BATHYMETRY AND GLACIOLOGY OF CENTRAL PORTION OF ARCTIC OCEAN

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BATHYMETRY

Until quite recently it was believed that the entire central portion of the Arctic Ocean consisted of a huge depression, with depths of more than 4,000 metres (Fig. 1; Bathymetric chart of 1940). Numerous soundings carried out in the Central Arctic by expeditions in late years have shown that the bottom structure of the Arctic basin is actually extremely complex. In 1948 the existence was discovered of an extensive range of submarine mountains extending from the islands of New Siberia to the North Pole, and beyond towards Greenland and Ellsmere Land. During the years that followed, this mountain range was explored in detail by scientific expeditions, and was named after V. Lomonossov, the great Russian scientist who devoted a considerable part of his life to research into natural conditions in the Arctic Ocean. It is now known that the Lomonossov Chain rises from 2,500 to 3,000 metres above the ocean-bottom, with steep slopes on either side. The minimum depth found on the crest was 954 metres, but the crest is usually under 1,100 to 1,200 metres of water (see Fig. 2: Bathymetric chart of 1954).

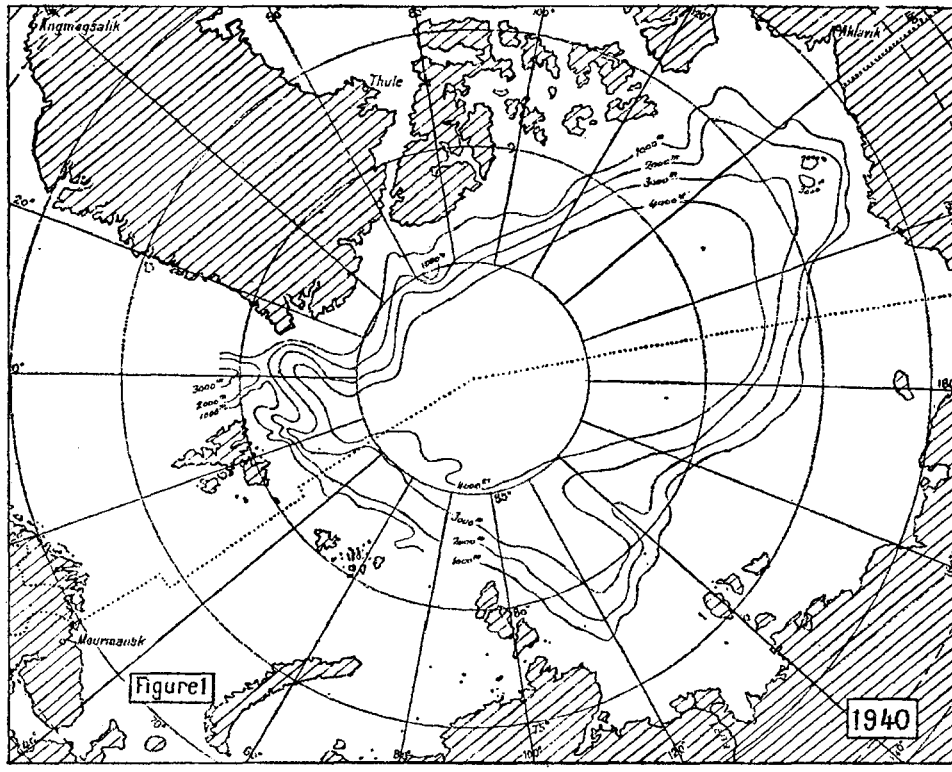
The Lomonossov Chain divides the Arctic Ocean into two more or less definite parts: the western or Atlantic part and the eastern or Pacific part.

