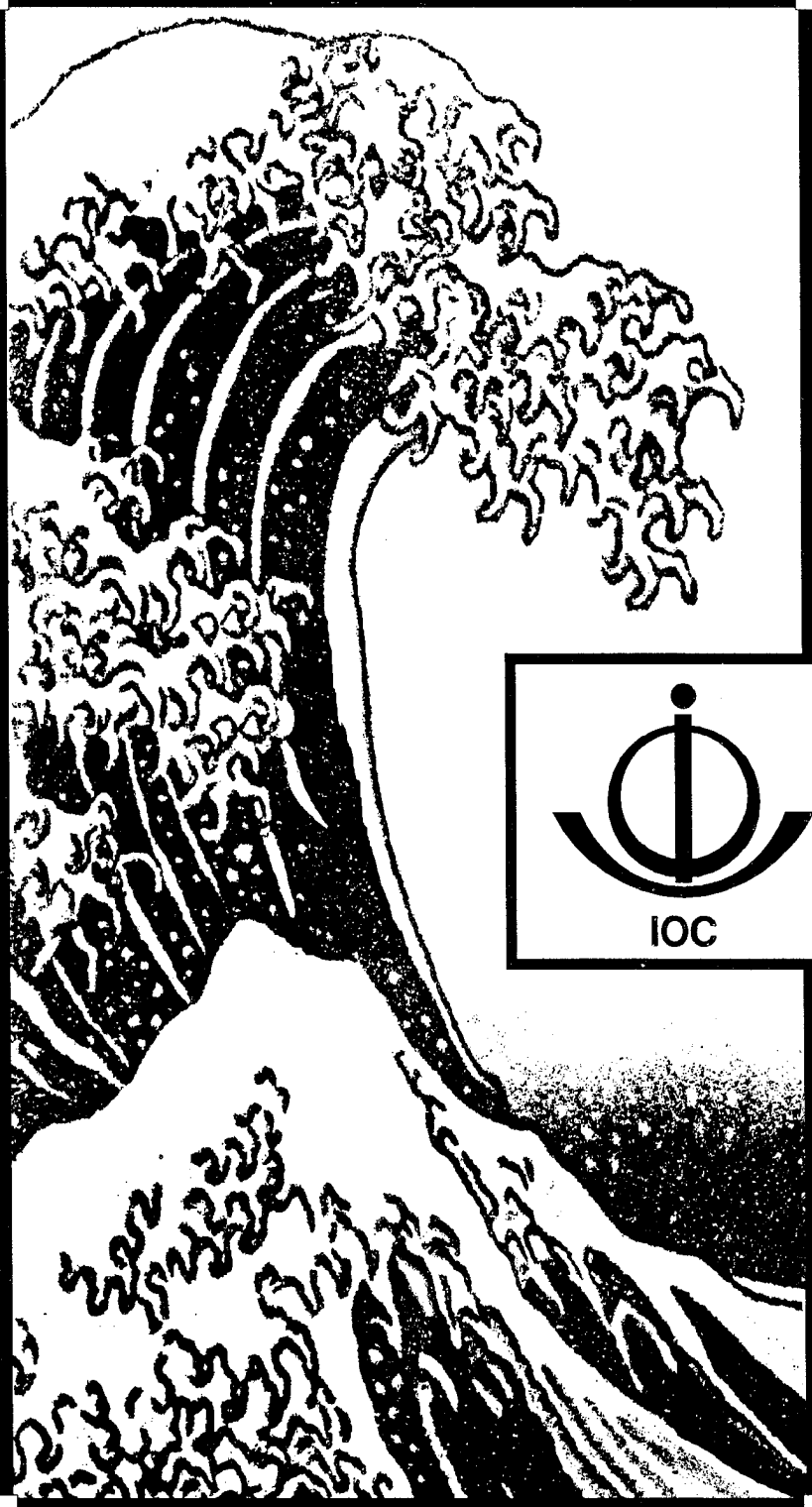


# TSUNAMI

D E C E M B E R - 1 9 9 1



VOLUME-XXIV-NO.2



IOC



ITIC

INTERNATIONAL  
TSUNAMI  
INFORMATION  
CENTER

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# NEWSLETTER

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## Tsunami Newsletter- December 1991

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#### Director:

*Dr. George Pararas-Carayannis*

*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 (ITIC) is maintained by the U.S. National Oceanic and Atmospheric Administration (NOAA) for the Intergovernmental Oceanographic Commission (IOC). The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.*

### MEMBER STATES

*Present membership of the IOC International Coordination Group for the Tsunami Warning System in the Pacific (ITSU) comprises of the following States:*

AUSTRALIA  
CANADA  
CHILE  
CHINA  
COLOMBIA  
COOK ISLANDS  
COSTA RICA  
DEMOCRATIC PEOPLE'S  
REPUBLIC OF KOREA  
ECUADOR  
FIJI  
FRANCE  
GUATEMALA  
INDONESIA  
JAPAN  
MEXICO  
NEW ZEALAND  
PERU  
PHILIPPINES  
REPUBLIC OF KOREA  
SINGAPORE  
THAILAND  
UNION OF SOVIET  
SOCIALIST REPUBLICS  
UNITED KINGDOM  
(HONG KONG)  
UNITED STATES OF AMERICA  
WESTERN SAMOA

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## News Events

### Earthquakes

#### 14 August 1991, Vanuatu Earthquake

An earthquake with magnitude 6.6 and epicenter at 13.60°S, 167.64°E struck the Vanuatu region on 14 August 1991. No tsunami was reported.

#### 17 August 1991, California Earthquake

An earthquake with magnitude 7.1 and epicenter at 41.61°N, 125.51°W, struck the West of California area on 17 August 1991. No tsunami was reported.

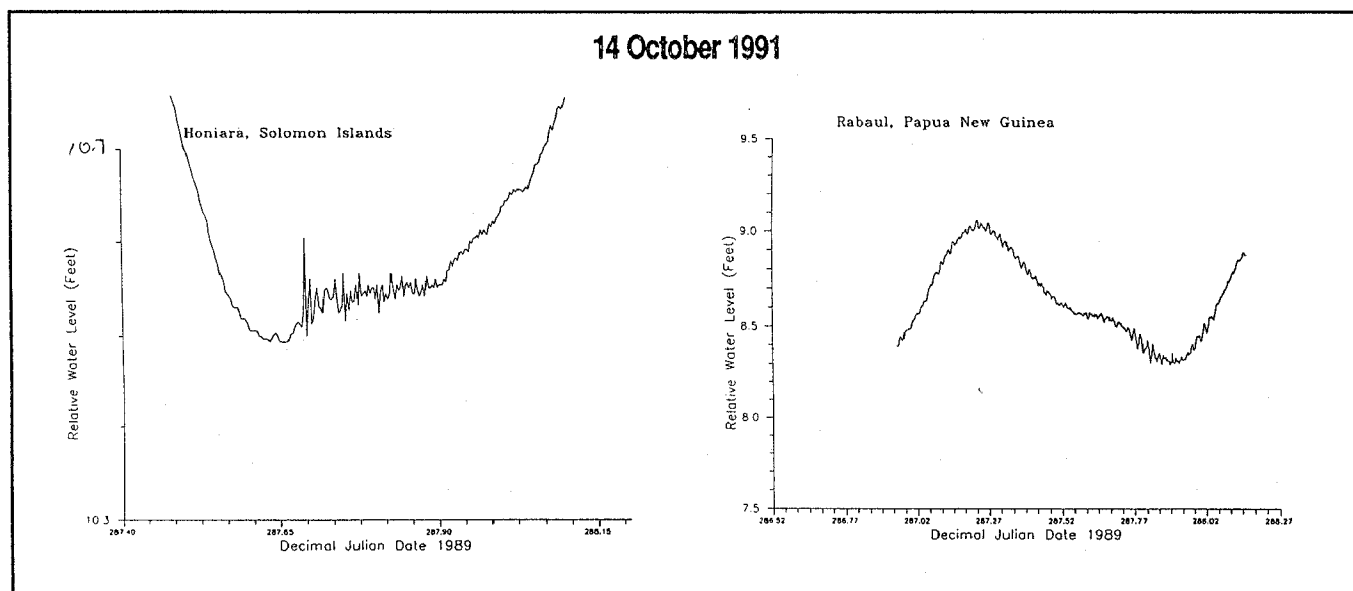
#### Solomon Islands Earthquake and Tsunami of 14 October 1991

An earthquake measuring 7.3 on the Richter Scale occurred in the Solomon Islands region on 14 October 1991. The quake's epicenter was at 8.70 S and at 158.9 E. Origin time was 15:58 Z. A small tsunami was generated which was re-

corded by tsunami stations in Honiara and Rabaul, and the signals were transmitted in real-time via the GOES-Satellite System to the Pacific Tsunami Warning Center in Honolulu. The records of the small tsunami is shown in the drawings below.

#### Southern Philippines Hit by 6.2 Earthquake, 13 November 1991

A strong earthquake struck Mindanao Island in the southern Philippines on 13 November 1991. The earthquake registered 6.2 on the Richter scale and could have caused heavy damage if it struck a populated area. Fortunately, the earthquake was centered 17 miles northeast of coastal Butuan City, which is 490 miles southeast of Manila. A powerful 7.7 magnitude earthquake killed more than 1,600 people and toppled scores of buildings in the northern Philippines in July 1990.



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## News Events

### **Volcanic Eruption of Mount Pinatubo**

Mt. Pinatubo, a volcano dormant for over 600 years, began on 2 April of this year to exhibit a series of small steam explosions. By 8 June, new explosions began, and the scientists had already declared a high probability of a major eruption and had recommended the evacuation of the area within a 20 km radius of Mt. Pinatubo.

The first violent explosion occurred on 12 June. The Philippine Government began a massive evacuation process within a 30 to 40 km radius of the volcano. This included residents of Angeles, San Fernando and Olongapo cities, many nomadic Aeta tribespeople, and most the 16,500 residents of the United States Air Base located at the foot of the volcano. A cataclysmic phase of the eruption begun on 14 and 15 June. By then, nearly a quarter of a million people had been evacuated. At least 740 people died in the eruption or from disease in evacuation centres.

