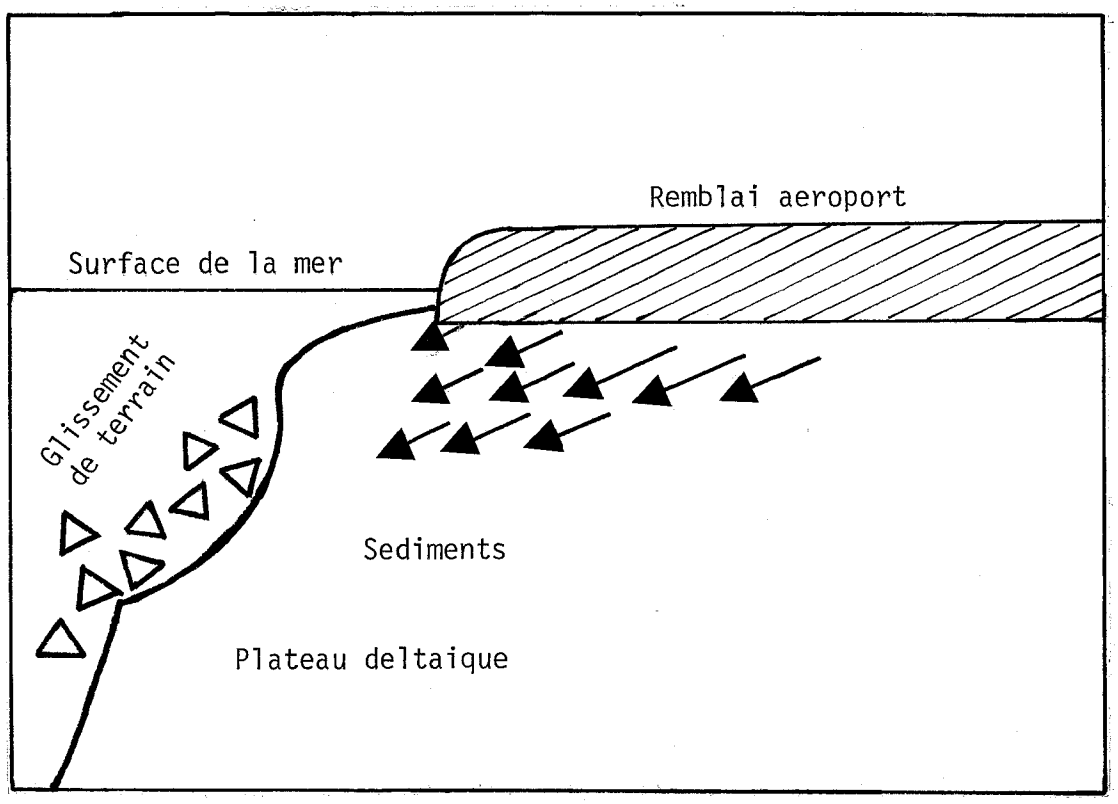


Figure 1. The Bay of Anges between Nice and Antibes. The tsunami wave was caused by a submarine landslide and propagated directly from an area near the airport of Nice to the beach of Salis. (Drawing by Croquis F.P. Langlade, Nice-Matin, 18 Oct 1979.)



According to Professor Mangin of the Faculty of Sciences of Nice, an enormous underwater avalanche of sediments into the underwater canyon of River Var in the heart of the Bay of Anges, was responsible for the tsunami. (Drawing by Croquis F.P. Langlade, Nice-Matin, 18 Oct 1979.)



According to local environmentalists, the tsunami was caused by a landslide triggered by excessive pressure on the sedimentary platform of the delta of River Var by ongoing harbor works in the area.

FEATURES

Tsunami Alerting Systems

Reprinted with the permission of the Earthquake Information Bulletin. By Harold E. Clark, Jr., Albuquerque Seismological Laboratory, U.S. Geological Survey, Albuquerque, N. Mex.

"As part of a joint effort between the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, we have recently built five TS-4 tsunami seismic systems and one TT-3 tsunami tide system for the National Weather Service. Both types of systems are designed to operate with the Geostationary Orbiting Environmental Satellite (GOES) Network (fig. 1).

Tsunami seismic system

The TS-4 seismic system (figs. 2 and 3) consists of a single board microprocessor-based unit used with a special narrow band filter board, level detector board, and oscillator board. This seismic system detects seismic events and then stores 14 separate event times in its memory before transmitting over the GOES network. The seismic signal is generated on a standard short-period seismometer and amplifier. The seismic signal,

as well as the three narrow-band filtered components of the original signal, is continually sampled by the microprocessor through level detector circuits. The filter board contains three narrow-band filters with center frequencies of 1.1, 1.41, and 2.59 hertz. Using time duration, preset signal levels, and the data from the narrow-band filters, the microprocessor can distinguish between noise and true seismic events.

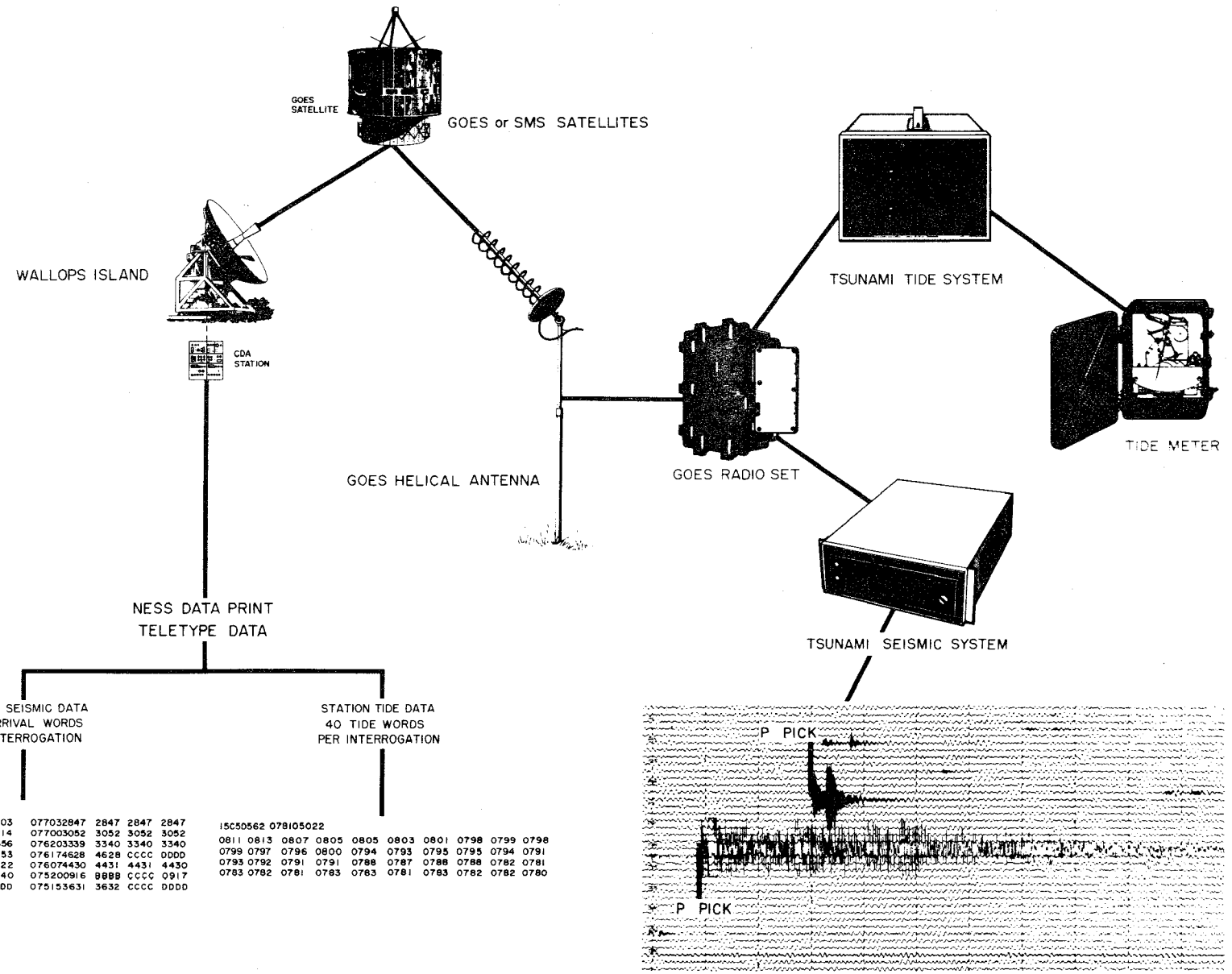
To verify an event, the seismic signal must meet the criteria for amplitude and time duration for the unfiltered data channel, as well as meeting similar criteria from any of the three filtered channels. If a seismic event is verified, the first arrival time of the unfiltered channel (channel A) is stored in memory along with the first arrival times of the filtered channels: 1.1 Hz (channel B), 1.41 Hz (channel C), and 2.59 Hz (channel D). These four arrival times form one detected seismic event and are stored as the latest of the 14 detected seismic events. The oldest detected event is dropped from memory. A typical stored event is (093225245 BBBB CCCC 5245). The value 093225245 indicates the channel A time pick occurred on the 093 day of the year, 22 hours, 52 minutes, 45 seconds. The BBBB and CCCC indicates the channel B as well as channel C did not meet the amplitude and time duration criteria. The 5245 indicates that channel D (2.59 Hz was the channel that was used to verify the main channel A pick. With appropriate parameters and typical Worldwide Standardized Seismograph Network seismometer-amplifier responses, we can select seismic events ranging in magnitude from 0 to 7 and above, as well as discriminate among very close-in local events, regional events, and teleseismic events by observing the channel B, C, and D picks. Very close-in locals are rich in all frequencies and will be characterized by time picks in channels B, C, and D. More distant locals will be characterized by time picks in channel D or channels C and D. Regional events are characterized by time picks in channel C or channels B and C. Teleseismic events are characterized by time picks in channel B. The typical example above indicates a not-too-close-in local event.

Another feature of the TS-4 seismic system is the capability to decode the GOES time. The seismic system will continually monitor the GOES time code and, upon detecting four consecutive good time decodes, will enter the correct time into the TS-4 system. If the TS- loses the GOES time code, the unit will automatically revert to the secondary oscillator time pulse and will continue to keep time until the proper GOES time code is again detected. This feature will allow very long term unattended operation of the TS-4 seismic system. The GOES time code contains day of year, hours, minutes, and seconds.

When the GOES transceiver unit, which is connected to the TS-4 seismic system, receives a command from the National Environmental Satellite Service (NESS) facilities at Suitland, and at Wallops Island, via one of the GOES an interrogation sequence will start. The TS-4 unit will transmit the 14 stored seismic event time picks and will initiate shutdown of the transceiver unit. The 14 seismic event time picks will be transferred over the GOES network and will be stored in the NESS computer facility for individual dial-up retrieval by remote user data sets.

Figure 1.

TSUNAMI SATELLITE SYSTEMS



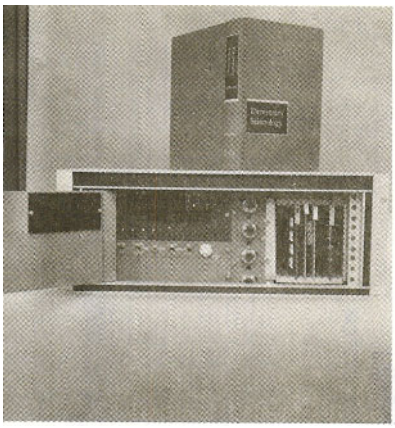


Figure 2. TS-4 seismic system (Photograph by Ed Tilgner)

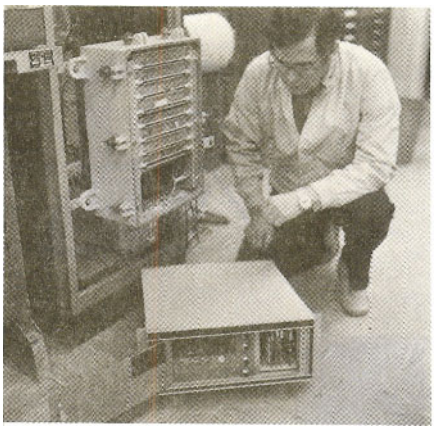


Figure 3. TS-4 seismic system next to a GOES transceiver radio unit (Photograph by Ed Tilgner)

We call the event detector a "P picker," which is short for primary phase arrival picker. The original intent of the TS-4 seismic system was to rapidly detect "P" arrival time for local and near regional events of magnitude 5.5 or greater for rough epicenter determinations by using a network of these units located in ocean areas. If the epicenter was determined to be in an ocean area, then there is a possibility of a tsunami being generated. The rapid interrogation and data retrieval time by using the TS-4 systems in conjunction with the GOES network will allow these initial epicenter determinations to be made within a matter of minutes after the occurrence of an earthquake. Conformation of the tsunami would be obtained by further interrogation of the tsunami tide systems over the same GOES network.

