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INTERNATIONAL TSUNAMI INFORMATION CENTER
P.O. Box 50027, Honolulu, Hawaii 96850
Telephone: (808) 546-2847

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
UNITED KINGDOM (HONG KONG)
USA
USSR
WESTERN SAMOA

NEWS EVENTS

Mt. St. Helens

Since Mt. St. Helens first erupted on March 27 this year there has been a dearth of interest and activity around the volcano. Scientists from all over the world study each sign of activity with the most advanced analytical equipment available today.

Smaller, but noteworthy eruptions occurred on 28 July, 7 and 15 August. There was no premonitory seismic activity on 15 August. Tracings of seismic activity were infrequent during late August and early September.

A trio of gigantic eruptions began at 9:40 PM, Thursday, 16 October (local time). Then, at 9:28 AM, Friday, 17 October the volcano exploded again. Both eruptions were preceded by 20 minutes of harmonic tremors and both lasted for almost two hours. Plumes of ash clouded the skies as high as 8.5 miles. Winds dissipated the clouds over wide areas of Oregon, Idaho and Washington. There have been as many as three subsequent eruptions.

Scientists admit that they still have little real understanding of the forces that move the volcano. Each seismic signature is unique. One interesting result of the research on Mt. St. Helens is the discovery that dissolved water, which collects in the volcano, is directly responsible for much of the pressure that results in an eruption. The finding that this has been true of the eruptions in the last 4,500 years has been proven by the high residue of water in the pumice of the eruptions that date back this long. A remarkable periodicity of the eruptions has also been established.

Earthquake in Algeria, 10 October 1980

On October 10, the Moslem Sabbath, at about noontime (local time) a strong earthquake jolted al-Asnam. Al-Asnam is a city of approximately 100,000 people located 100 miles (160 km) west south-west of Algiers, the capital of Algeria. Within a 35 miles radius there are many towns and villages with a total population of just 1,000,000.

A second earthquake struck about three hours after the first one. The two earthquakes measured 7.5 and 6.5 respectively, on the open-ended Richter scale. Each earthquake lasted about two minutes. Tremors of lesser magnitude continued throughout the night and the weekend. The radius of destruction was between six and ten miles.

It is estimated that 80% of the city was destroyed. Most of the roads were barely passable. Nearly all the means of communication with the city were unserviceable. Many of the outlying hamlets within the radius of destruction were 100% demolished. Early estimates of the numbers of victims were greatly exaggerated, but it is now believed that about 7,000 people were killed and 25,000 were injured in the two earthquakes. Some 250,000 people are camping out along the roadside, while others are being evacuated to other cities.

President Chadli Bendjedid personally coordinated the relief efforts. The Algerian Red Crescent appealed for aid to the League of Red Cross Societies in Geneva. France, from whom Algeria was granted independence in 1962, offered unlimited assistance to Algeria immediately. Many other concerned nations are pledging their unselfish assistance.

In 1954 an earthquake gutted al-Asnam which was then a small city. It left a toll of 1,250 dead and 15,000 injured. It is not yet known whether a tsunami was generated in the Mediterranean.

Earthquake of 18 August 1980

On August 18, 1980, at 10:09 AM (local time) the largest earthquake to strike Ecuador in thirty years rumbled through the port city of Guayaquil. Old buildings built of mud and wood, once the characteristic building style in the tropical city, that have little structural security, collapsed readily. It was in this rubble that most of the victims were caught. Early reports said that there were seven fatalities and no immediate number of casualties was able to be attained. Although there were not many fatalities, panic gripped most of the people in the city of one million.

The central business district of Guayaquil was basically intact after the earthquake. Guayaquil City Hall, the Ecuadorean Telecommunications Institute and other public and commercial buildings were reported to have serious cracks in their walls.

The U.S. Geological Survey in Golden, Colorado, measured the earthquake at 5.8. An event of this magnitude would described as being capable of "considerable to severe damage."

Democratic People's Republic of Korea Interested in Joining ICG/ITSU

The Deputy Secretary General of the National Commission of the Democratic People's Republic of Korea for UNESCO, Mr. Kang-dal-Seun, recently visited with the Secretary of the Intergovernmental Oceanographic Commission (IOC) in Paris informing him of his country's interest in joining the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU). ITIC recently forwarded to the Ministry of Foreign Affairs of the Democratic People's Republic of Korea information related to the Tsunami Warning System and educational publications of the International Tsunami Information Center (ITIC).

It is hoped that the Democratic People's Republic of Korea will soon be a member of ICG/ITSU, and will participate actively in the Tsunami Warning System.

Colombia Expresses Interest in Joining ICG/ITSU

Mr. Daniel Arango, Permanent Delegate of Colombia in UNESCO, in a letter to the Secretary of IOC, Dr. Mario Ruivo, expressed Colombia's interest in participating in the International Coordination Group for the Pacific Tsunami Warning System in the Pacific (ICG/ITSU), and in the Pacific Tsunami Warning System.

Colombia was struck in December 1979 by a large earthquake and a disastrous tsunami in the State of Narino in the Pacific Coast of that country. ITIC conducted a thorough survey of the tsunami and Dr. George Pararas-Carayannis, Director of ITIC, visited at that time with representatives from the Colombian Navy, the Commission of Oceanography, the Civil Defense and of the different educational institutions. Since then, a number of reports have been written about the earthquake and tsunami of 12 December 1979 in Colombia, and most recently, a report was completed by J. Ramirez of Javeriana University.

ITIC has responded to Mr. Arango's interest in having Colombia join the Pacific Tsunami Warning System by providing information on Colombia's participation in the International Tsunami Warning System, expressing hope that this membership will soon be ratified and that details concerning Colombia's participation will be worked out, such as communications, and the designation of tide stations that can serve also as tsunami stations.

Cook Islands Join the Tsunami Warning System

As of August 1980 the Cook Islands became member of the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), and participate in the Pacific Tsunami Warning System. Commissioner J. Butterworth, Superintendent of Police, is the national tsunami contact and the Police Headquarters in Rarotonga, have been added to the communications plan.

ITIC has provided the Cook Islands with tsunami travel time information which is used by the Tsunami Warning Center in issuing tsunami watches and warnings to this area. Similarly, ITIC has made inquiries to determine whether a tide gauge is operated in the Cook Islands for inclusion as an official tsunami tide station.

FEATURES

"Estimating Earthquake Potential"

By Robert A. Page and reprinted with the permission of the "Earthquake Information Bulletin," January-February 1980, Volume 12, Number 1.

The hazards to life and property from earthquakes can be minimized in three ways. First, structures can be designed and built to resist the effects of earthquakes. Second, the location of structures and human activities can be chosen to avoid or to limit the use of areas known to be subject to serious earthquake hazards. Third, preparations for an earthquake in response to a prediction or warning can reduce the loss of life and damage to property as well as promote a rapid recovery from the disaster. The success of the first two strategies, earthquake engineering and land use planning, depends on being able to reliably estimate the earthquake potential. The key considerations in defining the potential of a region are the location, size, and character of future earthquakes and the frequency of their occurrence. Both historic seismicity of the region and the geologic record are considered in evaluating earthquake potential.

Historic Seismicity: From historical records, we can document that earthquakes of a particular size and character have occurred at certain locations in the past. Under the assumption that history will repeat itself, the historic record allows an estimate of the size of earthquakes that may occur in the future. For example, on the basis of the 1906 San Francisco earthquake, the northern San Andreas fault in California may generate shocks as large as magnitude 8.3.

But historical records as such rarely constitute an adequate or, more important, a reliable basis for estimating earthquake potential. In most regions of the world, recorded history is short relative to the time between the largest earthquakes. Thus, the fact that there have been no historic earthquakes larger than a given size does not make us confident that they will also be absent in the future. It may alternatively be due to the short length of available historical records relative to the long repeat time for large earthquakes. Clearly, the historic record is most valuable and reliable in regions of the world that have long written histories and high rates of seismicity. Two of the outstanding records have been described by Nicholas Ambraseys for the eastern Mediterranean region and by Clarence Allen for China. Conversely, the historic record is least reliable in regions like the eastern United States where the seismicity is relatively low and the written history dates back only two or three centuries.

Geologic Record: The geologic record provides a means for greatly extending the historic record.

Detailed studies of geologically young faults and deformed geomorphic surfaces, such as shorelines and river terraces, may give us information about the size and date of prehistoric episodes of deformation. Some of these may be identified with single earthquake events. In such cases, empirical relations between earthquake magnitude and fault offset or between magnitude and vertical deformation can be used to deduce the size of these prehistoric earthquakes.

The geologic record may provide us with the rates of deformation over the past few million years. Through an understanding of the geologic framework of a region, long-term rates of deformation can give estimates of earthquake recurrence. Such estimates, of course, require knowledge or assumptions about the maximum possible earthquakes as well as what part of the deformation occurs without association with earthquakes; for example, as aseismic fault creep.

The geologic record may allow us to define regions of similar geologic behavior whose earthquake histories can be compared. It then may be possible to extend the historic record in one area by supplementing it with the records from other parts of the world that have analogous geologic structures and processes. In this way, a more reliable estimate of the maximum possible earthquake may be obtained for a region having a short historic record.

In regions characterized by young faults, we may estimate maximum earthquake magnitudes from the lengths of known active faults of from the length of individual fault segments that would be likely to rupture in a single earthquake. This is done by using empirical relations between magnitude and length of faulting for various types of earthquakes or styles of faulting. Such relations may involve the length of faulting derived from field measurements or deduced from seismological properties; for example, the extent of aftershocks or the character of the seismic energy radiated by the main shock. The length of surface faulting observed in the field is frequently only a fraction of the length of rupture at depth; this must be borne in mind when using magnitude-fault length relations based on surface faulting to estimate maximum earthquake size.

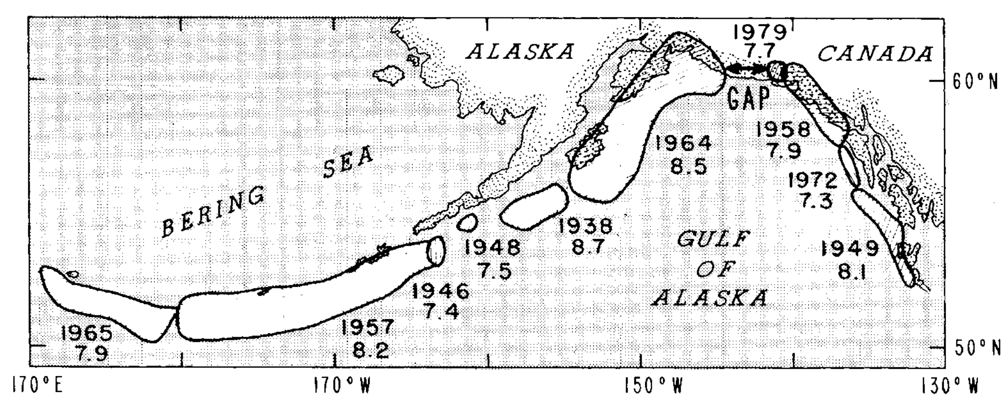
The absence of earthquake activity in a region with a relatively short recorded history can be assessed as significant or not on the basis of the tectonic processes operating in the region. For example, the absence of significant earthquake activity over intervals of tens of years along seismically active plate boundaries may reflect the imminence of a large earthquake. The location and magnitude of potentially damaging earthquakes have been reliably predicted on the basis of such "seismic gaps" in otherwise continuous belts of seismicity.