### **Another Volcanic Eruption in the Philippines**

At least 12,000 villagers fled their homes in the southern Philippines after a volcano began spewing out gray ash. Mount Malindang, in Misamis Occidental province on the island of Mindanao began emitting smoke in the evening of 16 September followed next day by a series of tremors. Dust and grayish smoke from the crater, 450 miles south of Manila, spread across neighboring provinces, reaching as far as Cagayan de Oro City 260 miles to the east.

### **Guatemalan Quakes of 18 September 1991**

Two earthquakes rocked Guatemala on 18 September, killing at least 19 people and injuring dozens when their houses collapsed. The tremors caused landslides that blocked the Pan American Highway.

The first earthquake, measuring 5.8 on the Richter scale, shook much of the country shortly after 4:00 am, Wednesday, and lasted about 10 seconds. A less powerful quake, measuring 4.0, struck in the early evening. The U.S. Geological Survey in Golden, Colorado said the initial quake was centered about 25 miles southwest of Guatemala City. Local officials reported more than 12 strong after-shocks. Reports of severe damage and deaths came from Pochuta, about 80 miles southwest of Guatemala City.

### **Hazards 91**

An International Symposium on Geophysical Hazards in Developing Countries and their Environmental Impacts was held 4-9 August 1991 at the University for Foreigners, in Perugia, Italy. Hazards 91 was convened by the International Natural Hazards Society (NHS) and it was hosted by the Water Resources Research and Documentation Center (WARREDOC) of the University for Foreigners. The International Symposium was the fourth in the continuing interdisciplinary series which begun in 1982, with the first being held in Honolulu, USA. The second one was held in Rimouski, Canada in 1986 and the third meeting in Ensenada, Mexico during 1988. The objectives of this series of

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## News Events

symposia on natural and man-made hazards are to promote the advancement of hazard sciences, to perceive and explore those aspects that may be similar among some of the various hazards, to review the newest developments in a few selected fields, and also to outline new directions for future research.

The symposium was co-sponsored by many international organizations including the International Decade for Natural Disaster Reduction (IDNDR) Secretariat, the United Nations Disaster Relief Organization (UNDRO), UNESCO-Intergovernmental Oceanographic Commission, the Tsunami Society, the International Association for the Physical Sciences of the Oceans (IAPSO), and

many other organizations including the International Tsunami Information Center (ITIC).

The meeting was opened by Professor Mohammed I. El-Sabh, President of NHS, and opening speeches were presented by Professor Franco Siccaldi of the Hydraulic Institute, University of Genova, Italy, and other Italian colleagues, and by Dr. J. Tomblin, Chief, Disaster Mitigation Branch, UNDRO. Dr. George Pararas-Carayannis, Director of ITIC also gave an opening speech.

The four-day program included papers on Earthquakes, Water Pollution, Wind Waves/Storm Surges, Climatic/ Atmospheric Hazards, Oil Slicks, Tsunamis, Socio/Economic Aspects of Disasters, Biological/Environmental Hazards, Landslides, and panel discussions on the International Decade for Natural Disaster Reduction. Approximately 75 papers on these subjects were presented. At the conclusion of the meeting, a banquet was held during which awards were presented. The Fifth International Symposium on Natural Disasters will be held in Quindao, China in late summer of 1993.

The following awards were presented during the official banquet concluding Hazards 91 on 8 August:

The NHS Public Awareness Award for outstanding contributions towards public awareness of natural disasters and human impact on global environment.



*Professor Mohammed El Sabh, President and Dr. George Pararas-Carayannis, Vice-President, Natural Hazards Society, addressing participants at the opening of the Hazards 91 Conference in Perugia, Italy, 5 August 1991.*



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## News Events

The award was presented to WHO-Pan African Center for Emergency Preparedness and Response (Addis Ababa, Ethiopia).

The NHS Scientific Contribution Award for outstanding long-term, scientific contributions in the field of hazards research and their mitigation. The award was presented to Professor Barbara Siegel and her late husband, Professor Sanford Siegel (USA).

The NHS Award for Developing Countries The awards were presented to Prof. A. R. Subramanian (India) and Prof. Axing Zhao (PR of China).

The George M. Goding Award for the best papers presented on earthquake research. The awards were presented to Prof. H. N. Srivastava. (India) and Prof. Ahmed F. Kamel (Egypt).

The Nekashizuka Award for the best papers presented on tsunami research. The awards were presented to Dr. Rasisa K. Mazoya (USSR); Dr. Efim N. Pelinovsky (USSR); Prof. Zygmunt Kowalik (USA); and Dr. Paul Whitmore (USA).

The W.M. Adams Award for outstanding long-term contributions to research on earthquake, tsunami, and tsunami warning systems. The award was presented to Prof. Nobuo Shuto (Japan).

The NHS Awards were presented by the Conference Chairman, Prof. Mohammed El-Sabh.

The Tsunami Society Awards were presented by the Secretary of the Society, Dr. George Pararas-Carayannis.

### **Natural Hazards Society Biennial Meeting, 7 August 1991**

The Natural Hazards Society held a biennial business meeting in Perugia, Italy during the Hazard 91 Conference. In addition to the meeting, elections were held for officers. The present officers of the Society were re-elected unanimously and in addition, Prof. Franko Siccaldi was elected as Second Vice-President of the Society for a term of six years.



*Professor N. Shuto (Japan) is presented the W.M. Adams Award, by Dr. George Pararas-Carayannis, Secretary, Tsunami Society, for his outstanding Long-term Contributions to Research on Earthquake, Tsunami, and Tsunami Warning Systems at the Hazards 91 Conference in Perugia, Italy.*



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## News Events

### **Tsunami Society Biennial Meeting, 19 August 1991**

On August 1991, the Tsunami Society held its biennial business meeting during the period of the IUGG Conference in Vienna, Austria. Among things discussed were the continuation of the publication of the Society Journal and the selection of new members. Elections of officers were held during which Dr. Fred Camfield of USA was elected President succeeding Mr. Willy Rapatz who retired earlier this year. Dr. George Pararas-Carayannis, Director of ITIC, was re-elected as Secretary of the Society, and Professor Augustine Furumoto as Treasurer.

### **IUGG - Tsunami Disaster Reduction Symposium, Vienna, Austria, 19-20 August 1991**

The Tsunami Commission, in conjunction with the International Association of Seismology and Physics of the Earth's Interior (IASPEI) and the International Association for the Physical Sciences of



*Meeting of the Natural Hazards Society (Perugia, Italy,  
8 August 1991)*



*Professor Franco Siccardi, Co-chairman of Hazards 91  
welcoming participants to Hazards 91*



*On the second and third days of Hazards 91 the ties  
and suites were gone and participants dressed in attire  
more suitable to the warm Italian summer. At the head  
table leading the discussion, left to right: Professor  
Franco Siccardi of the University of Genova, Dr. Andah  
Kodwo of the Italian University for Foreigners, and  
Professor Mohammed El-Sabh of the University of  
Quebec and Conference Chairman.*

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## News Events

the Ocean (IAPSO), held its 15th International Symposium on Tsunami Disaster Reduction in Vienna, Austria on 19-20 August 1991.

Themes of the symposium were: (1) historical and contemporary observations of tsunamis, (2) physical processes of tsunami evolution, and (3) hazard reduction through assessment techniques and warning systems.

Numerous papers were presented during the two-day symposium. Prof. Stefano Tinti (Italy) has agreed to serve as editor of the Symposium Proceedings. Papers submitted to him no later than 1 January 1992 will be reviewed by a panel of experts. The IUGG Tsunami Commission will ask Kluwer Publishers to publish the proceedings as a book. The cost of printing by Kluwer will be shared by the authors and contributions from IUGG.

The following scientists were elected to Membership of the International Union of Geodesy and Geophysics, Tsunami Commission: Drs. Petros Dimitriu (Greece), Sidi O. El Alami (Morocco), Frank Gonzalez (USA), Sin-Iti Iwasaki (Japan), Christopher Koutitas (Greece), Luis Mendes Victor (Portugal), Tetsuo Sakai (Japan), Mr. James Lander (USA) and Mr. Fred Stephenson (Canada).

### **IUGG-International Tsunami Symposium**

The International Union of Geodesy and Geophysics (IUGG) Tsunami Commission held a two-day symposium on 19-20

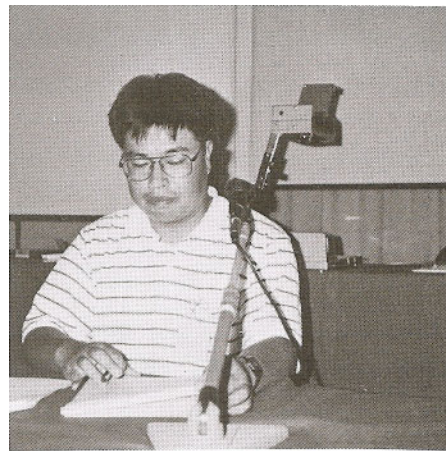
August 1991 in Vienna, Austria. During the two-day seminar the following papers were given:

### **Tsunami Observations**

Analyses of Deep Ocean Tsunami Measurements (*Gonzalez, F.I. and Kulikov, Ye.A.*)



*Hazard 91, Perugia, Italy - Dr. Rasisa Mazova (USSR) delivering award winning presentation which was shared with Dr. EFim N. Pelinovsky (USSR).*



*Professor Yoshinobu Tsuji of the Earthquake Research Institute (Japan) giving his presentation at Hazards 91*



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## News Events

Historical Tsunami Data Base for Kurile-Kamchatka Region (*Gusiakov, V. K. and Osipova, A.V.*)

Field Survey of the 1854 Ansei- Tokai Earthquake Tsunami Along the Coasts of the Tokai District (*Tsuji, Y.; Saito, A.; Ueda, K.; Iwasaki, I.; Yanuma, T.; and Kitahara, I.*)

