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Physiography of the North Labrador Sea, Davis Strait and Southern Baffin Bay*

PETER A. JEZEK
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Introduction

The continental shelf of southwest Greenland contains large numbers of transverse channels thought to be formed by glacial action (Holtedahl, 1970). More recently the shelf and fjords off the eastern coast of Baffin Island from 67° to 72°N were described and the absence of transverse channels was postulated by Løken and Hodgson (1971).

Charts prepared by Heezen, et al. (1969) and Johnson, et al. (1969) show canyons on the slope of the north Labrador Sea and the well defined mid-ocean canyon farther south. On the basis of their charts these authors suggested that the mid-ocean canyon cannot be traced farther to the north due to lack of soundings in some regions and their poor quality in others (Fig. 1).

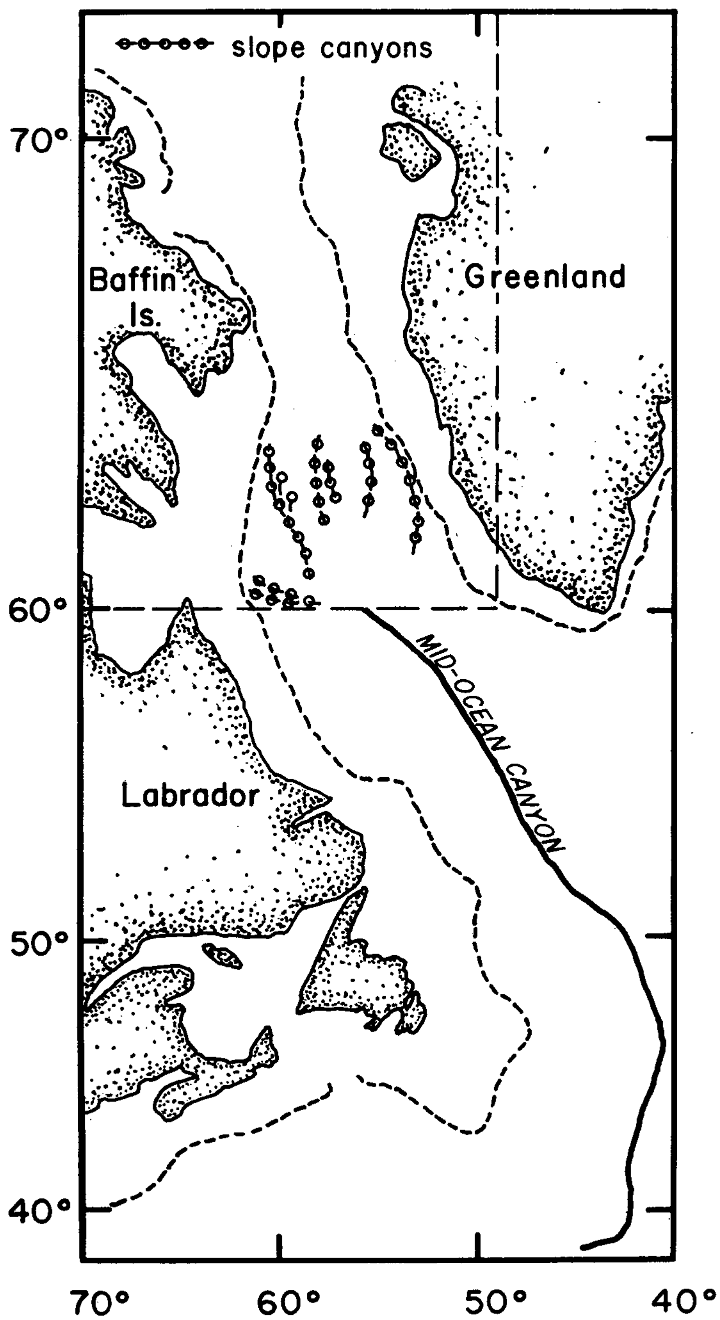

Figure 1 – Location chart of mid-ocean canyon, northwest Atlantic and the slope canyons of northern Labrador Sea (slope canyons shown by small circles; shelf break by short broken line; and map area of detailed study (Fig. 2) by long broken line.

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To clarify these points a new chart (between 69°W and 49°W longitude and 60°N and 72°N latitude) was compiled from original sounding data obtained from the Danish Hydrographic Service, Canadian Hydrographic Service, U.S. Naval Oceanographic Office, and the U.S. Coast Guard. The soundings were in metres corrected for the speed of sound in water (Matthews, 1939).