<u>Estimating Earthquake Potential in the Gulf of Alaska</u>: Many continental shelf areas bordering the United States are now being considered for oil and gas lease sales. Among these are several along the Pacific coast that experience high levels of earthquake activity. Successful development of these resources obviously requires that earthquake hazards in the offshore environment be carefully assessed. A particular area of concern is the Gulf of Alaska which is characterized by frequent earthquakes in the magnitude 8 range. As an example, we will consider the earthquake potential of an arbitrary site on Pamplona Ridge, a submarine ridge on the continental shelf of the Gulf of Alaska.

In evaluating the earthquake potential of a particular site, the seismologist must first look at the tectonic framework of the area. The entire Pacific coast of Alaska from British Columbia westward through the Aleutian Islands is a sector of intense seismicity caused by the interaction of the Pacific and North American crustal plates. Along the southeast panhandle of Alaska, the plates slide past one another producing strike-slip fault movement; along the Aleutian arc, the Pacific plate is thrust (subducted) under the North American plate causing dip-slip fault movement. The Pamplona Ridge is in a transition zone between these two regimes, so that both types of faulting are involved.

The tectonic framework of Pamplona Ridge shows that it lies in a major seismic belt. How frequently then, and where, are damaging earthquakes likely to occur in the future? Experience of past earthquakes reveals that damage from shaking may be significant to distances on the order of 25, 60, and 150 kilometers from the fault for shocks in the magnitude classes 6, 7, and 8, respectively. The historic record of seismicity includes 41 instrumentally located shocks of magnitude 6.0 or greater in the general area since 1899. Two magnitude 8 events occurred 50 km from Pamplona Ridge in 1899 and 1900. (We should remember that few seismographs were operating throughout the world then, so that location and magnitude may be in error. In fact, recent investigation of reported effects of the 1900 earthquake suggests that it probably occurred off Kodiak Island, about 500 km to the southwest.) In 1970, three magnitude 6 earthquakes occurred in the immediate vicinity of Pamplona Ridge. Most recently, in February 1979, a magnitude 7.7 shock occurred about 100 km northeast of the site. From the historic record, we conclude that earthquakes as large as magnitude 8 can occur sufficiently close to the site to be damaging.

The known seismic history for the Gulf of Alaska is short relative to the natural cycle of earthquake occurrence. As was pointed out earlier, long-term fluctuations in seismicity have been recognized for China and the eastern Mediterranean. Similar variations in seismicity could also be typical of the Gulf of Alaska. In terms of instrumentally located earthquakes, the history for events larger than magnitude 7 3/4 is complete only since 1899. For events down to magnitude 6, the history is complete only since the 1930's; and for earthquakes as small as magnitude 5.0, it is complete only since 1964 earthquake. Because the historic record is short, future earthquake activity cannot be confidently predicted by simply extrapolating from the historic seismicity.



Aftershock zones of earthquakes of magnitude 7.3 or greater since 1938, along the Pacific coast of Alaska. Year and magnitude are given.

Is it probable that the magnitude 8 shocks in 1899 and 1964 have released all the strain energy stored in the vicinity of Pamplona Ridge, so that a magnitude 8 earthquake in the next few decades is unlikely? The answer is unequivocally no. In fact, there are two lines of evidence suggesting that another major earthquake, very possibly in the magnitude 8 range, is likely to occur within the next few decades.

One line of evidence is contained in the deformational history of the uplifted marine terraces on Middleton Island as deduced by George Plafker of the U.S. Geological Survey. The differences in elevation between uplifted terraces on the island average 8 meters. In contrast, the uplift associated with the 1964 earthquake was only 4 m, suggesting that another earthquake involving uplift of an additional 4 m may be expected to occur within a short time compared to that required for waves to cut a new marine terrace, that is, within several decades. Nevertheless, the possibility of gradual vertical uplift of the island, not accompanied by an earthquake, cannot be rejected.

The other line of evidence is found in the pattern of historic seismicity along coastal southern Alaska. Large shallow-focus earthquakes are generally followed by mumerous shocks of smaller magnitude. The foci of these aftershocks typically define the zone that ruptures during the main earthquake. The aftershock zones of earthquakes of magnitude 7.3 and greater along the Pacific coast of Alaska since 1938 form nearly a continuous chain. A pronounced gap in the seismicity currently exists between the aftershock zones of the 1964 Prince William Sound and the 1958 Fairweather and 1979 St. Elias earthquakes. Such seismic gaps are thought to be temporary holes in the otherwise continuous chain of major earthquakes and to be the most likely sites for the future major earthquakes. (On the basis of a recognized seismic gap off southeast Alaska, the location and magnitude (7.3) of the 1972 Sitka earthquake was successfully predicted.) The Pamplona Ridge site lies in a well-defined post-1938 seismic gap, the Yakataga gap.

The magnitude of the maximum earthquake that could occur in the Yakataga gap can be estimated assuming that a single earthquake could rupture the entire gap and using an empirical relation between magnitude and fault length. More than one scenario for a gap-filling earthquake has been advanced. The favored scenario is a fault rupture at least 150 km long between the western end of the 1979 aftershock zone and the eastern end of the 1964 zone. The rupture is postulated to follow along a marked boundary in the geologic structure of the continental shelf along the trend of the Pamplona Ridge. A shock of magnitude 8 is reasonable for the postulated rupture length. Although it is plausible that a single earthquake could rupture the entire seismic gap, the possibility cannot be refuted that two or more earthquakes in the magnitude 7 class alternatively could relieve the strain accumulated in the gap.

The delineation of active faults both onshore and offshore in the seismic gap is important not only for resolving questions about the size of the maximum credible earthquake but also for assessing the potential for smaller earthquakes occurring close enough to the site to cause damage.

Faults can be identified directly by mapping offsets in surficial geologic units. Aerial photography is a valuable aid in mapping faults on land. Off the shoreline, seismic profiling serves an analogous role in delineating submarine faults. Seismic profiling utilizes reflected acoustic waves generated by a controlled explosive source to map the configuration of the seafloor and of subbottom geologic horizons. Faults appear as discontinuities in the round-trip travel time required for an acoustic pulse to bounce off a reflecting horizon. To classify a mapped fault as active, whether onshore or offshore, displacement of a geologic deposit of known young age must be demonstrated or earthquake activity must be correlated with the fault.

Accurate location of earthquakes is also an important technique in identifying active faults. Not only can accurate earthquake locations be used to establish that a recognized fault is active, but, in some instances, they reveal the presence of an active fault where no fault has been recognized through normal mapping procedures.

Techniques have been developed for both the relocation of larger historic earthquakes as well as the location of current small earthquakes. The relocation technique seeks more accurate locations for historic earthquakes recorded at large distances -- shocks larger than about magnitude 3 or 4. Routine locations of such earthquakes generally assume that the velocities of seismic waves through the Earth's interior are uniform from place to place. However, the Earth is not laterally homogeneous, and this can bias the location of historic earthquakes by as much as 25 to 50 km even for a relatively uniform azimuthal distribution of seismographs around the earthquake. This bias can be calculated with information from accurately located earthquakes occurring within dense regional seismograph networks or in some cases from large explosions at known locations.

The technique for delineating active faults from the accurate location of small earthquakes employs dense networks of sensitive seismographs to reduce the magnitude threshold of locatable shocks. This method capitalizes on the logarithmically increasing numbers of earthquakes with decreasing magnitude. By this means, a large number of earthquakes can be recorded in a relatively short interval of time.

Conclusion: Estimates of earthquake potential are more reliable in regions of high seismicity than in relatively quiet regions. In active areas, where the repeat time for damaging earthquakes is shorter, the history tends to be longer relative to the time scale of earthquakes. Thus, there are more opportunities to study the relation between earthquakes and geologic structures and processes. In areas of high seismicity, the tectonic processes that cause earthquakes are generally dominant processes in sculpting the surface of the Earth. Hence, it is easier to decipher the effects of these processes in the recent geologic record.

Preparing Children and Youth to Help in Disaster Situations

The following article appeared in the United Nations Disaster Relief Organization Newsletter, Number 10, September 1979. It is reprinted here with permission of UNDRO.

Anyone living in a country which is regularly exposed to violent natural phenomena will be prudent if he takes care to acquire at least an elementary knowledge of the causes of these events, and the precautions which can be taken to avoid or lessen their effects. In many countries which regularly experience predictable events, such as tropical storms which occur every year at certain seasons, there exists some form of disaster preparedness organization. Usually, although by no means invariably, these organizations regularly publish information in the media or elsewhere at the beginning of the period of danger in order to remind citizens of warning signals which will be used, the need to stock reserves of food, how to act to reduce the risks of bodily injury and of physical damage to houses and so on.

Where the risk is caused by irregular or unpredictable events, for example by volcanic eruptions or earthquakes, the decision to establish a permanent preparedness organization may be conditioned by the frequency with which the phenomena manifest themselves. Even so, it is much less probable that regular action will be taken to inform the public about protective measures which can be adopted, although it is possible that legislation may provide for the enforcement of building standards or for restrictions on buildings in known areas of particular danger.

In this International Year of the Child it is appropriate to consider what action could and should be taken by parents and teachers and by youth organizations to prepare children to meet, counter and survive potentially disastrous events. All these phenomena tend to cause fear: the unexpectedness of an earthquake and the sense of helplessness it creates in people, the violence of the winds in a hurricane and the sight of large pieces of flying debris, the speed of the inexorable advance of flood waters.

Effect of Fear: Fear can never be wholly eradicated, even though it can sometimes be suppressed or sublimated into bravado. Because this has the common result of placing the person concerned in greater danger, it causes others to risk their own safety to protect him. The effects of fear can however be reduced by an understanding of the causes of the event and of its likely development or outcome. This is as true for adults as it is for children. In a case known to the writer, it was the lack of this understanding which caused a panic-stricken mother to throw her baby onto a fire as a sacrifice to the gods whom, she thought, were responsible for the continuing tremors of an earthquake. The child was rescued, but years later was still undergoing surgery to remove the effects of his burns.

The Teacher's Role: A teacher's first care, then, should be to explain, in words and ideas suitable to the age of the child, the reasons why their district or country is regularly or occasionally beset by violent natural events. A description of the causes of the events can be given in simple language, whenever possible with illustrations appropriate to the child's own experience. For example, a child may readily understand that winds are caused by air moving "downhill" from an area of high pressure to one of low pressure; it is not necessary at that stage to introduce the complications of geostrophic force. Nor is it essential to speak about adiabatic lapse rates when explaining how rain is formed. Falling raindrops produce static electricity which, if the build-up is large enough, will be discharged as lightning. The build-up of static in this way can be compared to the similar phenomenon when a comb is repeatedly passed through the hair. Similarly, older children will grasp the concept of a volcano serving as a safety valve when pressure builds up inside the earth.

If, then, there is some understanding of what is happening, why, and what may happen (e.g. the period of calm when the eye of a tropical storm passes overhead, followed usually by more winds even stronger than before), children are much less likely to give way to an uncontrollable fear. For pre-teenage children, this may be as much as can reasonably be expected; if it can be put to them that by remaining quiet and doing what they are asked to do, they will be helping their parents or teachers, many children will be quick to respond.