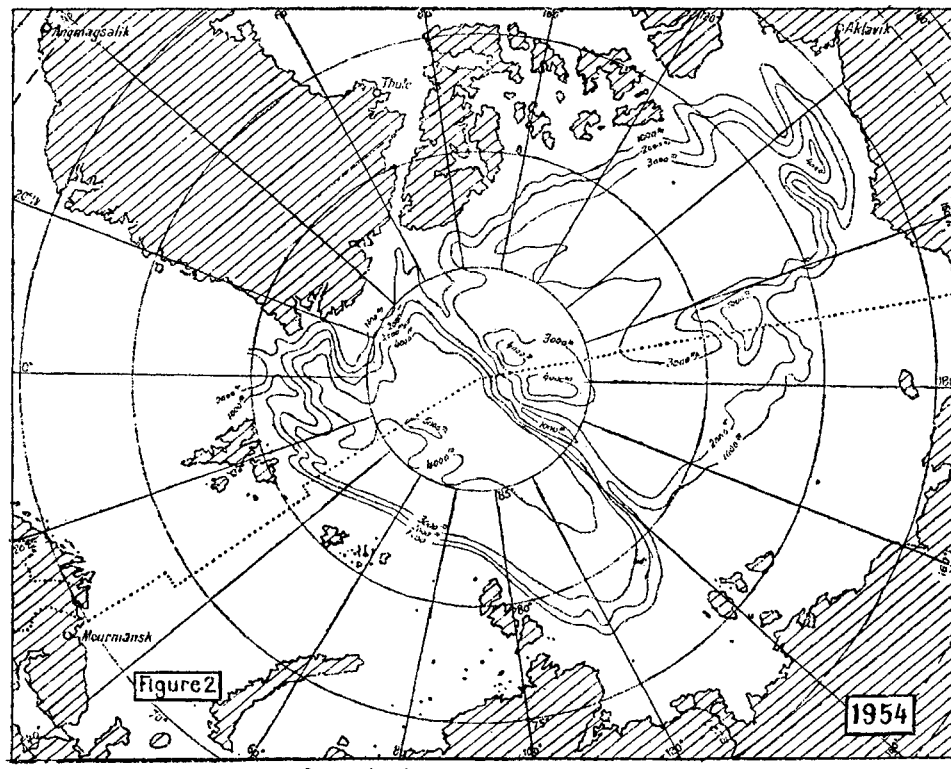
The temperature of the bottom layer of water is about — 0.8° in the Atlantic part, at the foot of the Lomonossov Chain, whereas on the other side of the Chain, in the Pacific part, the bottom-water temperature amounts to about — 0.4° C.

A thorough analysis of bottom samples taken during sounding operations showed that the sediments are of definitely different composition in the Atlantic and Pacific sections of the Arctic. The Pacific portion moreover contains new species of zooplankton which have not been encountered elsewhere in oceans the world over.

The chain of submarine mountains moreover has considerable influence on the distribution and movement of water masses, as well as on those of the ice covering the Arctic Ocean.

In addition to the Lomonossov Chain, other bottom irregularities have been discovered, including curious submarine crests, peninsulas and channels. The inaccuracy of the 5,400-metre depth obtained by Wilkins in 1927 with an echo-sounder, at the position 77° 46' N. by 175° W., has been definitely proved. Soundings have shown that in the neighbourhood of this position the depth of the ocean is only about 2,000 metres.





Carte bathymétrique de l'Océan Arctique

The results of the work carried out by the expeditions have enabled the plotting of a new bathymetric chart of the Arctic basin which reflects our present knowledge of the complex structure of the ocean-bottom in this area.

The discovery of the submarine chain of mountains connecting the Eurasian continent with North America has caused the revision by geologists of the history of the Arctic Ocean bed, and even of the entire geology of the Northern hemisphere.

GLACIOLOGY

Prior to the Soviet expeditions, only fragmentary information was available with regard to the central basin of the Arctic Ocean. Even up to very recently, many believed that the ice in the North Pole area was an almost compact block of paleocrystic, massive ice-fields.

