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Exceptionally Large Icebergs and Ice Islands in Eastern Canadian Waters: A Review of Sightings from 1900 to Present

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ABSTRACT. A review of post-1900 sightings of ice islands and exceptionally large icebergs in eastern Canadian waters between Baffin Bay and the Grand Banks demonstrates that current estimates of the maximum expected iceberg lengths are below many of the reported values. Analysis of these sightings reveals that for the area south of 55°N the frequency of sightings and the maximum reported lengths were greater during the first half of this century than during the period 1950-90. However, recent sightings in 1991 demonstrate that exceptionally large icebergs should still be considered when designing fixed offshore structures for the Grand Banks or Labrador Shelf.

Key words: icebergs, ice islands, Labrador Sea, Grand Banks, offshore oil

RÉSUMÉ. Une recension des observations postérieures à 1900 concernant les îles de glace et les icebergs de taille exceptionnelle dans les eaux canadiennes orientales situées entre la baie de Baffin et les Grands Bancs de Terre-Neuve révèle que les estimations courantes des longueurs maximales d'icebergs escomptées se situent en dessous de bien des valeurs rapportées. Une analyse de ces observations montre que pour la zone au sud du 55° N, la fréquence des observations et les longueurs maximales rapportées étaient plus grandes durant la première moitié de ce siècle que durant la période allant de 1950 à 1990. De récentes observations faites en 1991 révèlent cependant que la conception des structures fixes en mer sur les Grands Bancs ou sur le plateau continental du Labrador devrait toujours tenir compte des icebergs de taille exceptionnelle.

Mots clés : icebergs, îles de glace, mer du Labrador, Grands Bancs, pétrole exploité en mer

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INTRODUCTION

The icebergs and occasional ice islands that drift south along the coast of Labrador to the Grand Banks of Newfoundland have been monitored by the International Ice Patrol (IIP) since the sinking of the *Titanic* in 1912. The icebergs that follow this route are calved from glaciers in Greenland and northern Canada. These icebergs are carried south from Baffin Bay and Davis Strait by the Labrador Current, which flows southward along the coast of Labrador (Fig. 1). This southward drift is frequently retarded or terminated when the icebergs become grounded, frozen in landfast ice or swept into bays and straits. However, over the period 1913-87 an average of 395 icebergs per year drifted as far south as 48°N (Alfultis, 1987).

Ice islands are large low (generally under 5 m above sea level) pieces of floating ice that have broken away from an ice shelf. All the ice islands that reach eastern Canadian waters originate from the ice shelves found off the northern coast of Ellesmere Island and drift into Baffin Bay via Nares Strait. It is also possible that the ice islands that drift down the east coast of Greenland could find their way into Canadian waters, but no such cases have been documented. The existence of arctic ice islands was first made public in November 1950; however, the United States Air Force was aware of their existence for several years prior to this but kept this information secret (Koenig *et al.*, 1952). As a result, any ice islands sighted in the study area prior to November, 1950 would have most likely been described as large low icebergs.

The IIP, as a result of its mandate to protect the trans-Atlantic shipping lanes, has focused its surveillance program on the area south of 48°N. This reconnaissance program has allowed the IIP to develop an annual tabulation of the number of icebergs passing south of 48°N, which is the best documented index of iceberg severity available. This data base provides an excellent data source for investigating variations in iceberg flux; however, it provides only limited information on other variables, such as iceberg size. The recent interest in offshore oil exploration and production off the east coast of Canada has stimulated other aspects of iceberg research, such as attempts to document the mass and size distribution of icebergs. Unfortunately this research is limited by the relatively short period over which these data have been systematically collected.

Estimates of the largest iceberg that will occur in an area at a given probability level are critical for the design of fixed offshore structures, such as the oil production platform proposed for the Hibernia field on Grand Banks. The Environmental Impact Statement for the Hibernia development (Mobil Oil Canada Ltd., 1985) gives a mass of 10 million tonnes and a length of 320 m for the largest iceberg observed on the northern Grand Banks over the four years when measurements were carried out. An earlier study for the Labrador coast (Petro-Canada, 1982), based on data for 1973-79 gives a maximum observed mass of 25-30 million tonnes and a maximum length of 500-550 m.

