AN OBSERVATION OF "BALL ICE"

A PECULIAR type of ice formation of which no description has been found in the more easily accessible literature was observed in Antarctic waters (66° S., 152° E.) on 25 February 1948 during the cruise of the *Wyatt Earp* of the Australian National Antarctic Research Expedition. The temperature of the water surface was 29° F. (−1·7° C.), that of the air 25° F. (−3·9° C.), wind Beaufort 2. As shown in the photograph (Fig. 5, p. 316) numerous spheres of a diameter of one to two inches (2·5 to 5·0 cm.) were found floating in the sea. The balls were very soft and spongy; no internal structure could be clearly distinguished. They were generally arranged in "streams" in the same way as the slush that was simultaneously forming in many places.

The ball ice may possibly have originated from the coalescence of frazil ice particles and their subsequent rounding off by wave action and collision with other particles. Or they may be remnants of small pancakes worn down by the same process. This explanation is suggested by the association of the balls with slush and incipient pancake ice, but it appears nevertheless unlikely because no transition between the flat pancakes and the balls was observed. Another explanation is that snowflakes, which fell into the water, did not melt but were able to continue floating at the surface. The movement of the water brought them into contact with each other so that they stuck together, the agglomerate becoming rounded by water movements and the impact of other solid particles. This second explanation becomes more likely as snowflakes had actually been falling for some time before the observation. It would be interesting to know whether similar "ball ice" has been observed elsewhere and whether a more likely theory of its formation can be suggested.

FRITZ LOEWE (Melbourne University, Australia)

REVIEWS

THE COAST OF NORTHEAST GREENLAND. LOUISE A. BOYD. New York: American Geographical Society, Special Publication No. 30, 1948. Section on Studies in Glacial Geology and Geomorphology (1937) by Richard F. Flint, p. 91–210.

THE 1937 and 1938 expeditions of Miss Louise A. Boyd carried a group of scientists to the northeast coast of Greenland, with brief stops at Jan Mayen and Spitsbergen. Professor R. F. Flint of Yale University accompanied the 1937 expedition as geologist; Dr. A. Lincoln Washburn, now Director of the Arctic Institute of North America, was assistant geologist.

Publication of the results of these expeditions, withheld during the war years, forms a significant contribution to the knowledge of Greenland and complements the reports of Miss Boyd's two earlier expeditions.* Geologists and geographers alike will find that the present volume with its excellent illustrations and maps will add greatly to their fund of information on this relatively inaccessible region.

As geologist for the 1937 expedition, Professor Flint was primarily concerned with four objectives: (1) erosion and deposition by existing glaciers and their more extensive predecessors, (2) rate and character of deglaciation within the recent geologic past, (3) crustal uplift and changes of sea-level as related to deglaciation, and (4) major and minor geomorphic features of the fiord region.

* Fiords of East Greenland. *Geographical Review*, Vol. 22, 1932, p. 529–61. The Fiord Region of East Greenland. *American Geographical Society, Special Publication* No. 18, 1935.

His report, written in 1938 and comprising the section under review, occupies more than a third of the volume. Unfortunately, results of investigations made in this part of Greenland during the period 1938–48 have not been correlated with the present study.

Time permitted little more than brief reconnaissance studies of terminal portions of several glaciers and the adjacent terrain in Greenland and Sørbreen (South Glacier) on Jan Mayen. Excellent descriptions and illustrations of glaciers will form the basis for future comparative studies of glacier fluctuations. Again and again descriptions bring home to the reader the fact that glaciers, while fundamentally similar, are individually unique in their expression of common processes. Many interesting minor features are described, such as the "dike ridges" of fine sandy, silty debris on Sørbreen, Jan Mayen, and Skillegletscher (Skille Glacier, shown as Vintergata on the Norwegian map of 1937) on Clavering Ø, East Greenland, squeezed up along transverse fissures from subglacial positions. These are inferred indications of the thinness of the glacial ice. Material from the dike ridge of Skillegletscher, 2½ miles (4 km.) up valley from the ice terminus, contained an identifiable modern plant assemblage indicating an arctic climate similar to the present. The inference is that the flora represents a deposit formed previous to a readvance of the glacier, which may have occurred about two centuries ago.

On the basis of composite valley forms, Professor Flint tentatively and cautiously suggests that there is evidence in north-east Greenland for two major glaciations. Such geomorphic evidence indicates that they were separated by a long period of deglaciation, and are referable to "a part of Pleistocene time earlier than the relatively recent readvances recorded by certain deposits." More recent fluctuations consist of: (1) deglaciation with retreat from the maximum position indicated by the outermost moraines (probably the so-called postglacial maximum), (2) a recent advance, possibly reaching a maximum near the middle of the nineteenth century, and (3) a conspicuous glacial deterioration, still in progress (see recent summary by Ahlmann *).

Although no systematic study of the emerged strandlines and related features was possible, critical points along the shorelines of the coastal belt were examined wherever it was possible to go ashore. However, because of the random character of the observations, definite conclusions as to the significance of these features are not drawn, but it is suggested that there is evidence for two water planes, probably marine, at 65 to 75 m. and at 30 to 35 m. above the present sea-level. "By analogy with other regions of deglaciation it is probable that in this part of Greenland deglaciation has resulted in upwarping of the crust towards the west, the center of the ice sheet, and also in a eustatic rise of sea-level. Also by analogy, it is likely that emergence brought about by crustal upwarping has been greater than submergence brought about by rise of sea-level, and that this is the chief cause of the presence of elevated postglacial marine features." A plea is entered for a detailed survey of the entire fiord region using accurate vertical control and uniform standards of comparison.

The last section of the paper is a brief discussion of numerous by-product observations on weathering and mass-wasting, solifluction, cryoconite, and eolian features. Of special interest is the description of solution rilling of carbonate pebbles and cobbles in areas of solifluction and the suggestion that solution rilling is occurring so rapidly that stones are nearly destroyed by solution before they can be conspicuously rotated by frost-heaving.

It is disappointing that conditions did not permit more critical analysis of the glacial processes, solifluction, and the many glaciological phenomena. This, however, is the price of exploration and reconnaissance studies the results of which must necessarily be in large measure restricted to a descriptive test.

LOUIS L. RAY (Washington, D.C.)

* Ahlmann, H. W:son. Glaciological Research on the North Atlantic Coasts. *Royal Geographical Society, Research Series*, No. 1, 1948, 83 pages.