Brown in Greenland are not known. It is implied, however, that north of the Arctic Brown, Polar Desert soils should be encountered.[6]

Acknowledgement

The author thanks Professor A. L. Washburn of Yale University for giving him the opportunity to take part in his Greenland project.[7]

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ICE DRILLING IN FLETCHER'S ICE ISLAND (T-3) WITH A PORTABLE MECHANICAL DRILL

A scientific station (T-3) has been maintained on Fletcher's Ice Island by the Arctic Research Laboratory of the University of Alaska since 1961. In April 1964 it was located at 80°30′N. 140°20′W., close to the centre of the Canadian Basin. The apparent permanence of the ice island in both location and size (it is about 7 mi. long, 4 mi. wide and 100 ft. thick) makes it an ideal site for long-term underwater acoustic studies of ambient noise and transmission characteristics.

For all-year use of the station for such tests, however, it is desirable to install permanent hydrophones and seismometers, both in and below the ice of the island. To determine the feasibility of drilling through the island in a convenient manner to make such installations and to measure the thickness, temperature, and salinity of the ice, test holes were drilled by engineers from GM Defense Research Laboratories, General Motors Corporation, in April 1964.

The device used for the tests was a mechanical drill, model V-100, manufactured by the Houston Tool Company of Santa Susana, California (Fig. 1). The 700-lb., wheel-mounted drill is powered by two 6-hp., 4-cycle gasoline engines. One engine drives a rotary table, using a step-down gear and 2-speed transmission, which in turn rotates a kelly attached to a hollow drill string. Two- and three-cutter carbide-tipped bits with outer diameters of 3 in. were used. The second engine powers an airpump that can be connected either to blow air into (pressure mode) or suck air out of (vacuum mode) the hollow drill bit and drill string.

In the vacuum mode the ice cuttings travel through the drill pipe and are deposited in four separate vacuum chambers. During drilling these chambers have to be emptied periodically. One of the chambers provides cutting samples if they are desired. In the pressure mode the cuttings are forced up through the annulus of the hole to the surface where they are shovelled away by hand.

It was found quickly that the vacuum mode was not satisfactory in the cold ice of the island. The maximum drilling rate was only 0.5 ft./min. in the cold uppermost layers of T-3. Even more discouraging was the rate at which the vacuum tanks became plugged with the ice cuttings, which were of the consistency of very fine snow and caused the pump to lose suction and the hollow drill bit to plug with ice. No way was found

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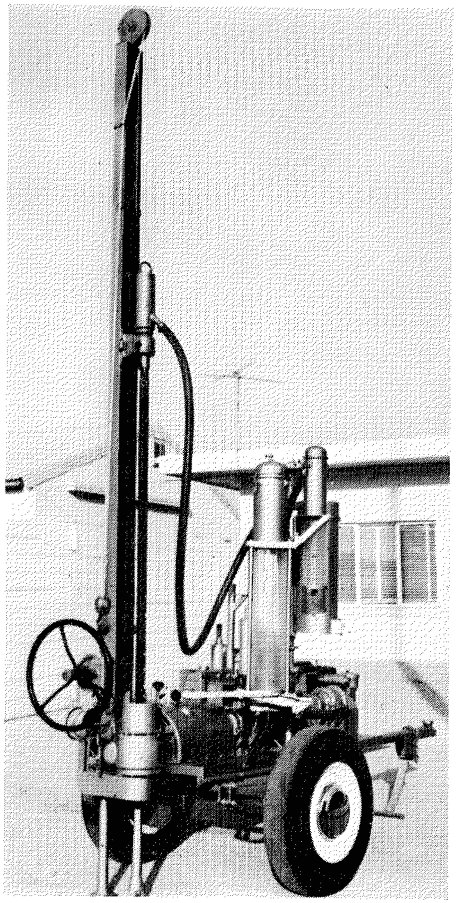

Fig. 1. Houston Model V-100 drill.

to clear the drill bit without removing the string — an arduous procedure in the prevailing —30° to —50°F. temperatures.

The drill operated satisfactorily in the pressure mode however, attaining a rate of about 2 ft./min. in the cold top-ice and greater in the warmer ice below. (The 2-ft./min. rate is the actual drilling rate and does not allow for the dead time for withdrawing the kelly and inserting a new drill pipe joint. If this time is included, the average drill rate was about 1 ft./min.).