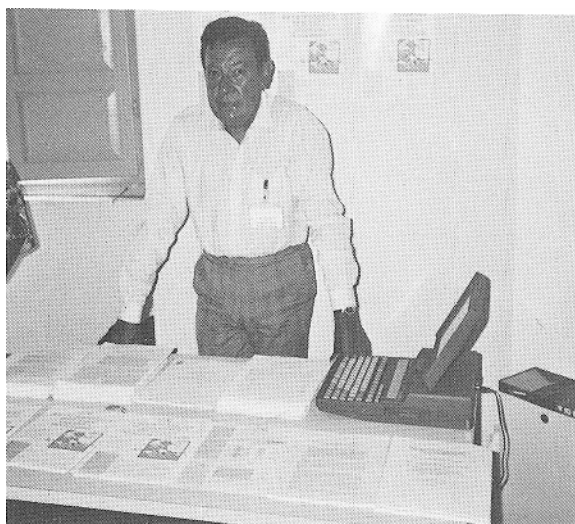
A Tsunami Data Base for the U.S. West Coast (*Lander, J.F.*)

Relation Between Earthquake Magnitude and Tsunami Scale (*Miyoshi, H.*)

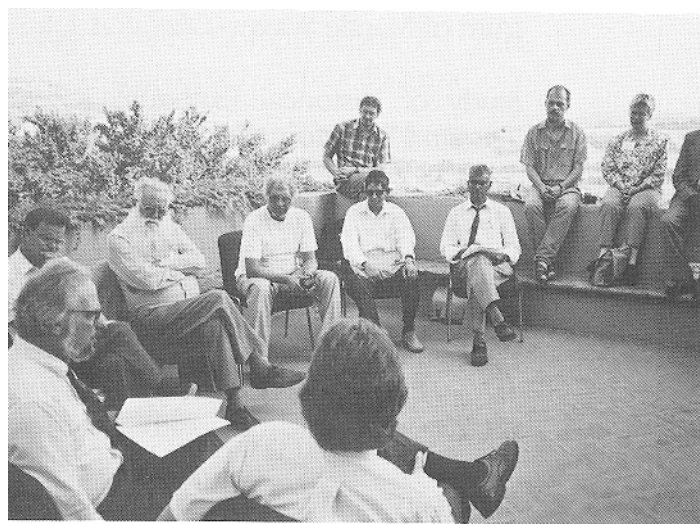
The Identification of Tsunami Deposits in Coastal Sediment Sequences (*Dawson, A.G.; Fostel, I.D.L.; Shi, S.; Smith, D.E.; and Long, D.*)



*It is said that beautiful and serene surroundings, such as those in Perugia, stimulate thinkers in their formation of new concepts and ideas. This creative process is evidently taking place in this photograph of Professor A. V. Nikoiaev of the institute of Physics of the Earth (Moscow) and Dr. I. Oliounine of UNESCO-Intergovernmental Oceanographic Commission (Paris)*



*Dr. Jacques Talandier of the Geophysical, Laboratory (Papeete, French Polynesia) had a wonderful display and demonstration of Earthquake Moment Magnitude Determination Methodology at the Hazards 91 Conference in Perugia*



*Some of the discussions of the Hazards 91 special committees of Hazards 91 took place outdoors in the veranda of the "Villa La Colombella" of the University for Foreigners overlooking the beautiful Umbrian countryside*

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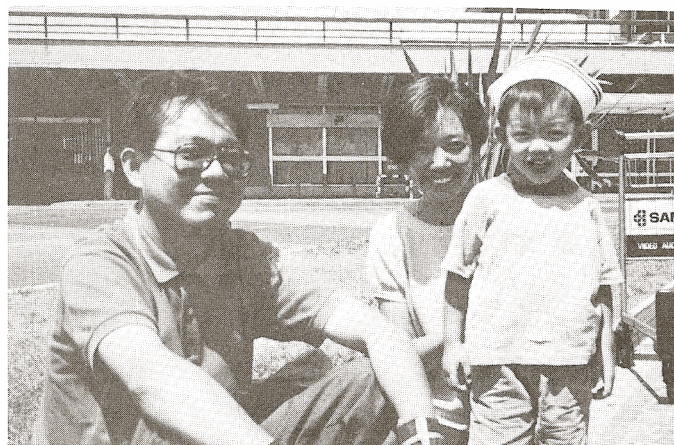
## News Events

Tsunamis in Western Mediterranean Generated by Strong Algerian Earthquakes with Sources on Land (*Soloviev, S.L.*)

Estimation of the Height of the Jogan 11 Earthquake-Tsunami (A.D. 869) in the Sendai Plain (*Abe, H.; Sugeno, Y.; and Cbigama, A.*)

Tsunamis Related to Volcanic Activity in Italy (*Tinti, S. and Saraceno, A.*)

Historical Tsunamis in Mainland Portugal and Azores-Case Histories (*Moreira, V.S.*)



*It is a long way from Kanagawa, Japan to Rome, Italy, but Perugia is still further away. In this photo Dr. S. Iwasaki of the National Research Institute for Earth Science and Disaster Prevention and his lovely family are waiting at the Rome airport for transportation to Perugia on the last leg of this "odyssey"*

### **Physical Processes - Generation**

A Possible Discriminant Between Double-Couples and Single Forces in the Spectrum of Mantle Waves (*Okal, E.A.*)

Study of Historical Earthquakes from Tsunami Waveform Data: The 1854 and 1944/1946 Earthquakes Along the Nankai Trough, Japan (*Satake, K.*)

A Comparison of T -Phase Spectrograms for Tsunamigenic and Non- Tsunamigenic Earthquakes (*Walker, D.A.; Bernard, E.N.; Hiyoshi, Y.; McCreery, C.S.; and Ludwig, R.*)

Microbarometric Oscillation as a Tsunami Precursor (*Iwasaki, S.I.*)

The Origin of the Tsunamis Excited by the 1989 Loma Prieta, 1906 San Francisco, California, and 1975 Kalapana,



*Professor Mohammed El-Sabh President, Natural Hazards Society (NHS), with Vice-President, Dr. George Pararas-Carayannis and newly elected Second Vice-President, Professor F. Siccaldi*



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## News Events



*Professor Mohammed El-Sabh is not known to ever be at loss for words. Here he is during the official banquet at the conclusion of Hazards 91 expressing the Group's appreciation to the Italian host and to the Hazards 91 Organizing Committees*



*The end of the Hazards 91 Conference culminated in the official banquet which left participants with a warm feeling for the Italian hospitality. From left to right, in this photo, are the lovely Ms. Debra Wohlschlegel (USA), Professor Lucio Ubertini, Director of the I.R.P.I.-C.N.R. (Italy), Dr. George Pararas-Carayannis, and Professor Mohammed El-Sabh*

Hawaii, Earthquakes (*Ma, K.F.; Satake, K.; and Kanamori, H.*)

A Tsunami Model of Kelvin-Wave Type (*Nakamura, S.*)

A Theory of the Excitation of Tsunami by Earthquake (*Zhdanov, M.A. and Soloviev, S.L.*)

A System of Tsunami Physical Modeling and Fast Relief Changes (*Ranguelev, B.K.*)

### **Physical Processes- Propagation**

Numerical Simulation and Analysis of OBS's Data for the 1990 Mariana Earthquake Tsunami (*Imamura, F.; Shuto, N.; Okada, M.; Nagai, T.; and Takenaka, H.*)

Using Parallel Computations for Fast Tsunami Travel-Time Estimation (*Marchuk, A.G.*)

Construction of Synthetic Tsunami Records Using Gaussian Beams (*Woods, M.T. and Okal, E.A.*)

Tsunami Resonant Conditions of the Gulf of California (*Sandoval, F.J. and Farreras, S.F.*)

The Meaning of Information of Tsunami Records (*Ivanov, V.V.*)

On Possibility of Electromagnetic Method for Tsunami Prediction (*Gershenzon, N.I. and Gokhberg, M.B.*)

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## News Events

Experiment of Oblique Reflection of Solitary Wave (*Nadai, A. and Tsuji, Y.*)  
Mitigating the Impact of Coastal Hazards in the Island of Java, Indonesia (*Sulaiman, D.M.*)

### Run-up

Tsunami Flooding—Numerical Investigation (*Kowalik, Z. and Murty, T.S.*)

Tsunami Hazard Assessment in Greece (*Kijko, A. and Papadopoulos, G.A.*)

Laboratory Study on Maximum Impulsive Force of Timbers Drifted by Borelike Tsunamis (*Matsutomi, H.*)

Development of a Tsunami Glossary (*Pararas-Carayannis, G.*)

### Warnings Application

Dynamic Response of Structures to Tsunami Attack (*Camfield, F.E.*)

Tsunami Impact on Northern Chile (*Lorca, E.*)

The Maximum Wave and Traveling Distance of Tsunami Off the Coast of Japan (*Watanabe, H.*)

Interactive Software for Near-Real-Time Tsunami Modeling (*Gustakov, V.K.; Marchuk, A.G.; and Titov, V.V.*)

Information Method of Tsunami Wave Estimation (*Ivanov, V.V.*)

On a System for Rapid Evaluation of Tsunami Potential (*Zama, S.*)

### Tsunami Hazard Reduction — Assessment

Evaluation of Tsunami Hazard in Calabria and Eastern Sicily, Italy (*Tinti, S.*)

A Simple Integrated Automatic System to Estimate Tsunami Risk in Far and Near Field (*Reymond, D.; Hyvernaud, O.; Talandier, J.; and Okal, E.A.*)

Mitigation of Complex Integrated and Secondary Hazards from Tsunamis (*Preuss, J.*)

On Estimation of the Tsunami Warning Systems' Efficiency (*Poplavskey, A.A.*)

Past, Present, and Future of Seismic Sea Waves in the Vicinity of Anatolia (*Yalciner, A.C. and Kuran, U.*)

Tsunami Intensity, Height and Disasters (*Shuto, N.*)

Tsunami Hazard in West Coast of Taiwan (*Hsu, M.K.; Huang, B.S.; and Yeh, Y.T.*)

Complementary Land-Based Tsunami Warning System in SW Portugal (*Simoes, J.Z.; Afilhado, A.; and Mendes-Victor, L.*)

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## News Events

The following is a summary of the IUGG-Tsunami Commission Symposium in Vienna, Austria, 19-20 August 1991, prepared by Dr. E. N. Bernard

Thirty-nine presentations on tsunami research were made by scientists from 13 countries during the 2-day Symposium on Tsunami Disaster Reduction. The sessions were organized into Observations, Physical Processes (i.e., generation, propagation, run-up), and Hazard Reduction. There was a wealth of new information on historical tsunamis in the North Sea (Dawson et al.), Italy (Tinti), Portugal (Moreira), Sicily (Tinti), Turkey (Yalciner), Greece (Papadopoulos), Chile (Lorca), Japan (Tsuji, Abe, Satake), the Kurile/Kamchatka region (Gusiakov), and the United States (Lander). From these data, risk assessment of the tsunami hazard for the Mediterranean countries is proceeding well, and it is clear that tsunami warning systems need to be established.

