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JT 2 - The Arctic Institute
Greenland Expedition, 1958

Expedition Ship RUNDØY
c/o Landshovdingens Kontor
Godthaab, Greenland
2 July 1958

Mr. Walter S. Rogers
Institute of Current World Affairs
522 Fifth Avenue
New York 36, N.Y.

Dear Mr. Rogers:

This present expedition, properly the Arctic Institute Greenland Expedition 1958, is the result of work begun four years ago, and carried through by the same nucleus of scientific personnel.

The first work was done as a sideline on the BLUE DOLPHIN Labrador Expedition, 1954, one of a series of BLUE DOLPHIN oceanographic expeditions in the Labrador area carried out under the auspices of the Arctic Institute of North America with funds provided by the Office of Naval Research. Leader of these expeditions is CDR David C. Nutt, oceanographer and Associate Professor of Geography at Dartmouth College. With him were Dr. P. F. Scholander, who is now leaving the Institute of Zoophysiology at the University of Oslo to join Scripps Oceanographic Institute, and Lawrence Coachman, presently doing studies for a Ph.D. in Oceanography at the University of Washington. All three are members of the present expedition; CDR Nutt in charge of plans and operations, Dr. Scholander as scientific leader.

On the 1954 expedition, samples were taken from six different icebergs along the Labrador coast, icebergs almost positively of Greenland origin. In temperate glaciers, melt water percolating through the snow in summer and freezing deeper down should cause an oxygen enrichment of the entrapped gases, as the gases dissolved in water which is equilibrated with air at 0° C contains 34.9 percent oxygen, while air itself has only 20.9 percent oxygen. However, in the interior of Greenland, where the temperature remains below freezing all year, this oxygen enrichment should not occur, and the entrapped gases should be purely atmospheric.

While all the iceberg samples (a total of thirty from the six bergs) showed an oxygen content close to that of the atmosphere, two of the icebergs gave a consistently lower percentage of oxygen, from 20.0 percent to 20.4 percent. This gave rise to the speculation that this ice might have been formed as long ago as the Pleistocene ice age, when the photosynthetic activity of green plants may have been curbed by cold climate, resulting in a slightly lower percentage of oxygen in the air.

This, then, raised the question of possibly determining the composition of ancient atmosphere through the study of the gases entrapped in high polar ice. The immediate problems were the determination of the diffusibility of gases through ice, and more accurate methods for the extraction and analysis of these gases.

This initial probe into gas inclusions in glacier ice was followed up the next year, with Coachman going to Norway and working with Dr. Scholander and others at the Institute of Zoophysiology atthe University of Oslo. Equipment was developed for the cold extraction of the gases, by grinding ice samples under vacuum, the gases then being analyzed in a $\frac{1}{2}$ cc gas analyzer developed by Dr. Scholander. This method was applied to a local Norwegian glacier of the temperate type. In the

summer of 1956 Coachman went to the Thule area in Greenland, obtaining ice samples which were then taken back to Oslo and analyzed. The entrapped gases approximated atmospheric composition, but the percentage of carbon dioxide was always at least double that found in air. This high CO_2 content, however, presented the possibility of collecting enough carbon dioxide for radiocarbon age dating of the gas.

At the same time diffusion tests were made by E. Hemmingsen at the Institute of Zoophysiology, and it was found that cold ice is nearly as impervious as glass to gas diffusion, and therefore an excellent preservative of the gases originally entrapped in it as long as it remains cold, i.e. below -2° C.

The next step was the development of equipment for the extraction of large quantities of gas from ice (or more properly, the extraction of gas from large quantities of ice) to obtain the requisite amount of carbon dioxide for radiocarbon dating. The system developed consisted of melting the ice under vaccum, pumping off the liberated gas, and collecting the carbon from the CO_2 by chemical means.

In the spring of 1957 this equipment was taken to the Storbreen Glacier in the Jotunheimen district of Norway, and a sample was run on the terminal ice of the glacier. Over a period of six weeks some five tons of ice were melted, which provided about 0.3 grams of carbon. The dating was done by Dr. De Vries at the University of Groningen, Holland, and gave an age of 710 years, plus or minus 120 years. This figure agreed with glaciological age determination of this glacier, thus indicating the accuracy and applicability of this new technique.

Analysis of the gas, however, showed the composition to be other than atmospheric, indicating contamination by melt water during the firnification process - which was expected in the temperate-type glacier. The next step, then, became the application of this method to high polar ice. If ancient atmosphere were found there, the radiocarbon dating combined with the gas analysis would provide information about the atmospheric composition at a determined period in the past, information which would be of great value in the study of climatic change.

These three years work, then, provided the genesis and impetus for the current Arctic Institute Greenland Expedition. Through the efforts of Dr. Scholander and CDR Nutt the requisite financial backing was finally obtained, plus the whole-hearted personal backing of such men as Dr. H. Wilson Ahlmann, and a carte-blanche from the Danish Government to carry out work in Greenland. The whole process, however, particularly the securing of funds, was nowhere nearly as simple as this sounds.

The equipment being used is essentially the same as that used on the Storbreen Glacier, though on a larger scale. Nearly all of the expedition personnel have been connected with the work over the past one to three years. Fortunately included among these is a Danish Physicist, W. Dansgaard, whose oxygen isotope analyses, it is hoped, will provide information as to the altitude at which the ice was formed. The biggest variable is the ice and the gases in it. What the final results will be is not yet known; this is the first systematic attempt of this nature on high polar ice. The problems are manifold, and the hoped-for, or expected, may or may not materialize.

Very sincerely,

John Tuck Jr.