Tsunami tide system

The tide meter is a commercial float and pulley type. It measures the liquid level by sensing the rise and fall of a buoyant float on the surface of the water.

The TT-3 tsunami tide system converts the analog signal from the tide meter every 15 seconds, which corresponds to one tide word. The TT-3 system will select every fourth tide word for storage in memory and will store the latest 40 tide words for transmission which corresponds to 40 minutes of tide data. Because the TT-3 is under software control, time between stored tide words can be any selected value. The selection of 40 minutes of tide data was based on the time to interrogate 50 to 100 other tide systems by GOES before having to reinterrogate the first tide system without a loss of tide data.

The TT-3 tide system can be interrogated and will transmit 40 tide words in a manner similar to the TS-4 seismic system. No time information is required by the TT-3 system because the tide data is being stored in real time. The latest tide word will be within 1 minute of time of the satellite interrogation time. The earliest tide word will be 40 minutes prior to the satellite interrogation time. After interrogation and transmission, the TT-3 will shutdown the transceiver unit and will continue to store tide readings."

UNESCO - IOC - ITSU

New Secretary of IOC, Dr. Mario Ruivo

The Director-General of Unesco announces the appointment of Dr. Mario J. de Oliveira Ruivo (Portugal) as Secretary of the Intergovernmental Oceanographic Commission to succeed Desmond P.D. Scott.

Dr. Ruivo has been active in international marine affairs, both as a representative of his country and within the United Nations system.

From 1954-61 he was Deputy Director of the Institute of Marine Biology at Lisbon, following which he joined FAO. During 13 years of service with that organization, he held a number of positions, notably that of Director of the Fishery Resources and Aquatic Environment Division.

Upon his return to Portugal in 1974, he assumed responsibility as Secretary of State for the reorganization of the fishery sector and promotion of marine research. During this period he also served as head of the Portuguese delegations to UNCLOS and the IOC and was chairman of the IOC working committee for the Global Investigation of Pollution in the Marine Environment.

Dr. Ruivo, who was special advisor in science and technology to the Minister of Science and Culture, has officially started his duties as Secretary IOC on 1 January 1980.

IOC Workshop Report No. 17 Available

Report of the Workshop on Oceanographic Products and the IGOSS Data Processing and Services System (IDPSS) held at Moscow, USSR, 9-11 April 1979, is now available from the Secretary IOC. Reports on previous workshops held may be requested either from the publishing bodies or from the Secretary IOC, UNESCO, Place de Fontenoy, 75700 Paris, France.

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO)

International Co-ordination Group for the
Tsunami Warning System in the Pacific

Seventh Session, Viña del Mar, Chile, 3-7 March 1980

ANNOTATED PROVISIONAL AGENDA

1. Opening of the session

The session will open at 10.00 on Monday, 3 March, in Viña del Mar, Chile.

The working languages for the session will be English and Spanish.

2. Adoption of the agenda and election of Chairman, Vice-Chairman and Rapporteur

A provisional agenda has been distributed together with the letter of invitation (IOC Circular Letter no 773 dated 20 November 1979).

In accordance with the Guidelines for the Subsidiary Bodies of the Commission, as adopted by the 11th session of the IOC Assembly, each Programme Group [formerly called International Co-ordination Group] will elect its own Chairman and Vice-Chairman, who will serve for two sessions and two intersessional periods, and who may be re-elected for one additional term of office. The election of a new Chairman and Vice-Chairman for ICG/ITSU is therefore required. They will assume their functions at the end of this session.

Whilst the member of the IOC Secretariat remains responsible for the report of the meeting, it would still be appreciated if a rapporteur could be elected from the participants, in order to keep a continuous record of the discussions (Rule 25.3 of the IOC Rules of Procedure applies).

REVIEW

3. State of implementation of resolution EC-X.14 and of recommendations from the sixth session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (Manila, 10-25 February 1978).

The Secretary will report on the state of implementation of the final paragraph of res. EC-X.14 on additional financial support for tsunami educational material; Member States are invited to report on the penultimate paragraph of this resoltuion. Recommendation ITSU-VI.2 refers to the same subject.

The Secretary will further report on the state of implementation of recommendation ITSU-VI.1 on the programme and budget for 1981-83.

4. Activity report by the Director, International Tsunami Information Center (ITIC)

The Director ITIC will present his activity report. It is recalled that in accordance with the Summary Report of the 6th session, paragraph 5, the Director ITIC is requested to submit future activity reports to Member States "two months prior to the ITSU meetings."

5. National activity reports

The representatives of Member States are invited to report on developments in their respective countries. Each speaker is requested to provide a short summary of his statement, in not more than three pages, in English, for distribution during the meeting. These reports will not be included in the Summary Report.

6. Decision of the IOC Assembly at its 11th session on the Associate Director for ITIC (Resolution XI-23)

The Secretary will introduce IOC Assembly resolution XI-23 on the Associate Director ITIC.

7. Consideration of recommendations from the IUGG Tsunami Committee meeting held in Canberra, Australia, December 1979

The Chairman of the Committee is invited to introduce any recommendations of the Committee relevant to ITSU activities.

NEW ACTIVITIES

8. Proposals for further expansion of the Tsunami Warning System in the Pacific (TWS)

a) Tide and seismic stations
b) Regional warning centres

At the last session, the Group agreed that the Director ITIC and interested Member States should examine the feasibility of establishing regional tsunami warning systems, should co-ordinate their efforts with the Office of the United Nations Disaster Relief Co-ordinator (UNDRO) and UNDP, and should explore the possibility of international funding for that purpose. The Director ITIC and Member States are therefore invited to report on their actions taken.

9. Proposals for further technical improvements of the Tsunami Warning System in the Pacific (TWS)

a) Rapid data and watch and warning dissemination
b) Implementation of satellite telemetry system

At the last session, the Group adopted an Action Plan on this subject which is contained in paragraph 9 of the Summary Report. It reads:

"The Group requests Canada and the USA to investigate the use of satellites in the TWS and to prepare a report for publication in the ITIC newsletter by 1 January 1979. The USSR and Japan are requested to provide information on their satellite programmes by 1 June 1978 for inclusion in this report.

The Group requests each Member State to review the communication facilities between its TWS gauges and the Pacific Tsunami Warning Center (PTWC) and submit a report to ITIC recommending the most expedient means of communication. This report should be submitted to ITIC by 1 June 1978.

ITIC will review these recommendations and suggest improvements in the TWS communication plan. Implementation of these recommended improvements will be the responsibility of the Member States.

The Group is of the opinion that the goal of the TWS should be to verify the existence of a tsunami within one hour after the time of generation. As a first step, ITIC and PTWC will prepare a report defining the system of TWS gauges needed to achieve the goal. The recommended network of gauges, based on historical data and communication links, will be published in the ITIC newsletter by September 1978. Member States are requested to consider establishment of the recommended gauges as appropriate and to report to ITSU-VII on their progress.

The Group requests each Member State to provide ITIC with a description of existing gauging equipment utilized at each tsunami gauge site, as well as any planned improvements. This information should be submitted by 1 June 1978."

Member States and the Directors ITIC and PTWC are requested to report on their actions taken.

10. Tsunami Warning System (TWS) operations

The Director ITIC will introduce this item.

11. Proposals for research on tsunamis

Member States, the Director ITIC and the Chairman of the IUGG Tsunami Committee are invited to make proposals for research projects on tsunamis within the intergovernmental frame work, taking into account agenda item 7.

12. Proposals for a tsunami educational programme

In view of the weakness of the general public educational programme, the Group, at its last session (Summary Report paragraph 11), emphasized that this element of the Commission's tsunami programme should receive special attention immediately.

As "funding of these activities are primarily the responsibility of each Member State," Member States are invited to report an action taken in this respect.

Furthermore, Member States were urged "to undertake one pilot educational programme within each country" ... "A report of these activities should be disseminated to other Member States via the ITIC, and an evaluation presented at the next session of ITSU." The Director ITIC will report on this matter.

The Group further requested the Director ITIC to arrange the preparation and distribution of "(1) A catalogue of emergency evacuation plans prepared by each Member State, and (2) An inventory of public educational material." The Director ITIC will report on this subject.

13. Programme forecast (and budget)

The Group is invited to consider its programme for the period 1984-85.

14. Date and Place of the Eighth session of the International Co-ordination Group for the Tsunami Warning System in the Pacific

Delegates are requested to consider inviting the Group for its next session, to be held in early 1982.

15. Adoption of the Summary Report and recommendations

The Secretary, with the assistance of the Rapporteur, will provide a draft Summary Report, with recommendations, for approval by the Group (in English only).

16. Closure of the session

The meeting is due to close at 6 p.m., on Friday, 7 March 1980.

INTERNATIONAL TSUNAMI INFORMATION CENTER - HONOLULU

Dr. G. Giermann Visits ITIC

Dr. Gunter Giermann, Deputy Secretary of the Intergovernmental Oceanographic Commission visited ITIC in Honolulu for three days, 30 September-2 October 1979. Dr. Giermann was returning to his office in Paris after attending a conference in Fiji. Dr. Giermann had discussions with the Director of ITIC, Dr. George Pararas-Carayannis, with whom he reviewed the ITIC work and plans for the forthcoming VII meeting of the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) in Vina del Mar (Chile). While in Hawaii Dr. Giermann visited also the Pacific Tsunami Warning Center (PTWC) and visited with Dr. Eddie Bernard, Director of the Center and his staff with whom he reviewed the operations of the Center.

ITIC Mission to Southeast Asia and Australia, 23 November - 9 December 1979

A visit was made to Hong Kong, Thailand, Indonesia, Papua New Guinea and Australia by Dr. George Pararas-Carayannis, Director of ITIC, between 23 November and 9 December 1979 for the purpose of assessing existing facilities, to determine whether improvements can be made to the Pacific Tsunami Warning System, and to familiarize personnel in these countries with the Tsunami Warning System and their effective participation into the System. The following is a brief account of activities and findings.

Hong Kong, 26 November

In Hong Kong I visited the Royal Observatory and met with Dr. J. E. Peacock, Acting Director, with Dr. Patrick Sham, Chairman of the ESCAP Typhoon Committee, and with Mr. K. H. Yeung, Seismologist. Mr. G. J. Bell, Director of the Observatory, was not available as he was attending the IUGG meetings in Canberra, Australia. In addition to discussing programs administered by the Royal Observatory, I was briefed on the ESCAP Typhoon

Committee's work and on the seismology program of the Royal Observatory. I reiterated to Dr. Peacock the need for continuous cooperation between the Royal Observatory and the Pacific Tsunami Warning Center (PTWC) in Honolulu, and I expressed appreciation for the good work the Royal Observatory has been doing in monitoring earthquakes and exchanging seismic data. Furthermore, we reviewed the Royal Observatory's tide station program in the South China Sea, and I expressed interest in the establishment of Waglan Island tide station as a secondary tsunami warning station. I promised to look into the availability of spare tide gauge equipment and of any additional parts that may be needed for an installation at Waglan Island. In addition, I familiarized Dr. Peacock with wave reporting procedures and I promised to transmit appropriate manuals for the training of observers. Dr. Peacock and Dr. Sham were very interested in augmenting the Royal Observatory's tidal network, and in installing appropriate telemetry for data and communications. Dr. Sham was of the opinion that proposed telemetry and instrumentation in the Southwest Pacific would also serve the additional purpose of monitoring typhoon surges and that the ESCAP Typhoon Committee would endorse a proposal to UNDP, if the proposed instrumentation and telemetry could serve the dual purpose of monitoring tsunamis and typhoon surges.

