Canada

GEOGRAPHICAL PAPER NO. 11

An Illustrated Glossary of Ice Types in the Gulf of St. Lawrence

W. A. Black

GEOGRAPHICAL BRANCH
Department of Mines and
Technical Surveys, Ottawa

Price: 75 cents

Canada

GEOGRAPHICAL PAPER NO. 11

An Illustrated Glossary of Ice Types in the Gulf of St. Lawrence

W. A. Black

GEOGRAPHICAL BRANCH
Department of Mines and
Technical Surveys, Ottawa

Price: 75 cents

94327—1

Royal Canadian Navy icebreaker H.M.C.S. *Labrador* with C.N.A.V. *Sackville* in tow, is passing through young ice in the Cabot Strait area, with winter ice in background. Total ice coverage in this photo is $\frac{9}{10}$. February 22, 1957.

PREFACE

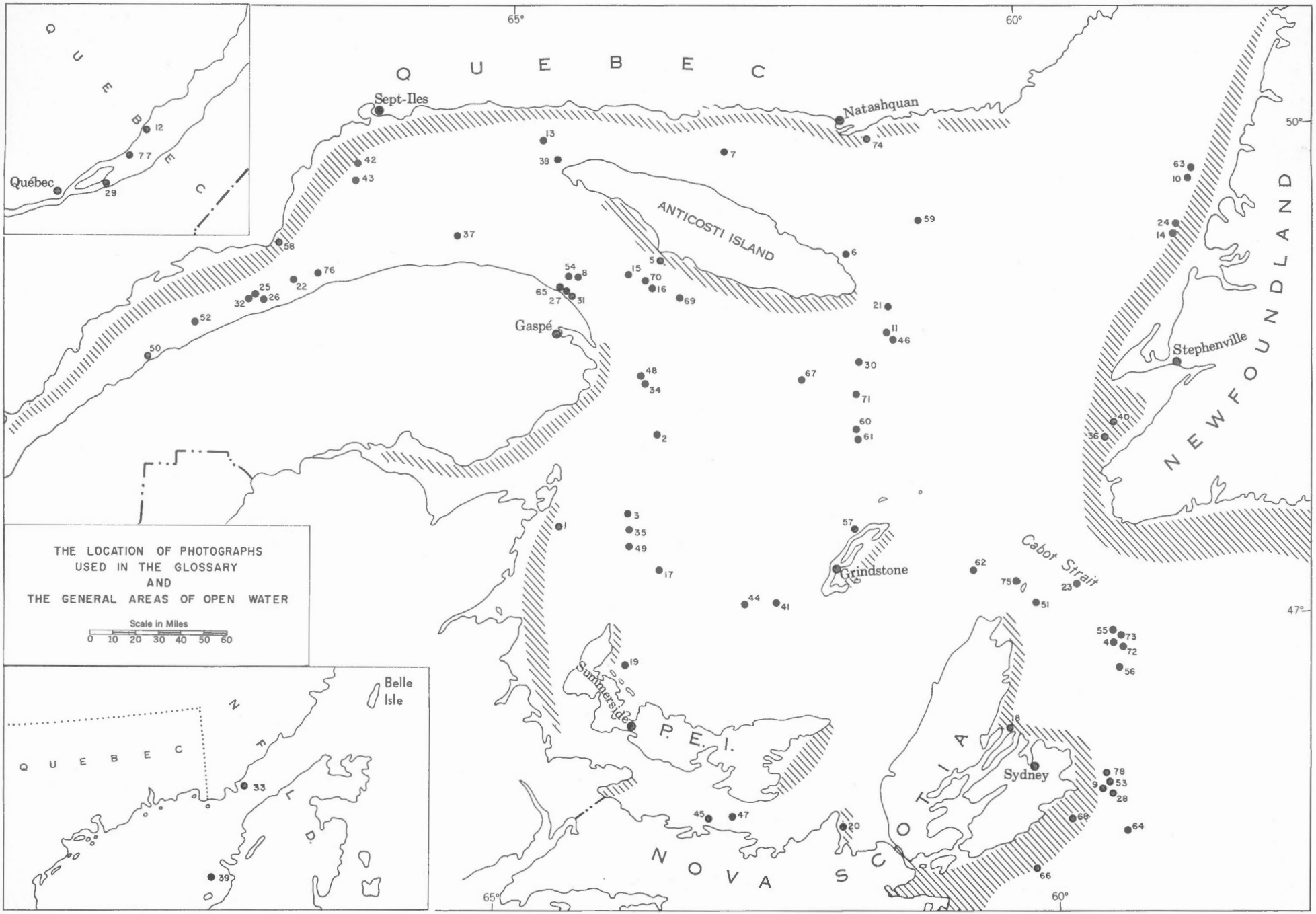
This illustrated glossary is the work of the Canadian Ice Distribution Survey which examines and reports on the condition and distribution of ice in specific areas of Canadian waters. It is an extension of the paper Ice Conditions, Gulf of St. Lawrence, Winter 1956 in Geographical Bulletin 10.