During the Physical Processes sessions, much interest was stimulated by Ma in her report on the 1989 Loma Prieta, 1906 San Francisco, and 1975 Kalapana, Hawaii, earthquakes that indicate underwater slumping plays an important role in tsunami generation for small earthquakes. Imamura showed deep water data from the Japanese gauges and found difficulty in modeling the observed propagation characteristics. Kovalik reported on some new techniques to better estimate run-up that hold promise for improved models.

Much progress is being made in the application of rapid earthquake assessment for use in tsunami warnings. Zama (Japan) reported on a three-component seismometer that could quickly determine earthquake size with a single station. Raymond (France) reported on the use of a broadband seismometer that could quickly estimate seismic moment from a single station, and Simoes (Portugal) reported on a seamount-based seismic system that was located in the area of highest tsunami potential. Gusiakov (USSR) reported on an interactive computer software package that could model tsunami generation and propagation in near real time.

In summary, the risk of tsunami hazard appears to be more widespread than the Pacific Ocean Basin. It appears that underwater slumps are an important component in tsunami generation. Finally, new technologies are emerging that could be used in a new generation of tsunami warning systems. Plans are to publish about 15 to 20 of these reports in a book to be edited by Professor Tinti of Italy.

### **13th Session of ICG/ITSU, Ensenada, Mexico, 10-13 September 1991**

The Thirteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ITSU-XIII) took place in Ensenada, Baja California, Mexico, 10-13 September 1991. Host for the conference was the Government of Mexico and the Centro de Investigacion Cientifica y Educacion



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## News Events

(CICESE) of Ensenada. Present at the meeting were delegates from seven Member States of ICG/ITSU, numerous observers, and representatives of international organizations.

The Chairman of ICG/ITSU, Mr. Richard Hagemeyer, opened the Thirteenth Session, and invited the Session to propose mechanisms and procedures for making the Tsunami Warning System in the Pacific more effective and organized so that it can cope with the increased demands for better and reliable warnings. Follow-

ing the opening by the Group Chairman, Dr. Mario Martinez Garcia, Director of CICESE, gave the welcoming address. Dr. Iouri Oliounine, Senior Assistant Secretary IOC, on behalf of the Secretary IOC, welcomed the participants and paid tribute to the Government of Mexico and CICESE for hosting the Session and providing the necessary support and facilities.

Following the opening remarks, the Provisional Agenda of the meeting was adopted and the Group proceeded to



*Thirteen Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ITSU-XIII) Ensenada, Baja California, Mexico, 10-13 September 1991. (Photo by S. Ramos)*

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## News Events

review the intersessional activities and action items which had resulted from implementation of resolutions and recommendations of the Twelfth Session of ICG/ITSU, the extension of the sea level networks in the Pacific, the expansion of ICG/ITSU activities to other tsunami areas of the world ocean, and support to ITIC, the Visiting Experts Program, and publications.

Following the Session, election of the Chairman and Vice-Chairman of the ICG/ITSU were held. Mr. Richard Hagemeyer was unanimously re-elected to serve for another term. The Group thanked Prof. S. Soloviev, Vice-Chairman of the ICG/ITSU, for his great contribution to the success of the Tsunami Warning System and elected Mr. Hiroo Uchiike from Japan as the new Vice-Chairman of the Group.

### **Numerical Investigation of Two Tsunamis Recorded at Adak, Alaska**

The following research paper was presented at the International Symposium on Geophysical Hazards in Developing Countries and their Environmental Impacts, 4-9 August 1991, Perugia, Italy.

By Zygmunt Kowalik; Institute of Marine Science; University of Alaska, Fairbanks Fairbanks, Alaska 99709  
and

Paul M. Whitmore; Alaska Tsunami Warning Center; 910 South Felton Street; Palmer, Alaska 99645.

### **Extended Abstract**

As microcomputers become increasingly faster, numerical modeling of tsunamis gain greater potential to predict wave heights prior to impact on the coast. We present a method to generate and propagate tsunamis. The method is tested with two tsunamis recorded at Adak, Alaska. These tsunamis, produced by the 1952 Kamchatka and 1986 Andrean of Islands earthquakes, provide an opportunity to model both a trans-Pacific and a locally-generated tsunami. The significance of various terms in the equations of motion is tested with the objective of accurate computing in the least amount of time. In addition the importance of accounting for moving fault rupture versus instantaneous uplift is also tested.

Propagation of tsunami signal over long distances requires solution of the equations of motion and continuity at a large number of grid points. An approach which saves computational time is to subdivide the large computational domain into a few sub-domains (Ng et al., 1990). To propagate a tsunami between the various domains we use interactive grids, such as a combination of coarse and fine grids. In interactive numerical grids the tsunami signal passes through the boundary not only from the coarse-grid domain to the fine-grid domain, but in the opposite direction as well (Ramming and Kowalik, 1980). The rationale behind using multiple grids is to reduce the total computational effort by placing a coarse grid in the deep ocean region

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and couple this with finer grids in the shallow coastal areas. At the same time, increasing spatial resolution from the open ocean towards the coastal regions provides greater accuracy in the numerical solution. The ocean-wide model propagates the tsunami from the source to the shelf region (about 500m depth). From this depth a fine resolution grid model propagates the tsunami signal into bays, inlets, and ports. In the final stage the signal is resolved by a super-fine model with spatial grid resolution of a few hundred meters. All these models are set over different geographical regions, therefore they must be connected along the boundaries. Successful grid splicing is possible only when the tsunami is properly resolved in both the fine and coarse grids. Shuto et al. (1985) carried out tsunami computations with a one dimensional model and showed that each wavelength must be covered by at least 10 to 20 grid points to diminish numerical dispersion (dissipation) in the shallow water calculations. The phase velocity of long waves can be a measure of the error introduced by numerical approximation (Ramming and Kowalik, 1980). Numerically calculated phase velocity ( $C_n$ ) depends on the grid spacing ( $h$ ) and the wavelength of the tsunami ( $L$ ), as,

$$C_n = \sqrt{gH} \left[ 1 - \frac{1}{6} \left( \frac{\pi h}{L} \right)^2 \right]$$

where  $g$  is the gravitational constant and  $H$  is the water depth. Choosing the numerical grid spacing to be 10 times shorter than the wavelength ( $L=10h$ ), the nu-

merically estimated phase velocity  $C_n = 0.98(gH)^{1/2}$  is only 2% smaller than the analytical phase velocity.

We use the multi-grid approach for computing tsunami amplitude at Adak, Alaska. This is a geographical area of complex bathymetry with multiple entrances connecting local bays to the open ocean. The main generating force of a tsunami triggered by an earthquake is the uplift or subsidence on the sea-floor which accompanies the earthquake. Okada's (1985) formulas are used to compute ground displacement from fault parameters. These parameters are provided from detailed seismological studies of the source earthquakes. Because the effects of source orientation play an important role in establishing the tsunami amplitude we have studied energy distribution radiated from the tsunami source. To describe energy transfer from the source to the various locations we use an energy flux vector ( $E$ ). The components of this vector along longitude and latitude are given by

$$E_\lambda = \rho u H \left[ \frac{(u^2 + v^2)}{2} + g\epsilon \right] \quad \text{and} \\ E_\phi = \rho v H \left[ \frac{(u^2 + v^2)}{2} + g\epsilon \right]$$

Here,  $\rho$  is density,  $u$  and  $v$  are components of velocity along  $\lambda$  and  $\phi$ , and  $\epsilon$  is the sea level change.

The comparison between observed and modeled tsunamis at Adak show that the computed elevations are in satisfactory

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agreement with those obtained from the observations. The amplitude recorded is within 20% of the modeled amplitude. We have also shown that Coriolis, bottom friction, and non-linear terms in the equations of motion show increasing importance with shallow depths. Inclusion of a moving rupture versus instantaneous uplift is shown to have just a small effect on the energy flux distribution. This effect is proportional to the ratio of tsunami velocity to rupture velocity. The maximum value of the ratio is smaller than 10%.

### References

Ng, M., P.H. LeBlond, and T.S. Murty, 1990. Numerical simulation of tsunami amplitudes on the coast of British Columbia due to local earthquakes. *Sci. Tsunami Hazards*, 8, 97-127.

Okada, Y., 1985. Surface deformation due to shear and tensile faults in a half-space. *Bull. Seism. Soc. Am.*, 75, 1135-1154.

Ramming, H.G., and Z. Kowalik, 1980. *Numerical Modelling of Marine Hydrodynamics*. Elsevier, New York, 368 pp.

Shuto, N., T. Suzuki, K. Hasegawa, and K. Inagaki, 1985. Summary of a study of numerical technique on the tsunami propagation and runup. *Proc. Int. Tsunami Symp.*, eds. T.S. Murty and W.J. Rapatz, *Ins. Ocean Sci.*, Sidney, B.C. Canada, 88-92.

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## International Decade for Natural Disaster Reduction

The United Nations Secretariat of the International Decade for Natural Disaster Reduction (IDNDR) has published the first issue of its bimonthly newsletter **Stop Disasters**. The newsletter disseminates information regarding IDNDR activities on an international level. It is published in English, Spanish, French, and Italian by the Osservatorio Vesuviano in Naples, Italy, as their contribution to the Decade.

The first issue contained articles discussing the goals of the Decade, news from the Decade Secretariat, an update on the IDNDR Scientific and Technical Committee, descriptions of international cooperative efforts and Decade activities in various countries, and a list of upcoming meetings.