Furthermore, we discussed with Dr. Peacock Hong Kong's membership into ITSU and details pertaining to membership. I expressed the hope that Hong Kong may be able to send a delegate to the ITSU VII meeting in Viña del Mar in March. Dr. Peacock mentioned that travel funds were limited, but that he would look into the matter.

Thailand, 27-29 November

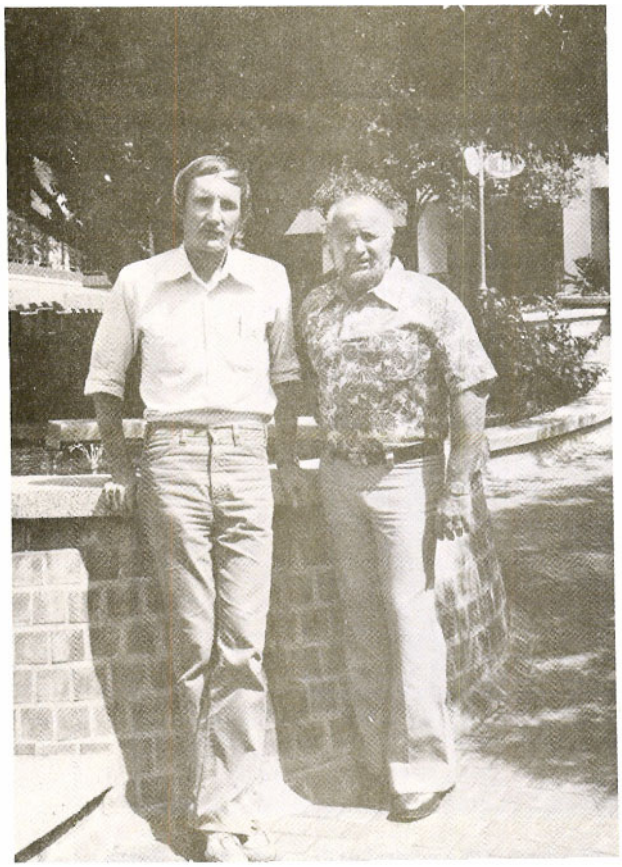
In Thailand I was met by Mr. Sumeth Hinsheranan of the Meteorological Department of Thailand who was an ITIC visiting scientist last year. Mr. Hinsheranan arranged meetings with the Meteorological Department and with the Thai Navy. At the Meteorological Department in Bangkok I met with Mr. Twee Montrivade, Associate Director, and the staff, as well as with Captain Thavon Pongpiput of the Royal Thai Navy. We discussed the Pacific Tsunami Warning System and Thailand's participation, and I expressed the desire to designate Navy tide stations at Songkhla and Phuket as secondary tsunami stations. These stations would provide coverage in the Gulf of Siam and the Andaman Sea and would be helpful in monitoring tsunami activity generated in the vicinity of Indonesia and of the Sunda Trench.

While visiting the Meteorological Department I familiarized myself with the existing seismic network operated by this Department, and discussed the possibility of exchanging seismic information. It was agreed to initiate a communication test in the near future to test transmission and exchange of data and information, using the AFTN network. In addition, we discussed the possibility of submitting a proposal to UNDP for tsunami instrumentation, telemetry, education and preparedness. Mr. Montrivade and his staff were very much in favor of an educational program dealing with natural disasters. Earthquakes and tsunamis do not constitute a serious hazard for Thailand, however, storm surges and flooding are quite frequent so that technology instrumentation, and communications established for

Mr. Twee Montrivade (second from left) Associate Director of the Meteorological Department of Thailand and members of the staff met with Dr. George Pararas-Carayannis during his recent visit to Thailand.

Commander Thanom Charoenlaph, of the Royal Thai Navy, in front of the tide gauge in Bangkok, which serves as a secondary tsunami station.

Mr. Sumeth Hinsheranan, of the Meteorologial Department and Commander Thanom Charoenlaph of the Royal Thai Navy pose with Dr. George Pararas-Carayannis of ITIC in front of the tsunami tide station in Bangkok, Thailand.



Dr. V. Gusiakov of Computer Center, Novosibirsk, USSR - recent visitor to ITIC in Hawaii with Dr. George Pararas-Carayannis Director of ITIC

tsunami monitoring could also serve in the monitoring of other hazards. Disaster preparedness is one area where a great deal of work is needed in Thailand.

Captain Thavon Pongpiput, the national tsunami contact for Thailand, arranged for a visit at the Navy Hydrographic facilities in Bangkok, where I met with Admiral Travit Podhipla and Commander Thanom Charoenlaph. Admiral Podhipla expressed his interest in the tsunami program, and in the state-of-the-art of oceanographic instrumentation. Captain Thavon Pongpiput and Commander Charoenlaph familiarized me with the Thai Navy tide gauge network and agreed that tide stations at Songkhla and Phuket could serve as secondary tsunami stations with which we can establish communications. I promised to forward copies of our wave reporting manual for training of tide observers, and I emphasized the need for testing communications using the AFTN network. I also expressed hope that a delegation from Thailand would attend the ITSU VII meeting in Chile in March. Captain Travon assured me that he would look into this matter and that he was hopeful that a Thai delegation would attend.

Indonesia, 30 November - 3 December

In Jakarta I was met by Dr. Aprilani Soegiarto, Director of the National Institute of Oceanology and our national tsunami contact who arranged for meetings at his Institute and at the Indonesian Navy Department. A meeting was called at the Navy Hydrographic Office sponsored by Admiral Martojo, Chief Hydrographer of the Indonesian Navy. The meeting was attended by Admiral Martojo, by Dr. Aprilani Soegiarto, by Dr. Susanto of the Meteorological & Geophysical Institute and by members of their staff. A great deal of interest was expressed in the Tsunami Warning System and Indonesia's participation into the System. A number of destructive earthquakes and tsunamis have occurred in Indonesia in the last three years with great loss of lives, and interest has been expressed at all government levels in mitigating the effects of such hazards. An Indonesian National Tsunami Committee has been established under the chairmanship of Dr. Aprilani Soegiarto, and this committee has formulated a plan of action dealing with training of observers, with establishing stations and instrumentation, and with a program of public awareness. The need for training of personnel was emphasized, and the hope was reiterated that ITIC may hold some training workshops in the future on tsunami instrumentation and preparedness.

Dr. Susanto and members of his staff familiarized me with recent catastrophic tsunamis in Indonesia, and we agreed of the need for documenting these events with surveys and reports so that we can learn more about these hazards. A great deal of interest was expressed in the formulation of a UNDP proposal for establishing additional tsunami stations and communications in Indonesia. A minimum of 12-15 stations were foreseen as required to cover the Indonesian Archipelago, which is one of the most seismically active areas of the world. It was agreed that stations would be needed not only in the inland seas of the major Indonesian Islands, but also on the Indian Ocean side of these islands, which face the seismically active Sunda Trench. It was agreed that details of the UNDP proposal should be worked jointly between Dr. Soegiarto and myself, and that a

regional tsunami network including seismic and tidal instruments, telemetry, communications and education should be included in the proposal. It was agreed that I should coordinate details of the proposal with Dr. Soegiarto and that I should familiarize the UNESCO Regional Office for Science & Technology of Southeast Asia of our efforts.

Furthermore, Indonesia's participation in ITSU was discussed. Existing tide stations at Jakarta, Surabaya, Makassar, and Cilacap would be useful tsunami stations and I urged that we designate these stations as official tsunami stations. Particularly the station at Cilacap is probably one of the more critical tide stations since it is on the Sunda Trench side of Java Island. I recommended that communications be established between these stations and PTWC.

It is very possible that Indonesia will send a delegation to the ITSU VII meeting in Chile in March 1980. I recommended that the members of the Indonesian delegation stop in Honolulu on their way to Chile to familiarize themselves with the Tsunami Warning Center and the regional Hawaiian tsunami network, and with the procedures followed in Hawaii for Civil Defense. It was agreed that this was a good idea, and I was assured that such a visit would be considered. Also, I extended an invitation for an Indonesian scientist to visit ITIC this coming year under the IOC sponsored Visiting Scientist Program. Dr. Soegiarto will coordinate the nomination of a scientist, and will forward it at a later time.

Following my visit to the National Institute of Science & Technology and the Indonesian Navy, I met with Dr. D. Troost, the Programme Specialist in the Marine Sciences of UNESCO for this region, whom I familiarized with the results of my meetings with Indonesian Government officials, and of the need to proceed with a UNDP regional proposal in support of this program. Dr. Troost was very knowledgeable and familiarized me with the UNDP program for Southeast Asia. He agreed to work quite closely with ITIC and with Dr. Soegiarto and the Indonesian National Tsunami Committee, in formulating this proposal.

Papua New Guinea, 4-5 December

In Port Moresby I met with Mr. Kevin McCue of the Port Moresby Geophysical Observatory. Dr. Ian D. Ripper, Observer-in-Charge, was attending at the time the IUGG Conference in Canberra, but I had the opportunity to meet with him subsequently. Mr. McCue arranged for meetings with Papua New Guinea's Harbour Board, the Hydrographic Department, and the Department of Energy & Minerals. Also, Mr. McCue arranged for a tour of the Port Moresby Observatory, and familiarized me with instrumentation and programs in Papua New Guinea.

The 24-hour exchange of seismic data with Port Moresby Geophysical Observatory was discussed, and I was assured that this was possible if some kind of an alarm device was connected to the seismograph and to the homes of the Geophysicists who live there. I explained that I would look into the availability of such seismic alarm. In addition, we discussed the adequacy of AFTN communications, and communications with existing tide stations

through the Civil Aviation Systems Controller of Port Moresby. A communication test was conducted during my visit at the Geophysical Observatory using the local telephone system and the AFTN network.

The program of data exchange with Port Moresby Geophysical Observatory and with Rabaul Volcanological Observatory was discussed, as well as research programs related to the understanding of the seismicity of the area. In Papua New Guinea the most active seismic zone lies along the New Britain, New Ireland, and Bougainville Island region extending southeast through the Solomon Islands. This is an extremely seismically active area, and damaging tsunamis had been reported in recent years at New Britain, New Ireland, Bougainville and parts of Papua New Guinea. A recent earthquake occurred at West Irian in November of 1979, which produced a small tsunami.

Subsequently to my visit at the Geophysical Observatory, Mr. McCue arranged for a visit to the Harbour Board where I met with Captain Saunders, with whom I discussed the inclusion of tide stations at Arawa Bay, Rabaul, Port Moresby and Vanimo into the Tsunami Warning System. These are stations that were recently established in Papua New Guinea, and which are effectively operated by the Department of Transport and Civil Aviation, Port Managers, Rabaul Volcanological Observatory, and the Hydrographic Department. A communication plan for these stations was drafted recently, and Dr. Ian Ripper supplied ITIC with an extensive communication plan for both seismic and tidal stations in Papua New Guinea.

Subsequently to my visit at the Department of Transport, I visited with Dr. McKinley, Chief Geologist of Papua New Guinea, who assured me that Papua New Guinea is planning to join ITSU, and that they will have a meeting in January with the Foreign Department of Papua New Guinea, to discuss ITSU membership. Further discussions were held with Dr. Ian Ripper in Canberra regarding participation in the UNDP proposal for regional upgrading of seismic and tidal instrumentation, as well as for a program of preparedness and education.

