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Lamont Geological Observatory

(Columbia University)

Final Report Contract W28-099 ac - 396

Investigations of elastic wave propagation across oceans revealed that high frequency sound waves (T phase) originating in submarine earthquakes travel through the ocean with the speed of sound in water and are detected by hydrophones in the ocean and seismographs on land. These waves may be useful in locating epicenters of earthquakes and would serve as valuable adjuncts in tsunami warning systems. Other studies revealed that Rayleigh waves propagated across the oceans are affected by the water layer. The mode of propagation of these waves is now explained by a well established physical theory which also gives the nature of crustal rocks under the oceans. In marked contrast to the continents, ocean basins are characterized by the absence of sialic rocks.

An investigation of frontal microseisms revealed that microseism storms of frontal origin are generated very soon after a front passes seaward from the land and while the front is over relatively shoal and very restricted waters. As the front recedes with distance and depth of water increasing, the spectrum of periods shifts, with periods becoming greater. Periods become fairly constant after fronts have crossed onto waters of greater and more uniform depth beyond the continental slope, suggesting depth as a significant factor in microseism generation. It seems significant that strong winds preceding a cold front have no noticeable effect in the production of microseism storms. Evidence indicated that surface wind waves and swell were not responsible for microseism generation.

Investigation of cyclonic microseisms supported the conclusion that periods are a function of the depth of water in the generating area and the distance to the storm. Regularity of microseisms appears to depend principally upon the uniformity of water depth in the generating area. Again it was found that linear surface streams of cold air are much more efficient mechanisms in the production of microseisms than streams of warm air of greater dimensions and velocities.

A re-investigation of the phenomena associated with the explosion of the volcano Krakatoa revealed a simultaneous arrival of the sound wave and the ocean tidal wave at several widely separated stations. This could only be interpreted in terms of coupling between the two types of waves. Subsequent work on elastic waves propagated through the floating ice of Lake Superior and Lake Cayuga resulted in the discovery of an air-coupled flexural wave. This wave occurs as a constant frequency train preceding the air pulse, the frequency depending on the thickness and elastic constants of the ice. It is possible that this wave will be useful in determining thickness of floating ice sheets. The theory for air-coupled flexural waves as well as air-coupled Rayleigh waves has been worked out. Preliminary theoretical investigations of the propagation of many types of elastic waves through floating ice sheets have been made.

Field investigations of the nature of the earth's crust have been made with portable land seismographs, using quarry blasts and depth charge explosions at sea. Special attention has been given to the Gulf of Maine and to the Adirondack Mountain area. In each area thickness and layering in the sialic rocks of the crust has been obtained.

In order to pursue these investigations it was necessary to construct specialized seismograph equipment as well as standard instruments for comparison. These instruments were used in the field or installed in the seismograph vaults of the Lamont Geological Observatory and at Fort George, Bermuda, the latter in coöperation with the Navy Sofar Station. A partial list of equipment assembled includes portable electronic field seismographs, three component visible recording station seismographs (T_o= 12 sec), three component photographic recording station seismographs (To = 12 sec, Tg = 15 sec), short period vertical electronic photographic recording seismograph (To = 1/5 sec), 10 identical vertical seismographs with periods adjustable from 1.5 to 15 sec, three component Benioff seismographs and accessory equipment.

These investigations have revealed the existence of important waves propagated through layers consisting of the atmosphere, ocean, and earth's crust. Analysis of these waves yields useful information concerning the nature of these layers. Now that we understand the physical nature of some of these phenomena, further experimental and theoretical results as well as new applications are to be expected. Continued support of these studies is therefore recommended.

<u>List of Technical Reports</u>

No. 1 - - - Ivan Tolstoy, Maurice Ewing, Frank Press, "The 'T' Phase of Shallow Focus Submarine Earthquakes" - January 1949

No. 2 - - - Maurice Ewing, Ivan Tolstoy, Frank Press, "Proposed Tsunami Warning System" - January 1949

No. 3 - - - Frank Press, Maurice Ewing, Ivan Tolstoy, "The Airy Phase of Shallow Focus Submarine Earthquakes" - March 1949

No. 4 - - - Maurice Ewing, Frank Press, "Crustal Structure and Surface Wave Dispersion" - July 1949

No. 5 - - - Frank Press, Maurice Ewing, "Propagation of Explosive Sound in a Liquid Layer Overlying a Semi-Infinite Elastic Solid" - December 1949

No. 6 - - - Charles B. Officer, Jr., "Theoretical Wave Studies" - July 1950

No. 7 - - - William L. Donn, "Studies of Frontal, Cyclonic and Hurricane Microseisms Generated in the Western North Atlantic: Introductory and Part I - Frontal Microseisms" - October 1950

No. 8 - - - Frank Press, Maurice Ewing, "Propagation of Elastic Waves in a Floating Ice Sheet" - November 1950

No. 9 - - - Samuel Katz, Richard S. Edwards, Frank Press, "Crustal Structure Beneath the Gulf of Maine" - December 1950

No. 10 - - - Bernard Luskin, Samuel Katz, Frank Press, "Instrumentation" - January 1951

No. 11 - - - W. S. Jardetzky, Frank Press , "Rayleigh Wave Coupling to Atmospheric Compressional Waves" - January 1951

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No. 6 - - - F. Press, M. Ewing, A.P. Crary, S. Katz, J. Oliver, "Air-Coupled Flexural Waves in Floating Ice" - November 1950

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