In all, eight holes were drilled. Considerable difficulties were encountered, which were attributed to the inexperienced crew and the effects of the cold weather on the machinery. During the operation, for example, one engine suffered a broken starter, the coupling between the other engine and the transmission sheared, ice formed repeatedly in the carburator of one engine, requiring it to be shut down and warmed periodically, and a bearing in the kelly hoist froze and had to be broken to free it. All these malfunctions, which are attributable directly or indirectly to the cold, were repaired on the ice and caused only short delays. Many troubles could have been prevented had a spare engine been available.

The eight holes were drilled at the present camp site on T-3. All were between 663 and 760 ft. from the edge of Colby Bay. The ice thickness was found to be a uniform 99 ft. with a snow cover 2 to 4 ft. thick in the camp area. The top of the ice at the drilling site was found to be about the same as the average of the remainder of the island (i.e., it was neither on one of the low hills, nor in one of the valleys on the island).

In 1960 the thickness of the island was measured by Muguruma and Higuchi[1], who reported it to be 113.8 ft. at a point 1476 ft. inland from the edge of Colby Bay. These investigators made their measurements by hand-drilling through the island with a SIPRE core auger. Crary[2] in 1954 measured the thickness using seismic techniques; he found the island to be 148 ft. thick at a point about 11,500 ft. from the hole drilled by Muguruma and Higuchi and "4 or 5 meters" above it. If their assumptions are correct, the thickness in 1954 at the site of their hole would have been 132 to 135 ft. The rate of decrease in thickness between 1954 and 1960 would therefore be about 3.3 ft./year and between 1960 and 1964 about 3.8 ft./year, assuming the thickness at the site of my holes was the same as theirs in 1960. An observation of the surface indicated that the two sites have about the same altitude.

In ref. 1 the finding of a "heavy dirt layer" at a depth of 27.5 ft. is reported. I too struck a dirt layer (at 26 ft.) but in only one hole, although all 8 holes were in a rectangular area 100 by 15 ft. (with the shorter edge parallel to the shore of Colby Bay). No analysis has been made of the few cubic centimetres of dirt collected. It would be interesting to analyze and compare this sample with that reported in ref. 1. If any reader should wish to do this I should be happy to forward the sample.

Ice samples from one hole were collected and later analyzed for chlorinity by Dr. Robert Paquette, who used the Mohr titration method with the results given in Fig. 2. Error at the 95-per cent probability level is about ± 2 p.p.m. Fig. 2 shows an increase in chlorinity between 77 and 82 ft.; this is similar to the results found in ref. 1. The maximum concentration that I found (12 p.p.m.) was considerably less than that reported in ref. 1 (50 p.p.m.).

In another hole a 7-element thermistor chain was installed and ice temperature readings were made twice daily during April 1 to 12, 1964. The results are given in Fig. 2. Surface temperatures during the period were made with a calibrated alcohol thermometer, installed 6 ft. above the ice surface. Air and snow temperatures

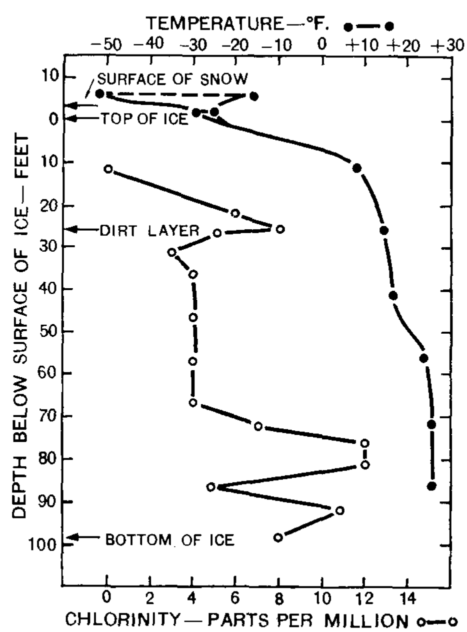

Fig. 2. Chlorinity.

varied as shown in Fig 2. Readings from thermistors in the ice did not vary. The accuracy of the temperature readings in Fig. 2 is ± 0.5°F.