Australia, 6-8 December

In Canberra, I attended the Tsunami Symposium of the Tsunami Commission of the International Union of Geodesy and Geophysics (IUGG). In addition, I participated in the business meeting of the Tsunami Commission of which I am a member, and took notes of the proceedings, action items, and recommendations for reporting in the ITIC Newsletter, and for presenting at the VII meeting of ITSU in Chile, in March. Among the items that were discussed, was the role that ITIC can play in assisting IUGG with its mailing distribution to scientists around the world interested in tsunamis. I assured participants that ITIC and the IUGG Tsunami Commission's interests are parallel, and that ITIC is willing to assist with any efforts that would promote and stimulate tsunami research and understanding. A separate report on the proceedings of the IUGG Tsunami Commission will be prepared outlining the discussions. These proceedings will be reported also in the Tsunami Newsletter.

In addition to the IUGG Tsunami Symposium, I attended other sections of IUGG, particularly those dealing with Tectonics, and with Physical Oceanography. Furthermore, I met with several Geophysicists from New Zealand who were attending the meetings -- among them, Mr. Norman Ridgway, previous Associate Director of ITIC, with whom we discussed New Zealand's tsunami program. Furthermore, I met with Dr. Ian B. Everingham of the Bureau of Mineral Resources of Australia to whom I reiterated our interest in having Australia join ITSU. Australia is the only country of the Pacific that has not joined ITSU, although it has excellent seismic and tidal network and extensive programs in both seismology and oceanography. Participation in the Pacific Tsunami Warning System by Australia will be very highly beneficial, not only to the community of nations participating in the System, but to Australia itself. Occasionally, through ITIC, Australia contributed data to the Pacific Tsunami Warning Center in Honolulu, however, there is no central organization in Australia that can serve as a focal point for coordinating the data exchange and transmission of tsunami messages. I emphasized to Mr. Everingham my concern about the tsunami hazard in Australia which although not frequent, is indeed present. I brought to his attention the effects of the earthquake of 19 August 1977 in Western Australia, and asked that the tsunami hazard in Australia be reviewed once again. I suggested that the Bureau of Mineral Resources should be the focal agency that may coordinate Australia's participation in ITSU.

Report of ITIC's Mission to Colombia and Ecuador, 26 December 1979 - 3 January 1980

A visit was made to Colombia and Ecuador by Dr. George Pararas-Carayannis, Director of ITIC, between 26 December 1979 and 3 January 1980 for the purpose of surveying the effects of the earthquake and tsunami, which struck the coast of Colombia and Ecuador on 12 December 1979. In addition, coordination was carried out with government officials in both countries for the purpose of familarizing them with the Tsunami Warning System. The following is a brief account of activities and findings during this mission.

Colombia, 26-31 December 1979

In Bogota, I contacted an official of the Inter-American Geodetic Survey, Mr. Sam Allen, who arranged for me to participate in the ongoing meetings of an Ad hoc Committee at the Geophysical Institute of Javeriana University. The purpose of these meetings were to assess the effects and impact of the recent earthquake and tsunami disaster in the western part of Colombia, to determine what studies should be conducted, and to determine what type of disaster preparedness plans should be taken in the future to mitigate the effects of such disasters in Colombia. Present at these meetings were:

J. E. Ramirez, S. J. Director, Geophysical Institute, Javeriana University

Colonel Victor Ramirez, General Secretary of the Colombian Civil Defense

Commander J. Alberto Calderon Schrader, Chief of the Hydrographic Section of the Navy

Captain Alberto Martinez Barbosa, President, Colombian Commission on Oceanography

J. R. Geterno, S. J. Geophysical Institute

Dr. Rodolfo Llinas, Sub-Director, Cartographic Institute Augustin Codazzi

Dr. Leonidas Ocola, CERESIS, Geophysical Institute of Peru

Engineer Fabio Pedraza Quigua, Civil Defense of Colombia

Dr. Gabriel Estrada, Geophysical Institute

Maria Pilar Monroy, Javeriana University

A quick assessment of the extent of the disaster was made during these meetings on the basis of available information. The consensus of opinion was that extensive geological, geophysical and oceanographic studies of the affected area should be made to document the effects of the earthquake and tsunami, and to understand better the geology of the region. Each of the delegates of agencies represented at this meeting, outlined a plan of action. The need to coordinate in the future matters related to such disasters was emphasized. It was agreed that tsunamis indeed represent a hazard along the west coast of Colombia, and it was decided that the history of tsunamis and earthquakes in Colombia should be studied. Furthermore, it was agreed that a Scientific Committee should be formalized to coordinate all aspects of the proposed interdisciplinary investigation.

I indicated to the Ad hoc Committee that indeed the tsunami hazard in Colombia has been recognized, and that large earthquakes occurred in 1906 and in 1958, and as recently as in November 1979. I expressed the opinion that a comprehensive historical study would document numerous large earthquakes and tsunamis in the region and I encouraged the undertaking of such a study. I pointed out my previous efforts in getting Colombia to participate in the Tsunami Warning System, and I emphasized the need for joining at this time, and for establishing official tsunami tide stations and communications along the western coast of Colombia, at Bahia, Solano, Buenaventura and Tumaco. The consensus of opinion was that indeed Colombia should join ITSU and the Tsunami Warning System, and that membership would be highly beneficial. Furthermore, I indicated the need for me to gain access to the affected area for the purpose of documenting the effects of the 12 December earthquake and tsunami, and asked the assistance of the Civil Defense and the Navy in providing me with support. Captain Martinez, who is the President of the Colombian Commission on Oceanography, made telephone calls to Tumaco and Buenaventura, and informed local Navy

Commanders of my pending arrival in the area. Civil Defense officials in the region were also contacted, asking them to provide me with assistance during my investigation.

Following my meetings in Bogota, I proceeded to Cali, where I tried unsuccessfully to get in contact with the pilot of the Civil Defense aircraft to fly me over the strickened area. Failing to make contact, I was forced to use a small commercial plane which flew me over part of the affected area and then to Tumaco. In Tumaco I met with Major Rafael Gomez Vergara of the Civil Defense who was coordinating the relief efforts and who briefed me on the local effects of the earthquake and of the tsunami and the extent of damage in the area. Meetings were arranged in Tumaco with Captain Jorge Gonzalez Echeverry, Commander of the Naval Force of the Pacific, and with Commander Calderon Zambrano of the Marines. Captain Gonzalez extended an invitation to me to board the Naval vessel "Andagoya," which was scheduled to take supplies to the islands strickened by the tsunami, before proceeding to Buenaventura. Using vehicles of the Navy and of the Department of Malaria, I conducted a survey of the immediate area of Tumaco, and of adjacent areas. The tide station in Tumaco was never located and no tide gauge record of the tsunami was obtained from the area. No one knew the location of the tide gauge.

The following day I boarded the ship "Andagoya" with which we proceeded to the island of San Juan, one of the major islands that was struck by the tsunami and earthquake. While the ship was unloading supplies, I undertook a survey of the coastal areas using a motorized canoe and making appropriate stops to make measurements and to take photos. Following the survey of the earthquake and tsunami, I reboarded the "Andagoya" and proceeded to Buenaventura. Because of the holiday season I was unable to obtain mareographic record of the tsunami in Buenaventura. However, efforts will be made to locate these records if indeed they exist. From Buenaventura I proceeded to Cali from where I traveled to Guayaquil, Ecuador.

Ecuador, 1-3 January 1980

In Guayaquil, I visited officials of the Oceanographic Institute of the Navy (INOCAR), with whom we had several communications in the past. Because of the holiday season, a number of people were absent. However, I met with Commander Patricio Padilla Mera, Sub-Director of INOCAR, and with engineer, Freddie Villao. My visit to Guayaquil was very fruitful as I was able to obtain the only available mareographic record of the tsunami from the northern port of Esmeraldas in Ecuador. Commander Padilla promised that additional records from other tide gauges in Ecuador will be sent to me. Copies of tide tables and other interesting publications were obtained to assist me with my investigation of the 12 December tsunami. Furthermore, I coordinated with INOCAR personnel aspects of Ecuador's participation in the Tsunami Warning System and emphasized the need for better communications with INOCAR in Guayaquil. Commander Padilla suggested that future communications with INOCAR be made directly via TELEX, rather than by using AFTN communications. He assured me that there are 24-hour-a-day operations at INOCAR, and that this would be the more

appropriate means of communication as there are several delays with the system presently used. Commander Padilla also suggested that instead of Baltra Island we install a tide gauge station at San Cristobal Island since maintenance of the gauge on that Island can be assured, as well as good communications. He expressed interest in new instrumentation and Ecuador's active participation in the Tsunami Warning System.

Director of ITIC Visits USSR

Dr. George Pararas-Carayannis, Director of ITIC, visited USSR last September and participated in the XIV Pacific Science Congress at Khabarovsk. In addition to giving a paper, Dr. Pararas-Carayannis gave a talk about Hawaii to a general audience, and was also interviewed for an English speaking radio program.

Following the Tsunami Symposium of the XIV Pacific Science Congress, Dr. Pararas-Carayannis participated in the informal discussions of the proposed Joint Experiments under the US/USSR Environmental Agreement. Present at this meeting, were scientists from the Sakhalin Complex Scientific Research Institute in Sakhalin and from U.S. NOAA's Joint Fisheries and Marine and Atmospheric Research. Dr. Sergei Soloviev, Dr. S. Lappo, Dr. E. Pelinovsky, Dr. A. Rabinovitch, Dr. E. Kulikov and several others, in addition to NOAA's Dr. Les Spielvogel and Lt. Steve Poole participated in the discussions outlining the Joint Tsunami Experiments to take place next year.

Following his visit at Khabarovsk, Dr. Pararas-Carayannis proceeded to Moscow where he met with scientists of the University of Moscow.

L to R: Dr. L. Spielvogel, Dr. A. Poplavsky, Dr. G. Pararas-Carayannis, Dr. Y. Starikov, and Lt. S. Poole, in Khabarovsk, USSR.

Visiting Scientists at the ITIC

During the past months, ITIC was visited by the following scientists:

Mr. Burton H. Kirschner	National Weather Service Headquarters, U.S.
Ms. Vivian M. Cottman	National Weather Service Headquarters, U.S.
Mr. James F. Lander	NOAA/EDIS, U.S.
Mr. Rajendra Singh	Mineral Resources Department of Fiji
Prof. Robert L. Wiegel	University of California, U.S.
Mr. V. K. Gusiakov	Computer Center, Novosibirsk, U.S.S.R.
Mr. Robert L. Pyle	NESS/Satellite Field Service Station, Honolulu Airport
Dr. Gordon Vaeth	NOAA/NESS, Washington D.C.
Ms. Pat Hoxie	National Weather Service Headquarters, U.S.
Mr. Gehard Rert	Munich, West Germany
Mr. Kenneth W. Osborn	AID/NOAA, Washington D.C.
LT Steve Poole	Joint Institute of Marine & Atmospheric Research, Honolulu
Dr. Les W. Spielvogel	Joint Institute of Marine & Atmospheric Research, Honolulu
Dr. Ian D. Ripper	Geophysical Observatory, Port Moresby, Papua New Guinea
Mr. Mickey K. Moss	NOAA, Pacific Tide Party, U.S.
LTJG Marianne Molchan	NOAA, Pacific Tide Party, U.S.