Physiographic Provinces

The region may be divided on the basis of morphology into three distinct areas: (1) Southern Baffin Bay, (2) Davis Strait, and (3) Northern Labrador Sea.

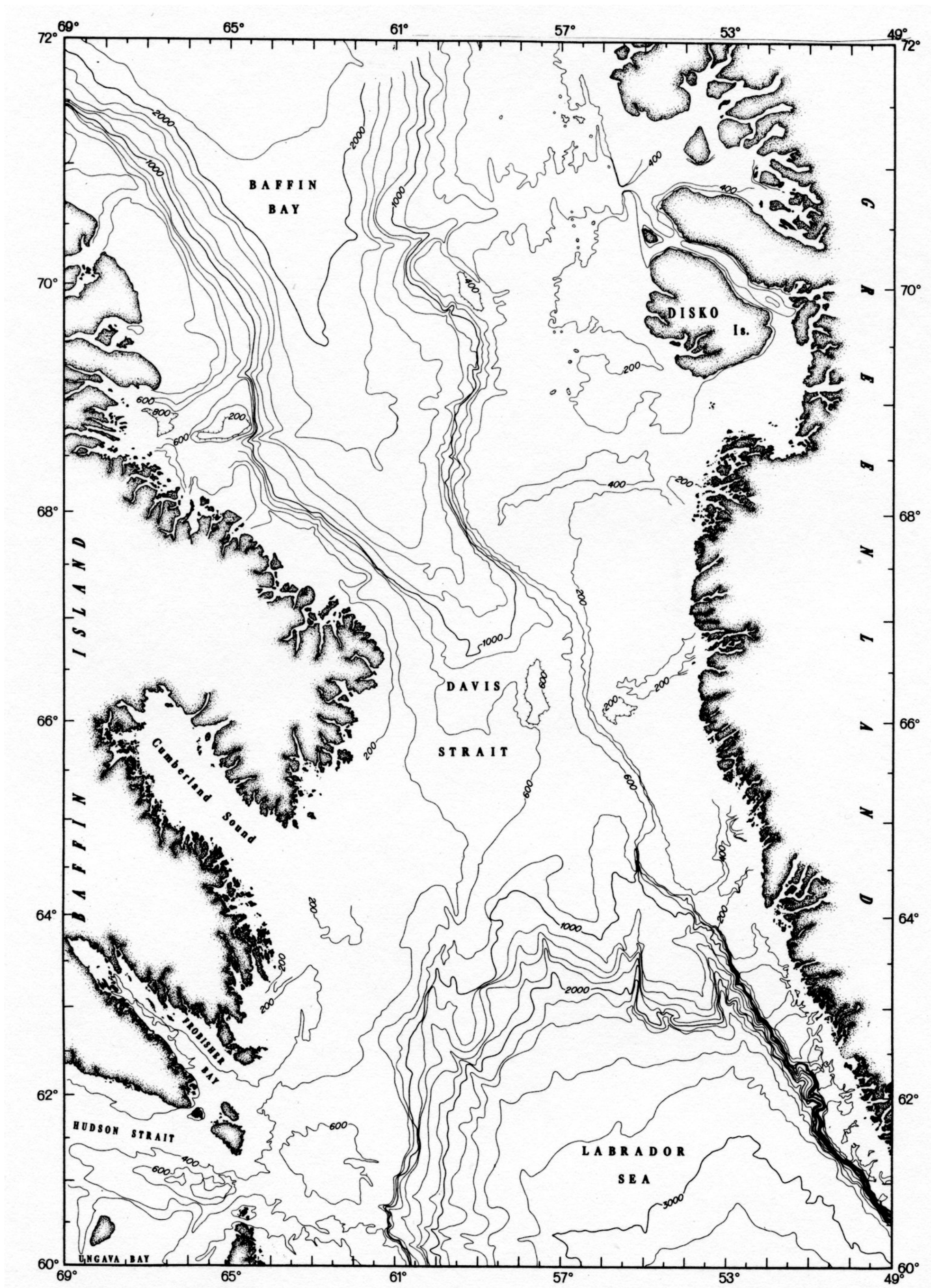

Figure 2 – Bathymetric chart of northern Labrador Sea, Davis Strait, and southern Baffin Bay; 200 metre contour interval. Depth in metres, corrected for speed of sound in sea water.