Taking more active steps to learn beforehand how to help disaster relief personnel in their work is a matter which really concerns mid- and late teenagers. In particular, it concerns those who are old enough to have joined civic or community organizations such as the Junior Red Cross, Boy Scouts and Girl Guides (Girl Scouts).

These organizations have a considerable pool of human resources, training and experience available for community action. They can be an important part of the response to disasters and can also assist in other disaster-related activities.

Scouts Services to the Community: Because they are trained and subject to some discipline, Scouts and others like them are in a unique position to increase their services to the community and contribute not only to relief work; they can also assist in promoting preparedness measures, especially in developing countries. Their links with community groups are an important basis for their contribution to the national disaster relief organization. They can operate under the direction of the local, provincial or even the national authorities.

In cooperation with the competent authorities, trained young people can provide direct assistance in time of disasters. For example, they can (a) help in rescue and other immediate activities, notably helping relief personnel in providing first aid, evacuating the injured, giving directions to secure points, established safety areas and local medical facilities; (b) distribute food and other supplies, such as blankets and clothing; (c) cooperate and assist in directing traffic and cordoning off disaster sites and providing accurate information to the public about food distribution points, evacuation sites, and general conditions in the disaster area. This service is especially important because it helps to diminish the prevalence of rumors and other misinformation and so reduces the potential for panic.

Youth and Disaster Preparedness: In disaster preparedness activities, young people can participate in training and education programmes, in particular learning and understanding the forecasting and warning systems, the location and preparation of stockpiles of food, medicines and other supplies, and the operation of communications and transport. Especially in isolated areas, they can assist in instructing the public and younger school children about the importance of understanding warnings and heeding them. A special charge for members of girls' organizations might well be the care of the old, sick and infirm, and children whose needs are often forgotten.

In some developing countries, older school children may be the only members of a family who are fully literate. The educational and informational responsibility which devolves upon them, in relation to their parents and younger brothers and sisters, can therefore be quite heavy. Naturally, they can only discharge it if they are given proper instruction. Those who teach, and those who themselves train teachers, must then pay attention to disaster education. Proper motivation at this level, and the subsequent application of a slogan coined for a literacy campaign but equally relevant here -- "Each one teach one" -- will do as much to help those who may be in danger as well as those in authority who seek to bring relief.

UNESCO - IOC - ITSU

Thirteenth Session of the Intergovernmental Oceanographic Commission Executive Council

The above mentioned session occurred Monday, 23 June to Saturday, 28 June 1980, at UNESCO House in Paris. The agenda included consideration of the IOC Biennial Report for 1978-1979 and the Summary Report and Recommendations of TEMA-III (Buenos Aires, April 1980).

The Intergovernmental Oceanographic Commission Publications

Recently a Summary Report of the Eleventh Session of the Assembly, including Resolutions from the Tenth and Eleventh Sessions of the Executive Council, was published. The meetings were held in UNESCO House in Paris from 15 October to 3 November 1979.

Also received during September was the Biennial Report, 1978-1979, of the IOC.

IOC Workshop on Caribbean Region

The Workshop on Coastal Area Management in the Caribbean Region was completed in Mexico City during 24 September to 5 October 1979. A summary, IOC Workshop Report Number 26, has been published by IOC, UNESCO. Copies are available in English and Spanish from UNESCO, IOC, Place de Fontenoy, 75700 Paris, France.

TEMA-III Considers New Strategies

The following is reprinted from the International Marine Science Newsletter, Number 25, Spring 1980.

Meeting from 21-26 April 1980 in Bueno Aires, delegates to the third session of the IOC Working Committee for Training, Education and Mutual Assistance in the Marine Sciences (TEMA-III) discussed the strengths and weakness of the programme and considered its future role.

A major focus of discussion was the expected implications of the new ocean regime emerging from UNCLOS. Delegates considered how the TEMA programme of the Commission could best assist member states to assume the new responsibilities in ocean research and management which would apply to considerably expanded areas of ocean space.

Mrs. Gwanda Ward, representative of the United Nations Secretariat for the UN Conference on the Law of the Sea, explained that *for many States, a major effort will be required to develop a comprehensive marine policy. The new Convention will have important implications also for co-operative arrangements among States and for the activities of international organizations concerned with ocean affairs.*

Turning to consideration of the TEMA programme as a whole, delegates observed that although considerable effort had been made to implement recommendations, this was not yet commensurate with the growing needs of member states.

The Committee reaffirmed the position that regional marine science programmes provide an excellent opportunity to member states, both within and outside a given region, for concerted action on major problems of common interest. Participants also emphasized that regionalization lays a framework for close co-operation amongst ICSPRO agencies towards common goals.

Faced by the pressing need for funds to strengthen TEMA, the Committee recommended that IOC develop a large-scale programme consisting of about 15-20 projects over the next ten years to be funded from extrabudgetary sources. At the same time, it urged member states to increase support through a consortium of funding sources including those of the ICSPRO agencies and contributions of member states to the IOC Trust Fund.

The Committee also called upon member states to provide support under the IOC Voluntary Assistance Programme to provide 100 fellowships of a one-year duration during the period 1981-83.

To guide the work of the Committee through its next session, planned for late 1982 or early 1983, delegates elected Dr. Ulf Lie (Norway) as chairman and Dr. F. A. Mutere (Kenya) as vice-chairman.

Attending the meeting were 36 delegates from 23 countries and representatives from eight organizations working with the Commission.

Chairman of ITSU Attends Thirteenth Session of IOC Executive Council

Mr. G. C. Dohler, Chairman of the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), was one of the participants of the 13th Session of the IOC Executive Council in July 1980 in Paris. Mr. Dohler emphasized to the Council the need for filling the post of Associate Director of ITIC, and the need for improving the Tsunami Warning System. While in Paris, Mr. Dohler sought assistance for tsunami training from the Division of Marine Sciences of UNESCO.

INTERNATIONAL TSUNAMI INFORMATION CENTER - HONOLULU

ITIC Associate Directorship

The position of Associate Director of the International Tsunami Information Center was established in 1974 by Recommendation EC - IV.6, to be filled from a Member State of the International Coordination Group for the Tsunami Warning System in the Pacific other than the United States. Salary and other cost of living allowances for the incumbent have to be covered by his Government. The former Associate Director left ITIC at the end of June 1979 and since then the position has been vacant. Member States are urged to submit names of suitable candidates for the position to ITIC at their earliest convenience.

ITIC's Response to ITSU Recommendations

At its meeting in Chile last March, the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) prepared a preliminary proposal on Extrabugetary Funding which was submitted as an annex to Recommendation No.2. This proposal received favorable review by the appropriate officials, who, however, requested additional documentation. In September, ITIC completed the rewriting of this proposal with documentation on the relative costs of the proposed instrumentation, installation, training, education, and maintenance components. In addition, the redrafted proposal elaborates specifically on equipment and relative cost, and provides details regarding participation of other interested countries. The final proposal has been forwarded to the IOC Secretariat for submission to the appropriate funding agencies.

Director of the Hydrographic Institute of Chile Visits ITIC

Captain Mariano Sepulveda, Director of the Hydrographic Institute of the Chilean Navy and Head of the Tsunami Warning System in Chile visited ITIC on November 5-9 on his way to a conference in Tokyo, Japan. Captain Sepulveda and his lovely wife, Iñez, were guests of Dr. George Pararas-Carayannis at a Tsunami Luncheon organized by ITIC in Honolulu during which research and operational aspects of the Tsunami Warning System were discussed. Captain Sepulveda had the opportunity to meet with General Valentine Siefermann, Head of Hawaii Civil Defense, as well as with other officials and scientists of the Civil Defense, the University of Hawaii and NOAA. Captain Sepulveda presented Dr. Pararas-Carayannis with an engraved commemorative bronze wall plaque citing and recognizing ITIC's permanent effort in improving tsunami preparedness.

Japanese Congressional Delegation Visits ITIC and the Pacific Tsunami Warning Center

A Japanese delegation comprising of members of the House of Representatives and of other Japanese Government Agencies, visited ITIC and the Pacific Tsunami Warning Center on 14 September 1980 for the purpose of familiarizing themselves with tsunamis and the Tsunami Warning System. These officials are members of a Committee on Natural Disasters and their visit to the Tsunami Warning facilities was very informative. The group's visit was hosted by Mr. Masanori Kita, Consul of Japan and Dr. George Pararas-Carayannis, Director of ITIC. Mr. Kijima of the House of Representatives was the head of the visiting group and also the Chairman of the Japanese Committee on Natural Disasters. Members of the visiting Committee included the following:

Mr. Kihei Kijima	Member of the House of Representatives
Mr. Kosei Amano	"
Mr. Akatoshi Fujita	"
Mr. Hideo Watanabe	"
Mr. Masataro Hiraishi	"
Ms. Midori Kurita	"
Mr. Harumi Maki	Official of the Bureau of Legislation, House of Representatives
Mr. Hirotsugu Shibata	Official of the National Land Agency

The Consulate General of Japan was represented by Mr. Masanori Kita, Consul and by Mr. Toshio Kobayashi, Assistant.

Japanese Consul Visits ITIC and Hawaii Civil Defense

In preparation for a visit by a Japanese Congressional Delegation, the Japanese Consul, Mr. Masanori Kita and his assistant, Mr. Toshio Kobayashi, of the Consulate General in Japan, visited ITIC and Hawaii's Civil Defense facilities in Honolulu and received a briefing on tsunami operations and Civil Defense procedures from General Valentine Siefermann, Head of Hawaii's Civil Defense and from Dr. George Pararas-Carayannis, Director of ITIC.

From left to right: Mr. Toshio Kobayashi, Mr. Masanori Kita (Japanese Consul), Major General Valentine Siefermann, and Dr. George Pararas-Carayannis.

ITIC Sponsors Tsunami Luncheon

On 6 November 1980, ITIC sponsored a tsunami luncheon at the Pagoda Floating Restaurant in Honolulu. The luncheon was attended by officials of Hawaii State Civil Defense, University of Hawaii, NOAA scientists and administrators, and the Director of the Chilean Hydrographic Office. The purpose of the meeting was to review tsunami activity in the Pacific in the last few months and to give an opportunity to the scientists and administrators to discuss their research work or operational status of their organizations, respectively. The following persons attended this meeting:

Joint Institute for Marine & Atmospheric Research (JIMAR), University of Hawaii

Bill Adams
Charles Bretschneider
Doak Cox
George Curtis
Gus Furumoto
Hal Loomis
Carter Louis
J. Miller
Narendra Saxena
Les Spielvogel

State Department of Defense

Major General Valentine Siefermann
James McClellan
Harry Gill

Pacific Region Headquarters, National Weather Service

Grady Harger
Paul Daugherty

Satellite Field Services Station

Bob Pyle

Pacific Tsunami Warning Center

Bill Mass

International Tsunami Information Center

George Pararas-Carayannis

Chilean Hydrographic Office

Captain & Mrs. Mariano Sepulveda

Tsunami Reports

ITIC is continuing its efforts to collect data for the different tsunami events that have occurred in the Pacific in the last few years. ITIC generates letters of inquiries to appropriate authorities in each country of origin where a large earthquake occurred requesting mareographic records of a possible tsunami or other information that may be of value. Copies of all available tsunami mareographic records are scrutinized by ITIC before publishing a report in its Tsunami Reports series, and copies of all available records are forwarded to the World Data Center-A Tsunami for appropriate classification and filing.