In an attempt to shed light on the longer term variations in iceberg size, this paper makes use of a variety of historical and contemporary sources to examine the trends in iceberg size from 1900 to the present. These data sources utilized include observations from aircraft and ships and a small number from shore-based observers. These early sightings are then compared with the iceberg statistics utilized by the oil industry for the design of offshore structures.

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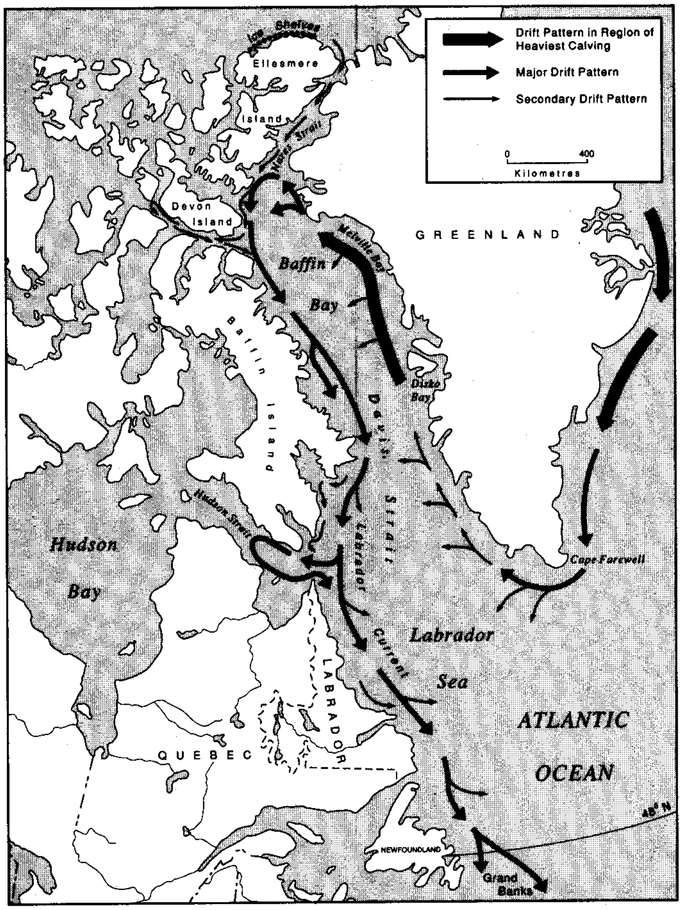

FIG. 1. Study region. Iceberg drift patterns based on United States Naval Oceanographic Office (1964).

DATA

The probability of sighting an exceptionally large iceberg has probably increased considerably since the introduction of regular aerial ice reconnaissance programs in the late 1940s. The value of ship reports, which were the main source of iceberg sightings prior to the introduction of aircraft, varies considerably and depends to a large extent on the existence of programs designed to collect iceberg data. For example, the data base for the Grand Banks region is considerably improved for the period after the introduction of the International Ice Patrol in 1913. The numerous expeditions that traveled the waters of the Labrador Sea, Hudson Strait and Baffin Bay during the first half of this century are another productive data source. In general, for the period prior to the introduction of aerial ice reconnaissance the best data base exists for the Grand Banks area, with less complete data sets for Baffin Bay and the Labrador coast. Due to these variations in the quality of these data sets, it is impossible to compare the frequency of sightings in different regions; however, it is possible to identify trends in the frequency of sightings within each region over time.

The factors that should be considered when carrying out analysis of long-term trends include a good sample of data points spread through the period of record, potential measurement errors in the data that are lower than the expected variations and elimination of systematic biases in the data set. When these criteria are applied to the various indices of iceberg size (mass, length, width, height and draft), only length offers a good potential for analysis. Both mass and draft are limited by the problems associated with obtaining reliable estimates from the types of data sources utilized in this study. Of the remaining dimensions, the number of observations containing height and width estimates is considerably lower than those for length. In addition, both of these dimensions are more difficult to estimate and therefore more prone to error than length. Recent experience with collecting iceberg data for the oil industry confirms that "length is the simplest and probably the most accurate dimension which can be measured for an iceberg" (Hotzel and Miller, 1983:122). In cases where height information is available, it is used to classify the sightings into one of three height categories (low, < 10 m; medium, 10-40 m; and high, > 40 m). This information is useful in estimating mass and in determining the risk to a fixed offshore structure from such an iceberg or ice island.

