Meetings

Alaska Earthquake, 27 March 1964

The cause and effect of the Alaska earthquake disaster were the main subjects discussed at a meeting held in Washington, D.C., 7 May 1964. The speakers represented the fields of geology, seismology, photogrammetry, and surveying and mapping.

In the opening address William Fischer (president, American Society of Photogrammetry) called attention to the various earth science disciplines engaged in studying the effects of the quake, which took place on Good Friday, 27 March 1964, and on subsequent days. Within 24 hours, he stated, scientists were in the field; they took seismic recordings of the aftershocks, photographed and mapped the great cracks and slumps in the Anchorage area, and appraised the damage caused by landslides.

Lawrence W. Swanson (vice president, American Society of Photogrammetry) introduced the speakers and explained how the scientific data are applied. Such studies are necessary, Swanson stated, to help alleviate damage in similar catastrophes in the future. In the field of hydrographic charting, such studies are used to provide the charting and navigational data for correcting nautical charts, which are essential for coastal communications.

In the opening lecture, "Coordinated survey effort in Alaska after the earthquake," H. Arnold Karo (director, U.S. Coast and Geodetic Survey) related that when they first received the news they immediately loaded three aircraft with seismic measuring gear, flew to Anchorage, and in 2 days had begun to obtain recordings. As a result of monitoring the aftershocks of the quake more seismic information was collected than from any previous earthquake. Karo stated that in his 41 years of survey experience he had never seen anything to match the magnitude of the shock in its destructive ability. The earthquake at 5:36 p.m. had released twice as much energy as the 1906 earthquake that wrecked San Francisco. It had crippled southcentral Alaska, left about 114 dead or missing, and caused close to $750 million in damage.

One of the big problems was the loss of income. Many waterfront communities, engaged in fishing and shipping, lost most of their means of livelihood. The biggest problem will be to finance and rebuild the wrecked areas. Had the earthquake occurred earlier, during the school and business hours, the loss of life would have been much, much greater. Also, had the seismic sea waves, triggered by the quake, struck the coastal communities at high tide instead of low tide, the loss of life and property would also have been far greater. Karo illustrated, by ground and aerial photographs, the tremendous damage done to buildings. Results of the survey should influence the design and construction of buildings in the future. He emphasized the fact that catastrophic earthquakes are a recurring phenomenon in the region and that man must learn to construct communities and public works in such a manner as to minimize the damage.

In the lecture "General seismicity of Alaska and its relation to the Prince William Sound earthquake," Rutlage Brazee (assistant chief, Seismology Division, U.S. Coast and Geodetic Survey) described the system by which seismologists of the Survey receive instrumental information from up to 1000 seismograph stations located in every part of the world. Information on some 3000 to 4000 earthquakes is processed each year. These furnish the data from which the internal structure of the earth is determined and mapped. This information is then used to calculate earthquake risk, and hopefully, will be used in the not too distant future to predict earthquakes.

Brazee described the zone of major activity as a circum-Pacific belt which skirts the rim of the Pacific from southern Chile through Central America, up the west coast of North America, then along the Aleutian arc through Kamchatka, the Kuriles, Japan, the Philippines, and on down to the Fiji and Tonga islands. This belt comprises the most consistent seismic activity of the earth. He stated that, historically, Alaska has been the scene of some of the most spectacular effects ever recorded. In 1899 an earthquake of major proportions occurred in the area of Yakutat Bay. A field party of the U.S. Geological Survey which visited the area in 1905 found a maximum uplift of 47½ feet, the largest ever recorded. Although this was a major shock, no damage or loss of life was experienced because the region was very sparsely populated.

Brazee stated that a comprehensive study of the aftershock sequence—strong motion effects, structural damage, and geological effects of the earthquake—is underway. The earthquake has provided a unique opportunity for seismological investigation; studies of local travel time, seismic velocities, crustal structure, epicentral location, and number and magnitude of aftershocks are also underway. The Wood-Anderson recording system will permit the calculation of Richter magnitude for local earthquakes and consequently, the strain energy release in the epicentral area.

This detailed study fits into a still larger program of seismic study aimed at the ultimate goal of seismologists everywhere—the prediction of destructive seisms to the nearest minute of time and the nearest few miles of distance. It is only by advance warnings that lives can be saved and the destruction of property mitigated.