Proposal for a Tsunami Educational Program

In the last two sessions of the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), recommendations were made for the development and support of an educational program on tsunamis. As a result of this recommendation, ITIC has developed such an educational program to be executed over a three-year period provided that funds become available. At the recent ITSU meetings it was resolved that such an educational program should be directed to three main groups: 1) the scientific community concerned with tsunami research; 2) the authorities responsible for devising and operating plans to prevent casualties and minimize damage in the event of a tsunami; and 3) the general public. ITIC has developed such a program which consists of catalogs of historical tsunamis, observed data, bibliographies of current research, training workshops, and educational materials in the form of brochures, slides, presentations, and films for the general public. A proposal was forwarded in early October to the IOC Secretariat for review and possible introduction into the UNESCO budget.

ITIC Catalog of Environmental Hazards for the Samoan Islands

Earlier this year ITIC completed a report entitled, "Catalog of Tsunamis in the Samoan Islands." A copy of this report was submitted to the U.S. Army Corps of Engineers, Waterways Experiment Station, and the report was used for the calibration of a numerical model developed by Mr. James Houston of the Hydraulics Laboratory.

A side benefit from this project has been the tabulation of an Earthquake Catalogue for the region, as well as a listing of all other environmental hazards for the area, such as hurricanes, flooding, and volcanic eruptions. ITIC is preparing a report on these other environmental hazards for the Samoan Islands.

ITIC Answers Inquiries from Around the World

ITIC frequently receives inquiries for tsunami information from around the world. These are answered expeditiously. Thus, ITIC plays a very important public relations role in the overall Pacific Tsunami Warning System, and tries to meet the educational needs of the general public for tsunami preparedness. This is probably one of the most valued services of ITIC, which in addition to serving a genuine need, also reflects very favorably on the organizations and the nations that support the overall Tsunami Warning System in the Pacific.

Former ITIC Associate Director Visits Honolulu

Mr. Norman Ridgway, former Associate Director of ITIC from New Zealand, recently visited ITIC in Honolulu while he was here on personal business. Mr. Ridgway returned to New Zealand in June 1979, but has continued his support of the tsunami program and his assistance to ITIC by providing archival information on tsunamis for the southwest Pacific, as well as continuing his work on a catalog of tide gauges for the Pacific. While in Honolulu, Mr. Ridgway discussed with Dr. George Pararas-Carayannis, Director of ITIC, details pertaining to New Zealand's participation in the Tsunami Warning System, and he was provided with computer outputs of tsunami travel time charts for Marsden Point and Lyttleton Harbour.

NATIONAL AND AREA REPORTS

All-Union Conference on Tsunamis in Vladivostok, USSR

The following proceeding was received from Prof. S.L. Soloviev, Chief, Laboratory of Seismology, Institute of Oceanology in Moscow.

The annual meeting of the Tsunami Committee of the Interdepartmental Council for Seismology and Earthquake Engineering (ICSEE) under the Presidium of the Academy of Sciences of the USSR organized jointly with the Far Eastern Regional Research Institute (FERRI) of the State Committee for Hydrometeorology of the USSR and the Pacific Oceanology Institute (POI) of the Far East Science Centre of the Academy of Sciences of the USSR was held in Vladivostok during June 10-14, 1980. The meeting was a kind of an All-Union conference on the Tsunami problem since it was attended by more than 100 experts who represented 40 institutions from all over the USSR. The sessions were held in the building of the Presidium of the Far East Science Centre of the Academy of Sciences and in part on board the weather research vessel "Academician Korolyov."

This was the second guest meeting of the Committee (the first similar conference was held in Minsk in 1979). The main purpose of the meeting was to discuss major results of research on the tsunami problem in the USSR during 1979-1980.

Location of the conference in the Far Eastern Region where the last similar meeting was held as long ago as 1972 aroused great interest among the scientific community of the country. The conference was the largest the committee has ever held not only as to the number of the *participants but first of all as to the volume of the information presented, which was reflected in the great number of papers submitted.*

The meeting was opened by addresses of Dr. V.G. Fedorei, Director of FERRI, Academician N.A. Shilo, President of the Far East Science Centre of the Academy of Sciences of the USSR, and Associate Academician S.L. Soloviev, Chairman of the Tsunami Committee who drew the meeting's attention to the great contribution made by Associate Academician E.F. Savarensky (1911-1980) and Academician M.A. Lavrentiev, Emeritus President of the Siberian Branch of the USSR Academy of Sciences into the development of tsunami research in the USSR and the organization of the tsunami warning service in the Far East. The conference sent a message of greetings to Academician M.A. Lavrientiev on the occasion of his forthcoming 80th birthday.

About half of the papers presented at the conference dealt with analytical description and numerical modeling of tsunamis, the other half dealt with performance of experiments, processing of experimental data, designation of special instruments and engineering problems. Interesting results have been obtained in all the aspects of tsunami research, and those of tsunami observation methods are of particular interest.

First let us discuss papers dedicated to the analytical aspects. A.I. Yanushauskas (Institute of Mathematics, Siberian Branch, USSR Academy of Sciences) proposed a new method to obtain approximate equations to describe oscillation of a liquid layer under the effect of sea floor oscillation by means of special exponential series. The first approximation yields shallow water equations; the following ones allow consideration of non-linearity, dispersion and other effects. V.V. Lobov and V.G. Trubin (Irkutsk University) dealt with reconstruction of the sea floor motion from a given surface disturbance of water by means of Hadamard's integral-differential equation. A common method to calculate directivity of tsunami energy radiation depending on the spatial-temporal heterogeneity of the source of disturbance was proposed by S.S. Voit, A.N. Lebedev and B.I. Sebekin (Instirute of Oceanology (IO), USSR AS). M.M. Chepinoga and B.S. Belozerov (Bielorussia University and Rostov Pedagogical Institute) studied Cauchy-Poisson's plane problems for a case when ice cover is present. It has been shown that the assumption of sliding of liquid at a hard surface does not complicate the expressions obtained essentially. Yu.P. Korolev (Sakhalin Complex Scientific Research Institute) studied asymptotic solution for water rise in a one- dimensional case. The dependence of the tsunami shape (number of crests, the form of the envelops, etc.) on the relation between the width of the source and the depth of the basin has been analyzed.

V.P. Maslov and V.A. Tsupin (Moscow Institute of Electronic Engineering) studied equations of Corteveg-de-Fries and Boussinesc for slowly changing initial data. Dispersion can be neglected until the moment when the profile of equation solutions becomes steep. For velocities of solitons that form, simple dependences on the height of their base and other parameters have been obtained. A.G. Kulikov and V.A. Reutov (Moscow Energetic Institute) discussed run-up of a plane single wave (tsunami) on to a long *ramdomly oriented undersea ridge. Two possible behaviours of the wave have been shown: running of the wave with the maximum possible amplitude when slight destruction of the wave and dissipation of the energy take place, and running of the wave with sub-maximum amplitude when the energy flow is preserved. A method for conjunction of the two behaviours has been developed. An.G. Marchuk (Institute of Theoretical and Applied Mechanics (ITAM) SB USSR AS) has obtained expressions for the path and time of tsunami movement from a random point in a water area towards a shore for model sea floor profiles, and an algorithm to calculate these parameters for a random depth distribution. B.A. Bubnov (Computing Centre, SB USSR AS) discussed the problem of run-up of a single wave onto an obstacle within a shallow water area in a case of gently sloping sea floor.*

I.V. Lavrenev (Moskow Physico-Technical Institute) discussed the mechanism of generation of seismic waves by tsunami that propagate in a basin with a rough bottom. A theoretical spectrum of Rayleigh waves generated by tsunami has been plotted, and an attempt has been made to compare the theoretical results with observations. V.I. Belokon and co-workers (Far Eastern University (FEU)) studied the effect of mantle conductivity, ocean bottom topography, non-linearity of waves and wave slope on the disturbance of the Earth's magnetic field by tsunami waves; it has been shown that amplification of the vertical component of the disturbances field is possible near sea floor heterogeneities.

E.N. Pelinovsky and V.E. Eridman (Institute of Applied Physics (IAP), USSR AS, Radiophysical Research Institute) showed that introduction of parameter Q/H where Q is equivalent charge determined from the energy of a volcanic explosion, and H is the depth of a basin allows connection of parameters of surface gravity waves and those of hydroacoustic signals from undersea volcanic eruptions. Several ideas on the physical processes that lead to tsunami generation were offered by A.A Poplavsky (SCSRI).

Finite-differential methods of numerical modeling of tsunami were used in seven papers. S.N. Ostroverkh (Institute of Hydromechanics, Ukrainian SSR AS) made a two-dimensional calculation of tsunami occurring over a buried sloping shift fracture. The author varied the source depth, velocity of dislocation distribution, distance of a sloping shore from the source, and direction of released tangential stresses. The plots obtained allow qualitative and quantitative evaluation of the effect these parameters have on the maximum water rise at the water edge and other tsunami characteristics. I.T. Selezov, V.A. Tkachenko and V.V. Yakovlev (the same Institute) studied the distribution of an unstable cylindrical wave from a localized initial water rise, and wave diffraction on a circular island having a random base. For long-wave approximation the authors used the numerical-analytical method: a method of generalized exponential series in a variable depth domain and numerical reflection of the Laplace transformation.

L.B. Chubarov (ITAM) offered models to elucidate the character of finite-differential approximations of mathematical models that include both *convective non-linearity and dispersion members. The author analyzed corresponding effects depending on the length and height of the initial disturbance and angle and extent of shore slope. Estimates were made of errors introduced by quantification of calculations. L.B. Chubarov, Yu.I. Shokin and A.A. Poplavsky calculated distribution along a 1000 km long coast of a tsunami caused by a bottom "piston" that is rectangular in plane and orthogonal to the coast. The transversal profile of the sea floor approximated the real profile near the Kuril Island Arc, but it did not change along the coast. Energy distribution along the coast has been shown to be effected due to multiple reflection from the coast and the shelf edge.*

I.V. Fain (SCSRI) calculated amplification coefficients of normally incident Poincare waves, and dispersion curves for edge waves within a frequency range of 0-3 cycles/hour and wave numbers of 0-0.016 km^{-1} *for the Kuril Island Arc area. Essential differences in frequency properties of different parts of the Kuril shelf have been revealed. V.G. Bukhteyev, G.P. Kleshcheva and N.L. Plink (Leningrad Hydrometeörological Institute) proposed two-dimensional calculations of tsunami entrance into the Kamchatka and the Kasatka Bays. Formation of proper oscillations (period of about 12 min) and flows along the coast has been observed for the Kamchatka Bay. A study of dry shore inundation has been continued; it has been shown, in particular, that the maximum height of water rise on shore cannot be more than three times as high as the tsunami height at the 20 m isobath. E.N. Pelinovsky and N.L. Plink continued one-dimensional calculations from the 20 m isobath to the water edge of tsunami caused by a generalized belt-like source along the Kuril-Kamchatka Arc, on assumption that tsunami inundates the shore smoothly.*

The information on the first instrumental recording of a tsunami offshore which was made on February 23, 1980, by means of a remote cable pressure pick-up placed at a depth of 100 m 10 km off the Shikotan Island can be considered to have been the central event of the conference. A tsunami with a height of about 10 cm caused by a South Kuril earthquake with M=7 was recorded. Recording of tsunami on shelf differs essentially from that by means of a shore tide gauge in the Malokurilsk Bay, but it is also accompanied by a train of proper oscillations that can be calculated theoretically knowing the sea floor topography. The information was prepared by a large group of SCSRI scientists and S.L. Soloviev.

