

GEOPHYSICAL INVESTIGATIONS AT FLETCHER'S ICE ISLAND, T-3*

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Introduction

The Geological Survey resumed field work on Fletcher's Ice Island, T-3 on April 12, 1959, with a four man party consisting of G. V. Keller, F. C. Frischknecht, Ronald Wahl and Dallas Jackson. Keller and Frischknecht left the island on May 8th, while Wahl and Jackson remained on the island until September 26th. The field work included seismic methods for determining ocean depths and bottom velocities, measurements of the gravity field and magnetic vector, measurements of ice thickness with electromagnetic methods, and solar navigation.

During the period covered by this status report, Donald Plouff continued the reduction of seismic and gravity data obtained during the 1958 summer season by the Geological Survey and during the 1958-1959 winter season by G. Cabaniss and D. Craven of Air Force Cambridge Research Center.

Navigation

Island locations were determined on 57 days between April 16 and August 30 using three sun shots for each determination. The longest time between determinations of island position was eight days, an interval which occurred twice because of prolonged bad weather, from April 27 to May 5 and from May 18 to May 26. During the first interval, the island drifted seven miles southeast with no intermediate locations being determined, and during the second interval, the island drifted 35 miles south, with no intermediate locations.

Azimuths were measured with each sun shot, but the data have not been computed. Island headings changed rapidly during August while T-3 was moving in open water.

Seismic Program

Reduction of data: Bottom depths and the dip and strike of the bottom have been computed for records from 135 days during the 1958 summer season. Acoustic velocity through sea water was computed using oceanographic data supplied by Air Force Cambridge Research Center and Kuwahara's tables of velocities as a function of depth, temperature, and salinity. Uncertainties about island positions as determined by solar navigation during the 1958 summer season have not been resolved, so

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a base is not available for the compilation of these data as a bathymetric map.

Dips and strikes were calculated using the difference in reflection arrival times at three seismometers in the form of a "T". The shot point was located at the intersection of the two geophone lines forming the T. Ordinarily, the geophones located at the ends of the geophone lines were used for dip computations, since these had the largest step-out times. The length of the geophone lines was changed from time to time during the summer, changing the dimension of the reflection triangle. Data obtained from the larger triangles should be more representative of average bottom dips than that obtained with small reflection triangles. With few exceptions, the dips are small, rarely exceeding 2° .

Seismic records obtained during the 1958-1959 winter season by Air Force Cambridge Research Center personnel were loaned to us for study of possible sub-bottom reflections. Dips and strikes for the ocean bottom were calculated for seventy-three of these records. For seismic records shot after December, 1958, the area of the reflection triangle is small. Dips and strikes calculated for this period are less reliable than those computed from earlier records having large reflection triangles.

Field work, 1959 summer season: Seismic field work at T-3 was resumed on April 14, 1959, by the U. S. Geological Survey. The recording site was moved from the 1958 hydrographic station to Colby Bay, closer to the main camp. Two geophone spreads were laid out for use during the summer; one with a fifty-foot geophone separation for correlation of reflections, and the other with a thousand foot separation so that reflection step-out times could be used to calculate sub-bottom velocities. Unfortunately, the insulation on the wire used for the long separation geophone spread deteriorated during the melt season, causing leakage. For much of the summer, records were obtained only from the correlation spread.

No detailed computations of depths and dips have yet been attempted on these records. Preliminary depth computations yield values ranging from 1300 feet during part of April to a maximum of 7000 feet recorded in September. This deep area was found at approximately $71^{\circ}20'N$, $136^{\circ}20'W$.

An attempt was made to use sonar in mapping ocean depths and bottom morphology. A sonar transducer was first set up at the main camp, where the ice is approximately 190 feet thick. The reflection of the sonar signal from the bottom of the ice made it impossible to detect the reflection from the ocean bottom. The sonar transducer was then moved off the edge of the island and placed in a hole cut through the ice. In this case the sonar worked, but the graphic recorder used to measure depth as a function of time did not. Because of this difficulty with the recorder, and since it required a great deal of effort to keep the transducer suspended in water, the sonar measurements were abandoned for the rest of the summer.

In addition to the routine seismic program, it was planned to do some shooting on the ocean bottom, and also to lower a geophone to the bottom to serve as a reference point in measuring island drift. Mechanical difficulties with the winch kept both of these things from being done.

Gravity Program

The program of gravity measurements during the 1959 summer season was expanded by the use of a Worden gravimeter in addition to the North American meter which has been on the island for several years. No base ties were made with the North American meter. Instead, ties were made with the Worden, which is not as susceptible to shocks as the North American. Ties were obtained three times: in early April, from Thule, Greenland to T-3; in early May, from T-3 to Thule and back to T-3; and in late September, from T-3 to Point Barrow, Alaska.

A comparison of the Worden and North American drift rates is informative. If both instruments are operating properly, with a linear drift rate, then the difference between the two sets of readings should increase linearly with time. From April 11 to June 3, the difference follows a linear trend, but with random departures of up to ten milligals from a linear drift rate. On June 3, the relays controlling the temperature of the North American meter were changed, following which there was a sudden 19.5 milligal rise in the difference. For the rest of the summer, the difference was very linear, with deviations averaging less than half a milligal except for the period from July 4th to July 11th. During this week, the difference decreased by 3.25 milligals then recovered 2.45 milligals of this difference. This drift curve shows how the use of the two meters can eliminate many of the errors which would go unnoticed with one meter alone.

The main purpose in using a second meter was not to check the drift curve of the North American, but for use in measuring gravity at other locations on the island outside of the main camp. During April and May, gravity meter readings were taken at a grid of stations extending from the main camp to the 1952 camp. After early June, travel away from camp was not practical, so the gravity station grid was reduced in dimensions to the length of the runway and the distance from the main camp to the seismic instrument shelter. From April 23rd to August 1st, gravity observations were made over the net of stations 58 times. When the island reached open water in August, the vibrations along the edge of the island were large enough to make reading the Worden meter impossible.

Magnetic Program

A three-component magnetic variagraph with photographic recording was borrowed from the U. S. Coast and Geodetic Survey and taken to T-3 in April, 1959. The instrument measured the vertical and horizontal components of magnetic field intensity and declination. A dip circle and proton magnetometer were used to determine absolute values for the magnetic field.

A non-magnetic shelter was built for the variagraph a few hundred feet from camp. The instrument was placed in operation in May. In July, the shelter was blown over during a storm. When attempts were made to place the instrument in operation again, it was found that the temperature regulator had been damaged.

Electrical Methods Program

No further long-spread resistivity measurements were made on T-3 during 1959. A small amount of electromagnetic work was done, primarily to check the

accuracy of the work done in 1958.

The data from electromagnetic measurements made along a profile across the center of the island in 1958 have been reduced. At its thickest point along this profile the island is 190 feet thick. There are irregularities with as much as thirty feet relief on the bottom of the island.

Further Work

Plans for the future include calculation of ocean depths and other parameters from the seismic records obtained during 1959; reduction of the gravity data, with calculations of horizontal and vertical gradients; and compilation of the other data which have been obtained at T-3.