Mark Spaeth (U.S. Coast and Geodetic Survey) spoke on the "Tsunami generated by the Prince William Sound earthquake." He described how the survey, after the Aleutian earthquake and tsunami on 1 April 1946 had caused 146 deaths in Hawaii, undertook the establishment of a seismic sea wave warning system to prevent a recurrence of this disaster.

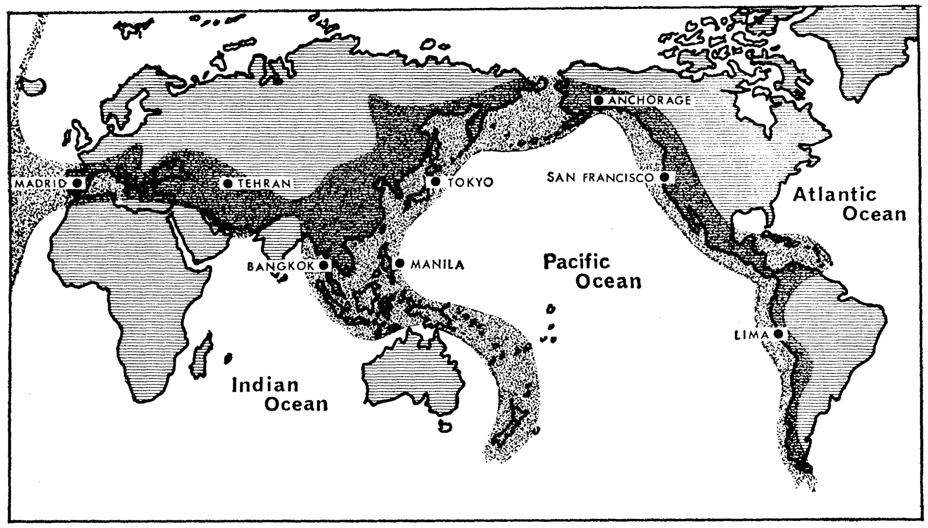
Headquarters of the warning system, first established in 1948, is at the Honolulu Observatory of the Coast and Geodetic Survey. Here earthquake epicenters are located, tide and seismic reports are gathered and interpreted, and warnings are provided to civilian and military agencies. Such agencies are then responsible for notifying the populations likely to be affected. In addition to the 15 seismological observatories, there are 30 tide stations in the system which the Honolulu station can call upon for definite information about whether a particular earthquake has generated a tsunami.

The Prince William Sound earthquake of 28 March generated one of the larger seismic sea waves of recent history. It also reemphasized the fallacy of two of the ancient shibboleths of tsunamic literature, namely, that an earthquake whose epicenter is on land will not generate a sea wave, and that the first noticeable action in a tsunami is the withdrawal of the water from the shore. Earthquakes which involve tectonic displacements under the ocean, even though their epicenters may be on land, cause tsunamis. Spaeth then discussed the chronological history of the tsunamis and secondary waves at recording stations at Hilo (Hawaii) and Honolulu, and observatories at College, Sitka, and others maintained in Alaska. Due to the destruction of communication facilities by the earthquake, it was not always possible to transmit seismic readings to Honolulu. At 0410 G.M.T. a report of a 30-foot tsunami was received at Kodiak from Cape Chiniak. The commanding officer at Kodiak Fleet Weather Control called the local armed forces radio station and had a warning broadcast which resulted in the evacuation to higher ground of personnel at Kodiak and Kodiak Naval Base. The prompt action of this officer undoubtedly saved many lives.

By 0452 G.M.T., 1 hour and 16 minutes after the earthquake, the seismologists at the Honolulu Observatory, with reports from only eight observatories, had computed the epicenter of the earthquake to be at 61°N and 147.5°W. The position of the epicenter was obtained by triangulation upon a 30-inch globe and was within 12 kilometers of the epicenter determined later from thousands of readings used in data processing machines.