NATIONAL AND AREA REPORT

New Tsunami Warning System Stations

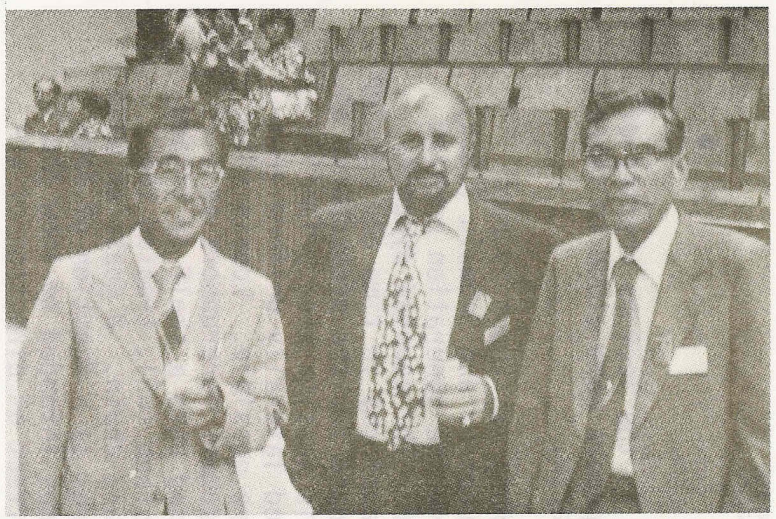
Approximately $100,000 is available to the Ocean Services Division of the U.S. National Weather Service for GOES platforms for the Tsunami Warning System. Part of the money will be used for site selection and installations of four automated tide stations. The following stations in order of priority, are considered for GOES platforms: Galapagos Islands, Easter Island, Socorro Island, Callao, LaPunta, Arica, Antofagasta, Valparaiso, Manzanillo, Acapulco, and Talcahuano. A preliminary site survey for the first automated tide stations has been completed.

XIV Pacific Science Congress, Khabarovsk, USSR, 20 August - 5 September 1979

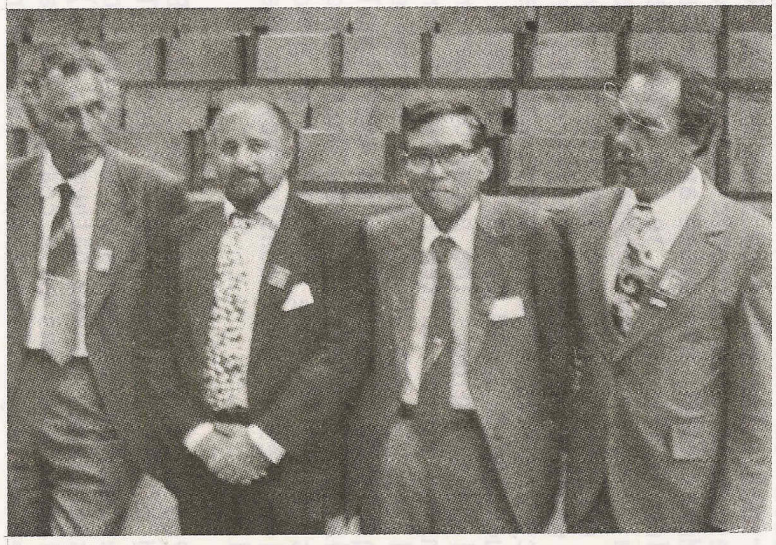
The XIV Pacific Science Congress was held in the city of Khabarovsk, USSR, between 20 August - 5 September 1979. Conferences of the Association are

Some of the Participants to the Tsunami Symposium of the XIV Pacific Science Congress, in Khabarovsk, USSR.

Dr. G. Pararas-Carayannis, Prof. S. Soloviev, Dr. Kusacov and Dr. Rabinovich, attending one of the social functions of the Pacific Science Congress in Khabarovsk, USSR.



Dr. Abe (left), University of Niigata and Dr. Iida, University of Nagoya (right) with Dr. G. Pararas-Carayannis, ITIC, at the Pacific Science Congress in Khabarovsk.



Prof. S. Soloviev, USSR; Dr. G. Pararas-Carayannis, ITIC; Dr. K. Iida, Nagoya University; and Dr. S. Lappo, Sakhalin Scientific Institute pose during a brief recess of the Tsunami Symposium of the Pacific Science Congress, in Khabarovsk, USSR.

Report on the IUGG Tsunami Symposium Canberra, 1979

By Harold G. Loomis, Convenor

The Tsunami symposium was held on Dec. 6-7, 1979 in the lecture theatre of the Australian Academy of Sciences. Twenty one papers were given in three sessions covering the full range of tsunami research.

The 1st session, chaired by Dr. Roger Braddock (AUS) was about tsunami generation and propagation. The paper by Voyt, Lebeder and Sebekin (USSR) reported a continuation of Soviet efforts to solve the generation problem treating the complete earth-ocean system together. The coupled dynamic equations are written and by means of Laplace transforms in time and Fourier transforms in space, an integral expression is found for the disturbance at the ocean surface. The rest of the papers in this session were primarily numerical. The paper by Shaw and Neu (US) treated laterally uniform geometries where time-harmonic standing wave forms are possible. Loomis (US) and Murty (CAN) discussed an interpretation of tsunami forerunners as a portion of the tsunami in the deep ocean diffracted onto a shelf or island ridge. The paper by Hebenstreit, Bernard and Vastano (US), treated the time dependent wave problem for the Hawaiian Island chain. A guassian wave form was time-stepped into the chain and the energy as a function of frequency and shoreline location was stored. This was intended to show the frequencies trapped by various islands and the effect of direction of arrival on trapping. The paper by Farrar (US) included turbulent mixing as a damping factor in the response of harbors to tsunamis. The paper by Melville (US) was about the mach-stem effect in which waves travelling obliquely to a coast have an additional amplification. The effect is essentially non-linear and the Boussinesq formulation is used. Tank experiments do not measure the effect as predicted and it is suggested that the problem lies in an inconsistency in the formulation of the mathematical model.

The 2nd session, chaired by Dr. Eddie Bernard (US) was about research related to the tsunami warning system. The paper by Adams and Lewis (US) suggested that segments of coastline could be treated as prototypes (convex shoreline, convex bathymetry, etc.) and predetermined amplifications applied to sections of a coast. The paper by Spielvogel (US) suggested a system whereby all research results were in a memory bank and used in real-time by the warning system. The paper by Bernard (US) discribed the use of computers and satellite communications in the warning system. Murty (CAN) and Loomis (US) propose a tsunami magnitude scale based on total tsunami energy, namely $M = 2 (\log E-19)$, which makes tsunami magnitudes compatible with earthquake magnitudes. Miyoshi (Japan) reported on the folly of building sea-walls on sand where liquifaction during an earthquake is likely. Curtis and Loomis (US) reported on a prototype tsunami wave gauge using a semiconductor strain gauge and a solid state memory. Caputo (Italy) presented a surprisingly long list of tsunamis in Italy. These appeared to be mostly associated with slumping or landslides during earthquakes. Morgan (US) was for more public education about the warning system.

The 3rd session, chaired by Prof. Kumizi Iida was about general tsunami problems. Tuck (AUS) treated the problem of the uncertainty of knowledge about the source of the tsunami generation. Even in the much-studied 1964 Alaskan Earthquake, uncertainties about the source deformation make tsunami wave prediction problematical. Noye (AUS) discussed tsunami propagation when velocities are not uniform on a vertical section. Heath (NZ) saw tsunami amplification in New Zealand as being related to waves trapped on a ridge running east from the north coast of the South Island. Braddock and Voss (AUS) presented an algorithm for finding minimum travel time paths across the ocean. The Soviet papers by S.L. Soloviev and I.V. Tulupov, E.N. Pelinovsky and Yu. A. Stepanvants; and S.N. Ostroverkl and V.M. Seimov were summarized.

At 1130 Dec. 7, a meeting of the Tsunami Commission was held. Dr. Loomis chaired the meeting at Prof. Iida's request. Officers elected were: Prof. Kumizi Iida, Chairman; Dr. T.S. Murty, Vice-Chairman; Prof. S.S. Voyt, Vice-Chairman, Dr. H.G. Loomis, Secretary. New members for the commission were elected as follows: R.P. Shaw (US), E.N. Bernard (US), G. Dohler (CAN), I. Ripper (Papua), H. Miyoshi (Japan), T. Iwasaki (Japan). An invitation from Japan to hold the next tsunami symposium in Ofunato, Japan in May 1981 was offered and accepted by the commission. Several resolutions were passed encouraging the collection and digitization of tsunami records, encouraging the establishment of national tsunami committees, and thanking the Canadian Dept. of Environment and Fisheries for publishing Murty's book on Tsunamis and the Proceedings of the Ensenada Symposium.

The program of the symposium follows.

National Report to the IUGG Tsunami Commission on Tsunami Research in the United States, 1975-1979

The national report consisted of the following Documents:

1. Tsunami Research in the U.S., 1975-1979, by Dr. Harold G. Loomis
2. The U.S. Tsunami Warning System, 1979, by Dr. E. N. Bernard
3. Report to IAPSO by Prof. R. O. Reid
4. Tsunami Data Services, A Status Report to the IUGG Tsunami Committee, by Lt. John B. Nelson, NOAA

Tsunami Research in the U.S., 1975-1979

Dr. Harold G. Loomis
Joint Institute for Marine and Atmospheric Research
University of Hawaii
Honolulu

During the period covered by this report, the research activities in tsunami were declining due to reduced funding. The Joint Tsunami Research Effort at the University of Hawaii was dissolved and Tsunami efforts continue individually within the Joint Institute for Marine and Atmospheric Research which has broader research interests as its name implies. This reduction in effort was offset somewhat by the inclusion of tsunami as part of the Earthquake Hazards Reduction Act. Funding for tsunami research has been available through the National Science Foundation and the U.S. Geological Survey. Research projects are now funded in finite-element wave propagation schemes, and in experimental and theoretical work in nonlinear tsunami wave propagation. A second impetus for Tsunami research (but little money) has come from the national Flood Insurance Act which requires the definition of the Coastal High Hazard Zone. This gives a very sharp focus to the problem of predicting tsunami wave heights, extent of flooding, and frequency of tsunami recurrences. Under this program, tsunami wave heights on the West Coast of the U.S. were calculated numerically from hypothetical generating areas in the Pacific. A steady-state, finite-element model of the Hawaiian Islands was constructed which was then used to predict transient wave heights by harmonic decomposition. A finite difference program which includes flooding has been constructed for predicting tsunami inundation.

On Nov. 29, 1975, a damaging local tsunami was generated near Kalapana, Hawaii. Waves of 8 meters were common near the source region and approximately 300 km of coastline was affected. Careful measurements were made of maximum wave heights along the coast. A time-stepping, finite-element scheme was used to simulate this tsunami, and the results compared reasonably with measured wave heights. Even though this earthquake was closely observed and the displacements of the land carefully measured, it was impossible to find the information needed for tsunami generation. This points up another problem which is getting more attention in the last year, namely, what do we need to know about earth motion to give reasonable solutions to the generation problem, and where do we get the necessary information for this?

A continuing program of US-USSR cooperation in tsunami research resulted in several exchanges of scientists for periods of up to 4 months. In 1975, a joint US-USSR project was carried out to place pressure gauges on the ocean floor over a two month period near Hokaido in hopes of measuring a tsunami in the deep ocean. No tsunami occurred. However, the deep ocean measurements of about 20 days duration from seven gauges are useful data for measuring tides and edge waves. A similar experiment in 1978 was carried out from a Soviet ship that placed pressure gauges along a line from Hokaido to Guam. Three of these were recovered within approximately 30 days of record each, but no tsunami had occurred. The experiment also

involved four ocean-bottom seismometers along the flank of the Japan Trench, but only one record was obtained from these. This record was useful in estimating seismic velocities in this region.

Two other instrumental programs that are near completion should be mentioned. A program at JIMAR is under way to put a deep-ocean pressure gauge under a buoy. The data is transmitted from the gauge to the buoy acoustically and relayed to shore by radio telemetry. The second part of this project is the completion of a radio-satellite link to relay data from the buoy to shore. A preliminary step toward this goal is now being done by relaying a signal by satellite from a gauge in moderately deep water at Wake Island.

Probably the greatest progress in the last four years has been in the area of computing. The size and speed of computers has increased to where considerable refinement and accuracy is now expected from computational problems. The finite-element approximations to the wave equation show great promise for tsunami work because the mesh can be tailored to the region - the problem of constructing a transparent boundary to a computational region has been widely examined and a number of schemes are now in use in computations that greatly reduce boundary problems, at least for a while.