North American standardized ice terminology and ice classifications are used in this glossary, and an alphabetical listing of ice terms and their definitions is included.

It is hoped that the visual presentation of ice types may bring about a clearer understanding of ice conditions encountered in the winter navigation of the Gulf of St. Lawrence.

N. L. Nicholson,
Director,
Geographical Branch

94327—1½


QUEBEC
Sept-Iles
Natashquan
ANTICOSTI ISLAND
Gaspé
Stephenville
NEWFOUNDLAND
Grindstone
Cabot Strait
Summerside
P. E. I.
Sydney
NOVA SCOTIA
Belle Isle
NEWFOUNDLAND
Québec
65°
60°
50°
47°
THE LOCATION OF PHOTOGRAPHS
USED IN THE GLOSSARY
AND
THE GENERAL AREAS OF OPEN WATER
Scale in Miles
0 10 20 30 40 50 60

AN ILLUSTRATED GLOSSARY OF ICE TYPES IN THE GULF OF ST. LAWRENCE

INTRODUCTION AND ACKNOWLEDGEMENTS

This glossary is intended as a practical aid to air and marine navigation in the Gulf of St. Lawrence. It illustrates the appearance of ice from the air and is restricted to representative ice types most frequently found in the gulf.

The illustrations are the result of a photographic survey made in the winter of 1957. The ice survey of the Gulf of St. Lawrence was conducted by the Geographical Branch, the Atlantic Oceanographic Group, the Royal Canadian Navy and the Royal Canadian Air Force co-ordinated by the Geophysical Research Section of the Defence Research Board. Specific acknowledgements are made to T.A. Harwood, Geophysical Research Section, L.M. Lauzier, Atlantic Oceanographic Group, and G/C W.H. Swetman, R.C.A.F. Maritime Air Command. All photos are by courtesy of the Royal Canadian Air Force except the Royal Canadian Navy photo in the frontispiece.

An F.24 type camera with a 5-inch focal length was employed, Super XX film was used, and flights were made at approximately 1,000 feet elevation. Scale of the photographs is 200 $\pm$ 10 feet to the inch except where otherwise stated in the caption. The list with dates of photographs is given on page vii and the location of each photograph is indicated on an accompanying map.

The winter of 1957 was a particularly favourable one for photographic work. Because of the abnormally low January temperatures, (15°F. to 18°F. below the mean of 2°F. to 6°F. in the northern part of the gulf, and 6°F. to 7°F. below the mean of 18°F. to 19°F. in the southern part,) most of the gulf was covered with

ice. This provided a more extensive selection and a wider coverage of ice types than usual.

Although the processes of ice formation may exist concurrently or in opposition one to the other, this glossary attempts to separate them into two parts. The first part, (figures 1 to 46 inclusive), largely emphasizes the forms resulting from constructional processes. The second part (figures 47 to 78 inclusive), primarily emphasizes ice forms resulting from destructional processes. In addition, classification of the ice is given in figures 51 to 78 inclusive.

The differences between gulf ice and arctic ice are apparent to the navigator and to the reader who compares this glossary with an arctic ice glossary. For example, light or heavy arctic floes are substantially larger than light or heavy gulf floes. Because of the long period of summer warmth, the ice surface of the gulf is generally level, pressure ridges are low, the ice is relatively thin, much of the gulf contains open water, and the ice surface is dominated by young forms. In addition, the ice is normally escaping through Cabot Strait into the warmer Atlantic waters during the winter months. The ice types presented in the glossary represent normal features of gulf ice.