The definition of an exceptionally large iceberg used in this study was based on the values for maximum iceberg length given in the oil industry reports noted earlier. For the area north of 50° latitude it is any iceberg longer than 500 m, while south of this latitude it is any iceberg longer than 300 m. These values are near the upper limits cited by Mobil Oil (1985) and Petro-Canada (1982). By comparison, the largest categories used by the International Ice Patrol are very large non-tabular, which have a length greater than 213 m, and large tabular, which have a length greater than 213 m (Murray, 1968).

All observations given in miles are assumed to be in nautical miles (1.85 km) unless otherwise indicated. Undoubtedly, some of these observers could have used statute miles; however, since the majority of the observations originated from ships, the use of nautical miles was presumably more common. In cases where the observers did not use the metric measurement system, the metric values are given after the original value. This system was used since direct conversion would often convey a different degree of precision. For example, a reported length of 1.85 km could appear more reliable than a reported length of one mile.

SIGHTINGS IN STUDY AREA

Table 1 presents a summary of sightings of exceptionally large icebergs and ice islands in the study region, which includes the west side of Baffin Bay, Davis Strait, Hudson Strait, the coast of Labrador, the waters east of Newfoundland and the southern Grand Banks. The following discussion expands on a few of these reports and is intended to provide some indication of the data quality and reliability.

The first documented sighting during this century of an iceberg meeting the size criteria outlined previously was in 1911. During June of that year an iceberg more than two miles (> 3.7 km) long was reported off southern Labrador. It was reported that this iceberg remained stranded all season and rapidly diminished in size. This iceberg was photographed in July when it was ¾ mile (1.39 km) long by ¼ mile (0.46 km) wide and 60 feet (18.6 m) high (Amy, 1912). This photograph shows a tabular iceberg with sheer sides and a very level upper surface.

TABLE 1. Summary of sightings 1900-92

Year/Month	Lat. (N) Long. (W)	Length (km)	Ht.† (m)	Source
1991/7	48.8, 53.3	2.81	15	Rudkin (pers. comm. 1991)
1991/7	49.3, 53.1	0.91	76	Rudkin (pers. comm. 1991)
1978/5	48.9, 51.5	0.70	?	IIP (1978)
1976/5	49.3, 49.6	0.75	5	IIP (1976)
1976/6*	47.5, 49.1	0.65	Low	IIP (1976)
1975/5	81.0	2.00	Low	Dunbar (1978)
1974/7	54.6 55.5	0.57	61	MAREX (1974)
1967/7	82.5	1.60	?	Lindsay *et al.* (1968)
1964/6	57.2 60.5	6.50	Low	Nutt (1966)
1964/2	61.2 63.8	0.61	3	IIP (1964)
1964/4	50.4 52.5	0.46	12	IIP (1964)
1963/7	81.0	20.4	Low	Nutt (1966)
1960/9	70.5	9.30	Low	Dunbar (1962)
1959/5	42.8 49.5	0.30	84	IIP (1959)
1957/7	46.5 48.0	0.27	38	IIP (1957)
1955	75.0 60.0	1.40	24	Polar Times (1955)
1953/3	47.6 52.2	0.30	30	IIP (1953)
1953/5	48.2 51.9	0.59	74	IIP (1953)
1953/5	81.0	7.40	Low	Greenaway (1953)
1952/5	51.9 55.1	0.93	12	IIP (1952)
1952/6	49.4 53.7	0.30	43	IIP (1952)
1950/6	52.4 52.7	1.40	Low	IIP (1950)
1950/7	49.9 49.7	0.45	?	IIP (1950)
1950/9	52.6 51.1	0.93	?	IIP (1950)
1950/10	60.6 46.5	1.40	61	IIP (1950)
1950/9	74.5	3.70	11	Canada, DOT (1951)
1945/5	43.1 49.3	1.40	15	IIP (1945)
1943/4	49.3 48.0	0.46	60	IIP (1943)
1940/8	58.2	1.90	?	IIP (1940)
1940/9	70.7 67.8	9.30	14	IIP (1940)
1940/9*	70.7 67.8	4.30	14	IIP (1940)
1940/9	75.0 60.0	0.56	101	IIP (1940)
1938/7	64.6 59.0	0.92	?	IIP (1938)
1934/7	62.6 60.7	13.0	?	Hennessy (1935)
1933/7	54.7	1.85	?	Wyatt (1934)
1928/6	47.5 52.5	1.40	?	IIP (1928)
1928/7	62.5 70.5	1.40	18	McLean (1929)
1928/8	52.0	7.40	24	Smith (1931)
1928/6	52.0	12.0	30	Hennessy (1932)
1928/7	52.0	1.80	?	Hennessy (1932)
1914/7	55.0	0.90	46	Wilson (1975)
1911/6	53.0	3.70	18	Amy (1912)
1911/7*	53.0	1.40	18	Amy (1912)