To contribute news items, contact the Osservatorio Vesuviano, via A. Manzoni, 249-80123 Naples, Italy; tel: (39-81) 7695904; fax: (39-81) 7694239; telex: 722678 OBSORV. To request copies of the newsletter, contact the United Nations, IDNDR Secretariat, Palais Des Nations, CH-1211, Geneva 10, Switzerland; tel: (41) 22 798 68 50, (41) 22 798 84 00; fax: (41) 22 7338695.

### International Day for Natural Disaster Reduction

The UN, with its 44/236 Resolution, has declared the Decade from 1990 to 1999 as a Period dedicated to Natural Disaster Reduction (International Decade for Natural Disaster Reduction - IDNDR). 9 October 1991 was designated and cel-

ebrated as the International Day for Natural Disaster Reduction.

### UNDRO Publishes Disaster Mitigation Manual

In support of the IDNDR, the Office of the United Nations Disaster Relief Coordinator (UNDRO) has just published *Mitigating Natural Disaster: Phenomena, Effects and Options*, a 160-page manual for policy makers and planners. The book is in four parts. The first describes the planning process of assessment, decision making, and implementation necessary to reduce risks due to natural hazards. The three subsequent sections describe the phenomena to be considered — from tropical cyclones to earthquakes; the potential effects of these phenomena on various types of structures and ways to categorize and quantify these risks; and options to reduce these hazards. These final sections are very specific, separately addressing hydrologic (riverine flooding, coastal flooding, and tropical cyclones) and geologic hazards (earthquakes, volcanoes, and land slides), and presenting particular structural solutions to these threats.

*Mitigating Natural Disaster* is a guidebook to effective hazards planning. Communities, provinces, and nations considering any kind of program to reduce their risks due to natural hazards will find the book a useful starting point and a productive guide.

*Mitigating Natural Disaster* costs \$30.00 and can be ordered from the United



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## International Tsunami Information Center

Nations, Publications Sales Section, New York, NY 10017, (212) 963-1234. Please note the sales number - E.90.III.M.1- when ordering. International Tsunami Information Center.

### **UNDRO Consultants Visit ITIC**

Mr. Glenn O. Johnson and Dr. Norman S. Macleod, consulting scientists on a United Nations Disaster Relief Organization (ONDRO) project visited ITIC on 1 October 1991 on their way to Indonesia where they will undertake a study on disaster mitigation on the island of Sulawesi in Indonesia.

### **ITIC's Visiting Scientists Program for 1991**

Dr. Hansjorgen Meyer from Bogota, Colombia and Dr. Im Sang Oh from Seoul, Korea were the two visiting experts participating in ITIC's Visiting Scientists Program for 1991. Dr. Meyer is Director of the Seismological Laboratory of the Universidad del Valle in Colombia and Dr. Oh is an Associate Professor in Physical Oceanography at the Seoul National University in Korea.

The ITIC Visiting Scientists Program is sponsored and funded by the Intergovernmental Oceanographic



*Prof. Im Sang Oh (Korea) is presented the Certificate of Completion of the ITIC Training Course of Visiting Scientists by Mr. Richard Hagemeyer, Chairman of ICG/ITSU. Watching are Dr. George Pararas-Carayannis, Director ITIC, and Prof. Hansjorgen Meyer (Colombia), Visiting Scientist.*



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## International Tsunami Information Center

Commission and its purpose is to provide training to officials in ITSU Member Countries so that improvements can be made to the Tsunami Warning System in the Pacific.

### Director of ITIC Visits Chile

While on a personal trip to South America in late November this year, the Director ITI, Dr. George Pararas-Carayannis took the opportunity to meet with the Director of the Hydrographic Institute of, the Chilean Navy in Valparaiso, Chile, Captain Hugo Gorziglia, with Mr. Emilio Lorca, Director of the Institute's Tsunami Program, and other Institute officials. In addition to discussing the action items from the XIII Session of ICG/ITSU which took place in Ensenada, Mexico in early September, a review was made of the educational materials collected by Captain Gorziglia, who is chairman of the ITSU educational committee. Also, a review was made of the on-going pilot program on tsunami awareness and education being tested presently in Chile for primary and secondary school children before adoption to other ITSU member countries.



*Prof. Hansjorgen Meyer (Colombia) is presented the Certificate of Completion of the ITIC Training Course of Visiting Scientists by Mr. Richard Hagemeyer, Chairman of ICG/ITSU.*



*Graduation day brings a lot of smiles to two happy people: Prof. Im Sang Oh (Korea) and Prof. Hansjorgen Meyer (Colombia). Dr. George Pararas-Carayannis, Director ITIC, seems happy too, although he got no diploma.*



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## International Tsunami Information Center

### Millie Ching Retires

A disaster of major proportions struck the International Tsunami Information Center (ITIC) recently when Mrs. Mildred Ching, ITIC Secretary and Administrative Assistant for the last 16 years announced that she will be retiring at the end of the year. "This is a disaster I cannot survive," said the Director ITIC, Dr. George Pararas-Carayannis. "I'd rather have a tsunami strike this office, than this." Mrs. Mildred Ching, "Millie" as she has been known by the hundreds of international visitors to the Center over the years, graced with her charm and personality the ITIC office. All visitors to the office always remarked how comfortable and relaxed Millie made them feel with her friendly smile and her valuable assistance. Millie will be missed greatly by all her friends and particularly by George Pararas-Carayannis.



*"Millie" at her work station on a typical day, any day of the year.*



*Mrs. Millie Ching and Dr. George Pararas-Carayannis -- the "heart" and "soul" of ITIC, posing in front of the Christmas tree Millie decorated.*

*Millie with the smiling face*

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## International Tsunami Information Center

### Visitors to ITC in 1991

Sergei Soloviev	Moscow Institute of Oceanology
Iouri Oliounine	IOC/UNESCO, Paris
John Learned	Physicist, Honolulu
Scott Sorensen	Photo journalist, Honolulu
Michael Blackford	Geophysicist, PTWC, Ewa Beach
Bobbie Quitan	Director of Sales, Waikiki Terrace Hotel
Kathy Ah Sam	Sales Assistant, Waikiki Terrace Hotel
Chul Soon Choi	Korea Power Engineering Company
Chong-Hak Kim	Korea Electric Power Corp., Korea
Constance Utter	Honolulu
Noble Tume	Honolulu
Dr. & Mrs. Ray Jensen	Bedford, Texas
Dr. Eiji Nakazaki	Honolulu
Glenn Trapp	Area Manager, WSFO, Honolulu Int'l Airport
Darrell Kahalewai	Data Acquisition Clerk, PRH, Honolulu
Catherine Carnite	Student, Vancouver, Canada
Lena Yim	Student, Sacred Hearts Academy, Honolulu
Daphne Clarke	Honolulu
George Curtis	Researcher, JIMAR, University of Hawaii
Robert Meyer	Honolulu
Deborah Ward	Publications Editor, Off. of Hawaiian Affairs
Mary Lewis	Grad Student, Honolulu
Chris Douwes	Project Manager, Honolulu
Bill Dupin	California
Carolyn Wyche	Colorado
Norman MacLeod	Consulting Geologist, Washington
Glenn Johnson	Consultant Planning/GIS, Long Beach, Calif.
Cynthia Root	Honolulu
Dr. Im San Oh	Prof., Oceanographer, Seoul, Korea
Dr. Hansjurgen Meyer	Director, Seismological Laboratory, Colombia
Prof. Geof Lennon	Director, National Tidal Facility, Australia

## IOC/ITSU

### LIST OF NATIONAL CONTACTS OF ICG/ITSU

The following is a list of National Contacts of ITSU members on file at the ITIC office. Please inform ITIC if there are any changes.

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#### CHINA

Mr. Luo Yuru  
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#### COLOMBIA

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## IOC/ITSU

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### Chairman, ICG/ITSU

Mr. Richard H. Hagemeyer  
Director  
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Honolulu, Hawaii 96850-4993, USA

### **Costa Rica Joins ICG/ITSU**

Mr. Manuel M. Murillo, National Contact of Costa Rica to the Intergovernmental Oceanographic Commission (IOC) informed the Secretary, Dr. Gunnar Kullenberg, that Costa Rica wishes to join the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU). This request was endorsed by Lic. Eladio Zarate, Director General of the National Meteorological Institute of Costa Rica and accepted by the IOC Secretariat and the ICG/ITSU Chairman, Mr. Richard Hagemeyer. Mr. Alejandro Gutierrez, Coordinator of the Mareographic Service of Costa Rica was designated as the official National ITSU Contact. Costa Rica is the 25th nation to join the Tsunami Warning System in the Pacific.

### **13th Session - Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans**

IOC has published the Proceedings of the Thirteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans which took place in Leningrad, USSR, 10-12 June 1991. Copies of the Proceedings can be obtained from the IOC Secretariat.

### **IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series**

The Fifth Session of the IOC Edition, IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, took place in Trieste, 26-28 June 1991. A report

of the Proceedings can be obtained from the IOC Secretariat.

### **National Report of the Democratic People's Republic of Korea for the Thirteenth Session of the ICG/ITSU**

Mr. Ryom Jae Song, Secretary of the National Oceanographic Commission informed the Chairman ICG/ITSU, Mr. Richard Hagemeyer, on 28 August 1991 that the Democratic People's Republic of Korea was unable to attend the XIII Session of ICG/ITSU, in Mexico. However, he provided the following National Report which is reproduced here as it was not included in the Summary Report of the ICG/ITSU Meeting.

#### **1. Introduction**

Storm surges and tsunami as well as the typhoons, floods and heavy rains that strike the Democratic People's Republic of Korea (DPRK) are regarded to be natural disaster events. The last major tsunami was the Akita tsunami which originated on the West coast of Japan on 26 May 1983.

It is well known, that the Democratic People's Republic of Korea is affected by tsunami sources in the West coast of the Sea of Japan. However, numerous local earthquakes and tsunamis have occurred also in the coastal area of the Korean Peninsula. Tsunami and earthquake events have been recorded for about 2000 years and historical data catalogs have been published.

