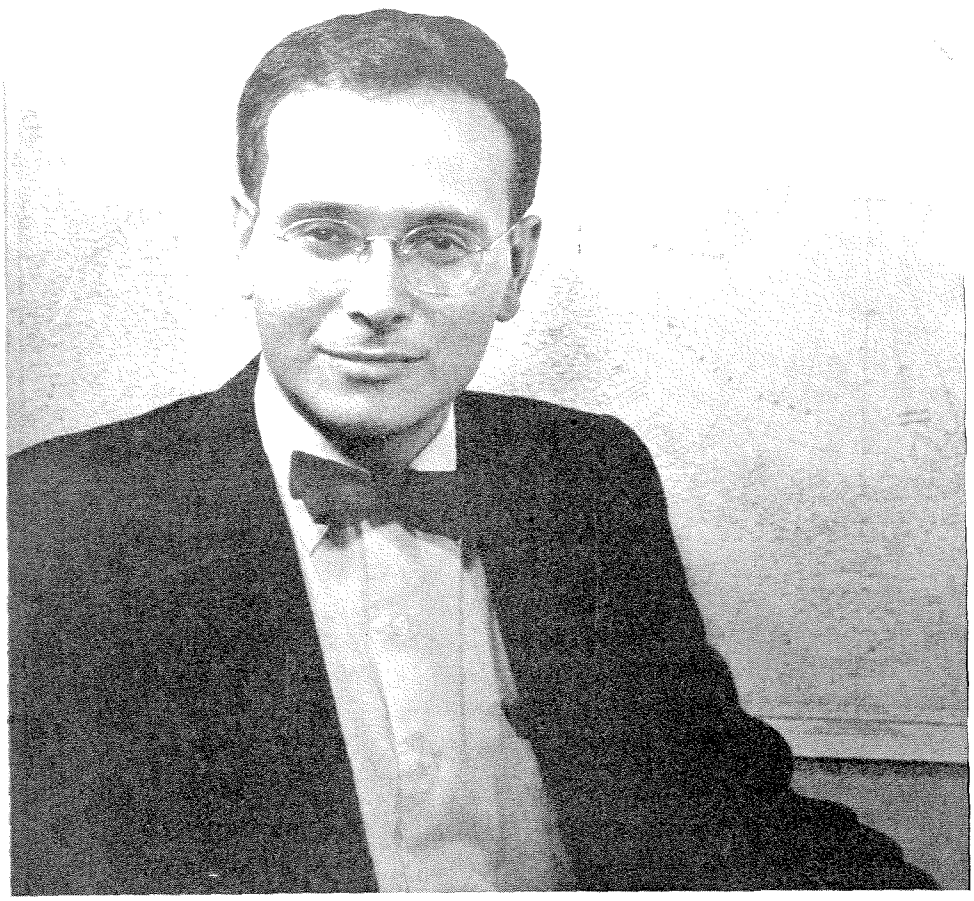
Frank Press, professor of geophysics, is a member of the IGY Continental Committee (which is in charge of overall planning of all research projects on this continent), and is also vice-president of the Technical Panel on Glaciology.



CALTECH AND THE IGY

ANTARCTIC SEISMOLOGY

by FRANK PRESS

ONE INDEX of the tremendous activity in the geophysical sciences during the International Geophysical Year is the program in Antarctic seismology. During IGY there will be more first class seismograph stations in Antarctica than in all of South America. As many as five or six seismic field parties, using the best portable apparatus available from the petroleum industry, will be sounding the barren wastes of Antarctica, determining ice thickness and identifying the rocks beneath the ice.

The Antarctic seismology program has been organized with three specific problems in mind: Determination of (1) ice thickness, (2) the nature of the Antarctic continent and, (3) the seismic geography of the Southern Hemisphere, with particular attention to Antarctic regions.

Geophysicists are very much interested in the "water budget" of the earth, particularly in the partitions of water between the oceans and continental ice sheets. The proportion of water locked in ice sheets is a variable

quantity which both reflects and affects worldwide climatic variations. Sea-level changes of the order of several hundred feet are associated with advances and retreats of continental ice sheets. It is not surprising that much effort will go into the determination of ice thickness in Antarctica so that reliable estimates of ice volume can be made.