An attempt was made to keep one of the holes free of ice by replacing the sea water by diesel fuel. Since this has approximately the same density as the relatively pure glacial ice of the island, the oil filled the hole to within a few inches from the top. (Actually more oil than needed to fill the 3-in hole completely was poured in to make sure that all sea water would be expelled.) The hole did remain "open" for about one day. Then a plug of ice about 2 ft. thick formed at the bottom and there was no way to break through it. It is believed that the oil seeped out through small fissures in the new ice at the bottom of the island and was replaced by sea water, which in contact with the cold oil froze solid. This plug could have been melted easily with a simple electrical heat drill in a matter of minutes. This technique may be a practical means of keeping a hole through the island available for use when desired.

It was also found that a quarter-inch hydrophone cable, well greased with silicone grease, could be raised and lowered for about 5 hours before freezing solid in the hole. The hydrophone was weighted with 5 lbs of lead. Air temperature was −35°F.

Some applications make it desirable to position instruments precisely at the ice bottom. To determine how accurately this could be done with the Houston drill, "logging" equipment designed to measure the inclination angle from vertical at selected depths in oil well holes was used. It was found possible to come out at the bottom within 1.5 ft. of the vertical from the top of the hole if care was taken to drill slowly and keep the kelly hoist vertical during the first 15 to 20 ft. of drilling.

Immediately after drilling a hole the sea water rose to about 8 ft. from the top of the ice. Slush ice formed at the top of the water column almost immediately but did not impede the withdrawal of the drill string, which took about 20 minutes. To lower hydrophones and other instruments it was necessary first to break the ice by hand with a 15-ft. section of drill rod and then pour 5 to 10 gal. of diesel oil into the hole, mixing it well with the slush.

It is concluded that the Model V-100 Houston drill offers a satisfactory means of drilling in cold ice to depths of at least 100 ft. when used in its "pressure mode". A single hole can be drilled in about 3 hours with a two-man crew, but at that rate it is exhausting work. A considerable improvement could be gained by housing the drill in a heated wanigan. With this arrangement and relief crews and without mechanical breakdowns, it is estimated that as many as five or six holes could be drilled through ice island T-3 per day.

The author wishes to acknowledge the excellent support services of the Arctic Research Laboratory in making this test possible. The other members of the drilling crew were Donald M. Johnson and Charles R. Greene, both of the GM Defense Research Laboratories, General Motors Corporation. The test was conducted under contract Nonr 4322(00) with the Office of Naval Research.

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Correction

The author of the paper "General ecology and vascular plants of the Hazen Camp area", which appeared in *Arctic* 17:237-58, wishes to point out that through an oversight caused by altered publication arrangements, an acknowledgement to the Defence Research Board of Canada and particularly to Dr. G. Hattersley-Smith was omitted. Their generosity in allowing the facilities at Hazen Camp to be used is greatly appreciated.

NOTES ON THE SCIENTIFIC RESULTS OF THE UNIVERSITY OF OTTAWA EXPEDITION TO SOMERSET ISLAND, 1964

The general aim of the expedition was to study the geology and geomorphology of northern Somerset Island[1], with a view to extending work into other parts of the Precambrian highlands in later field seasons.

The expedition arrived at Somerset Island on 11 June 1964 and left on 14 August. A rapid examination by helicopter of the north coast between Aston Bay and Prince Leopold Island provided valuable data on local topography, surficial and solid geological formations and eskimo sites.

Geology of the Aston and Hunting formations

These strata were first mapped during "Operation Franklin" and a Proterozoic age was presumed. Blackadar[2] later carried out further examination, noting the large numbers of gabbro dykes and sills and the difficulties encountered in distinguishing between the gneisses of the Archaean and the overlying quartzites of the Aston formation.

Sections in the two formations were studied in detail and the entire outcrop area on the southern flank of Aston Bay was covered. The Aston formation is a generally coarse red sequence of quartzitic sandstones and grits. Cross-stratification together with other sedimentary features, was studied where possible. Stromatolites of a columnar type are locally common.

A covered interval of 100 feet between the Aston and the Hunting formations appears to be occupied by argillaceous rocks.

The Hunting formation comprises a sequence of 3,000 feet of limestones and dolomites with very minor intercalations of shale. The limestones show many features of shallow water deposition and algal activity. Detailed studies of these rocks will be continued, with special attention given to their mode of origin.