After locating the epicenter, the observatory began contacting tide stations in the vicinity of the quake to determine whether a seismic sea wave had been generated. The first advisory issued at 0502 G.M.T. to agencies in the warning system reported that a severe earthquake had occurred near Seward, Alaska. This was followed by a further advisory at 0530 G.M.T. which gave estimated arrival times of the tsunami at 32 stations in and around the Pacific. At this time no confirmation had been received at Honolulu Observatory that a tsunami had been generated. The first complete description of the tsunami received at Honolulu was at 0630 G.M.T. by a message from Kodiak Tide Station. This description had been relayed by the Naval Communication Station at San Francisco. The observatory immediately issued a warning that a wave had been generated and then repeated the estimated times of arrival at the various stations in and around the Pacific. Spaeth then showed, on a screen, the position of the wave front when arrival times were given for several typical stations—Neah Bay, Washington; Crescent City, California; Hilo, Hawaii; Valparaiso, Chile; Kwajalein; and Truk.

The tsunami was recorded as far south as the Argentine Islands on the western side of the Palmer Peninsula in Antarctica. When it arrived on 29 March, almost 22 hours after it was set in motion, it had an amplitude of 3 to 4 feet. At Valparaiso, the maximum wave amplitude was 11.3 feet. At Huasco, Chile, the maximum amplitude was 16.4 feet. Wave heights of 30 feet were reported from Seward and Cordova, Alaska, and at Kodiak waves of 30 to 35 feet were observed. Major damage was caused by the tsunami along the coast of Alaska from Kenai Peninsula to Cordova, and along the coast of Kodiak Island. Damage was also heavy along the coast of Canada and in Crescent City, California. The communities hardest hit in Alaska were Seward, Whittier, Valdez, and Kodiak.



Earthquake "belts" of the world. [U.S. Geological Survey]

Twenty-seven city blocks were virtually destroyed in Crescent City when the third and fourth waves of the tsunami swept into the town. All the fatalities and most of the damage was caused by the fourth wave. These waves were estimated at 12 feet. More than 300 buildings were destroyed or washed off their foundations.

The deaths in California revealed an ignorance on the part of the local population about the action that should be taken in the event of a tsunami. The first wave in a tsunami is seldom the most damaging. In Crescent City, those people who had evacuated the danger area began returning home after the first and second wave had passed. At San Francisco, 10,000 people jammed the beach at the critical time. If a major wave, similar to the fourth wave at Crescent City, had occurred most of the 10,000 might have died.

Spaeth noted that although tsunamis are comparatively rare events, 25 have been recorded in the Pacific Ocean since 1956. Of this number, 6 were generated off the coast of South America, 5 near Japan, 4 in the Kuriles, 3 off the coast of Central America and Mexico, 2 off Kamchatka, 2 in Alaska, and 1 each in the South Pacific, Aleutians, and the New Hebrides. In recent history the Chilean tsunami of May 1960 was the most destructive and caused deaths in Chile, Hawaii, the Philippines, Okinawa, and Japan.

The Seismic Sea Wave Warning System, operated by the U.S. Coast and Geodetic Survey for the protection of the Pacific region, has operated effectively during all of these tsunamis.

George Gates (coordinator, Alaska

Earthquake Studies, U.S. Geological Survey) presented the closing lecture. He related how within 24 hours of the shock, Alaska geologists of the U.S. Geological Survey were on the scene in Anchorage and elsewhere; they were photographing and undertaking studies related to the cause and effect of the great cracks and earth slumps which combed the area. Most of the damage was found to be caused by landslides triggered by the earthquake. Gates described first some of the basic principles of Alaska's geology. He reminded the audience that the earth's crust is "restless" and is continually changing as a result of the stresses exerted from deep within the crust. Normally, the crust "flexes" and stretches to accommodate internal activity, but occasionally the stresses build up to enormous proportions. Then, a sudden "snap" of the earth's crust may relieve the geologic stress and at the same time cause vibrations that we call earthquakes. Gates stated that the earthquake serves as a reminder of the importance of applying geologic knowledge to construction plans involving earthquake-resistant structures. He emphasized the fact that earthquakes are a recurring phenomenon and that structures and public works must be built in a manner to minimize damage. It was stated also that the nature of the ground itself is of more importance in the design of earthquake-resistant structures than the distance to the epicenter. Basic to good design is adequate knowledge of the surface and subsurface conditions upon which the structures must be built.