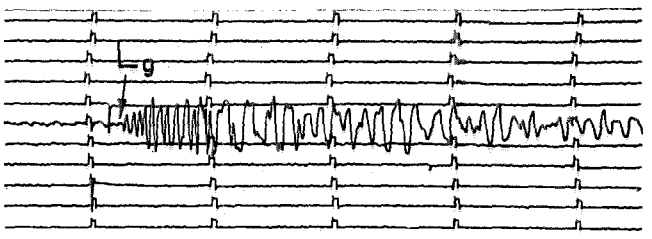
Field parties from the United States, Great Britain, the Soviet Union and France will make long traverses in tractor trains equipped with portable seismic equipment. Using techniques not unlike those employed in petroleum exploration, measurements of travel time of explosion-generated sound waves reflected from the ice-rock interface will be interpreted in terms of ice thickness. Three American parties under Albert P. Crary, chief glaciologist of the Antarctic expedition, will make traverses radiating from the Little America, South Pole and Byrd stations. A fourth airborne party will make spot measurements in areas inaccessible to the other teams.

Ice thickness

A novel approach to the ice thickness problem will also be attempted. The Antarctic ice sheet, bounded as it is by air and rock, forms an efficient elastic wave guide. Earthquake-generated elastic wave pulses are dispersed by propagation through the wave guide in a predictable manner, depending on the elasticity of the ice and rock and the ice thickness. Records from the half-dozen newly established Antarctic seismograph stations will furnish the basic dispersion data from which ice thickness can be obtained. An advantage of this method is that average ice thickness for the region between earthquake and seismograph station is obtained, in contrast to the point-by-point determinations of the field party. A serious defect in the method — and one which may render it useless — is its dependence on the occurrence of a suitably placed earthquake during IGY operations in Antarctica.

Information on the nature of the Antarctic continent is a major target of the Antarctic program. Some indications of the ice-buried topography will be revealed by the seismic field traverses. Of particular interest is the occurrence of buried mountain ranges, and indications of land elevations below sea level, as were found in Greenland. The underlying terrain will be examined by recording explosion-generated sound waves refracted through the materials of which it is composed. In this way, occurrences of unconsolidated rocks, sedimentary rocks, and igneous rocks beneath the ice will be charted.

The extent and continuity of the Antarctic continent will be examined, using recently discovered seismic waves guided by channels limited to the earth's continental crust. Channel waves have many features in common with "whispering gallery" sounds sometimes observed at the base of architectural domes. Known as *Lg* waves, these earthquake-induced vibrations reveal by their presence or absence whether or not the path between earthquake and seismograph station is continuous or interrupted. Thus, the unlikely possibility that Antarctica is composed of a number of islands, rather than a single continental mass, will be examined. The structure of the earth's crust in Antarctica will be compared with that of other continents. The manner of adjustment of the Antarctic crust to the ice load will be revealed by observations of gravitational acceleration together with land elevation and ice thickness.



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Most of the world's seismograph stations are located in the Northern Hemisphere. The precision of earthquake determinations in the Southern Hemisphere suffers as a result of this distribution. Many basic questions remain unanswered and await the flow of data from the newly established Antarctic stations. The details of the closure of the southern portion of the circum-Pacific earthquake belt require more accurate epicenter determinations, especially for the smaller shocks. Suggested connections of the Pacific belt with Atlantic and Indian Ocean earthquake belts have yet to be verified. The fact that earthquakes mark submarine mountain chains raises the interesting possibility of discovering new mountain belts in the poorly charted southern oceans from the location of epicenters. The presence or absence of earthquakes in the Antarctic interior is diagnostic of the broad geological picture. It may well be that a new species of tremor associated with motions in the ice sheet will be recorded by the seismograph stations. It is not surprising that seismology will be a major effort of IGY operations in Antarctica.

Caltech and the Antarctic program

Staff members in Caltech's Division of Geological Sciences have been actively involved in the planning of the Antarctic scientific program. The Caltech Seismological Laboratory is responsible for the training of personnel and the design of equipment for the Knox Coast seismograph station in Antarctica. The seismographs have been especially designed to detect *Lg* waves, and ice-guided waves. The instruments are particularly sensitive in order to detect the numerous small earthquakes which might ordinarily pass unnoticed. This is necessary to ensure the recording of a sufficient number of earthquakes in the short time available for operations.

It is not an unusual role for earth scientists to participate in the opening of a new region for exploration and exploitation. Perhaps the IGY effort presages such an era for Antarctica.