(1) Southern Baffin Bay:

Southern Baffin Bay (Fig. 2) to 72°N, is an open "V"-shaped valley trending in a north-northwest direction. The slope of the bottom after crossing the steeper southern section decreases first to 1:600 and then 1:1000.

The shelf on the Greenland side has a width of 500 km, and is cut by one major fjord outlet which extends to the main basin. This feature has a maximum depth of approximately 500 m. A valley trending in an east-west direction along 68°20'N latitude decreases in depth from 500 m in the centre to the depth of the shelf on both ends, and does not reach the main basin or fjord. The shelf's edge is about 400 m.

On the western side of Baffin Bay the width of the shelf is 130 km or less, with the shelf's edge being about 200 m deep. The Home Bay area and the Inugsuin Fjord are the major depressions present on the surface of the shelf (Løken and Hodgson, 1971).

The slope on the Greenland side is steeper in the southern section, where it has a gradient of 1:15, than in the northern section, where the gradient decreases to 1:70. On the western side of Baffin Bay the slope has a gradient of 1:25 and, at the depth of 1,000 m, grades into the rise.

(2) Davis Strait:

The Davis Strait divides Baffin Bay from the northern Labrador Sea and, thus, from the North Atlantic. The narrowest portion of the strait is found at about 66°N latitude with a width of 800 km and a depth of 650 m. The shelf and slope are well developed only along the eastern side of the strait. On the western side due to the greater depth of the shelf the slope is absent.

(3) Northern Labrador Sea:

The northern Labrador Sea is a "U"-shaped feature with its deepest part displaced toward Greenland. The Labrador Sea gradually deepens to the southeast at an average gradient of 1:240. The southern boundary can be placed at approximately 60° north latitude. The northern boundary is marked by Davis Strait with a maximum depth of approximately 650 m.

There is a marked difference in the width and shape of the shelf between the west Greenland side and the east coast of Canada (Fig. 2). The shelf on the western side of the north Labrador Sea is smooth and its width varies between 140 and 200 km. The shelf's edge in most places is at 400 m. The shelf's width on the east side varies from about 100 km in the southern part to about 290 km near Davis Strait. The shelf's edge is at a depth of 200 m. Between the latitudes 64°15'N and 65°N, however, the shelf's edge is deeper, being at a depth of 300 m. On this side the shelf is disrupted by many traverse channels which display the greatest depth in their central parts and become shallow toward the ends. These channels lie offshore from fjords and are believed to be glacial in origin (Holtedahl, 1970). The deepest channel with a 600-m depth at its central point is located at 64°40'N.

The continental slope off the west coast of Greenland is steep with a gradient of approximately 1:10. The base of the slope in the southern section is at the depth of 2,700 m and, in the northern section, at 600 m. On the western side, the continental slope is less pronounced except toward the south where it reaches a gradient of 1:25. The slope-rise boundary is at the depth of 1,800 m. Toward the north the slope decreases in gradient to 1:50.

The basin rise is well developed in the western and northern parts of the northern Labrador Sea where it has a slope of 1:100. In the eastern section the rise is poorly developed and where present it is irregular in form.

Between 61°30'W and 64°W and 60°20'N and 61°30'N is a shallow depression reaching a depth of approximately 700 m at its centre. This depression is separated on the western side from Hudson Strait by a sill about 450 m deep. On the eastern side the sill depth, dividing this depression from the basin of north Labrador Sea, reaches 550 m.

Numerous canyons are present on the slope of the northern Labrador Sea (Fig. 2). Following the trend of the base of the slope off Greenland is a marginal valley which can be traced for approximately 180 km. At the depth of 2,600 m it seems to fan out; and at greater depths it disappears.

A very narrow steep-sided canyon trends north-south along approximately the 55°W meridan and can be traced for about 210 km. At a depth of 2,500 m it probably dies out in a large sedimentary pool.

In the western part of the northern Labrador Sea at least four branching canyons can be seen, but they are hard to delineate precisely due to poor and, in many places, conflicting data (Figs. 2 and 3). If the mid-ocean canyon continued north from the 60°N latitude, it probably followed the western side of the north Labrador Sea, and connected with these canyons.