ICE DISTRIBUTION IN THE GULF OF ST. LAWRENCE

Ice begins to form along the shore of the Gulf of St. Lawrence in November, reaches its maximum extent in February, and disappears from the gulf in May. In mid-winter, the gulf is not covered by a solid ice sheet but by masses of ice that drift with the currents and tides. Throughout the winter months the ice moves from various parts of the gulf to Cabot Strait. In the area south of the line Gaspé-Magdalen Islands-Cape Breton where the work of consolidation is most in evidence the ice gradually drifts east to Cabot Strait at a $\frac{1}{2}$ to 1 knot. The ice from Northumberland Strait appears to move northeastward at a rate of $\frac{1}{2}$ to $1\frac{1}{2}$ knots. Ice moves east from the St. Lawrence estuary at 2 knots but in the open gulf at a $\frac{1}{2}$ knot. There is

also a southwest drift from the Strait of Belle Isle. As the gulf ice moves toward Cabot Strait it is gradually replaced by young ice which, from compaction, shelving, rafting and snowfall, gradually grows thicker to become winter ice. Whenever the latter reaches a concentration of 4/10 or more of the water surface it has become sufficiently thick and extensive enough to prevent ship navigation, except by vessels with reinforced hulls.

To the windward of young ice open water usually occurs, a characteristic feature of the gulf and one frequently accompanied by low-lying stratocumulus clouds. Such open waters generally parallel the north shore of the St. Lawrence River from the mouth of the Saguenay River to Pointe des Monts, and commonly cover the other areas indicated on the accompanying map. The open water areas appear to result principally from the blowing of the ice seaward by the prevailing westerly or northerly winds as the water is only slightly warmer than that covered by ice. A current that enters Cabot Strait off Cape Ray and follows the Newfoundland coast northward is largely responsible for the open water area which frequently lies off Newfoundland's west coast. During a period of southerly winds ice drifts off the coasts in the southern and eastern parts of the gulf. The low temperature of the near-freezing surface water is quickly reduced to freezing by the low temperature of the air masses that pass over the region, and ice formation follows. The result is that the lightest ice parallels the areas of open water. Depending on wind, current and temperature conditions, the local areas of open water are constantly expanding and contracting, but the actual extent of the gulf ice during any particular winter is intimately related to the climatic and oceanographic influences prior to the beginning of winter. *

The ice in the Gulf of St. Lawrence does not attain the thickness or the

---

*Lauzier, L.M: A Preliminary Report of the Winter Oceanographic Survey in the Gulf of St. Lawrence, 1956. Atlantic Oceanographic Group, St. Andrews, N.B., December, 1956.

massiveness of arctic ice. The most massive ice in the area is that which enters the gulf from the Labrador coast through the Strait of Belle Isle and passes southward through Cabot Strait. The second area of massive ice lies directly to the west of the Magdalen Islands, the islands acting as a barrier to its escape into Cabot Strait. The third important area comprises the landfast ice occupying bays, lagoons, harbours and other areas that shelter the landfast ice from wind and wave action.

Many visible changes take place in the growth of sea ice, from its various young forms to its winter forms. In this process forces of consolidation and disintegration are constantly at work. In the southern gulf region forces of consolidation are foremost; elsewhere in the gulf forces of consolidation and disintegration follow one another in rapid succession with the passing of the low and high pressure air masses over the region. As the ice passes into Cabot Strait the forces of disintegration are dominant, except in the spring of the year when the ice gradually disappears from the southern gulf area through the increasing warmth of the air and water.

EXPLANATION OF TERMS

Block: A fragment of sea ice ranging in size from 6 to 30 feet across.

Brash: Fragments of floating ice, less than 6 feet across, resulting from the wreckage of other forms of ice.

Consolidated ice: Ice of different sizes that is compacted into larger ice forms.