*Indicates second sighting.
†In some cases an exact height is not given but the iceberg or ice island is referred to as low, medium or high; these cases are coded as such.

The number of sightings in the first two decades of this century is considerably lower than in the 1920s and 1930s. This may be a reflection of the ice research programs conducted in the latter decades. The United States Coast Guard (IIP) commenced ice patrols off the Grand Banks in 1914; however, it was not until the 1920s that the IIP started investigating ice conditions farther north. During the 1920s the Canadian government also commenced regular monitoring of ice conditions on the route to Hudson Strait to support shipping to the port of Churchill. These programs, combined with activity by explorers such as Captain R. Bartlett and Commander D. MacMillan, significantly increased the probability of detecting such icebergs or ice islands after 1920.

The number of sightings of exceptionally large icebergs reached a peak in 1928. In July of that year the Canadian Hudson Strait Expedition photographed an iceberg in the strait that was 60 feet (18.3 m) high and ¾ mile (1.39 km) long (McLean, 1929). In July of the same year four icebergs approximately one mile (1.85 km) long were reported at latitude 52°35′N (Marine Observer, 1929; Hennessy, 1932). In the same area another iceberg was reported as 100 feet (30.5 m) high and 6½ miles (12.3 km) in length (Marine Observer, 1929), and another reported in August was at least 4 miles (7.4 km) long and 80 feet (24.4 m) high, with peaks 100 feet (30.5 m) high (Smith, 1931). Reports of huge icebergs persisted until September of that year (Marine Observer, 1929; Hennessy, 1932). The most southerly report of this type of iceberg in 1928 was a ¾ mile (1.39 km) iceberg reported on the Grand Banks (IIP, 1928). Iceberg reports from the Grand Banks during this season also include many references to large low icebergs and unusual amounts of earth deposits on the icebergs (IIP, 1928). Hennessy (1932:77) describes the season as follows: "During the 1928 season ships steaming on the Belle Isle tracks reported many bergs of such dimensions as hitherto been thought to exist only in southern waters."

The largest iceberg identified was sighted in Davis Strait (62°53′N) in June 1934. It was described as a huge berg approximately 7 miles (12.95 km) in length, bordering an extensive ice field (Hennessy, 1935). While the reliability of a report such as this, which was obtained from a secondary source, can be questioned, there can be little doubt about the following report. In September 1940 an IIP cruise observed and mapped an "Antarctic type iceberg" 2.3 miles (4.26 km) long off the Baffin coast (70°45′N). This iceberg was 45 feet (13.7 m) high and was described as "actually a chain of flat-topped bergs which shortly before our arrival had apparently been one single berg 5 miles (9.25 km) or so in length" (Smith, 1940:18).

The most southerly sighting identified was made in 1959, when a U.S. Coast Guard ship tracked an iceberg 275 feet (83.9 m) high and 1000 feet (305 m) long near 42°50′N (IIP, 1959). This iceberg was grounded in water 164 m deep on the edge of the Grand Banks. The second most southerly sighting was a 4500 foot long, 3300 foot wide and 50 foot high (1373 m × 1007 m × 15 m) flat iceberg reported on the Grand Banks at 43.1°N in 1945 (IIP, 1945). When sighted, this iceberg was in open water several hundred kilometres south of the sea ice limit.