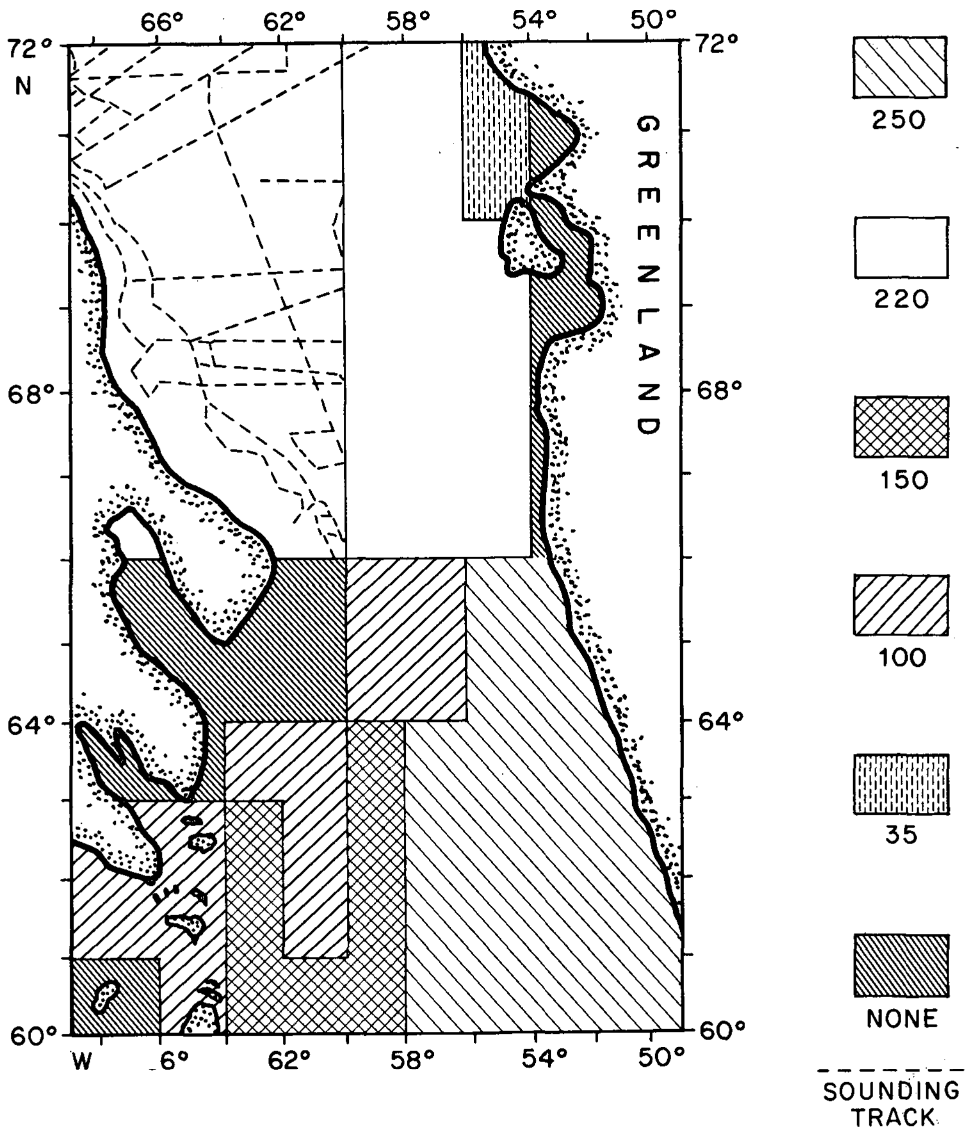

Figure 3 – Mapped area with the number of soundings per degree square.