Floe: A piece of sea ice. In terms of size a small floe is from 30 to 600 feet across; a medium floe is 600 to 3,000 feet; a large, or giant floe is 3,000 feet to 5 miles, and an ice-field an area of sea ice greater than 5 miles across.

Ice concentration: The ratio of the areal extent of ice present to the total extent of the ice and water surface. Concentration is usually measured in

tenths; for example, $\frac{9}{621}$ concentration indicates 6/10 brash and block, 2/10 small to medium floes and 1/10 giant floes and field; total surface of ice coverage 9/10.

Landfast ice: Any type of ice attached to the shore, beached, stranded in shoal water, or attached to the bottom of shoal areas.

Pressure ridge: A ridge of ice. Wherever a substantial area of the ice is in the form of pressure ridges, coverage may be expressed in tenths; for example, $\frac{PR}{3}$ denotes 3/10 of the area of the ice surface is in the form of pressure ridges.

Rafting: In this study rafting denotes the overriding of one floe by another floe of winter ice.

Shelving: In this study shelving denotes the rectangular pattern of interfingerings of young ice.

Sludge: An accumulation of small pieces of soft ice mixed with slush. The surface of the sludge is usually hardened into an ice crust.

Slush: An accumulation of ice crystals such as would result from snow that has fallen into water at approximately freezing temperature. Slush forms a thick soupy mass in the water. The coverage of slush and sludge may be expressed in tenths; thus $\frac{S}{5}$ - 5/10 of slush and sludge.

Very young ice: Ice that is recently formed in calm water. Coverage is expressed in tenths; thus, $\frac{VY}{6}$ - 6/10 of very young ice.

Winter ice: Ice produced during the current winter, usually ridged and capable of maintaining a snow cover without the snow becoming grey from water seepage through the ice. Coverage is expressed in tenths; thus, $\frac{W}{5}$ - 5/10 of winter ice.

Young ice: Newly formed ice that is generally transparent; if it includes slush or sludge it is usually grey in appearance. Coverage is expressed in tenths; thus, $\frac{Y}{7}$ - 7/10 of young ice.

BIBLIOGRAPHY

Armstrong, Terence: Sea Ice Recording and Reporting Methods. Canada, National Defence Department, Defence Research Board. Queen's Printer, Ottawa, 1955.

Armstrong, Terence, and Roberts, Brian: Illustrated Ice Glossary. Defence Research Board of Canada. Reprint in Polar Record, Vol. 8, No. 52: 4-12. January, 1956.

Black, W.A.: Ice Conditions: Gulf of St. Lawrence, 1956. Geographical Bulletin, No. 10: (in press) 1957.

Forward, C.N.: Ice Distribution in the Gulf of St. Lawrence During the Break-up Season. Geographical Bulletin, No. 6: 45-84. 1954.

Palosuo, Erkki: A Treatise on Severe Ice Conditions in the Central Baltic. Fennia 77 N: 01. Helsinki, 1953.

United Kingdom, Admiralty Hydrographic Department: Glossary of Terms Used in Admiralty Charts and in Associated Publications, 1953. Part 5. Ice and Snow Terms. Professional Paper No. 11. London, 1953.

United States, Navy Hydrographic Office: A Functional Glossary of Ice Terminology. H.O. Publication No. 609. G.P.O., Washington, 1952.

LIST AND DATES OF PHOTOGRAPHS:

GULF OF ST. LAWRENCE AREA, 1957.