U.S. Tsunami Warning System, December 1979

Dr. E. N. Bernard
Director
Pacific Tsunami Warning Center

Through a series of technological and management changes, the U.S. National Weather Service has placed special emphasis on improving tsunami warning services. Recognition of problems in acquiring data and quickly reacting to local tsunami events has lead to the formulation of long term plans which will significantly enhance the tsunami warning system.

The National Weather Service set the stage for tsunami warning emphasis by changing the names of Honolulu and Palmer Observatories to the Pacific and Alaska Tsunami Warning Centers. The Pacific Tsunami Warning Center is now required to develop techniques to improve tsunami warning services. To assist in this evolution, two physical oceanographers have joined the tsunami warning system. The present composition of professional staff at the two centers is six seismologists and two oceanographers.

Technological developments may be described in three areas: 1) the creation of a computer system which involves dedicated on-line mini-computers and time-share access to a large memory computer; 2) the implementation of a tide gage which transmit real time data via satellite to the warning center; and, 3) the establishment of a reliable real time tsunami monitoring system for the Hawaiian Islands.

The computer system now in use by the tsunami warning system was designed to serve the present and future real time computational needs of each

center and to satisfy large scale modeling project needs. The real time requirements were satisfied by the installation of a mini-computer at each center. These computers will automatically monitor seismic and tide activities of the Alaska and Hawaii regions so that rapid reaction to tsunamis may be accomplished. The computer automation is expected to make warning services in these areas faster and more accurate. Completion of this project is scheduled for 1982. The large scale modeling projects are to be satisfied by utilizing a time-share system. This system has large memory computers located in Chicago and Washington, D.C. which are accessible by Alaska and Pacific Tsunami Warning Centers. Not only does this system provide the ability to conduct large model experiments, but also allows each center to act in each other's place. Thus, the time-share system is a valuable back-up system.

Another equally important technological development is the utilization of satellites to transmit tide and seismic data to the warning centers in real time. One prototype sensor monitors water levels by a tide gauge which stores the data in digital form until the data is requested. Another prototype sensor monitors seismic activity until the background noise level exceeds a certain threshold. The time of threshold breaking is stored as the time of "P" wave arrival and is available upon request. These platforms are interrogated by a NOAA geostationary satellite upon request from the tsunami warning centers. The time required from requesting data until receipt of data at the centers is about three minutes. These prototype systems have been monitored for two years and demonstrate a 98% communication reliability in over 4800 transmissions. This is a great improvement over conventional teletypewriter circuits which may take hours to relay information from point to point. Four tide stations in South and Central America are scheduled for upgrade to satellite communications in 1980. Utilizing the satellite communication system, tsunami warnings can be issued much faster to the Pacific community.

A third area of technological development is the establishment of a real time tsunami monitoring network in Hawaii. The network consists of nine seismometers and four tide gages on the Hawaiian Islands of Oahu, Maui, and Hawaii. Data from these instruments are telemetered in real time to the Pacific Tsunami Warning Center via a VHF frequency modulated system and dedicated land lines. From each instrument, data are transmitted at a particular sub-carrier frequency, mixed with other frequencies, and transmitted along a carrier frequency to PTWC. At PTWC the individual frequencies are separated and recorded for use in the tsunami warning system. The average operational reliability of each component in the system has been 97% during the last 18 months. By having thirteen components (4 tide, 9 seismic) transmitted over two different VHF paths, the probability of total system failure is less.

Report on IUGG Committee on Tsunamis for the Period 1976-1979 *

Prof. R. O. Reid
USA

Symposia relating to the subject of tsunamis were held at several international meetings during the reference period. These include:

Session on Tsunamis at the 15th International Conference on Coastal Engineering, 11-17 July 1976, Honolulu, Hawaii

I.U.A.M. Symposium on Surface Gravity Waves in Water of Variable Depth, at Canberra, 18-23 July 1976

I.U.G.G. Symposium on Tsunamis, 23-26 March 1977, Ensenada, Mexico

Symposium on Long Waves in the Ocean, National Research Council of Canada, 6-8 June 1978, Ottawa, Canada. Endorsed by IUGG, among others.

The following workshop to identify needed research on tsunamis is also relevant.

Workshop on Tsunamis, 6-9 May 1979, Trabuco Canyon, California Sponsored by the U.S. National Science Foundation

The Tsunami Committee of the IUGG met in business session on 26 March 1977 at Ensenada with eleven members in attendance. Vice-chairman K. Iida (Japan) presided in the absence of Chairman S. L. Soloviev (USSR). Dr. H. Loomis (USA) was selected to fill the vacancy left by the death of Dr. Gaylord Miller (USA). Dr. T. S. Murty (Canada) was elected as second vice-chairman and Dr. Loomis as secretary. Agenda items included plans for the Tsunami Symposium at the present IUGG General Assembly in Australia. Also a sub-committee (chaired by Dr. W. M. Adams, USA) was named to look into the matter of data exchange and data requirements for tsunami research. Several resolutions were adopted, including a recommended procedure to be followed by the International Tsunami Information Center (ITIC) in conducting tsunami surveys for large tsunamis.

Other meetings pertinent to tsunami-related activities include the 5th and 6th meetings of the International Coordination Group for Tsunami Warning System in the Pacific (ICG/ITSU) of IOC which were held in Lima, Peru, 23-27 February 1976 and Manila, Philippines, 20-25 February 1978, The next meeting of this group will be in March 1980 in Chile.

In closing this report, I should like to draw attention to the subsuming of the Joint Tsunami Research Effort (JTRE) under the newly-established Joint Institute for Marine and Atmospheric Research (JIMAR) of the U.S. Department of Commerce, NOAA, in cooperation with the University of Hawaii, Honolulu.

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* *Submitted to the Plenary Session of the XVII, IAPSO General Assembly, Canberra, Australia, December 1979.*

Tsunami Data Service -- A Status Report to the IUGG Tsunami Committee

LT John B. Nelson
NOAA

The World Data Center (WDC) system, first established by the International Council of Scientific Unions (ICSU) in 1957 for the International Geophysical Year, collects and distributes data from a variety of scientific disciplines. As a result of its initial success in the field of geophysics, the WDC system has become increasingly active through the years in the fields of solid earth geophysics, glaciology, oceanography, rockets and satellites, meteorology, and solar-terrestrial physics.

As part of its activity in the solid earth geophysics disciplines, World Data Center-A, operated by the United States, has been developing a data base for tsunami research. The guidelines for data exchange have been established and are periodically revised by ICSU's relevant associations and unions. At present, the data base is composed of three principal data sets: 1. microfilm of all available tide gage mareograms depicting tsunami activity; 2. a photo file of tsunami waves and their resulting effects; and 3. seismograms recording tsunamigenic earthquakes.

World Data Center-A is striving to fulfill its goals of producing and preserving as useful and complete a data base as possible. This requires the establishment of an effective but flexible system to aid the flow of data into and out of the center. WDC-A's policy of exchanging data with contributing sources has encouraged and increased the data flow and interest surrounding the many ongoing programs underway at its centers. Hopefully, this method of data exchange will promote the creation of the tsunami data base.

DATA BASE

The current tide gage microfilming project files are taken from two sources. The first is the holdings of the International Tsunami Information Center, consisting of data from Pacific-wide stations operated by the countries of North and South America, the South Pacific, and Japan. The primary events documented by this subset are; April 1, 1946; November 4, 1952; March 9, 1957; May 22, 1960; and March 28, 1964. This collection is available upon request on 35-mm microfilm for the cost of duplication.

The second collection of tide gage data is from the National Ocean Survey/NOAA. This collection is being assembled from archive originals and will be available on 35-mm microfilm or microfiche. The 35-mm microfilm will contain approximately 20 station-months per reel. The 35-mm microfiche will contain a minimum of 5 days of analog data encompassing an event for each reporting station. The microfiche will also contain a header or pertinent data relating to the particular recording station site status just prior to the event's arrival. This microfilm mareogram file currently contains 2000 mareograms for events from through 1975. It will eventually contain over 3,000 records from United States maintained gages and stations worldwide, for over 150 events from 1854 to the present. Current information on the holdings of the WDC-A is available upon request.

The second focal point of the WDC-A tsunami data base effort is a photographic file containing over 700 photos of tsunami waves and resulting damage. This collection is intended to satisfy the many varied requests from engineers, teachers, and researchers.

The photographic file has many contributors including the International Tsunami Information Center, Joint Institute for Marine and Atmospheric Research, U.S. Army Corps of Engineers, U.S. Navy, Japan Meteorology Agency, and the Bureau of Mineral Resources, Geology, and Geophysics of Australia. The photographs in this file each have captions giving photograph date, event date, photograph description, and credits. The photographs also have an index numbering system that contains keyword descriptors of the photograph. These descriptors specify the photo location, event location, photo subject, photo quality, etc. These two systems allow an investigator to select photographs by either reviewing captions or by indicating keyword information for computer searches. We are adding to this file as other sources are located.

WDC-A's future activity will be directed at completing the tsunami mareogram and photograph files through various means. For example, with the endorsement and assistance of the International Hydrographic Bureau (IHB), an article requesting tsunami data in the form of mareographic and photographic data was printed in the January 1979 issue of the IHB's monthly publication. The IHB also sent requests for data to selected member countries. A number of positive responses have already been received from such countries as New Zealand, Japan, Chile, Hong Kong, and Australia.

The third portion of the tsunami data base is concerned with the seismogram data set. The holdings of this file extend from 1962 to the present, with over 3.5 million chip copies of seismograms available in the file. The seismograms are available in several formats; 70-mm positive and negative (rolls and chips), 35-mm rolls, and full-size paper "blowbacks."

WDC-A, in conjunction with the U.S. Geological Survey and in response to an International Association of Seismology and Physics of the Earth's Interior (IASPEI) recommendation, is attempting to complete its seismogram file by collecting and microfilming seismograms worldwide from the earliest available (late 19th Century) to 1962. In undertaking this historical seismogram project, WDC-A is attempting to preserve, maintain, and update as complete a seismogram file as possible for present and future researchers from many scientific fields. Current plans are to film the entire file of seismograms at a small select network of worldwide stations. Selected events including all large tsunamigenic earthquakes will be filmed at a more extensive network of stations for addition to the file. Organized sets of station bulletins may also be filmed and made available in the same form as the 1962 to present day portion of the file.

ADDITIONAL ACTIVITIES

Once it is completed, this tsunami data base will be available to interested parties through the centers of the World Data Center System on an exchange basis for contributors or at the cost of producing the copies.

In conjunction with the creation of this data base, several publications, application computer programs, and related projects are in the preparation stages and will hopefully increase its usefulness to the research community.

Current publications available from WDC-A include the catalogs: "Tsunamis in Alaska," "Tsunamis in Hawaii," and "Tsunami Photographs." There is also a flier announcing the data available from the tide gage mareogram file. Other tsunami publications are available from the WDC-A Tsunami library file, depending on copyright provisions. These include catalogs, research papers, proceedings from meetings, etc. Prospective WDC-A tsunami publications in the near future include a catalog of tsunami mareograms and a world map in color showing areas of reported tsunamigenic earthquake activity and locations which commonly receive extensive damage from tsunamis. Included on this map will be a data summation for the major events depicted on maps such as death and destruction figures, and particular wave and seismic information.

There are also plans for a set of computer application type programs that will operate on the data sets in two ways. First, a set of inventory type programs will be able to give a requestor information on the availability of either seismic, photographic, or mareographic data. Secondly, specific programs will be able to draw out seismic and tsunami wave data information on particular events and either present the raw data or display it on a plotted geographical representation.

In the near future, WDC-A will become more involved in a project to digitize mareograms. The data are presently being studied by Dr. Harold Loomis to determine the logistical and data format problems that must be handled to produce a useful digitized data set. This is to be discussed at the Canberra meeting of the IUGG Tsunami Committee to establish an internationally acceptable format. WDC-A will also be undertaking a tsunami atlas project with the International Tsunami Information Center (ITIC). The atlas will contain both information on the digital representation of the analog record and necessary information on the analog record itself.

