The Disturbance of Arctic Lake Sediments by "Bottom Ice": A Hazard for Palynology

Bryson and Ragotzkie in 1964[1] made airborne observations of "mud-centre" tundra lakes in Manitoba. The mud flats (apparently not remanent "rotten ice") which occupied the middle of these arctic lakes in July had occasional rocks, sticks, bones, and caribou antlers on the surface. No firm conclusion was reached as to their origin. The present observations are believed to have some bearing on the problem.

The author spent most of June and July 1966 camped beside a small unnamed lake (about 100 metres long and 3 metres deep) approximately 15 kilometres north of Pelly Lake, close to the Arctic Circle (66°05′N., 101°04′W.). The lake was largely frozen on arrival in the area on 15 June and the surface ice had melted by 1 July. A week of almost continuous sunshine followed, with mean daily air temperatures of 16°C. and mean daily water temperatures in very shallow ponds (25 cm. deep) of up to 14°C. By contrast, the water of the lake next to the campsite remained close to freezing point, due no doubt to the presence of ice on the bottom of the lake, which could be perceived from the bank.

After the surface of the lake had been ice free for about a week, there occurred a disturbance of the lake waters and I was able to observe "bottom ice" floating to the surface in massive blocks several metres in length and at least one metre (estimated) in thickness. This ice was quite dark, being impregnated with sand and mud, and seemed to contain a large portion of the lake sediments. The floating ice melted in a few days, and then the water temperature rose rapidly. I suggest that this may be the origin of the phenomenon described by Bryson and Ragotzkie[1] as a "mud-centre" lake.

I had been exploring the area for fossil organic materials — particularly peat — for a palynological study of former climatic changes. I was therefore very concerned to note that the disturbance of the lacustrine sediments involved in the flotation of "bottom ice" would lead to a massive mixing of materials of different ages, making them stratigraphically valueless or misleading.

As the ice melted, the sediments fell to the bottom in random order. Winds blew the ice from one side of the lake to the other, while sediment "fall out" continued. As the melting proceeded, the wasted blocks sometimes became unstable and rolled over in the water, reversing the sedimentary sequence trapped in the ice. The moat of open water surrounding the ice experienced strong currents due to wind, which further mixed the unconsolidated materials.

On the basis of this evidence, it seems reasonable to suggest that shallow lakes in arctic or subarctic regions (and in high mountains) whose sediments are liable to disturbance by ice flotation should not be used for stratigraphic purposes such as pollen analysis. It is possible that such disruption of sedimentary superimposition might be recognized by apparently anomalous radiocarbon determinations of the age of lake deposits. Lakes which are now too deep to be completely frozen may in the past have undergone fluctuations of level or experienced more severe cold which allowed this factor to operate. While the central deposits of a deep lake basin may not be frozen, the shallow-water peripheral sediments of such a lake may be affected. The flotation of these marginal deposits by ice would expose them to redistribution over the lake by wind, before the ice melted. It is possible that an example of this phenomenon is represented in the photograph in the paper by Bryson and Ragotzkie[1] reproduced here by permission of the authors. In this picture, the large lake in the right middle distance has a festoon of dark floating ice around its margin. The lake in the foreground may owe its large "mud-centre" to more or less complete freezing and flotation of its sediments.

It must be borne in mind that during the Pleistocene glaciations, areas which now have a temperate climate experienced conditions similar to those of the present-day Arctic. One may therefore expect to encounter stratigraphic disturbance by ice in glacial and, in some areas, late-glacial lacustrine deposits.

[1] Bryson, R.A., and R. A. Ragotzkie. 1964. "Mud-center" tundra lakes. *Limnology and Oceanography*, 9:146-47.

FIG. 1. "Mud-centre" lakes located about 80 km. south of Churchill, Manitoba. Oblique photograph taken from about 30 m. altitude; reproduced by permission of R. A. Bryson and R. A. Ragotzkie.

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