Other papers that reflected empirical data were also interesting. M.P. Garber, V.M. Zhak, V.E. Konnov and A.V. Rodionov (FERRI, SCSRI) reported that during the 25th cruise of the weather RV Okean two self-contained bottom hydrophysical stations were installed due to operate for a year.

Possible micro-tsunami were revealed in records of bottom pressure pickups that had operated during the 2nd USSR-USA expedition to study tsunami off shore. This and general results of the expedition were reported in two papers by a group of SCSRI scientists. V.Ya. Arsenin, V.V. Ivanov and G.P. Cherny (Institute of Applied Mathematics, USSR AS, Research Institute of Physical and Optical Measurements of Gosstandart) proposed an *original method to reconstruct the shape of a tsunami that approaches shore tide gauges and is complicated by oscillations of water in recording points. L.N. Poplavskaya (SCSRI) showed that contours of tsunami sources coincides with 9-degree isoseists. S.L. Soloviev (IO) obtained for tsunami recurrence in the Pacific Ocean for 1969-1978 the same results that those for the period to 1968. The process of tsunami generation was almost continuous during the past 20 years near southern Kuril Isles, "longitudinal" and "transversal" sources alternating in time and space. I.V. Tulupov (Institute of Physics of the Earth, USSR AS) generalized actual data on southern Kuril tsunami and made an attempt to predict maximum water rise in the settlements of Burevestnik, Yuzhno-Kurilsk, Malokurilsk and Kurisk for 100 years ahead.*

Several papers dealt with improvement of the seismic part of the tsunami warning service. An effective algorithm to promptly distinguish arrivals of P and S waves by means of a computer was proposed by I.V. Nikiforov and I.D. Tikhonov (Institute of Control Problems, USSR AS, SCSRI). A.G. Totok and A.A. Poplavsky (Central Machinery Technology Institute, SCSRI) showed that the epicentral area of an earthquake can be found approximately from the order of reaction of seismic receivers of a rather dense net distributed evenly over a zone. A.N. Morgunov, A.A. Poplavsky and R.S. Sen (SCSRI) spoke about the progress made in automation of operator-seismologists work. Using digitized records of tsunamigenic and non-tsunamigenic Pacific earthquakes obtained by means of long-period seismographs, V.K. Gusyakov (Computing Centre, SB USSR AS) showed that spectra of Rayleigh waves of these two earthquake groups differ as to the positions of maxima and forms. Their low-frequency part is much more intensive for tsunamigenic earthquakes, which fact can be used for tsunami prediction.

K.P. Rizhkov (State Committee for Hydrometeorology) informed about the preparation of a draft of a new Governmental Decree on tsunami warning service. Plans to participate in the fulfillment of the decree were discussed by V.V. Sviridov (Kharkov Institute of Radioelectronics) and K.G. Karnaukh and others (Bureau for Designing Means of Automation and Control, Minpribor).

Separate instruments that are of interest for tsunami observation system were discussed in papers "Acoustic measurer of the plane vector of currents" by V.A. Korotkov, V.I. Krylovich and O.G. Martynenko (Institute of Heat and Mass Exchange, AS of Bielorussian SSR), "A Telemetric Aggregate to study slowly Changing Hydrophysical Fields" by A.S. Popov (FEU), on a 100-meter laser extensometer by U.Kh. Kopvillem (POI), on calibration of potentiometric transducers for measurers of currents by a group of FEU scientists, on instruments to study ionic composition of water by I.I. Zalyubovsky and P.M. Gopych (Kharkov University) and in other papers.

P.P. Kulmach (Higher Military Engineering School) presented a review of foreign engineering measures for protection from tsunamis. A.V. Silin (Giprorybprom) called upon the participants of the conference to speed up introduction of scientific developments into practical engineering in tsunami-risk zones.

The conference made adjustments to the coordinated project of tsunami research for the XI five-year plan and solved a number of organizational problems.

As a whole, the conference was interesting and successful, and it showed that tsunami research in the USSR gains strength.

Proposal for Establishing a Tsunami Warning System in Indonesia

Mr. Sulaiman Ismail of the Indonesian Institute of Meteorology was a recent ITIC visitor this summer. While at ITIC, Mr. Ismail, with assistance from Dr. George Pararas-Carayannis, Director of ITIC, prepared a proposal for a Regional Tsunami Warning network in Indonesia naming specific stations and giving specific costs for the proposed network. This proposal was taken back to Indonesia by Mr. Ismail to be presented to the appropriate government agencies for their review and concurrence.

Tsunami Research in Australia

Dr. H. Allison, Principal Research Scientist at the Institute of Earth Resources of the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia recently wrote to ITIC informing that his organization is going to undertake research on the effects of tsunamis in the Indian Ocean to the Western Australian coastline. ITIC has made arrangement to send photographs, slides, and possibly a copy of an educational film on tsunamis to Australia, and has asked Dr. Allison to keep ITIC informed regarding research being undertaken at the Institute.

Possible Tsunami from the 25 July 1979 Earthquake

An inquiry was recently received at ITIC regarding the tsunami of 25 July 1979 at the Mururoa Atoll (Tuamotu Islands). Event No. 1979-12 reported in the ITIC Newsletter in January 1980 reported the epicenter of an earthquake in the Java Sea at 10.5 S, 108.2 E for that date. The magnitude of the earthquake was only 6.6 which is marginal for the generation of a tsunami. It is very unlikely that even a small tsunami generated in the Java Sea would be recorded as far away as Mururoa Atoll, particularly because of the distance and because of the islands surrounding the epicenter area. If indeed a tsunami was observed at Mururoa, it is very unlikely that it had its origin in the Java Sea. ITIC is investigating if there is a connection between the earthquake in the Java Sea and a possible tsunami at Mururoa.

Work on the Pacific Tsunami Catalogue Continues

Work on the final version of the Pacific Tsunami Catalogue continues. A Preliminary Tsunami Catalogue was published in 1967 and since then work has continued among the principal authors of this publication who are Dr. Kumizi Iida, Dr. Sergei Soloviev, Dr. Doak Cox, and Dr. George Pararas-Carayannis. Differences in the reports of different tsunami events among the principal authors are presently being reconciled and additions and corrections are continuing. Dr. Doak Cox will be going to the World Data Center-A Tsunami in Boulder, Colorado to work on the Pacific Tsunami Catalogue during his 6-8 months sabbatical leave starting later this year. The file for the catalogue will be transferred from the University of Hawaii computer where it now is to the computer at the University of Colorado. Efforts are being made among the principal authors to agree on the status of the file before the transfer to the University of Colorado computer is made.

NOAA Applies Advanced Technology to Improve Warnings of Natural Hazards

The following is reprinted from the Natural Hazards "Observer," Volume IV, Number 2, December 1979.

To provide warnings of natural hazards, the National Oceanic and Atmospheric Administration (NOAA) maintains over 300 field offices supported by a complex array of computers, satellites, and communications. Over the next decade, NOAA will devote increased emphasis to the preparation and dissemination of very short-range forecasts of severe weather (0-3 hours), to provide additional time for local disaster teams to save lives and property in emergency situations.

The Prototype Regional Observing and Forecasting System (PROFS) is a new, major program which NOAA has mounted to promote the development of very short-range forecasts. PROFS is designed to examine remote sensing techniques and to determine how they can be incorporated into an operational system for the rapid collection, analysis, and dissemination of weather information.

Another NOAA initiative is the Coastal Hazards Program. Over 75% of our population lives within 100 miles of the coasts and the Great Lakes. The National Weather Service seeks to improve forecasts of coastal zone flooding from hurricanes, tidal action, tsunamis, and severe storms. NOAA's Office of Coastal Zone Management is involved in evaluating ways in which losses due to severe natural phenomena can be minimized by effective land use.

A third NOAA initiative is an effort to improve flash flood warnings. In cooperation with the Appalachian Regional Commission, a pilot program is being developed in a 12-county area of Virginia, West Virginia and Kentucky. This project will be expanded next year to other parts of these states and to Pennsylvania.

Conference on National Tsunami Research Plan for U.S.A

From August 25 through the 29th of this year, a group of American scientists met to look at the United States efforts in tsunami research. The meeting held on Rosario Island, Washington (northwest corner of the state), reviewed the topic of a National Tsunami Research Plan. The group represented a selection on research interests from universities, private groups, and the Federal Government. The scientists who attended are shown in the picture below.

Top Row L-R

Jerry Harbor (NCR), George Lea (NSF), Chi Liu (NSF), Roger Stewart (USGS), James *Houston (ACOE), Bernard LeMehaute (U. Miami), David Tung (N.* Caro-*lina State), Keen Lee (Tetra Tech), Richard Goulet (NSF), Eddie Bernard (NOAA).*

Bottom Row L-R

Dennis Moore (JIMAR), Ted Wu (Cal Tech), George Carrier (Harvard), Li San Hwang (Tetra Tech), William Van Dorn *(Scripps), Phil Hseuh (NSF), Hal Loomis (NOAA), Charles Theil (FEMA),* Fred *Raichlen (Cal Tech).*

Not Photographed: Andrew Vastano (Texas A&M)

During the course of the conference on tsunami research within the United States, the group reviewed the many aspects required to produce a more focused effort. The overall idea was formed within the need (e.g., legislative mandates including tsunamis) for a more coordinated effort, including a review of tsunami losses in the past and the possibilities for the future. Within this framework, the following topics were discussed:

Needed Categories of Research
State-of-the-Art
Federal Agency Contributions
Research Capacity/Capabilities
Funds Required for a National Effort
Coordination of Efforts
Results Expected Near-Term, Long-Term

By the conclusion of the conference, attendees agreed that a paper indicating a National Plan for Tsunami Research for the United States was possible. In response to this, each member of the conference is assisting in the creation of such a plan for expected release in draft form later in the year.

Tsunami Station Inspection

Lt. Kathy Andreen, Lt. B. Dearbaugh, Lt.jg. Marianne Molchan, Mr. Mickey Moss and Mr. K. Welker of the Pacific Tide Party of NOAA completed the following inspection and maintenance of tide stations of the Pacific Tsunami Warning System during July and August this year. All of the stations are in Alaska.

July 5	Seward
July 13-14	Sand Point
July 22-26	Anchorage
July 22	Unalaska
July 24	Adak
July 31 - August 1	Kodiak
August 3-4	Yakutat
August 10-12	Sitka

Presently the Pacific Tide Party is conducting maintenance and inspection of several tsunami and tide stations in the Pacific island. The excellent work of the Pacific Tide Party in maintaining a number of these tsunami stations is greatly appreciated by Member States. This contribution to the Pacific Warning System is a large factor in monitoring effectively tsunami activity in the Pacific Ocean.

ABSTRACTS AND RESUMES

Data from Investigation on Seismic Sea Waves Events in the Eastern Mediterranean from Antiquity to 500 B.C.

J. Antonopoulos
Patissia - Athens, Greece

1. Introduction

Tsunamis from Antiquity to 500 B.C. in the Eastern Mediterranean between 31-44 N and 18-36 E excluding Black Sea and the Italian coasts of the Adriatic Sea is the object of the present paper.

The terms "tidal wave" and "tsunami" are often used instead of the term seismic "sea waves." The first term is rather misleading, since seismic sea waves are vary rarely connected with tides. The term "tsunami," derived from the Japanese, seems to have been universally accepted.