## **2. Observational System for the Tsunami Warning**

The State Hydrometeorological Administration (SHMA) of the Democratic People's Republic of Korea has the responsibility for Tsunami Warnings in our country. For such Tsunami Warnings, we receive and use the earthquake data from the Pacific Tsunami Warning Center (PTWC) and from the Japan Meteorological Agency (JMA). In our country, 11 tidal stations are under the management of SHMA. These are equipped with the automatic Sea level gauges. However, they are not used to tsunami warning because they do not transmit the data in real-time. The Earthquake Institute has seven seismic stations which help determine earthquakes occurring in the region.

## **3. Tsunami Events**

During the two-year intersessional period, following the Twelfth Session of the International Coordination Group of the Pacific Tsunami Warning System (Novosibirsk, USSR on August 1989), we received tsunami information 25 times through the Global Telecommunication System (GTS) of WMO. No tsunami events were recorded in our coastal areas during this period.

## **4. Tsunami Research Work After Twelfth Session**

Tsunami research work in our country is carried out by the West Oceanographic

Research Institute under SHMA and by the Earthquake Research Institute. The tsunami research group of the West Oceanographic Research Institute has calculated the travel times of all tsunami waves originating from all tsunami sources in the West coast of Japan, and have organized all the historical tsunami data in the East coast of the Korean Peninsula. Using historical data, tsunami heights have been calculated for different frequencies and different sources in the East Korean Coastline.

The research group has investigated mareograms in collaboration with the research group of Marine Geology and Geophysics Research Institute in Yuzhno-Sakhalinsk, USSR for the purpose of documenting tsunamis in the East Korean Seacoast. The research group of the Earthquake Research Institute investigated historical earthquake sources in the region.

## **5. Training of Tsunami Experts**

Tsunami experts in our country are oceanographers or physical scientists trained at the Geographical and Physical Faculties of Kim 11 Sung University in Pyongyang. There is no special training program for tsunami experts in our country. An announcement of training programme on Tsunami Public Education and Awareness was received from IOC/ITSU recently. Our tsunami experts are interested in this training programme. Tsunami research work in our country has intensified after the tsunami of 26 May 1983. There is a great deal of interest



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## IOC/ITSU

in training experts who can in turn assist in improving the organizations and procedures to be applied in the Tsunami Warning System in our country.

### **National Report of Guatemala to the Thirteenth Session of the ICG/ITSU**

The following national report was forwarded by Mr. Eddy Hardie Sanchez Benett, who is the national contact for Guatemala, to the XIII Session of ICG/ITSU in Ensenada, Mexico.

The National Institute of Seismology, Volcanology, Meteorology and Hydrology of Guatemala (INSIVUMEH) is part of the Ministry of Communications, Transportation and Public Works and the institutional member of ITSU which has consistently responded to the best of its ability to the objectives and recommendations of ITSU.

### **General Activities**

INSIVUMEH maintains different observational networks related to the weather, hydrology, seismology, and volcanology.

Since 1978 the Institute has installed a seismic array to cover the most populated and seismic active area of the country. The seismic activity is monitored by 14 stations and the data is telemetered to Guatemala City Central recording station. At least four stations are located near the tsunamigenic area of the Pacific coast. The central station in Guatemala has the capability of sending and receiving seismic and tsunami in-

formation to the global seismic network, to NEIC, to PTWC, and to ITIC. Arrangements have been made with broadcast and TV stations in the country to broadcast warning messages, and close contact is maintained with the national committee of emergency and other organizations responsible for civil defense. Warnings are also issued to the Guatemalan Navy Commander at Port Quetzal, and messages can be telefaxed or telexed via the WMO communication system, AFTN.

The tide gauge station in Port Quetzal has been out of operation since 1989. Guatemala is requesting the support of the ITSU Group in obtaining, through the voluntary cooperation program (VCP) of IOC, support for the reinstallation of a tide gauge at Port Quetzal, where arrangements have been made in the pier for the installation of the new instrument. The largest historical earthquake in the region (MS 8.3) occurred offshore along the margin of Cocos Plate and the Caribbean Plate in 1902 causing a small Tsunami.

### **Status of the Global Sea-Level Observing System (GLOSS)**

By Circular Letter No. 1318, the Secretary of IOC, Dr. Gunnar Kullenberg informed GLOSS National Contacts of the status of the Global Sea-Level Observing System (GLOSS), and requested review of GLOSS stations in each country and to consider action of ways and means to speed up sea-level data submission to PSMSL as well as to other international sea-level

data centres: TOGA Sea Level Centre (Honolulu, USA), WOCE Sea Level Data Assembly Centres (Honolulu, USA and Bidston, UK), SOC for the IGOSS Sea Level Programmes in the Pacific (Honolulu, USA), and the SOC for the IGOSS Sea Level Pilot Project for the North and Tropical Atlantic (Ottawa, Canada) in accordance with the provisions of the GLOSS Implementation Plan.

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## National and Area Reports

### **Mexico's National Disaster Prevention Center**

Following the devastating 1985 Mexico City earthquake, the government of Mexico reassessed its methods for dealing with major national emergencies. One result was the creation of a National Civil Protection System and, within this context, a national center for disaster prevention. Enabled in large part through a bilateral agreement with Japan, the government established the Centro Nacional de Prevencion de Desastres—CENAPRED—in Mexico City.

Similar to CISMID, the Center for Seismic Engineering and Mitigation of Disasters in Lima, Peru (a joint venture of Japan and Peru), CENAPRED supports research and development studies concerning disaster prevention and mitigation. The center also maintains a library, data bases, and other materials for use by disaster agencies and professionals, and offers training and information on preparedness and prevention to both the disaster community and the general population. For additional information about CENAPRED, contact Enrique Solorzano Mier, Co-ordinator of International Affairs, Centro Nacional de Prevencion de Desastres, Av. Delfin Madrigal No. 665, Col. Pedregal de Santo Domingo, Delegacion Coyoacan, C.P. 04360, Mexico, D.F.; tel: 658-5127, 658-5167, 554-8390; fax: 554-8041, 606-7956.

### **Second Japan-U.S. Workshop on Natural Disaster Reduction**

The Second Workshop on Natural Disas-

ter Reduction (Earthquakes and Tsunamis) took place at Karuizawa, Japan, 23-27 September 1991. The Workshop was held under the Japan-U.S. Science and Technology Agreement. Mr. Richard Hagemeyer, Chairman of the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/TTSU) participated as part of the U.S. Delegation. Participants included the following: Hiroshi Wakita (Univ. of Tokyo), Co-chairman, William Prescott (USGS), Co-chairman, Richard Hagemeyer (NOAA), Kazuo Hamada (NIED), Akira Hasegawa (Tohoku Univ.), Yoshihiro Kinugasa (GSI), Kazuo Komaki (GSI), Shozo Matsumura (NIED), Toshio Mori (JMA), Patricia Stahlschmidt (FEMA), Nobuo Shuto (Tohoku Univ.), and Kozo Takahashi (CRL).

A report was produced by the Earthquake and Tsunami Working Group. The recommendations of the working group are divided into three areas: Earthquakes, Tsunamis, and Mitigation Policy. In this section we will list the recommendations for each of the three areas. In the next section, each of the recommendations are discussed in greater detail. A final section of the report makes some general suggestions for improving the process.

### **Earthquakes**

1. Exchange information on measurements to detect crustal movement by space techniques;
2. Evaluation of anomalies in continuous observations;

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## National and Area Reports

3. Comparison of experiences in areas of intensified observation;
4. Joint activities;
5. Symposium on specific topics and exchange of scientists;
6. Deep drilling and borehole measurements in seismically active areas to study fault properties.

### **Tsunamis**

1. TIME project;
2. Tsunami initial profile for submarine earthquake;
3. Numerical models for forecasting far-field tsunami;
4. Develop common data base of maps of tsunami data, and contours of sea bottom and coast;
5. Use of PEACESAT.

### **Mitigation Policy**

1. Education and awareness;
2. Preparedness and response;
3. Seismic construction standards for new and existing buildings;
4. Planning and land use.

### **The following is the Summary of the Workshop.**

The report prepared by a working group during the First Workshop on Natural Disaster Reduction outlined several broad areas of research and several specific projects for cooperative work. This report is the result of a refinement of the process that began at the First Workshop. In particular the present working group supports and encourages continuation of the specific projects discussed in the

earlier report.

This report is still an interim report. The present working group recognizes that if these recommendations are to have an effect, we need to establish mechanisms carrying them beyond the pencil and paper stage. We also recognized that if we are to advance toward our goal of reducing natural disasters resulting from earthquakes and tsunamis, we need to broaden our perspective on the problem. Reducing the loss of life and property during earthquakes is the responsibility of three rather separate communities: the scientific community, the engineering community and the community of practitioners or government officials who utilize this information to implement mitigation measures. At both this Workshop and the first Workshop only the scientific community was well represented. At this second Workshop the community of practitioners/government officials was represented by one member of U.S. Federal Management Agency. The earthquake-engineering community was not represented at either workshop. We believe that a broader perspective on the problem will be more likely to be effective.

The present working group was also concerned that there is inadequate coordination between the various joint Japan-U.S. committees. In particular, the efforts of the UJNR Panel on Earthquake Prediction Technology and this UJST Working Group should be much better coordinated. While there is some overlap

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## National and Area Reports

of membership on the Japanese side, on the U.S. side the two committees have operated completely independently.

### **Chile Holds Earthquake Exercise in the Santiago Metropolitan Area**

ONEMI, the National Office of Emergency in Chile, held a large scale earthquake exercise on 12 October 1991 for the Metropolitan region of greater Santiago. The exercise involved more than 2,500 officials and volunteers from the Fire Department, Red Cross, Civil Defense, Boy Scouts, Areal Federation, the Radio Club, the Police Department and many other organizations including hundreds of students. The epicenter of the simulated earthquake was located in the area known as Cajon del Maipo, affecting to a greater extent the community of La Florida which is densely populated. The simulated earthquake had a magnitude of about 6.0 on the Richter scale and, according to the exercise scenario, killed many people, injured dozens of others, and caused extensive damage throughout the region. According to the Director of ONEMI, Mr. Sergio Navas, the purpose of the exercise was to help with the training of officials and for the education of the public on how Chile's Civil Defense infrastructure should function in case of a real catastrophe. He emphasized the need for the Chilean population to be well prepared as the country is exposed to numerous natural disasters.