During the 1950s it became clear that ice islands could escape the Arctic Ocean by drifting south through Nares Strait or down the coast of East Greenland. The best documented drift of an ice island south of Nares Strait is the drift of WH-5 in 1963-64 (Nutt, 1966). After its breakup and escape from the Arctic Ocean in the fall of 1963, the fragments of WH-5 drifted south and reached the Labrador coast in the winter and spring of 1964. The largest fragment of the ice island sighted off Labrador was 1.5 × 3.5 miles (2.78 × 6.48 km). In 1964 fragments from the ice island WH-5 up to 2000 feet (610 m) long were reported on the Grand Banks (Nutt, 1966).

Several sightings of large icebergs were made during the mid-1970s. It is possible that the more extensive sea ice cover during these years increased the survival rate for this type of iceberg. During the summer of 1974 a tabular iceberg 515 m long and 61 m high (mass estimated at 30 million tonnes) was reported by a drill ship operating off Labrador (MAREX, 1974). This iceberg was presumably the maximum iceberg cited by Petro-Canada (1982) in its review of 1972-79 data. During the same year a number of other icebergs with similar heights and lengths ranging from 256 to 475 m were reported.

In May and June 1976 a very large tabular iceberg (750 m × 350 m) with a 4-5 m profile was sighted on the Grand Banks (Robe *et al.*, 1977). The possibility that this berg was an ice island was considered, but later evidence (Dunbar, 1978) indicates that it may have originated from the Petermann Glacier in northeast Greenland. From May to July 1978 an iceberg described as similar in size and shape to the one sighted in 1976 crossed the Grand Banks. This iceberg measured 700 m × 300 m when first sighted at 48°53′N (IIP, 1978). The IIP files give it an estimated height of 43 m.

The most recent reports identified are for July 1991. On 11 July a private ice reconnaissance flight measured a 2.8 km long, 1.0 km wide and 15 m high iceberg at 48°49.8′N, 53°21.9′W and a 0.91 km long, 0.4 km wide and 76 m high iceberg at 49°21.8′N, 53°06.4′W. In both cases the length was estimated to be accurate to within 100 m (P. Rudkin, pers. comm. 1991). The largest of these icebergs was sighted but not measured by another ship-based observer.

ANALYSIS OF SIGHTING DATA

A plot of iceberg length versus latitude (Fig. 2) demonstrates that the maximum length of the icebergs considered decreases rapidly south of 50°N but changes very little north of that latitude. The rapid decrease in maximum iceberg length south of 50°N clearly results from the higher sea surface temperatures and increased exposure to wave action in this area. It is also clear from this figure that since 1900 there have been a number of icebergs sighted on the Grand Banks and off Labrador that exceed the maximum iceberg lengths cited by the oil industry.

Figure 2 also delineates the upper limit of iceberg or ice island size by latitude for the entire study period and for the 1950-90 period. Comparison of these limits suggests a decrease in maximum iceberg size in Newfoundland waters following 1949. This may indicate that the marine environment was more favorable for the survival of these icebergs prior to 1950 or that the size of icebergs and ice islands produced has decreased. In the case of ice islands, there is ample evidence for a drastic decrease in the extent of the ice shelves of northern Canada over the past century (Jeffries, 1992). There is also evidence that many West Greenland