The research made so far on the origin and development of seismic sea waves can be classified into two broad categories. Theoretical studies and observational analyses. Theoretical studies, necessarily, involved oversimplified assumptions, and their results although have been proved helpful in understanding certain phases of the phenomenon, they have not as yet disclosed any particularly interesting fundamental characteristic of the phenomenon itself. Observational analyses seem to be more effective in particular when supplemented by theoretical findings, but due to the scanty of observational data they are rarely successfully applicable.

In undertaking an observational study of the origin of seismic sea waves we sought primarily that the region over which we were to carry out our investigation should satisfy two conditions. First that the number of individual seismic events in this region should be as large and well documented as possible, and second that the region should be more or less self-contained of limited extent and geotectonically well documented.

In preparing our paper we were fully aware that its outcome would be more suggestive than definitive. Also we were aware of the fact that the older historical accounts of seismic phenomena rarely include much useful information other than reports of damage and casualties. These we considered worthwhile our labours.

2. Key to Descriptions of Events

The description of events is arranged in the following manner.

Dates are given in headlines in the new style (Gregorian). They are followed by the name of the region in which the seismic sea wave was felt. This is followed by the name of cities, towns or areas which were particularly affected. The intensity, m, of the wave is given in small

Roman numerals and it refers to Sieberg's modified intensity scale where the height of the wave on land or the distance which it flooded inland is known is indicated as (H=) and (L=) respectively. The geographical coordinates of the epicentre of the main earthquake shock, when known are given together with the intensity of the shock (I=in the modified Mercalli scale), magnitude (M=after Guttenberg) and the focal depth (d=, s:shallow, n:normal, i:intermediate). This is followed by the references consulted which are pertinent to the phenomenon itself, to the accompanying earthquake, and to the information necessary for the dating of the event. Numerals outside the parentheses refer to references in the Bibliography. In the parentheses, Roman numerals refer to the book (liber) and the following numbers to the chapter and line respectively of the text. P : refers to a standard system of pagination while p : indicates the page. Folio is indicated by f. Page references to an authority is not given when the material in that authority is arranged chronologically. Entries marked with an asterisk are doubtful events quoted mostly by modern writers, which have been included for the sake of completeness.

Place names mentioned in the originals suffered many changes during historical and recent times. When these differ from those of today, the former are shown in brackets where they first occur, and the modern name is used thereafter. Modern places are spelt after Lippincott.

In what follows the headlines more information is given mainly about the last events. For all the other events only a bare outline is given.

With so many dates, controversial points, so many foreign names and such a multitude of references as crowd this paper; though we have done our best to be as accurate as possible, many errors must necessarily have crept in. We shall feel most greatful to those who will point these out to us.

3. <u>Description of Events</u>

1) II millenium B.C. Syrian coasts (vi?). From cuneiform texts 8, 15, 16, 18.

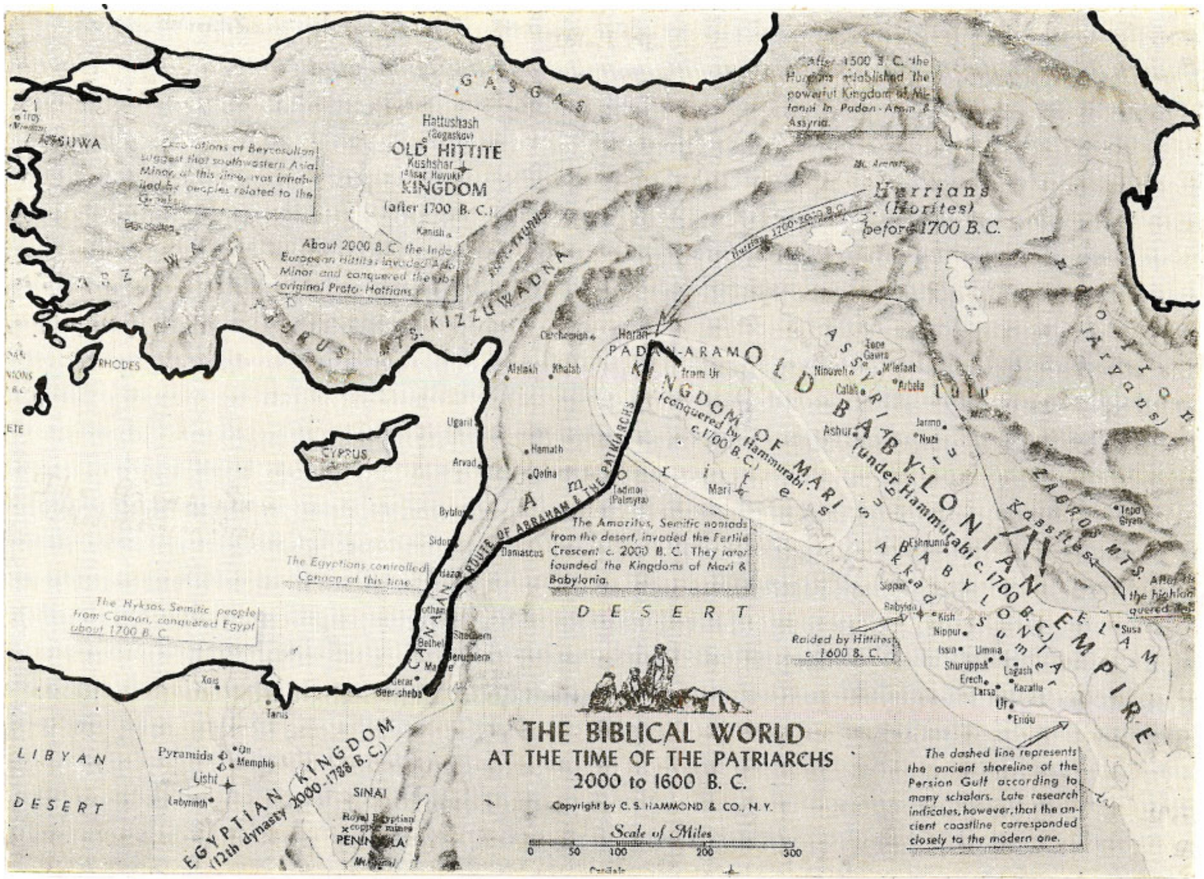


Fig. 1 Syrian coasts at the time of tsunami of II millenium B,C.

2) 1410 ± 100. North coast of Crete, Grecian Archipelago (vi?) 7, 9, 10, 11, 13, 14.

By the end of the period of the Second Palace, circa 1500 BC, the long history of Creto-Minoan civilization shows that a wide spread disaster occurred in Crete. All over the island the catastrophes seem to be simultaneous and show very clearly signs of a seismic convulsion.

The seismic history of the island and the Crito-Minoan religion lead De Ballore (1923) to the conclusion that the destruction of the Minoan Crete might have been caused by a series of violent earthquakes and devastating seismic sea waves.

Evans (1928) suggested that these catastrophes were caused only by earthquakes, a suggestion which could not account for the destruction of Minoan cities situated in exceptionally stable regions of the island.

In 1934 Marinatos put forward a theory according to which the devastation of Minoan Crete was caused by a huge seismic sea wave which was generated by the eruption of the volcano at Thera (Santorin). This theory Marinatos develops at some length in 1939 and 1960, that the devastation visible on so many late Minoan sites was caused by the great eruption of Thera, much greater than that of Krakatoa to judge by the size of the caldera. This disaster he dates about 1520 BC, and he may be right, though we think arguments could be advanced for a somewhat later date. A carbon-14 age determination made on samples of wood found in a pumice quarry in Thera by Galanopoulos (1957) (1958) (1960c) shows that the eruption alluded to by Marinatos must have occurred in 1410 $\pm$ 100 BC.

Marinatos's theory, which we believe to be reasonable, makes it easy to explain the destruction of coastal towns situated on seismically stable parts of the island. Earthquakes, catastrophic seismic sea waves and heavy pumice from the eruption of Thera 60 miles from the north coasts of Crete may easily account for the destruction of so many Minoan cities. Undoubtedly his theory requires additional archaeological and geological support. Should the collapse of the 30-square-mile caldera was gradual or the eruption developed in stages, his comparison with Krakatoa becomes unattainable and the generation of a catastrophic seismic sea wave is questionable.

It seems very probably that the earliest seismic sea wave in the Grecian Archipelago, for which sufficient though not conclusive evidence exists, is that alluded to by Marinatos and Galanopoulos (1960c)[1].

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[1] In connection with the 1500 BC eruption of the volcano at Thera and the accompanying seismic sea wave, Galanopoulos (1960b,c,d) developed a theory that the deluge of Deukalion and the myth of Atlantis must be related, and that the metropolis of Atlantis must be placed on at Thera, or rather on the submerged part of the island.

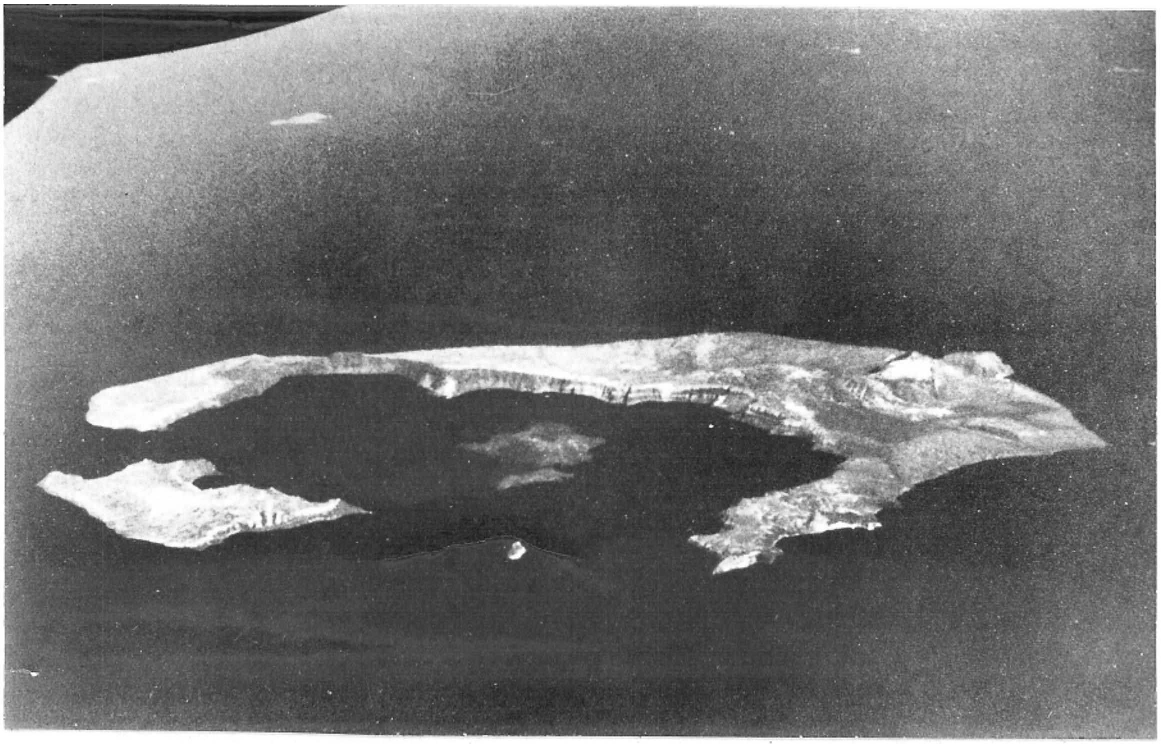

Fig. 2 The whole island group of Thera from the west. The largest portion is Thera proper, to the left is Therasia, and the very small fragment at the entrance to the caldera is Aspronisi. In the centre of the bay is the volcanic dome consisting of the smaller island of Palaea Kameni and the larger island Nea Kameni which is the present focus of volcanic activity. (lla).