WDC-A has a guest worker program to allow visiting scientists an extended access to the different data files. This program provides office space, support, access to data and data processing equipment, and limited financial support. Inquiries are invited.

SUMMARY

In the last several years, major progress has been made in developing a useful data base of mareograms, seismograms, and tsunami effect photographs. In the future there will be increased efforts to expand the holding of mareograms, seismograms, and photographs as outline in the new Guide for International Data Exchange both in terms of additional foreign records and records for earlier events. There will also be services developed which will present these data in ways which will be useful to both researcher and layman alike.

Tsunami Station Inspection

During the period of June 27 to July 21, 1979, the Pacific Tide Party personnel inspected the Alaska Tsunami Warning System at the following stations:

June 27-28	Yakutat
July 1-2	Kodiak
July 6	Seward
July 9-11	Sand Point
July 12-17	Unalaska
July 17	Sitka
July 19-21	Adak

On the whole, all tide and tsunami equipments inspected were found in good operating condition. In some stations, metercraft gas-purged pressure tide gauges were installed.

Visit of People's Republic of China Delegation to Hawaii

A 15-person delegation of scientists from People's Republic of China visited scientific facilities in Hawaii including the Pacific Tsunami Warning Center (PTWC) on December 6-7, 1979. The visiting group of five meteorologists and ten oceanographers was led by the Deputy Chief of the Chinese Meteorological Service. The group was on an extensive tour of the U.S. facilities and institutions. In addition to the PTWC visit, the group, while in Hawaii, visited scientific installations on Mauna Loa, at the University, and at the Honolulu Weather Forecast Office.

ANNOUNCEMENTS

Earthquake Education

San Francisco State University has initiated a teacher training program in earthquake education as part of the National Science Foundation's Precollege Teacher Development in Science Project. The objective is to promote a student awareness of, and an interest in, the environment through the study of earthquakes. This program will aid elementary school teachers by providing: 1) background information necessary for an understanding of earthquakes, 2) assistance in the development of an interdisciplinary curriculum on earthquakes, 3) laboratory and field experience for a greater understanding of earthquake effects, and 4) continuing guidance and support to enable teachers to serve as resource personnel within their school or district. For information about this program contact: *Raymond Sullivan, Department of Geology, San Francisco State University, San Francisco, CA 94132, (415) 469-2080.*

Symposium of Natural Disasters as Environment

A general symposium of Natural Disasters as Environment will be held as part of the Congress of the International Geographical Union in Tokyo, September 3, 1980. The aim of the symposium is to exchange and summarize geographical experience, knowledge and methods that might be useful in future studies on natural disasters throughout the world. Particular attention will be given to a global summary of disasters and prevention, extreme meteorological events, and earthquakes. Papers dealing with damages and human response to natural disasters are solicited.

Information about the symposium and details of paper submission are available from *Takamasa Nakano, Department of Geography, Tokyo Metropolitan University, Setagaya-ku, Tokyo, Japan.*

International Newsletter Published

The first issue of Disaster Preparedness in the Americas, published by the Emergency Preparedness and Relief Coordination Unit of the Pan American Health Organization (PAHO), contains information about the activities of PAHO and of other organizations involved in disaster planning and assistance. In addition, the newsletter invites readers to submit news about disaster planning activities in member countries. Monthly searches of world literature are conducted by PAHO and particularly relevant publications are noted in the newsletter. To be added to the mailing list write: *Emergency Preparedness and Disaster Relief Coordination Unit, Pan American Health Organization, Regional Office of the World Health Organization, 525 23rd Street, N.W., Washington, DC 20037, (202) 233-4700.*

Research on Ilopango Volcano Eruption in Central America 300 AD

Past Volcanic Eruptions in Central America: Geologists have long recognized Central America as one of the most volcanically active areas of the world. Recent information indicates that it is one of the most hazardous as well. Research at the University of Colorado has encountered evidence of a massive volcanic disaster circa 300 AD. When Ilopango volcano erupted in what now is the center of El Salvador, thousands of square kilometers of fertile Mayan farmland were rendered uncultivable. This research has studied the process of recovery from that disaster: recovery of soils by weathering, recovery of vegetation, and human recolonization. Soils have yet to fully recover their pre-Ilopango fertility. Vegetation recovery was somewhat more rapid, largely occurring within a century or two after the eruption. Human recovery was well underway in the research area by 500 AD when another eruption struck. Although more localized than Ilopango, the ash from Laguna Caldera volcano deposited 5m of sterile overburden on villages and farmhouses in the area. Evidence was encountered of two still later eruptions (1000 AD, Volcan San Salvador, and in 1658 AD, Volcan El Playon), indicating the hazardous nature of the Salvadoran environment in prehistory and contemporary times.

Project for Natural Disaster Vulnerability Analysis at Center for Development Studies of the University of Bath

The project for analyzing natural disaster vulnerability, established in December 1977, has commenced with a study of international attitudes conditioned by distant disaster magnitudes, and has assessed the national scale of occurrence upon small, particularly island, countries.

Field work and research analysis have been or are being undertaken on Sri-Lanka, Tonga and Indonesia.

Selected publications from the project include:

1. "Towards Self-Reliance in Disaster"
2. "Volcano in Tonga"
3. "Disaster Assistance: Appraisal, Reform and New Approaches"
4. "Mitigation and Preparedness for Natural Disaster in the Kingdom of Tonga"

For more information about the publications and project, please contact: *Dr. James Lewis, Project for Natural Disaster Vulnerability Analysis, Centre for Development Studies (H & SS), University of Bath, Bath BA2 7AY, England.*

Documentary Film on Tsunamis

A 30 minute film production on tsunamis has been prepared by Hawaii Public Television. The purpose of the film is to remind the population of Hawaii of the dangers associated with tsunamis and to bridge the gap between scientific based warnings and individual response to these warnings. The filming took place during the summer of 1979 and has been completed.

New Hazards Center in Australia

A Centre for Information and Research on Disasters and Natural Hazards has been established at the Caulfield Institute of Technology in Victoria, Australia. Initially the Centre will serve as a broad-based, multi-disciplinary clearinghouse for information and research relating to disasters throughout Australia, with the expectation of eventually expanding its operation to include information from other countries. The emphasis is on psychological, social, economic and human geographic aspects of disaster mitigation and recovery. The Centre welcomes information about similar work in other countries and will send a description of its activities upon request. *Ian G. Murray, Acting Coordinator, CIRDNH, Caulfield Institute of Technology, 900 Dandenong Road, P.O. Box 197, Caulfield East, Victoria, 3145, Australia.*

Handbook of Dos and Don'ts Available

A Natural Hazards Awareness Workshop was held in Corpus Christi, Texas, March 21-23, 1979. The workshop, funded by the National Oceanic and Atmospheric Administration, was jointly sponsored by the Texas Coastal and Marine Council and the Natural Hazards Research and Applications Information Center, with Texas A & M University acting as the host institution. The conference participants exchanged information on approaches which have been used to improve hazard awareness and discussed steps which might be taken to improve the effectiveness of future awareness efforts. A "Handbook of Dos and Don'ts" will be available shortly. Contact: *Sally Davenport, Texas Coastal and Marine Council, Hurricane Awareness Program, P.O. Box 13407, Austin, TX 78700, (512) 475-5849.*

Oceanexpo 80

The fourth Oceanexpo in conjunction with Oceantropiques will be held from 4 to 8 March 1980 in Bordeaux, France. It will be an exhibition and symposium on the achievements, activities and projects of the developing countries particularly concerned with the seas, rivers, lakes and lagoons. It will also be the main centre for meetings on technical and commercial questions between the industralized and developing countries. For information, please write or telephone: *Louis Algoud, OCEANEXPO, 8 rue de la Michodiere, 75002 Paris, France, telephone 742-9256, telex 210550 Systele Paris Extension 135.*

Detailed Hydrographic Data Available

The above mentioned data for 58 one-degree-square areas off the California and Hawaii coasts are now available from the National Geophysical and Solar-Terrestrial Data Center (NGSDC). These data supplement the ones from the Atlantic and Gulf coasts available previously. Other hydrographic data for Alaska, the Great Lakes and the remainder of the Atlantic, Gulf and Pacific Coasts should be available by the end of 1979. For further information, write: *National Geophysical and Solar-Terrestrial Data Center, NOAA/EDIS, Code D621, Boulder, CO 80303.*

Tide Gauge Records, Photographs and Seismograms on Tsunami Events Available from World Data Center-A

Tide gauge records on 33 tsunami events that occurred from 1963-75 available in microfiche format for $0.50/fiche. Records include Alaska, U.S. Pacific coasts, Hawaii, and North and South Pacific.

A file of 500 photographs covering eight major tsunamigenic events is also available in prints, negatives and slides format. These eight major events are as follows:

arranged every four years, in a member country. The following fourteen Scientific Committees of the Science Council of the Pacific Science Association held concurrent meetings in Khabarovsk: Botany; Environmental Protection; Entomology; Forestry; Fresh-Water Sciences; Geography; Marine Sciences; Museums in Pacific Research; Nutrition; Public Health and Medical Sciences; Science Communication and Education; Scientific Study of Coral Reefs; Social Sciences and Humanities; and Solid Earth Sciences. A Tsunami Symposium was held on 29-30 August 1979 under the Marine Science Section under the chairmanship of Professor S. Soloviev.

The following are the topics of tsunami papers presented at the Pacific Science Congress:

On Deformation of Tsunami Wave Symmetrical Over Axis

International Tsunami Watch and Warning Service. State and Problems

Theoretical and Experimental Investigations of Long Waves in the Kuril ARC Region

Tsunami Run-Up on Shores with Different Profiles of the Bottom and Land

Tsunami Investigation in the Open Sea

Current Tsunami Research

The Lowest Mode in the Narrow Mouthed Bay at the Initial Stage of a Inundating Tsunami

Nonlinear Dynamics of Tsunami Waves

On the Numerical Tsunami-Zoning Problem

On the Some Model of the Tsunami Waves Generation Under the Horizontal Bottom Displacement

Tsunami Problems in Relation to the Life of Pacific Communities

Numerical Modeling of Tsunami Flooding

On Works of Tsunami Problems in Japan

Marine Geodetic Applications to Tsunami Detection

Local Tsunamis and Hazard Management in Hawaii

Search of Tsunamigeneity Criteria of Earthquakes

Reconstruction of Tsunami Source from Wave Field Known Inside an Area of the Ocean

Parameters to Improve Tsunami Predictions

State of Works on Tsunami Problem in the USSR

Linear Theory of Tsunami Excitation in Open Ocean

Numerical Experiment of the 1952 Kamchatka Tsunami on a Seismological Fault Model

A Review of Tsunami Investigation in Japan

Effects of a Continental Shelf with a Constant Slope Upon the Propagation of a Tsunami Edge Wave

1.	1 April 1946	Alaska-Hawaii
2.	4 November 1952	Kamchatka
3.	9 March 1957	Alaska-Hawaii
4.	22 May 1960	Chile-Hawaii
5.	28 March 1964	Alaska, U.S. West Coast
6.	16 May 1968	Japan
7.	3 October 1974	Peru
8.	29 November 1975	Hawaii

A large selection of worldwide seismograms are available on microfilm or paper for each event. For inquiries and orders, please write to: *World Data Center-A for Solid-Earth Geophysics, National Geophysical and Solar-Terrestrial Data Center, National Oceanic and Atmospheric Administration, Boulder, CO 80303, USA.*

Symposium on "Oceanography from Space"

Sponsored by the Committee on Space Research; the Scientific Committee on Oceanic Research; and the Inter-Union (IUGG and URSI) Commission on Radio Meteorology, the Symposium on "Oceanography from Space" will be held 26-30 May 1980 in Venice. For information, write to: *J.F.R. Gower, Institute of Ocean Sciences, P.O. Box 6000, Sidney, British Columbia, V8L 4B2 Canada.*

First Pan-American Conference on Ocean Engineering

Under the sponsorship of the Pan-American Federation of Engineers Association and the Mexican Committee on Ocean Resources, the First Pan-American Conference on Ocean Engineering will be held in Mexico City, 20-23 October 1980. For information, write: *Comite Organizador del Congresso Pan-Americano de Ingenieria Oceanica, Apartado Postal 60-549, Mexico 18, D.F., Mexico.*

ABSTRACTS AND RESUMES

Mitigation and Preparedness for Natural Disaster in the Kingdom of Tonga

James Lewis
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Abstract

The frequent events of natural disasters in the Kingdom of Tonga reinforce a national awareness of risk. The report reviews recorded incidents of disasters, such as: hurricanes, storms, earthquakes, tsunamis, volcanic

eruptions, etc. Hurricane relieves from the government was quite limited until 1973 when the Hurricane Relief Committee was formed. Preventive measure on ecological awareness and mitigation conditions of damage are discussed as well as preparedness measures which are felt to be as important. Recommendations are made in reference to agriculture, building constructions, water storage, food, evacuation plans, and maintaining contacts with international agencies on relief-aids and disasters forecasting...etc.