The Mid-Ocean Canyon and its Possible Continuation North of Latitude 60°N

The northwest Atlantic mid-ocean canyon stretches in approximately a north-south direction for 3,200 km (Fig. 1). This canyon has been traced from the Labrador Sea to the Sohm Abyssal Plain where it appears to die out (Johnson, et al., 1969). The longitudinal gradient is steeper in the northern section between 60°N and 59°N latitude where it has a slope of 1:600. In the southern section between 50°N and 40°N latitude it flattens out to 1:2200. The floor of the canyon is up to 180 m below the banks. The western levee, on the average, is 20 m higher than the east one. The bottom of the canyon is also shallower on the western side than on the eastern side. This could be related to a possible deflection of the bottom currents by Coriolis Force. Many authors in the past have tried to define the head of the mid-ocean canyon (Heezen and Tharp, 1968; Heezen, et al., 1969). Based on present data there is no conclusive evidence for the continuation of the canyon north of latitude 60°N. The present chart (Fig. 2) and charts prepared by other writers (Heezen, et al., 1969; Johnson, et al., 1969) show a large number of canyons and deep valleys north of 61°N, but their connection with the well defined mid-ocean canyon farther south cannot be demonstrated. The canyon appears to have been formed during the Pleistocene at which time it is probable that large amounts of silt-clay loaded water were brought to the slope of northern Labrador Sea by glacial melt water and turbidity currents were formed. These currents cut the large number of tributary canyons and sea valleys. These valleys fused together in the southern direction and formed the mid-ocean canyon. At the end of the Pleistocene the supply of silt-loaded water was cut off and the canyons became inactive. Subsequently, sediments moved by bottom currents buried the lower parts of the canyons and valleys disconnecting them from the mid-ocean canyon.

Conclusions

The bottom topography of the described area was strongly modified during the Pleistocene. The shelves are distinctly deeper than the world average of 132 m (Shepard, 1963), and their width varies between 100 and 500 km. On the shelf off the west coast of Greenland the glaciers carved a large number of transverse channels. It appears that during the interglacial periods and after the last glaciation when the ice cover had partially or completely melted and the large volume of the water loaded with silt and clay deposited great amounts of sediment on or near the slope eventually leading to the development of turbidity currents which followed the hydrodynamically most desirable paths to the abyss of the north Labrador Sea and Baffin Bay, and thus formed the features now expressed in the form of fossil canyons and sea valleys. The mid-ocean canyon was probably the main artery toward the south for the vast volume of sediment-suspension delivered to the area between 60° and 61°N by the slope canyons and sea valleys of Labrador Sea. These slope canyons were then partially filled by the action of bottom currents moving sediments derived from the lower slope and upper rise.

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References cited

EWING, M., HEEZEN, B.C., ERICSON, D.B., NORTHRUP, J., and DORMAN, Jr., 1953, Exploration of the Northwest Atlantic mid-ocean canyon. Bull. Geol. Soc. Am., 64, pp. 865-868.

HEEZEN, B.C., and THARP, M., 1957, 1968, Physiographic diagram of the North Atlantic. Geol. Soc. Am., Boulder, Colorado.

____________, HOLLISTER, C.D., and RUDDIMAN, W.R., 1966, Shaping of the continental rise by deep geostrophic contour currents. Science, 152, pp. 501-508.

____________, JOHNSON, G.L., and HOLLISTER, C.D., 1969, The northwest Atlantic mid-ocean canyon. Can. Jour. Earth Sci. 6, pp. 1441-1453.

HOLTEDAHL, O., 1970, On the morphology of the west Greenland shelf with general remarks on the "marginal channel" problems. Marine Geol., 8, pp. 155-173.

JOHNSON, G.L., CLOSUIT, A.W., and PEW, J.A., 1969, Geologic and geophysical investigations in the northern Labrador Sea. Arctic, 22, pp. 56-68.

JONES, E.J.W., EWING, J., EWING, J.I., EITTREIN, S.L., 1970, Influences of Norwegian Sea overflow water on sedimentation in the northern North Atlantic and Labrador Sea. Jour. Geophys. Res., 75, pp. 1655-1680.

LØKEN, O.H., and HODGSON, D.A., 1971, On the submarine geomorphology along the east coast of Baffin Island. Can. Jour. Earth Sci., 8 (2), pp. 185-195.

MATTHEWS, D.J., 1939, Tables of the velocity of sound in pure water and sea water for use in echo-sounding and sound-ranging. Brit. Admiralty Hydrog. Dep. Publ. H.D. 282, 2nd edition.

RVACHEV, V.D., 1967, On the origin of the mid-ocean canyon in the North Atlantic (in Russian). Okeanologiya. A.N. USSR, 7, pp. 477-483.

SHEPARD, F.P., 1963, Submarine geology (2nd ed.) New York, Harper and Row.

____________, and DILL, R.F., 1966, Submarine canyons and other sea valleys. Rand McNally and Co., Chicago.