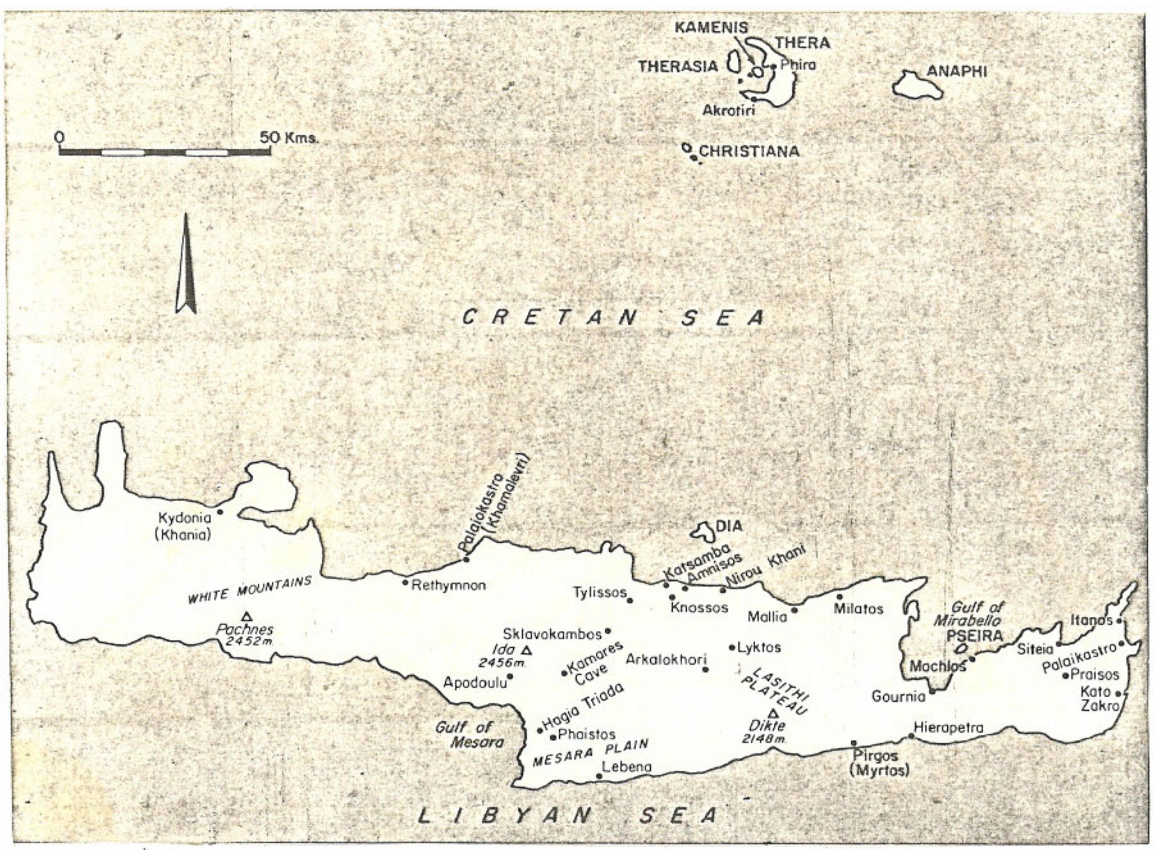

Fig. 3 Crete and Thera showing mentioned in the text (lla).

Fig. 4

Ruins excavated at Ammisos, the port of Knossosin Crete. This low-lying site would have been extremely vulnerable to the effect of tsunamis. (11a)

Fig. 5

The small plain at Kato Zakro in Crete, known as the "Valley of the Dead". It was an important naval base and port, and destroyed at the same time as the other sites in Crete. (12b)

3) 1365 ± 5 BC. Syrian coasts, Ugarit near Minet-el-Beida (vi?) 12, 15, 16.

Democles Phygaleus[1] records certain great earthquakes some of which, long ago, took place about Lydia and Ionia as far north as the Troad. These earthquakes not only engulfed villages but Mt. Sipylus was shattered in the reign of Tantalus. Lakes arose from swamps and a tidal wave submerged the Troad.

No other historical account survives of this event in the Troad, which undoubtedly was a seismic sea wave. Democles's statement, and on his authority Strabo's statements (lib.i, § 3.17) like many other narrations connected with the ancient historical reminiscences, is an echo of the early seismic catastrophe in Asia Minor[2].

Democles's statement about the Troad, most probably refers to the time when Asia Minor was convulsed by those early seismic phenomena which one should connect with the epoch of Tantalus. From early legends[3] these phenomena, in many places and in particular in the Troad[4], seem to have been accompanied by disastrous seismic sea waves, one or more of which, are mentioned by Democles.

4) c.1300. Ionian coasts and towns in Asia Minor, Troad (v?).

5) c. 760. Coasts of Israel and Lebanon. Amos (i, 1); Zacharias (xiv, 5).

6) c. 590. Coasts of Lebanon. Sur (Tyre) (vi?) 17, (p.198). Not found in early texts.

7) c. 525* BC. Coasts of Lebanon, Saida (Sidon). 17. (p.198) 4, 2, (i, 3, 16), 1.(xxiv,24).

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1 Flourished in the 5th or 4th Century BC. He compiled a catalogue of earthquakes of which little is known.

2 Diodorus (lib. iv. §74), Ovidius (Metamorph. lib.vi, §401), Pindar (Ol. lib.i, §60), Antonius Liberalis (§36), Homer (Odyssey lib.xi §582), Eurepides (Orestes §5) etc. Cf. Hylen (1896).

3 Homer (Iliad lib. xx, §145), cf. Lang (1883) p.517; p.403; Murray (1957), vol. 2, p.381.

4 Schaeffer (1948) mentions a Tell el Amarna letter according to which Ugarit, Asia Minor, Tarsus and Troy were destroyed by earthquakes in 2400, 2300, 2100, 2000, 1730 and 1365 BC.

Sieberg (1932) p.198 says that circa 525 BC an earthquake occurred in Syria which damaged Tyre and which was felt as far as the Cyclade Islands and Euboea. This earthquake, Sieberg maintains, was followed by a seismic sea wave on the Syrian coasts. He quotes no authority.

This very earthquake is described, on the authority of Poseidonios of Apameia (nat. c.130 BC)[1], by Nicolaos Damascenos (nat. 64 AD)[2], Strabo (lib.i, §3.16) and Seneca (Qust. Natur. lib.24, §24). But we find neither mention of a seismic sea wave in these authors nor any information from which the date of this earthquake can be fixed.

It is not improbable that Sieberg infered this event.

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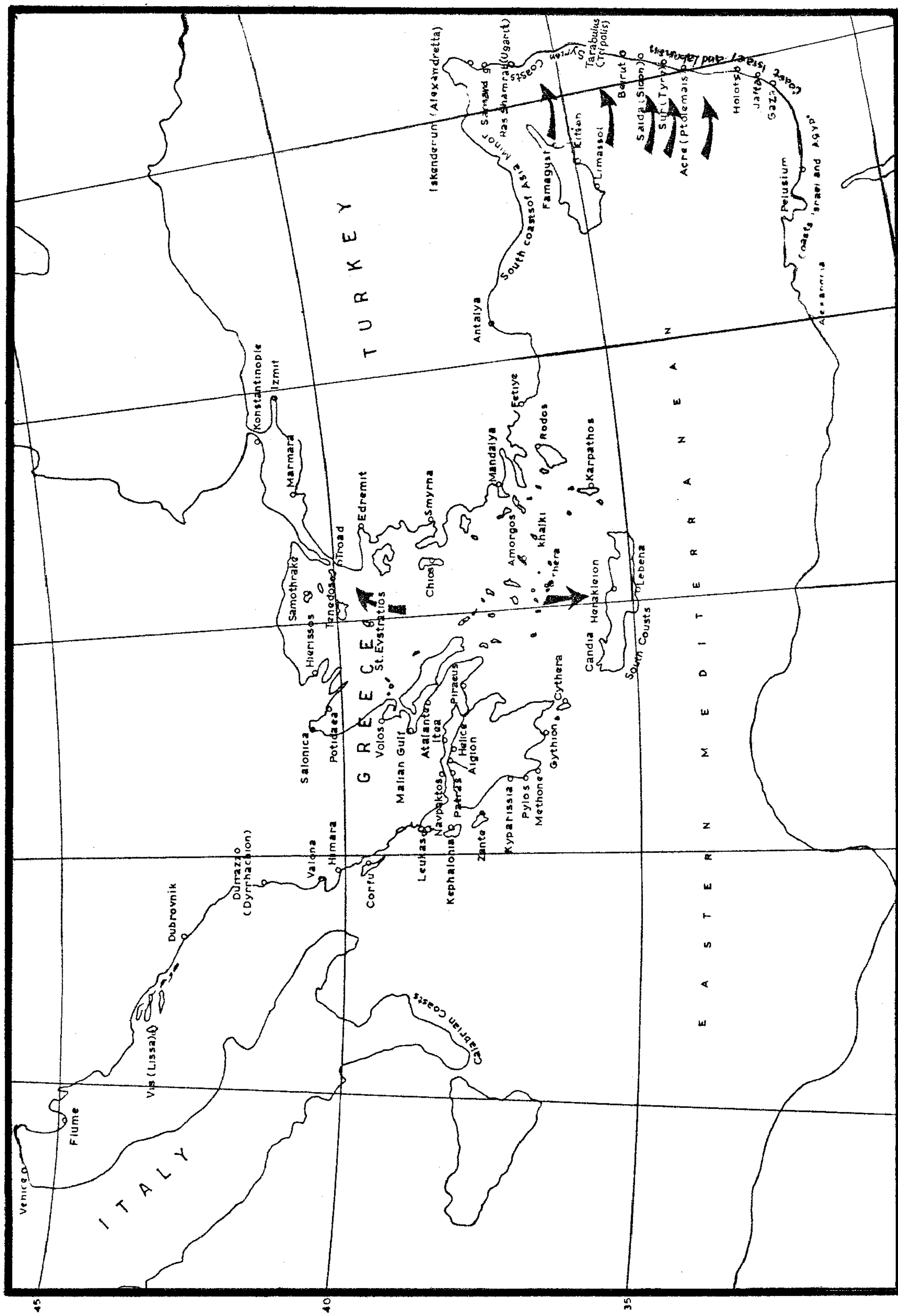
1 In the Fragmenta Historicorum Graecorum by C. Muller (1868) vol. 3, p.285, fragm.76, Edit. A.F.Didot, Paris.

2 It is not certain that Nikolaos in this place refers to the same event as Poseidonios; it is not improbable that he refers to the earthquake which occurred during the reign of Tigranes '83-69 BC). Cf. Justin, lib.xl, § 1).



