Recommendation No. 8

Tsunami Research Group

A recommendation for improvement of the Seismic Sea - Wave Warning System

On the Utilization of Atmospheric Data for the Evaluation of Potential Tsunamis

by

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Part 1: Current Policy

Two components of crustal motion can be associated with earthquakes, those involving horizontal movements and those associated with vertical movements. Tsunamigenic earthquakes are those which involve vertical displacements of the ocean floor.

At present the Seismic Sea-Wave Warning System (SSWWS) cannot determine with sufficient rapidity the nature of the displacements at the source by seismological methods alone, although such methods may eventually be perfected. For practical purposes, therefore, the SSWWS conservatively assumes that a wave is always generated and relies on information from tide gage stations to confirm or disprove the generation of a tsunami. A number of tide gage stations comprising the Pacific Tsunami Warning System are in communication with the Pacific headquarters and report any unusual water activity that may confirm the tsunami generation. But even then, the average minimum response time--the time lag between earthquake and the arrival of tsunami waves at the nearest station--is about two hours (Adams, 1966).

Often, as in the case of earthquakes in South America, where few tide gage stations exist, the minimum response time is much greater, and communications are not always good. Thus, it may be possible that adequate data will not be available for the evaluation of a tsunami in Hawaii.

However, it has recently been demonstrated that tsunamigenic earthquakes, which involve vertical movements over large areas, disturb the atmosphere and create atmospheric waves. These waves propagate away from the earthquake area at a velocity of approximately 1050 ft/sec ± 30 ft/sec (Van Dorn, 1964), nearly twice the speed of sea waves. They can be easily distinguished on a microbarograph record from the background pressure variations. Thus, it may be possible from such atmospheric data to establish the nature of an earthquake and whether a tsunami has been generated.

The SSWWS does not presently utilize any atmospheric data for the evaluation of a potential tsunami. In the following paragraphs, therefore, the advantages of utilizing such data are discussed.

Part 2: Examples

The Alaska earthquake of March 27, 1964, generated atmospheric waves that created a rather distinct pressure fluctuation (0.1 mb) which was recorded by a microbarograph located in La Jolla (Van Dorn, 1964). This microbarograph record is shown in Figure 1.

The atmospheric waves from Alaska arrived in La Jolla at 0655 Z or a little more than two and one-half hours before the arrival of the tsunami waves. A marigram of the tsunami in La Jolla and its arrival are shown in Figure 2.

The sea waves arrived in La Jolla at 9:25 Z. Thus, California would have known <u>for certain</u> that a tsunami had been generated and would have had at least two and one-half hours of warning time. Additional confirmation that a tsunami had been generated and clues as to the directivity of the waves would have been obtained if an array of microbarograph stations existed. The time saved would not necessarily have been greater than the minimum response time, for this particular earthquake, but it could have

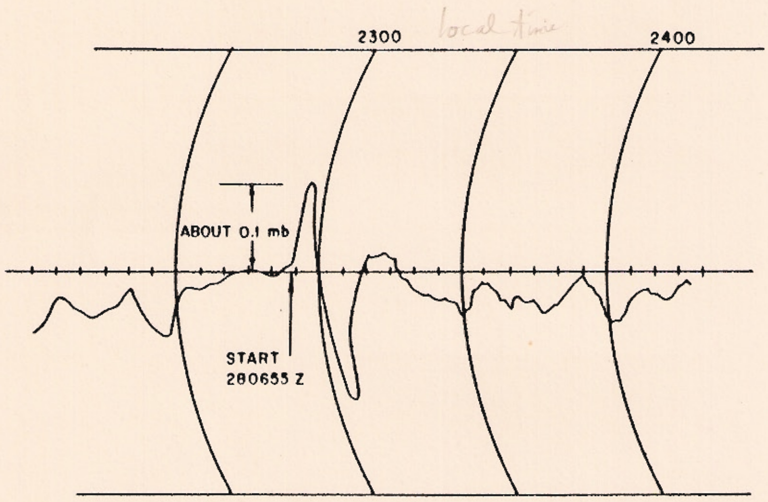

Fig. 1. Microbarograph record from La Jolla, [California] showing atmospheric tsunami from Alaska earthquake (signature is typical of that for large dipole source) (from Spaeth and Berkman, 1965).

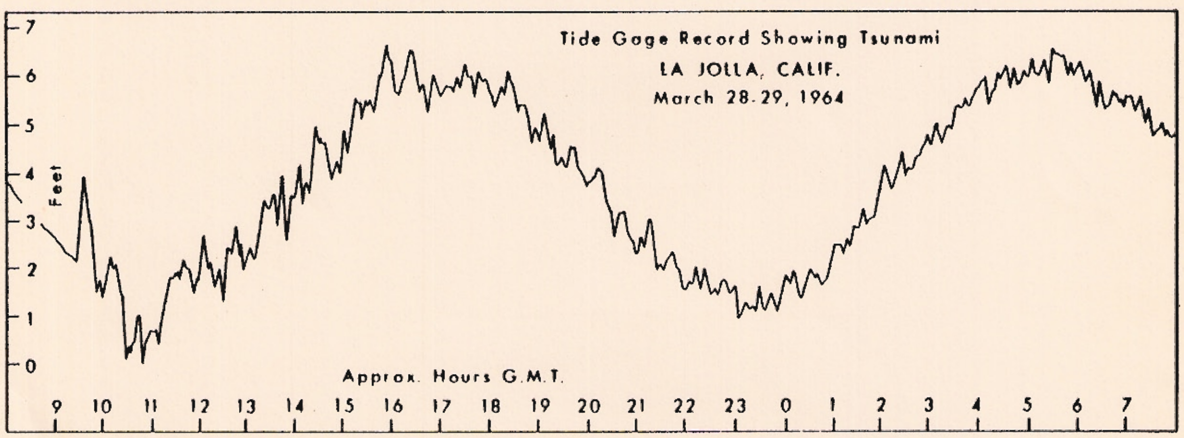

Fig. 2. Tide gage record showing [Alaska] tsunami, La Jolla, California, March 28-29, 1964 (from Van Dorn, 1964).

been greater for a South American earthquake. Most important, it would provide data received on an error-free channel, giving the redundancy deemed so desirable by Adams (1966).