Gates showed, by means of aerial photographs, the recurring nature of landslides in the Anchorage area. Some of these landslides are apparently of ancient origin. The unstable condition which caused the slumping is an unstable clay which underlies the area. All the landslides occurred in areas underlain at shallow depths by the "Bootlegger Cove Clay." Information on the distribution and physical properties of the clay ["Surficial geology of Anchorage and vicinity, Alaska," Robert D. Miller and Ernest Dobrovolny, *U.S. Geol. Surv. Bull. 1093* (1959)] had contained a warning (pp. 103–107) of the possibility of earthquake-triggering landslides in Anchorage and vicinity. Such slides on 27 March produced most of the damage.

Gates also announced that a newly published 35-page report, "Geological Survey Circular 49—Alaska's Good Friday Earthquake—March 27, 1964," by Arthur Grantz, George Plafker, and Reuben Kachadoorian, discusses in detail the causes, nature, and extent of damage of the quake. Geologic factors apparently played the chief role in determining the distribution of the damage. They controlled the distribution of fracturing, compaction, lurching, and landslides, and thereby the distribution of damage to structures. Structures in the area that were underlain by a thin layer of glacial outwash overlying the Bootlegger Cove Clay, or underlain by silt, were more severely hit than those underlain by a thicker layer of gravel.

Structures on bedrock were damaged less than those on unconsolidated deposits. As an example, at Whittier, large concrete buildings that were built on bedrock received less damage, even though they were closer to the epicenter, than the concrete structures of Anchorage which were built on outwash gravel and clay. Gates concluded that much has been learned from the earthquake that will be of value in designing and locating the new buildings and structures. Thus, he stated, geologic knowledge can be used to minimize loss of life and reduce damage to property.

This meeting was sponsored by the American Society of Photogrammetry, the American Congress on Surveying and Mapping, and the Eastern Section of the Seismological Society of America.

DAVID LANDEN
American Society of Photogrammetry, Falls Church, Virginia

Artificial Internal Organs

Topics covering all phases of artificial kidney design, maintenance, application, and results; extracorporeal circulatory machines and problems; transplantation of organs; implantation of artificial organs and cardiovascular prostheses; and basic problems of electrochemistry and stimulation of various intact organs were discussed at the annual meeting of the American Society for Artificial Internal Organs, Chicago, Illinois, 12–13 April 1964. Participants included representatives from England, France, Canada, Australia, Japan, and the United States.

Investigations of the basic aspects of dialyzers included better methods for evaluating dialyzer and membrane performance. Such studies were performed to find the optimum dialyzer design, mechanisms for improving solute transfer by improving fluid distribution within the dialyzer, and new materials for supporting membranes to increase efficiency of dialyzing fluid circulation. New synthetic membranes are more effective than the standard cellophane membrane.

Electrolyte changes in the blood and urine during open-heart surgery are made with no-blood prime and mannitol to reduce the hazards of blood transfusion. Studies of new machines and techniques and physiologic observations are extending our knowledge and application of extracorporeal circulation, and will aid in evaluating open-heart surgery and in assisting circulation.

Discussions on equipment, techniques, and artificial organs included: (i) new design of dialyzers, modification of the operational techniques for hemodialysis and cannula design, and methods of cannulation of blood vessels for purposes of hemodialysis; (ii) new designs and principles of implantable artificial hearts and a piezoelectric pump which may lead to the eventual development of a permanently implantable mechanical heart; and (iii) performance characteristics of artificial kidneys under various operational methods and clinical experience of various large centers with the use of hemodialysis for both acute and chronic renal failure.

Advances in the field of cardiovascular prostheses include new methods for replacement of arteries and heart valves, and study of the functional anatomy of the normal aortic valve. The antigenic influence of the thymus, kidney donor problems, and the place of hemodialysis in renal homotransplantation were stimulants for lively discussions.

Reports on peritoneal dialysis dealt with improved cannulae, cannulations, and techniques. Presentations on other methods of dialysis included reports on new techniques for dextran filtration of uremic blood, electrodialysis of blood, cross-circulation, parabiotic dialysis, and intestinal perfusion.

Investigations of the effects of dialysis, not concerned with renal failure, included changes in brain urea and water content, studies of endogenous and exogenous metabolites and poisons, of barbiturates, and of radioactive strontium.

Sessions on cardiovascular electrochemistry and electrostimulation of organs dealt with basic studies of electrocardiograms, ionic architecture at