TURKEY
GREECE
ITALY
EASTERN MEDITERRANEAN
Venice
Fiume
Vis (Lissa)
Dubrovnik
Durazzo (Dyrrhachion)
Valona
Himara
Corfu
Calabrian Coasts
Leukas
Kephalonia
Zante
Navpaktos
Patras
Kyparissia
Pylos
Methone
Gythion
Cythera
Aigion
Helice
Itea
Atalante
Piraeus
Malian Gulf
Volos
Salonica
Potidaea
Hierissos
St. Evstratios
Samothrake
Tenedos
Troad
Edremit
Marmara
Konstantinople
Izmit
Smyrna
Chios
Amorgos
Khalki
Mandalya
Rodos
Karpathos
Fetiye
Candia
Herakleion
Lebena
South Coasts
Antalya
South coasts of Asia Minor
Iskenderun (Alexandretta)
Ras Shamra (Ugarit)
Syrian Coasts
Famagust
Kition
Limassol
Tarabulus (Tripolis)
Beirut
Saida (Sidon)
Sur (Tyre)
Acre (Ptolemais)
Holots
Jaffa
Gaza
Pelusium
Coasts Israel and Agypt
45
40
35
30
25
20
15

Acknowledgments

I have been much assisted by Professor N. Ambraseys of the Imperial College, University of London, to whom I am indebted. Without his invaluable help this work could not have been carried out.

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Biographical Note

Diploma of the National Technical University of Athens in Civil Engineering (1950). Diploma of Imperial College of Science and Technology (University of London) Seismology Department. Dr. Eng. of the National Technical University of Athens. Special Senior Lecturer of the University of Patras, Greece.

On Reliability of Tsunami Magnitude Estimations

(Volcanology and Seismology, Number 4, 1979)

Professor S.L. Soloviev
Institute of Oceanology, USSR

In 1977 I.B. Everingham published "Preliminary catalogue of tsunamis in the New Guinea/Solomon Islands region, 1768-1972" (Bureau of Mineral Resources, Geology and Geophysics, Australia, Report 180), where estimations of tsunamis magnitude are given according to the Imamura-Iida scale.

Earlier similar estimations were done by S.L. Soloviev and Ch.N. Go in their "Catalogue of tsunamis on west coast of the Pacific Ocean" (Nauka, Moscow, 1974, in Russian).

It is interesting to compare these two series of estimations as it allows to conclude on the reliability of tsunami magnitude estimations, on the whole. The table shows the results which are very encouraging. The mean absolute difference is only 0,4 if not to take into account three cases of incorrect magnitude values. It seems that in general the accuracy of tsunami magnitude calculations is not worse than $\pm 1/2$ if there are adequate data on the tsunami effects at the coast, that is estimations of tsunami magnitude (or intensity I, according to S.L. Soloviev) can be regarded as relatively stable and reliable.

Tsunamis for the New Guinea/Solomon Islands region 1768-1960. Comparison of magnitude determination by Everingham(Ev.) and by Soloviev & Go (SG).

Date	m(I)		Date	m(I)	
	Ev	SG		Ev	SG
1856/1857	2	1-2	1930 Dec	2-3	1-2*
1864 May	1-2	1-2	1931 Oct	2-3	2-3
1873	1?	2	1937 May	1	1-2
1878 Feb	0	1	1939 Jan	1	1
1888 Mar	3	3-4	1939 Apr	2-3	1-2*
1899	1?	1-2	1941 Jan	0	- 2 1/2**
1900 Sep	2	1-2	1949 Oct	0?	- 1
1906 Sep	1-2	1-2	1953 Apr	0-1?	0
1906 Oct	1-2	1-2	1960 Jun	0?	0
1910 Feb	0	0	1916 Jan	2	2
1911 May	0?	0	1919 May	1-2	1
1913 Oct	2?	-	1926 Sep	1-2	1-2
1914 May	2	2			

* Incorrect estimation due to lack of actual data.

** Occasional mistake.

Terremotos Colombianos Noviembre 23 y Diciembre 12 de 1979

J. Emilio Ramirez, S. J.
Director, Instituto Geofisico
Universidad Javeriana
Bogota, Colombia

The preceding report was not abstracted. It is, however, available in Spanish from the source noted above.

Geodynamics International - 16

Report SE-23, May 1980

World Data Center A for Solid Earth Geophysics
NOAA/Environmental Data & Information Service

The Geodynamics Project is an international programme of research on the dynamics and dynamic history of the earth with emphasis on deep-seated foundations of geological phenomena. This includes investigations related to movements and deformations, past and present, of the lithosphere and all relevant properties of the earth's interior and especially any evidence for motions at depth. The programme is an interdisciplinary one, coordinated by the Inter-Union Commission on Geodynamics (ICG) established by ICSU at the request of IUGG and IUGS, with rules providing for the active participation of all interested ICSU Unions and Committees.

The Commission consists of a Bureau, Chairmen of Working Groups and representatives of ICSU, the sponsoring Unions and other interested Unions and Committees, and the Past President.

Tsunami Engineering

Special Report No. 6, February 1980

Frederick E. Camfield
Coastal Engineering Research Center, Virginia

Report distributed by Government Printing Office, Stock Number 008-022-00145-0.

This report provides a source of state-of-the-art information on tsunami engineering. The report summarizes available information, identifies gaps in existing knowledge, and discusses methods of predicting tsunami flooding. The generating mechanisms of tsunamis and the method of determing the probability of occurrence are given.

Because of the limited data available on tsunamis, numerical methods are commonly used to predict tsunami flooding of coastal areas.

Finite-difference equations are presented for simulating the propagation of tsunamis, but computer programs are omitted because of the continuing work in progress and the availability of up-to-date computer programs from other sources. Known mathematical solutions, for tsunamis approaching the shoreline and tsunami-shoreline interaction, are given to illustrate the effects of tsunamis and provide means of verifying numerical results. The report discusses tsunami-structure interaction and illustrates various types of damage caused by tsunamis.

Tsunami Elevation Predictions for American Samoa

Technical Report HL-80-16, September 1980

James R. Houston
U.S. Army Engineer Waterways Experiment Station, Mississippi

Frequency-of-occurrence curves for tsunami elevations in American Samoa were determined. The islands of Tutuila, Aunuu, Ofu, Olosega, and Tau were considered in the analysis. A catalog of historical tsunamis in the Samoan Islands was compiled. Historical data were used to determine a frequency-of-occurrence curve for Pago Pago Harbor on Tutuila. A hybrid finite-element numerical model was then used to extend the historical data at Pago Pago to allow frequency-of-occurrence curves to be determined throughout American Samoa.

Parameters of Tsunami Waves in the Source

N.R. Mirchina, E.N. Pelinovsky and S.Kh. Shavratsky
Academy of Sciences of the USSR

Correlation relations of the displacement and tsunami wave length in the source to the earthquake magnitude have been obtained useful for tsunami wave calculations.

The efficiency of hydrodynamic methods of calculation of possible damage caused by a tsunami wave on the shore depends in many respects on the knowledge of "initial conditions," namely tsunami wave parameters in the source or in the open ocean at least. However, direct instrumental data on tsunami waves in the open ocean are not available. At the same time the theoretical methods of calculation of tsunami wave parameters in the source are not sufficiently reliable. As a rule, displacement and velocity fields at the bottom are taken as initial conditions (for tsunamis generated by earthquakes) but generally speaking they are unknown because instrumental measurements of real bottom displacements during an earthquake are not available (there is lack of data even on residual bottom deformation). Common solution of the hydrodynamic and elasticity equations employed in an effort to relate the wave parameters in the source to measurable characteristics of a seismic process is undoubtedly, beneficial for elucidation of physics of generation of tsunami waves (particularly for definition of the type and orientation of the motion).

However, reliable comparison of the results of a theoretical model and the data on actual tsunami is not yet available and forecast formulae have not been deduced yet. Under these conditions it seems attractive to use the data on the former tsunamis for establishing the unknown relation of tsunami wave parameters in the source to the basic characteristics of their cause, for example, the earthquake magnitude M, the wave field in the source being determined by the shore station data, i.e. by hydrodynamic methods. Lack of shore data and the difficulties of solving the inverse problem do not allow to establish exact relations between the characteristics under study. Nevertheless, there is a point in establishing such relations, if only on average, as it allows to put these data into a definite order, to reveal doubtful data and to make rough estimates necessary for practical forecasts. The paper deals with a critical analysis of the available dependencies and a number of new ones which allow to estimate tsunami wave parameters such as water surface displacement, and tsunami wavelength in the source by such earthquake parameters as magnitude and crustal displacement.

(Because of the technical nature and length of this paper, only the abstract is published in the Tsunami Newsletter. Copies of the entire paper can be obtained by writing to the authors directly: Applied Physics Institute, Academy of Sciences of the USSR, Ul'yanova 46, 603600 Gorky, USSR).

PACIFIC TSUNAMI WARNING CENTER

Seismic Summary (July 1, 1980 to Press Time)

Event No.	Event	Location	Action Taken
1980-11 (PTWC)	Jul 8 2319 (UT) 7.3	New Hebrides 12.8 S 166.3 E	Press Release
1980-12 (PTWC)	Jul 16 1957 (UT) 6.9	New Guinea 4.8 S 143.8 E	Press Release
1980-13 (PTWC)	Jul 17 1942 (UT) 7.9	New Hebrides 13.0 S 166.3 E	Watch, Watch Supplement, Watch Cancellation, Press Release
1980-14 (PTWC)	Jul 29 0312 (UT) 6.8	New Hebrides 11.7 S 166.6 E	Press Release

Event No.		Event	Location	Action Taken
1980-15	(PTWC)	Oct 10 1225 (UT) 7.4	Near Oran, Algeria 35.3 N 0.5 W	Press Release
1980-16	(PTWC)	Oct 24 0326 (UT) 6.5	Loyalty Islands 21.6 S 170.5 E	Press Release
1980-17	(PTWC)	Oct 24 1453 (UT) 6.5	Southern Mexico 18.1 N 97.2 W	Press Release
1980-18	(PTWC)	Oct 25 0700 (UT) 6.6	Loyalty Islands 21.9 S 169.9 E	Press Release
1980-19	(PTWC)	Oct 25 1101 (UT) 7.3	New Hebrides 16.9 S 171.3 E	Press Release

SPECIAL BULLETIN

EARTHQUAKE OF NOVEMBER 23, 1980 IN SOUTH ITALY

Italy's worst earthquake in 50 years occurred on November 23, 1980 in the southern province near Naples. Several thousand people were reported injured and thousands more were homeless. As of November 25 1,012 bodies had been found, but the death toll was expected to reach 3,000 or more.

The earthquake measured 6.8 on the Richter scale and jolted an area with a total population of 7 million. Earthquake damage spread over an area of 10,156 square miles, an area that includes Naples, Salerno, Mount Vesuvius and the ancient cities of Pompeii and Herculaneum.

One of the worst hit was at the village of Balvano, 60 miles east of Naples. So far 59 bodies were found and 100 people were reported missing. Most of these killed were crushed when the roof of the Church of Santa Maria Assunta caved in during evening Mass. In Salerno, an estimated 20,000 people were homeless. Eighty percent of Sant'Angelo dei Lombardi in the Avellino province was flattened, including a modern hospital, and an estimated 300 people perished. Ninety percent of the buildings in Laviano were destroyed, leaving only two houses and a discotheque still standing. In Naples, 11 people were killed when a 10-story apartment house collapsed.

the staff of
ITIC
wishes you

MERRY
CHRISTMAS
and
HAPPY
NEW
YEAR