Accurate exploration sucessfully carried out by airborne personnel has clearly shown that ice formations of various thicknesses are to be found in the Central Arctic, and that their degree of accumulation and age appear to vary according to zone. As a general rule, the thickness of the ice increases as one moves north. However, in the circumpolar regions, younger ice-zones of lesser thickness than in the areas farther south are occasionally found. Only in the areas adjacent to the Beaufort Sea does thick paleocrystic ice invariably prevail.

At certain points, extremely large ice formations are found known as « Ice-Islands ». These were spotted for the first time by an aviator, many years ago. The largest of these islands, which is approximately 30 km. in diameter, was located and inspected by aircraft in April 1948, in 82° 30' N. by 170° E.

The ice-islands may be several tens of metres thick. Their surface, which in general is relatively even, nevertheless shows very extensive rounded crests, and some may rise as much as 10 or 12 metres above the surrounding sea-ice.

Ice-islands are not often encountered; it is now known that they originate from the Canadian Arctic Archipelago (Ellesmere Land) and drift into the Central Arctic.

Large areas of smooth unbroken ice exist in the Central Arctic. Extensive zones of intensive dynamic activity are also found, in which the mass of ice is much broken up by compression and drift. Clefts and channels appear in the younger as well as older ice formations.

A fairly frequent occurrence is that of fissures splitting the ice-layer over huge distances without any change of direction and regardless of the thickness of the ice in the path of travel. Their development seems to be due to oscillations of the mass of water which holds up the ice. On the other hand, observation has shown that the disruption and drift of the ice largely depend on synoptic conditions, and increase upon the approach of meteorological disturbances.

A few laws regarding the drift of ice have been dicovered. As an example, it was once thought that the ice in all parts of the Central Arctic basin emptied into the Atlantic mainly through the passages between Greenland and Spitzbergen. Explorations during the past few years have shown that, from the Pacific section of the Central Arctic, only a small fraction of the ice is carried annually in this direction; the Central Arctic ice-mass slowly travels, over a period of many years, along a fairly complex, almost circular path. This rotation occurs

in a clockwise direction; in other words, the ice circulates in the manner of anticyclones.

It should be added that this type of circulation was suggested long ago, mainly by members of the Russian Arctic Expedition of 1900-1903. The direct observation of the movements of extensive ice-fields, icebergs and ice-islands for many years has now proved the actual existence of this phenomenon.

Such a circular route was followed, as a matter of fact, by the ice-field which carried Station « North Pole II ». In April 1951, when the station was evacuated, this block was located in 81° 45' N. by 162° 20' W. In April 1954, after drifting for three years over a long circular route, its position was 75° 04' N. by 170° 20' W.

This rotating movement in the Pacific section of the Central Arctic results in the prevalence of large formations of older ice in this zone. Old hummocks, evened down by the summer thaw over a number of years, give the ice-field surface the appearance of frozen waves: practically no steep-edged hummocks are found.

During the spring of 1954, the ice-field on which the « North Pole II » station had operated was re-examined in detail. An interesting point that should be noted is the fact that the tents which in April 1951 had been set up on the level field were now located on high ice pedestals, which owed their formation to the preservation of the old ice, since the tents protected the ice surface from the action of the sun's rays; whereas on the unsheltered surface, the ice thawed continuously. The overall thickness of the ice field was discovered to be about the same as in 1951.

Thus the Pacific portion of the Central Arctic contains old ice fields which describe closed curves, and are subject to continuous « rejuvenation » with practically no change in thickness. This shows that in these zones the thickness alone of the ice gives no indication of age.

The younger ice (two or three years old) in the Atlantic section of the Central Arctic, near the Laptev and Kara Seas, forms in these seas, and after drifting through the middle of the Ocean, empties into the Greenland Sea. The tracks followed by the floes do not remain constant.

The ice occasionally drifts away from the closed-circulation areas towards other zones, and may thus reach certain sectors of the North Sea route, where they seriously interfere with navigation.