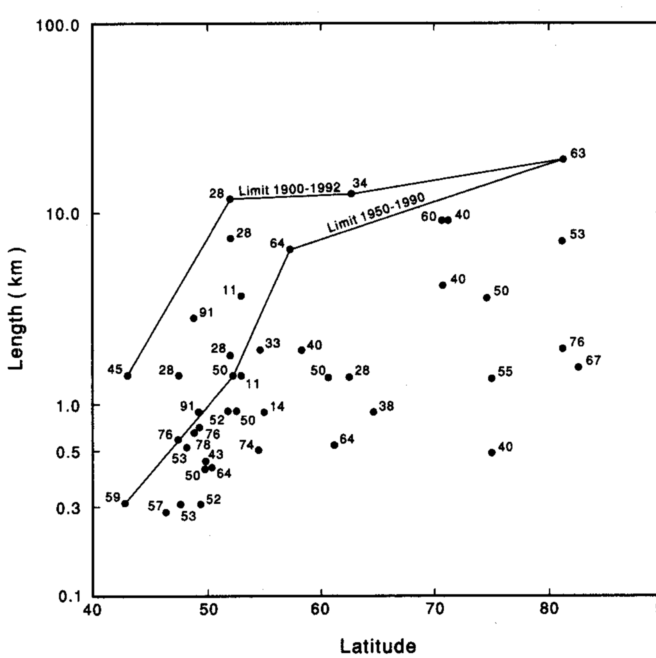

FIG. 2. Iceberg or ice island length versus latitude. The symbols indicate year of sighting. The upper limits for 1950-90 and 1900-92 sightings are given.

glaciers have retreated over the past century (Weidick, 1968). Both of these factors may influence the probability of producing exceptionally large icebergs and ice islands.

A plot of exceptionally large iceberg and ice islands sightings south of 55°N by year (Fig. 3) demonstrates that the maximum length was greatest during the 1920s, was lowest during the 1960s and appears to be increasing in recent decades. This pattern follows the trend in Labrador sea ice clearing dates compiled by Newell (1990, 1992). This is not surprising, since both the Labrador clearing dates and southward iceberg transport along the Labrador coast are related to the strength of the northwesterly winds off Labrador during spring.

After length, the second most common characteristic reported was height. To facilitate analysis of the data by height, the observations are separated into three height categories. The first group includes all icebergs greater than 40 m high. The second includes icebergs with heights between 10 m and 40 m. The final group, those with heights less than 10 m, includes icebergs and ice islands. It is possible that large, heavily ridged multi-year ice floes from the Arctic could be misidentified as low icebergs or ice islands and included in this group.

The categorization of sightings by height classes is important for assessing the risk to fixed offshore structures. A fixed offshore structure situated on the Grand Banks or Labrador shelf, areas with water depths generally less than 100 m, is in little danger of an impact from an iceberg with a draft greater than the water depth. Such an iceberg would probably ground before reaching the structure. Unfortunately, the length of the exceptional icebergs considered in this study cannot be used to estimate draft. However, an estimate of draft can be obtained if the height is known. Based on published draft-to-height ratios for tabular icebergs (El-Tahan and El-Tahan, 1982; Danish Hydrological Institute, 1979), it is clear that exceptionally long tabular icebergs in the highest height category considered (>40 m high) would represent a low risk for a structure situated in water depths less than 100 m. Conversely, an iceberg or ice island in the lowest height category (<10 m high) would represent a danger to a fixed structure on all but the shallowest offshore banks. The danger from icebergs in the intermediate height category would vary with the nature of the iceberg and the water depth.

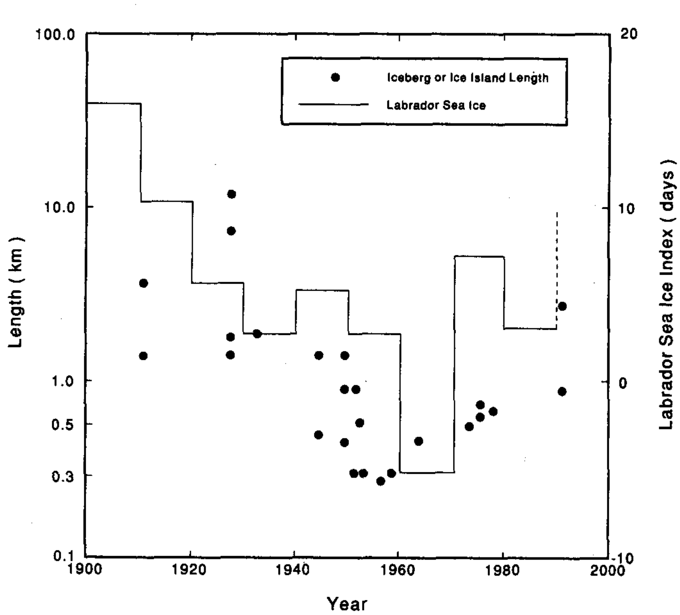

FIG. 3. Iceberg or ice island length versus year for all sightings south of 55°N and the mean Labrador sea ice index (Newell, 1990) for each decade. The Labrador ice index gives the departure (in days) of the sea ice clearing date at 55.0°N from the median clearing date for 1964-84, with positive departures indicating later clearing dates.