### **Chile Holds Earthquake and Tsunami Exercise in Arica**

Another large scale earthquake and tsunami exercise was held on 12 October 1991, in the northern city of Arica, a place known well for its past large earthquake and tsunami disasters. The exercise was part of a series of such exercises held in Chile in celebration of the National Day of Civil Protection. The exercise was directed by the Provincial Director of Emergency, Mr. Alfredo Navarrete and was coordinated by the Civil Defense, and the Police and Fire Departments of the region. The purpose of the exercise was to test the effectiveness of local authorities to transmit warnings to the local population and to coordinate evacuation of vulnerable areas. The exercise was very successful.

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## Announcements

### **IDNDR Summit Conference on Earthquake and Natural Disaster Countermeasures 1991**

The Japanese Government, Tokyo Metropolitan Government, and Japan National Committee for the IDNDR, held a Conference in Tokyo, Japan, 8-11 October 1991. The goal of this conference was to exchange ideas and experiences concerning natural disaster reduction, focusing on earthquake countermeasures and discussing international cooperation for development of effective natural disaster reduction. For further information regarding the proceedings of this meeting, contact the IDNDR Promotion Office, Disaster Prevention Bureau, National Land Agency, 1-2-2, Kasumigaseki, Chiyoda-Ku, Tokyo, 100 Japan; tel: 81-3-3501-6996, fax: 81-3-3503-5690.

### **The World at Risk: Natural Hazards and Climate Change. National Science Foundation, Engineering Division, Natural and Man-Made Hazard Mitigation Program. Cambridge, Massachusetts, 14-16 January 1992.**

Global environmental changes could significantly affect the occurrence and severity of natural disasters. Thus, with the great attention being focused on the continued increase in greenhouse gases and predicted global warming, attention should also be extended to the consequent effects on natural hazards such as drought, desertification, severe storms, flooding, sea level rise, and prolonged temperature extremes. The Massachusetts Institute of Technology's Center for Global Change Science is hosting this

symposium to emphasize this link between climate change and natural hazards. The symposium will focus on predicting hazards impacted by climate change, outlining strategies for prevention and/or adaptation to such hazards, and the response of both engineering scientists and government. Abstracts are due September 1. For details contact Anne Slinn, Center for Global Change Science, MIT, Building 54-1312, Cambridge, MA 02139, (617) 253-4902; fax: (617) 253-0354.

### **Rising Challenge of the Sea, International Workshop, 9-13 March 1992, Margarita Island (Venezuela).**

Contact: Marta Perdomo, Ministerio del Ambiente, A.P. 66401, Las Americas, Caracas 1061-A, Venezuela. Tel: (58-2) 541-3132; fax: (58-2) 545-0607.

### **EMEX'92, Emergency Management Exposition and Conference, 17-19 March 1992, San Francisco, California (USA)**

Needham, Mass., 15 July 1991 — Emergency management professionals from the public and private sectors have outlined a six-track conference agenda under which some 40 sessions will be offered at EMEX'92, the emergency management exposition and conference, 17-19 March 1992, at San Francisco's Moscone Center.

Representing the National Coordinating Council on Emergency Management (NCCEM), the American Red Cross, Northwest Airlines, Rescue Training Associates, the City of San Francisco and

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## Announcements

developed tracks for: Emergency Management, Communications & Technology, Operational Business Continuance, Urban Search & Rescue, Government Issues and Training.

A horizontal trade show, EMEX'92 will feature the latest products, services, ideas and technologies for corporate and community protection, and relief/recovery from natural and man-made disasters.

For further information contact: Victor Cruz, 300 First Ave., Needham, MA 02194, USA, Tel: (617) 449-6600, Fax: (617) 449-6953, Telex: 174273

### **Second U.S.-Asia Conference on Engineering for Mitigating Natural Hazards Damage, Jakarta and Jogjakarta, Indonesia, 23-27 March 1992**

This conference will address five specific natural hazards—volcanoes, earthquakes, ground failures, floods, and extreme winds—through keynote speeches, lectures, paper presentations, group discussions, and field trips. The meeting will provide an open forum for intensive discussion and permit the sharing of experiences in mitigating natural hazards damage, the identification of problems of mutual interest, and the development of possible cooperative projects. For further information, contact Arthur N.L. Chiu, Department of Civil Engineering, University of Hawaii at Manoa, 2540 Dole Street, Holmes 383, Honolulu, HI 96822, (808) 956-7170; fax: (808) 956-5014; telex: 7431199 ACHIUI; or Aspan S. Danuatmodjo, Indonesia

Disaster Management Center, Wismar Tanah Air, Jalan Dewi Sartika No. 200, Cawang III, Jakarta 13630, Indonesia; tel: (62-21) 809-3391; fax: (62-21) 809-0917; telex: 46027 BKN PBA IA.

### **XVII Meeting of the European Geophysical Society, Edinburgh, 6-10 April 1992**

The XVII General Assembly of the European Society will hold its annual meeting at the University of Edinburgh; Edinburgh, United Kingdom; 6-10 April 1992. A symposium on "Theoretical and Observational Aspects of Tsunamis" will be held on 8 April. In addition to the Tsunami Symposium a field excursion of tsunami sites in Scotland has been tentatively scheduled for 7 April. Professors A.G. Dawson and D.E. Smith will lead the excursion. The purpose of which will be to examine sites where ancient tsunami sediments are visible in coastal sediment sequences. For further information regarding the XVII General Assembly of the European Geophysical Society and the Tsunami Symposium contact: European Geophysical Society, c/o Local Organizing Committee, University of Edinburgh, Department of Geology & Geophysics, King's Building, Edinburgh EH9 3JZ, United Kingdom.



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## Announcements

**First Canadian Symposium on  
Geotechnique and Natural Hazards.  
Canadian Geotechnical Society and  
Vancouver Geotechnical Society.  
Vancouver, British Columbia, Canada,  
6-9 May 1992**

Among other geologic phenomena, this meeting will examine ground failure, landslides, avalanches, earthquakes, liquefaction, tsunamis, and volcanoes. Interested persons should contact the Organizing Secretary, GeoHazards '92, 970 Burrard Street, Vancouver, British Columbia, Canada V6Z 1Y3, (604) 663-1651; fax: (604) 663-1940.

**Pacific Congress on Marine Science and  
Technology (PACON), 31 May - 5 June  
1992, Kona, Hawaii (USA)**

PACON International will be held from 31 May to 5 June 1992 at the Kona Beach Hotel in Kona, Hawaii. The tentative technical program of PACON 92 will include: General lectures by Dr. Joe Baker, Australia and Dr. Sylvia Earle, USA; Ocean Science and Technology presentations; Marine Resource Management and Development and Workshops. For more information on PACON 92, write to: PACON International, c/o Dept. of Civil Engineering, University of Hawaii at Manoa, 2540 Dole Street, Holmes 383, Honolulu, HI 96822.

Submit abstracts by 30 October 1991 on "Post-baccalaureat Education in Marine Affairs." Contact: PACON, PO Box 11568, Honolulu, HI 96828, USA. Fax: (1-808) 956-2580.

**Ocean Management in Global Change,  
22-26 June 1992, Genoa (Italy)**

Among other activities celebrating quinquenary of Columbus' historic voyage. Contact: Ente Colombo '92, Specialized International Exhibition, "Christopher Columbus: Ships and the Sea," Palazzo Serra Gerace, Via Sottoripa 5, 16123 Genoa, Italy. Phone (39-10) 284 111; fax: (39-10) 292 693.

**27th IGU Congress/General Assembly,  
9-14 August 1992, Washington, DC (USA)**

Contact: 27th IGU Congress Secretariat, 127th and M Streets, NW, Washington, DC 20036 (USA).

**International Seminar on Earthquake  
Prognostics, 22-26 September 1992,  
Thailand**

Prof./Dr. Satyendra P. Gupta, Senior Research Scientist at the Asian Institute of Technology in Thailand, informed ITIC that the 7th International Seminar on Earthquake Prognostics will be held in Bangkok, Thailand, 22-26 September 1992.

Those who wish to submit a paper to this seminar are requested to send an abstract (in English) not exceeding 500 words to the Chairman of the Organizing Committee before 15 January 1992. Each abstract will be reviewed and acceptance conveyed to the author by 25 February 1992. The full papers must be submitted by 15 July 1992.

An exhibition of equipment, instruments, engineering studies, demonstration

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## Announcements

models, books and publications, etc. is being planned. For further information please contact the Chairman of the Organizing Committee not later than 31 July 1992.

The papers presented at the seminar will be published as a special volume of the Vieweg publication series "Progress in Earthquake Research and Engineering." Complete manuscripts for publication in the proceedings should be submitted before 15 July 1992. Instructions to authors will be distributed when the papers are accepted for presentation.

For more information on this international seminar, contact: Prof./Dr. Satyendra P. Gupta, Asian Disaster Preparedness Center, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand. Tel: (66-2) 524-5356; Fax: (66-2) 524-5360; Cable: AIT BANGKOK.

### **International Tsunami Symposium - Tsunami '93, Wakayama, Japan**

The International Tsunami Symposium, Tsunami '93 of the Tsunami Commission of the International Union of Geodesy and Geophysics (IUGG) will be held in Wakayama, Japan on 23-27 August 1993. The Third International Workshop on the Technical Aspects of Tsunami Analysis, Prediction and Communications, sponsored by UNESCO-Intergovernmental Oceanographic Commission (IOC), will also be held in the period. The IUGG Tsunami Symposium is organized by the Local Organiz-

ing Committee of the Japan Society of Civil Engineers. IOC is organizing the Third International Tsunami Workshop.

The symposium will be held at Wakayama Tokyu Inn in Wakayama City. Wakayama is one of the most historical areas in the prevention of tsunami disasters in Japan. The city is located 60 km south of Osaka. It takes only one hour from Osaka and four hours from Tokyo by train.

Social and recreational programs and a post symposium technical tour are being arranged for accompanied persons as well as for the participants in the scientific and technical sessions.

The IUGG symposium proceedings will be published and distributed to the participants at the symposium. Only camera-ready full manuscripts will be accepted. The author(s) is obliged to present orally at the symposium.