Volcano in Tonga

James Lewis
Disaster Mitigation Consultant
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Journal of Administration Overseas, Vol 18, No. 2, pp. 116-121, April 1979

One of the two inhabited volcanic islands in Tonga is Niua Fo'ou where in September of 1946, a major eruption occurred. The whole population was evacuated from the island to Tongatapu and then to the Island of "Eua." This article gives an account of this event through reference to the diary of Mr. Moeake Takai who was one of the residents of Niua Fo'ou at that time. The account indicates that the evacuation was ad hoc and unplanned and that the decision to carry it out was precipitated. Tonga now pays more attention to preparedness planning and measures for disaster mitigation.

Tsunami

Prof. S. L. Soloviev
Academy of Sciences of the USSR
Moscow 109004, USSR

The Assessment and Mitigation of Earthquake Risk (Natural Hazards, I)
UNESCO, 1978

Provides a general discussion of tsunami generation, propagation and damages; tsunamigenic zones, tsunami recurrence and material loss; methodological bases of the tsunami warning system; and lists of actions to be needed in order to reduce the losses from tsunamis.

Some Problems in the Prediction of the Nemuro-oki Earthquake

Katsuyuki Abe
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The latest results concerning the prediction of the June 17, 1973, Nemuro-oki earthquake (magnitude 7.4), off the Pacific coast of Hokkaido are discussed with special emphasis on the mode of strain release. This

earthquake filled in the seismic gap that had been cited as a likely place for a future earthquake, but the preseismic land subsidence extending over the Eastern Hokkaido was not recovered. These facts suggest that the seismic slip at the plate boundary was deficient. Presently available evidence indicates that such a slip deficiency is unlikely to be taken up in the near future, by either a seismic faulting or occurrence of a great shock. More likely case proposed here is that much of the stored strain energy may remain unreleased during the interseismic quiescent period of seismic activity. In this case, it is suggested that the area of faulting and amount of slip differs greatly each time interplate earthquakes recur in at least a certain area, in view of the idea that plate motions at the subduction zone are not regular in size on a time scale of several hundreds of years or more.

Tectonic Implications of the Large Shioya-Oki Earthquakes of 1938

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Abstract

Abe, K., 1977. Tectonic implications of the large Shioya-Oki earthquakes of 1938. Tectonophysics, 41:269-289.

The tectonic processes taking place along the southern part of the Japan trench are discussed on the basis of the focal mechanism of the 1938 Shioya-Oki event which consists of the five large earthquakes of M_S=7.4, 7.7, 7.8, 7.7 and 7.1. Detailed analyses of seismic waves and tsunamis are made for each of these earthquakes, and the dislocation parameters are obtained. The total seismic moment amounts to $2.3 \cdot 10^{28}$ dyn.cm. The five earthquakes are grouped into either a low-angle thrust type or a nearly vertical normal-fault type. These mechanisms are common with other great earthquakes of the northwestern Pacific belt, and can be explained in terms of the interaction between the oceanic and continental plates. The vertical displacement inferred from the seismic results is in approximate agreement with the precise level data over the period from 1939 and 1897. This agreement suggests that the rate of the strain accumulation at the preseismic time is very small in the epicentral area. Repeated levelings at the postseismic time reveal a large-scale recovery of the coseismic subsidence. The postseismic deformation is one-third to one-half of the coseismic displacement. The time constant of the recovery is estimated to be 5 years or less. This type of deformation may be a manifestation of viscoelasticity of a weak zone underlying the continent. The amount of dislocation, together with the long-term seismicity, suggests a seismic slip rate of about 0.4 cm/year, which is one order of magnitude smaller than that for the adjacent regions. This suggests that a large part of the plate motion is taking place aseismically in this region. The tectonic process now taking place in the southern Japan trench can be considered to represent a stage just prior to a complete detachment of the sinking portion of the oceanic plate.

British Columbia's Tsunami Warning System: an evaluation

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Accepted February 25, 1976

The magnitude of any disaster is a reflection of societal preparedness. One aspect of predisaster response to risk is the development of warning systems. These are unique communications networks. If they are to function effectively during an emergency they must be tested, yet this process, if repeated too often, can impair their utility.

This paper critically reviews the structure and anticipated operation of British Columbia's Tsunami Warning System. Attention is drawn to the many implicit assumptions underlying its design and the weaknesses these create in its potential performance. Examples are presented which illustrate the difficulties those responsible for its operation are likely to face should these suppositions fail to hold when a tsunamigenic earthquake occurs. As a result of this review, several suggestions are presented for improving the existing system.

On a Band-Limited Wave Transfer Function

Shigeo Kinoshita
National Research Center for Disaster Prevention
Japan

Report of the National Research Center for Disaster Prevention, No. 21, March 1979

Abstract

Solving the wave transfer function in the closed form, the poles are investigated in a complex plane. The equal time layered model is applied for this purpose so that the predominant frequencies and the equivalent damping factors are easily obtained by making use of poles estimated. Furthermore, the statistical relations of input and output waves is discussed with the transmittancy function.

Particularly, the equivalent damping factor is distinguished between the quantity due to the diffusive damping effect and the one due to the internal damping effect. In this report, the above-mentioned wave transfer function is derived theoretically and the quantitative comparisons by making use the observed data are performed.

Size of Great Earthquakes of 1837-1974 Inferred from Tsunami Data

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A new magnitude scale M_t is defined by using the logarithm of the maximum amplitude of far-field tsunami waves measured by tide gauges or their substitutes. The M_t scale is experimentally adjusted to the M_w scale introduced by Kanamori (1977), so that the M_t scale measures the seismic moment of a tsunamigenic earthquake as well as the overall size of tsunami at the source. M_t and the conventional tsunami magnitude m are distinct scales. By using many amplitude data of tsunami waves now available the values of M_t are assigned to 65 tsunamigenic earthquakes that occurred in the Pacific area during the period from 1837 to 1974. The 1960 Chilean shock has the largest M_t, 9.4. The 1946 Aleutian (M_t = 9.3), the 1837 Chilean (M_t = 9 1/4), and the 1964 Alaskan (M_t = 9.1) events follow. Nine great events having M_t = 9 or over occurred during this period, and their occurrence is clustered in the years around 1840, 1870, and 1960. Of all the 65 events listed, at least six unusual earthquakes having tsunamis with an amplitude disproportionately large for their surface-wave magnitude M_s are identified from the M_t-M_s relation.

PACIFIC TSUNAMI WARNING CENTER

Computer Installed to Monitor Earthquake at the Pacific Tsunami Warning Center (PTWC) at Ewa Beach, Hawaii

Since the implementation of computer in the warning system at PTWC, it has saved an enormous amount of manual calculation time used to be required in locating the epicenter of an earthquake, and estimate the travel time of a tsunami. The warning system is now operating 99 percent of the time compared to only 40 percent previously. Also, the computer automatically interrogates gauges in the Pacific-wide warning network and determines how long it would take for a tsunami to reach 62 vulnerable locations. It is expected to monitor all local seismic activity within two years and be even more valuable in the future as it is used to expand knowledge of tsunamis.

Dr. William J. Mass Joined Pacific Tsunami Warning Center

Dr. William Mass assumed the duties of Geophysicist at PTWC on October 15, 1979. Dr. Mass comes to PTWC from the Joint Institute for Marine and Atmospheric Research at the University of Hawaii, where he was a visiting scientist working on tsunami related problems. Prior to coming to Hawaii, he attended Texas A&M University where he earned his PhD in physical oceanography.

Seismic Summary (May 2, 1979 to Press Time)

Event No.	Event	Location	Action Taken
1979-8	May 20 0814 (UT)	Southwest of Kodiak, Alaska 56.6 N	
(PTWC)	6.1	156.2 W	
1979-9	Jun 22 0630 (UT)	Guatamala 16.5 N	
(PTWC)	6.2	92.2 W	
1979-10	Jun 25 0528 (UT)	New Guinea 5.8 S	
(PTWC)	6.2	145.4 E	
1979-11	Jul 1 2038 (UT)	Costa Rica 9.7 N	
(PTWC)	6.3	80.63 W	
1979-12	Jul 24 1931 (UT)	Java Sea 10.5 S	
(PTWC)	6.6	108.2 E	
1979-13	Aug 26 1431 (UT)	Philippines 19.4 N	Press Release
(PTWC)	6.7	121.6 E	
1979-14	Sep 12 0518 (UT)	West Irian 1.1 S	Press Release
(PTWC)	7.8	136.2 E	
1979-15	Sep 22 0800 (UT)	Island of Hawaii 19.3 N	
(PTWC)	5.6	155.1 W	
1979-16	Sep 29 1844 (UT)	Indonesia 1.5 N	Press Release
(PTWC)	6.8	94.0 E	
1979-17	Oct 12 1025 (UT)	New Zealand Region 48.6 S	Press Release
(PTWC)	7.5	164.8 E	
1979-18	Oct 15 2317 (UT)	Baja California 33.4 N	Press Release
(PTWC)	6.8	114.8 W	
1979-19	Oct 16 1300 (UT)	* French Riviera	

* Tsunami caused by submarine landslide.

Event No.	Event	Location	Action Taken
1979-20	Oct 17 0543 (UT)	18.9 N	
(PTWC)	6.0	145.9 E	
1979-21	Oct 22 0559 (UT)	Celebes Region 0.9 N	Press Release
(PTWC)	6.5	126.0 E	
1979-22	Oct 23 0951 (UT)	Solomon Region 10.1 S	Press Release
(PTWC)	7.1	162.0 E	
1979-23	Oct 27 2143 (UT)	Guatamala 13.5 N	
(PTWC)	6.3	90.7 W	
1979-24	Nov 6 1138 (UT)	Solomon Island Area	
(PTWC)	6.3		
1979-25	Nov 13 2043 (UT)	Tonga Island Area 23.4 S	
(PTWC)	6.2	174.8 W	
1979-26	Nov 14 0221 (UT)	North East Iran 35.0 N	
(PTWC)	6.6	60.0 W	
1979-27	Nov 16 1521 (UT)	Fiji Island Region 16.2 S	Press Release
(PTWC)	6.9	179.6 W	
1979-28	Nov 23 2340 (UT)	Near Bogota, Colombia 5.0 N	Press Release
(PTWC)	6.7	75.5 W	
1979-29	Nov 24 1910 (UT)	Fiji Island Area 18.0 S	
(PTWC)	6.2	177.0 E	
1979-30	Dec 11 1726 (UT)	Bonin Islands 29.2 N	
(PTWC)	6.1	140.8 E	
1979-31	Dec 12 0759 (UT)	South West Colombia 1.584 N	Watch Watch Supplement
(PTWC)	7.8	79.386 W	Watch Final Supp. Press Release

Investigation reopened next morning
Small Tsunami in Hawaii