The longest of the high icebergs reported was the observation of a 61 m high, 1373 m long iceberg off Labrador in October 1950. This iceberg was over 2.5 times longer than the largest iceberg reported by Petro-Canada (1982). The 585 m long, 73 m high iceberg sighted near 48.2°N in 1953 and the 0.91 km long, 76 m high iceberg sighted in 1991 were the largest icebergs of this type sighted south of 50°N. Also noteworthy is the report of an 84 m high, 305 m long iceberg sighted at 42.8°N in 1959. This is an exceptionally southerly location for such a large iceberg. The limited number of reports of this type of iceberg prior to 1950 may simply be a result of the fact that this type of iceberg was not considered exceptional enough to receive special notice in the pre-1950 shipping reports.

Review of the observations of medium-height icebergs for the area south of Baffin Bay indicates that all but one of the sightings of icebergs in this group with lengths greater than 1 km were prior to 1950, the exception being the 2.8 km long iceberg sighted in 1991. The largest iceberg in this category was the 1928 report of an iceberg 12 km long near the Strait of Belle Isle. Five medium-height icebergs longer than 300 m were reported south of 50°N. Not only are these icebergs longer than the longest iceberg reported for the Grand Banks region by the oil industry (Mobil Oil Canada Ltd., 1985), but almost all of them are considerably longer than the longest iceberg reported for Labrador (Petro-Canada, 1982).

Clear identification of low icebergs and ice islands is more difficult than for medium and high icebergs, since these low icebergs can be confused with heavy multi-year floes. For example, a 10 mile (18.5 km) long ice pan reported off Labrador in 1914 (Wilson, 1975) could have been a large low iceberg or an ice island. In the majority of cases it is impossible to separate sightings of ice islands from those of large low icebergs — for example, the 1.4 km long exceptionally low iceberg sighted in 1950. The longest of the low icebergs sighted south of 50°N was the 0.75 km iceberg sighted in 1976.

Figure 4 presents an analysis similar to that in Figure 2 but with the height category of the iceberg indicated. This figure demonstrates that south of 55°N the longest icebergs generally fall into the medium or high categories. This is not surprising considering that many of these icebergs were sighted in open water. It would be expected that the more massive icebergs would survive longer under these conditions than the low icebergs, which are more vulnerable to breakup as a result of wave action. However, there is still ample evidence that medium-height icebergs and low icebergs or ice islands reach the northern Grand Banks.

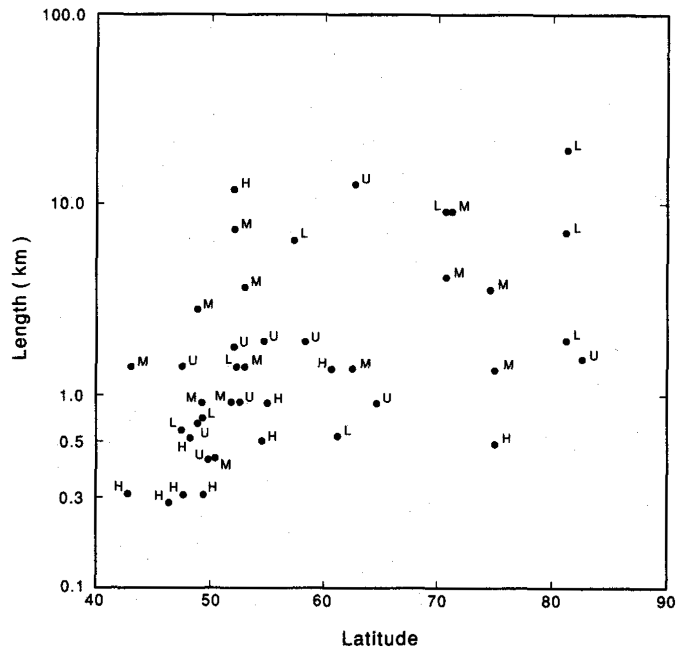

FIG. 4. Iceberg or ice island length versus latitude. The symbols indicate the height code (Low, Medium, High or Unknown) for each sighting.