Participation in the Third International Tsunami Workshop will be by invitation only from the Intergovernmental Oceanographic Commission. A specific program will be developed for this Workshop with specific presentations from invited speakers. Please indicate your interest in participation by sending your name, affiliation and address to: Tsunami '93, Disaster Prevention Research Institute, Kyoto University, Uji, Kyoto 611, Japan.

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## Announcements

### **Tsunami Catalog for Kamchatka**

Mr. James F. Lander informed ITIC that an English translation of "Catalog of Tsunamis in Kamchatka" by Yu. A. Zayakin and A. A. Luchinina, 1987, 74 pp.; has been prepared for the National Technical Information Service, Springfield, VA 22161 (Order No. PB91-100650 for \$27.00). This catalog extends the "Summary of Data on Tsunamis in the USSR" by Soloviev and Ferchev for the Kamchatka region through 1985. It includes copies of marigrams for all local and teletsunamis since 1952 and includes numerous detailed location maps and travel time charts. The short reference list is a useful guide to published field studies and recent compilations not generally available in English. The NTIS has prepared a bibliography of over 170 other tsunami publications available through them ("Tsunamis. March 1970 - March 1990," PB90-871203 for \$60.00). The user may also search the NTIS Bibliographic Data Base on the Dialog system to find the order numbers and the price of various tsunami publications.

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## Pacific Tsunami Warning Center

### **Instrumentation/Automation - Pacific Tsunami Warning System**

The Pacific Satellite Sea-Level Network consists of 76 DCPs.

PTWC operates 18 DCPs: Adak Is., Baltra Is., Caldera, Chatham Is., Dutch Harbor, Easter Is., Juan Fernandez, Kodiak, La Libertad, La Punta, Malakal Is., Midway Is., Rarotonga, San Felix Is., Socorro Is., Valparaiso, Wake Is., and Yap.

NWS operates 2 meteorological/water level DCPs: Johnston Is. and French Frigate Shoals.

NOAA/TOGA operates 17 water level DCPs: Arica, Cabo San Lucas, Funafuti, Honiara, Kanton, Kapingamarangi, Kritimati, Lobos de Afuera Is., Majuro, Nauru, Noumea, Nuku Hiva, Penrhyn, Pohnpei, Rabaul, Santa Cruz, and Tarawa.

Lobos de Afuera Island, Peru and Arica, Chile are owned and continue to be maintained by Dr. David Enfield's group at AOML. The remaining NOAA/TOGA platforms are owned and maintained by the TOGA Sea Level Center at the University of Hawaii.

39 NGWLMS DCPs in the Pacific Basin report via GOES and dedicated circuits to PTWC. Hawaii State CD has 8 LARCs: Kapoho, Hawaii; Kahului and Lahaina, Maui; Kalaupapa, Mokokai; Haleiwa and Waianae, Oahu; and Port Allen and Nawiliwili, Kauai. All are functioning except Kalaupapa which is out of service awaiting completion of pier renovation.

### **Gordon Burton Retires**

After ten years of solid service that resulted in major improvements to the operations of the Pacific Tsunami Warning Center (PTWC) in Honolulu, its Director, Mr. Gordon Burton, retired in August 1991. He is now living in Dunkirk, Maryland.

### **Michael Blackford, New Director of PTWC**

Michael Blackford is the new Director of PTWC succeeding Gordon Burton. Mr. Blackford has extensive experience in seismology and tsunamis having worked for the Nuclear Regulatory Commission and for the Alaska Regional Tsunami Warning System.

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## Pacific Tsunami Warning Center

### SEISMIC SUMMARY (DECEMBER 1990 TO PRESS TIME)

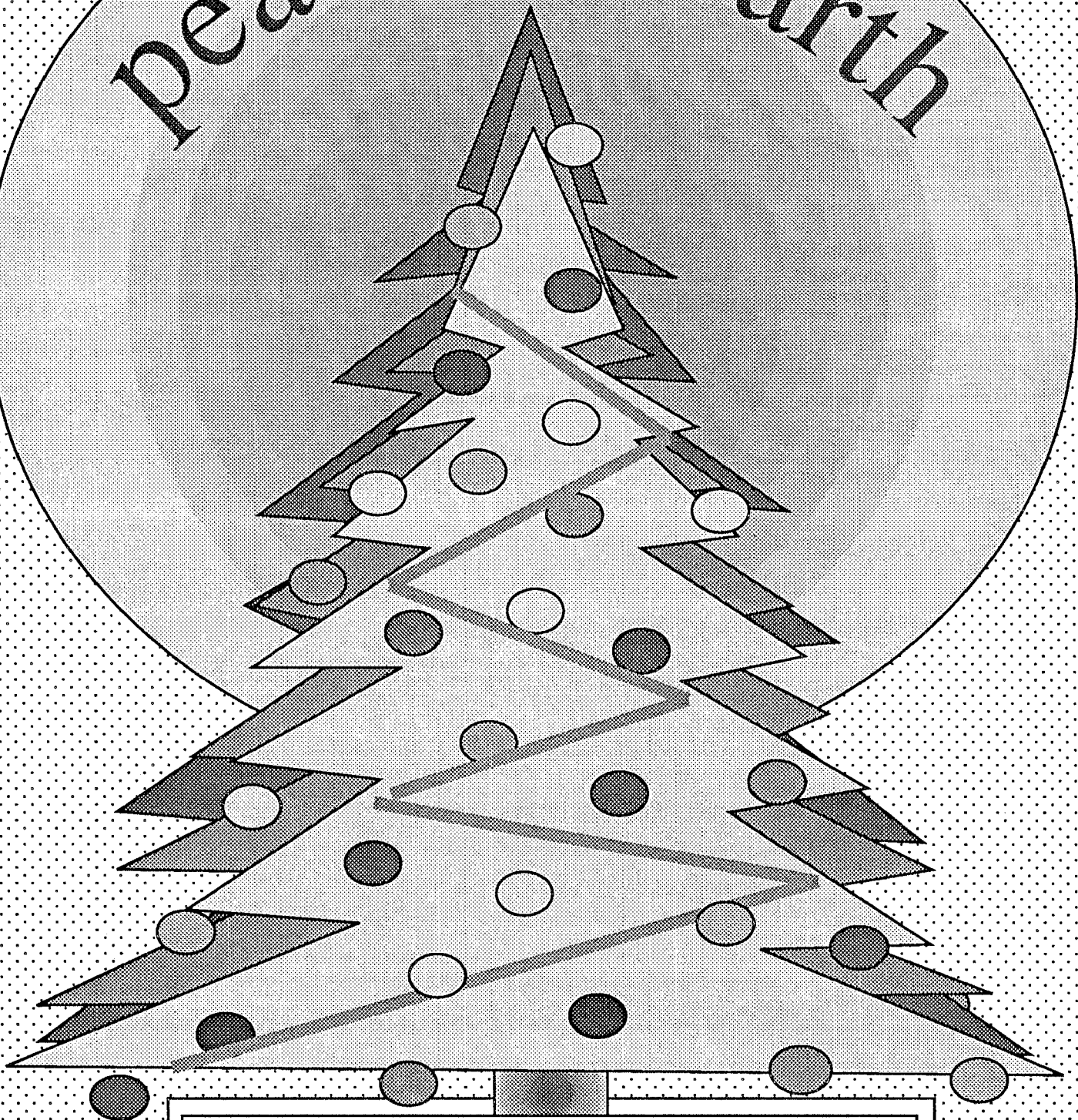
Event No.	Event	Location	Action Taken
1990-16	Dec 13 1950Z 6.6	Taiwan 25.2N 120.9E	Tsunami information bulletin issued
1991-01	Jan 05 1457Z 6.9	Burma 22.2N 95.9E	No Tsunami information bulletin issued
1991-02	Jan 31 2303Z 6.6	Hindu Kush Region 36.8N 70.9E	No Tsunami information bulletin issued
1991-03	Feb 09 1619Z 6.9	Solomon Islands 8.8N 158.8E	Tsunami information bulletin issued
1991-04	Feb 21 0236Z 6.8	Bering Sea 58.7N 175.6W	No Tsunami information bulletin issued
1991-05	Mar 08 1137Z 6.9	Kamchatka Peninsula 61.3N 166.6E	Tsunami information bulletin issued
1991-06	Apr 05 0419Z 6.8	Northern Peru 5.3S 77.6W	No Tsunami information bulletin issued
1991-07	Apr 22 2157Z 7.4	Limon, Costa Rica 9.5N 82.5W	Tsunami information bulletin issued
1991-08	Apr 29 0913Z 6.9	Soviet Georgia, USSR 43.0N 43.6E	No Tsunami information bulletin issued
1991-09	May 19 0058Z 6.8	Southern Celebes Sea 2.0N 123.4E	Tsunami information bulletin issued

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## Pacific Tsunami Warning Center

1991-10	May 30 1318Z 6.6	SW of Shumagin Is., Alaska 54.6N 161.7W	Tsunami information bulletin issued
1991-11	Jun 15 0113Z 6.6 (NEIC)	South Sandwich Islands 58.4S 24.6W	No Tsunami information bulletin issued
1991-12	Jun 20 0518Z 7.1	Southern Celebes Sea 1.9N 122.8E	Tsunami information bulletin issued
1991-13	Jul 13 0250Z 6.6	Off Southern Oregon Coast 42.0N 125.7W	No Tsunami information bulletin issued
1991-14	Aug 14 1915Z 6.6	Vanuatu Islands 13.6S 167.5E	Tsunami information bulletin issued
1991-15	Aug 17 2217Z 6.8	West of Crescent City, Calif. 41.7N 125.4W	Tsunami information bulletin issued
1991-16	Sep 28 2027Z 6.5	New Britain 4.6S 151.4E	Tsunami information bulletin issued
1991-17	Oct 14 1558Z 7.3	Solomon Islands 8.7S 158.9E	Tsunami information bulletin issued
1991-18	Oct 19 2123Z 6.5	Northeast of New Deli 30.1N 78.9E	No tsunami information bulletin issued
1991-19	Nov 19 2229Z 7.0	NW Coast of Columbia 6.1N 78.0W	Tsunami information bulletin issued

peace on earth



Happy Holidays  
from the staff at ITIC!