More data about the tsunami generating area could also have been derived by examining the period and the number of the waves shown on the microbarograph record. Figure 1 for example shows that the first pressure wave to arrive in La Jolla was positive and had a period of 5 minutes while the negative wave following had a period of about 8 minutes. This is indicative of the dipole movement of the earthquake area. The periods of the atmospheric waves appear to be directly related to the width of the uplifted and subsided area affected by the Alaska earthquake as shown in Figure 3 (Pararas-Carayannis, 1965), although this may be purely coincidental.

In the Hiroshima A-bomb museum is a record of the blast wave from one of the Bikini tests. The period was approximately 5 minutes and an amplitude of 0.2 mmHg (0.26 millibar). The Japanese gave the velocity of this atmospheric wave at 971 ± 36 ft/sec.

Part 3. Suggested Procedure

Although not many microbarograph records from earthquakes are available to substantiate the above arguments, it is suggested that an array of microbarograph recorders distributed around the Pacific could provide the SSWWS with additional advance information as to whether the earthquake involves vertical movement and therefore whether a tsunami has been generated. In addition, atmospheric data from a number of recorders possibly could be interpreted to give the approximate orientation and the

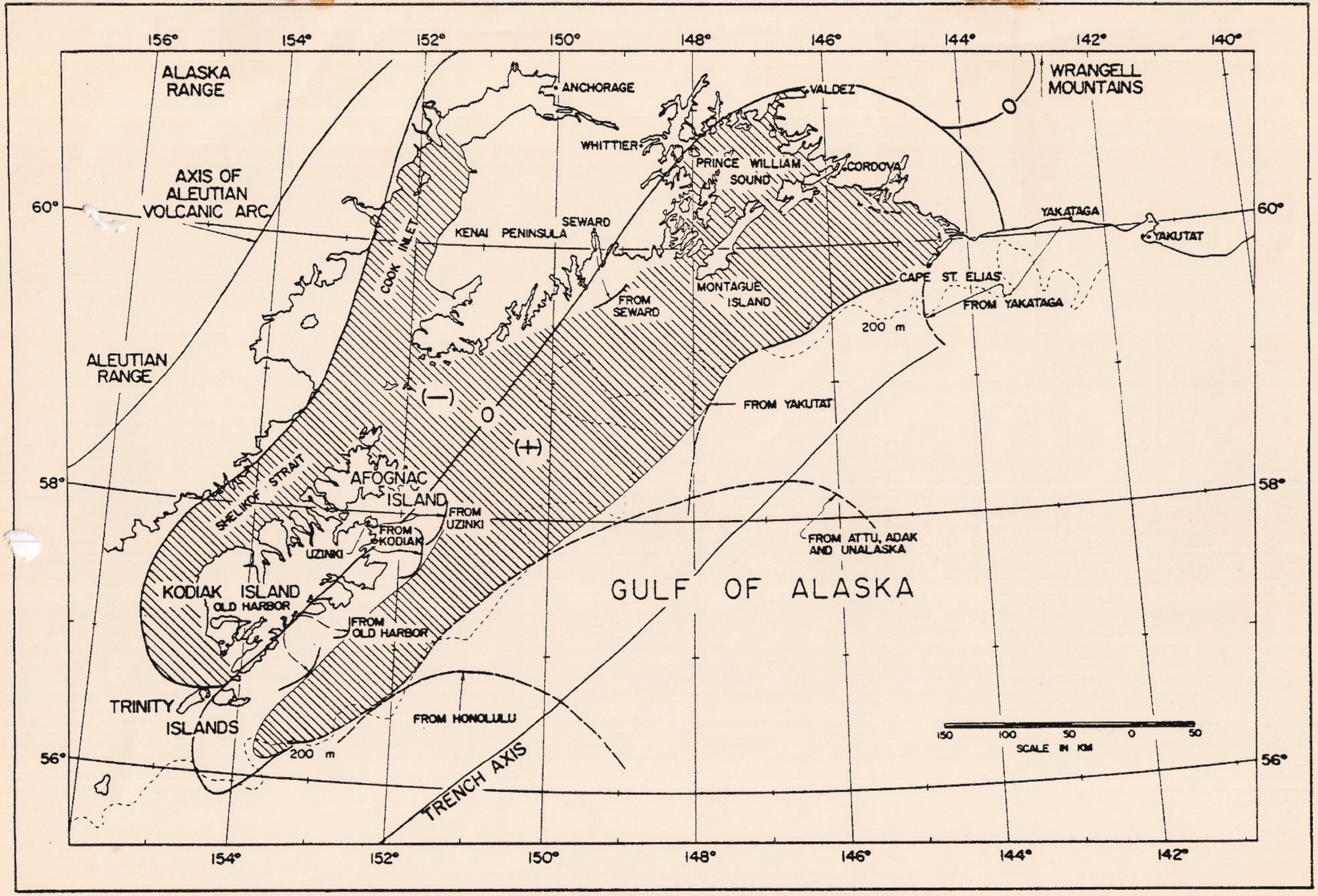

Fig. 3. Generating area of the Alaska tsunami--areas of subsidence and uplift (from Pararas-Carayannis and Furumoto, 1965).