An additional aspect of these exceptionally large icebergs and ice islands is the influence that they may have on the number of icebergs that reach the Grand Banks. If one exceptionally large iceberg broke up, it could theoretically produce more icebergs than the average number reaching the Grand Banks each year (approximately 400). This is demonstrated by the fact that an iceberg 3 km long, 1.5 km wide and 10 m high has a mass of approximately 100 million tonnes, compared with icebergs on the Grand Banks, which have a median mass near 110 000 tonnes (Hotzel and Miller, 1983). While this may not be a common occurrence, if it does occasionally occur it could bias traditional methods used to forecast iceberg flux.

The breakup of large icebergs may explain why an attempt to hindcast iceberg flux based on transport (Schell, 1962) significantly underestimated the flux in 1929 and 1945 (1329 and 1083 icebergs respectively, which are the highest counts for the period 1900-71). The IIP Bulletin for 1929 contains a number of remarks regarding large low icebergs sighted on the Grand Banks, and other sources refer to numerous icebergs of huge dimensions northeast of Newfoundland (Marine Observer, 1930); unfortunately, no dimensions were reported. In addition, during the preceding year (1928) there were several sightings of very large icebergs, including the largest ever sighted south of 60°N. Similarly, the IIP Bulletin for 1945 notes that several large flat-topped icebergs were sighted on the Grand Banks, the largest of which was 4500 feet long (1.37 km). The IIP Bulletin for this year also indicates that the iceberg count included a large number of small icebergs sighted early in the season.

These sightings and comments suggest that exceptionally large icebergs were more numerous in 1929 and 1945. If one of these exceptionally large icebergs broke up before reaching the Grand Banks, the number of iceberg sightings in these years would be inflated. Such events could not be predicted by a hindcast based on transport. There is no evidence that similar events influenced the iceberg count in recent severe iceberg years (e.g., 1972, 1984 and 1991). However, this does not conflict with the speculation regarding 1929 and 1945, since the factors responsible for severe iceberg seasons may have changed.

CONCLUSION

From the data presented it is clear that for both the Grand Banks and Labrador regions (north and south of 50°N) there have been numerous icebergs and ice islands sighted since 1900 that meet the definition for extremely large used in this study (>300 m long south of 50°N and >500 m long north of 50°N). This demonstrates a problem with existing methods used to develop design criteria for fixed offshore structures, such as the one planned for the Grand Banks. The existing method, which relies on extrapolating from a sample of icebergs measured over a period of a few years, does not account for sporadic occurrence of exceptionally large icebergs or ice islands.

The validity of using this early data for design depends on the stability of the factors responsible for the production and survival of these exceptionally large icebergs and ice islands. There is clear evidence that the extent of West Greenland glaciers and the Ellesmere Island ice shelves have varied over the past century. Both of these factors can influence the production of exceptionally large icebergs and ice islands. In addition, sea ice conditions in the Labrador Sea, which are closely related to iceberg transport and survival, have changed significantly over the study period. Further research is required to determine if these changes have significantly altered the risk of exceptionally large icebergs or ice islands reaching the Grand Banks. However, the sighting of a 2.8 km long iceberg south of 50°N in July 1991 demonstrates that the risk is not completely eliminated.

Other factors must also be considered when evaluating the risk to a fixed structure from an iceberg or ice island similar to those described in this study. For example, the size of the Grand Banks is such that any iceberg that reaches these latitudes has a low probability of actually passing over any particular location. In addition, the size of these icebergs or ice islands is such that they could be identified and tracked well before they reach the Grand Banks. However, the ability to detect these icebergs or ice islands depends on the nature and frequency of ice reconnaissance programs. Further research should be conducted to identify the source regions for such icebergs, and ice reconnaissance programs should be designed to identify any that drift south of Davis Strait.

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