Figure	-	Date	Figure	-	Date
1	-	Mar. 1	40	-	Mar. 1
2	-	Feb. 6	41	-	Mar. 13
3	-	Feb. 28	42	-	Feb. 14
4	-	Feb. 21	43	-	Feb. 28
5	-	Mar. 1	44	-	Mar. 13
6	-	Feb. 14	45	-	Mar. 1
7	-	Feb. 14	46	-	Feb. 14
8	-	Mar. 1	47	-	Mar. 1
9	-	Feb. 19	48	-	Feb. 6
10	-	Feb. 19	49	-	Feb. 28
11	-	Feb. 14	50	-	Feb. 28
12	-	Feb. 21	51	-	Mar. 13
13	-	Feb. 19	52	-	Feb. 6
14	-	Feb. 19	53	-	Feb. 19
15	-	Feb. 21	54	-	Mar. 1
16	-	Feb. 21	55	-	Feb. 21
17	-	Feb. 28	56	-	Feb. 21
18	-	Feb. 6	57	-	Mar. 13
19	-	Feb. 21	58	-	Feb. 14
20	-	Feb. 14	59	-	Mar. 13
21	-	Feb. 6	60	-	Mar. 13
22	-	Feb. 6	61	-	Mar. 13
23	-	Feb. 21	62	-	Mar. 13
24	-	Feb. 19	63	-	Feb. 19
25	-	Feb. 6	64	-	Feb. 14
26	-	Feb. 14	65	-	Feb. 14
27	-	Feb. 14	66	-	Feb. 14
28	-	Feb. 19	67	-	Feb. 21
29	-	Feb. 21	68	-	Feb. 21
30	-	Feb. 28	69	-	Feb. 21
31	-	Feb. 14	70	-	Feb. 21
32	-	Feb. 6	71	-	Mar. 13
33	-	Feb. 19	72	-	Feb. 21
34	-	Feb. 6	73	-	Feb. 21
35	-	Feb. 28	74	-	Feb. 19
36	-	Mar. 1	75	-	Feb. 28
37	-	Feb. 6	76	-	Feb. 14
38	-	Mar. 1	77	-	Feb. 21
39	-	Feb. 19	78	-	Feb. 19

94327—2½

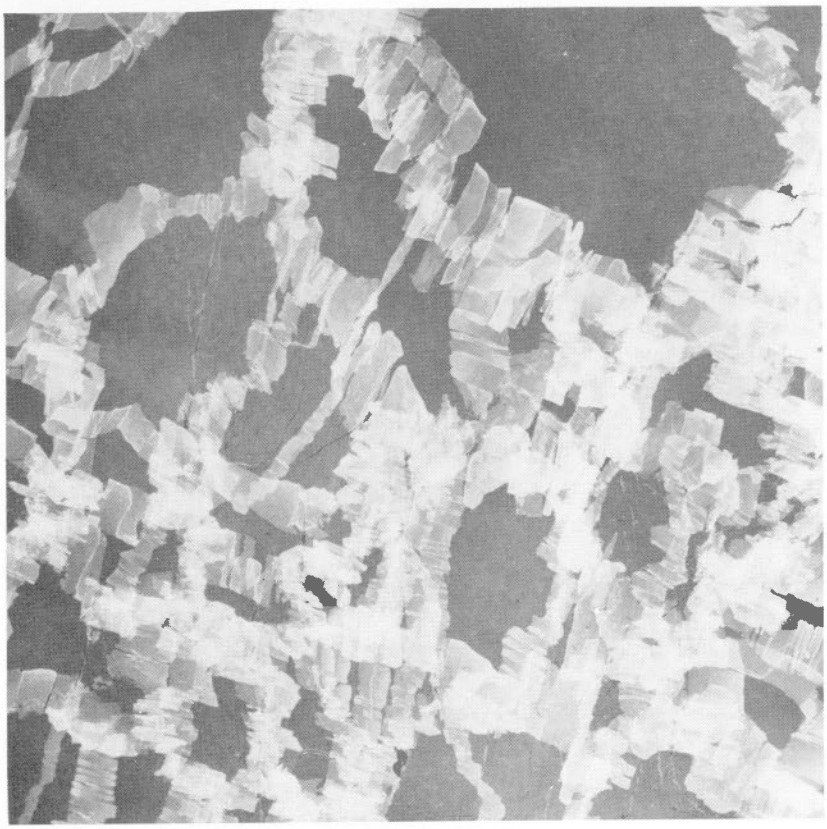


Figure 1

Very young ice from the air appears dark. The ice has attained sufficient rigidity to raft under pressure or to produce clear-cut cracks upon release of pressure. The interfingerings of young ice are rectangular in shape and frequently overlap by as much as 150 feet.

Figure 2

Young ice, from the air, has a grey appearance. The pair of eyes' are recently frozen openings, caused by the higher salinity of the water in restricted areas reducing the freezing temperature of sea water.

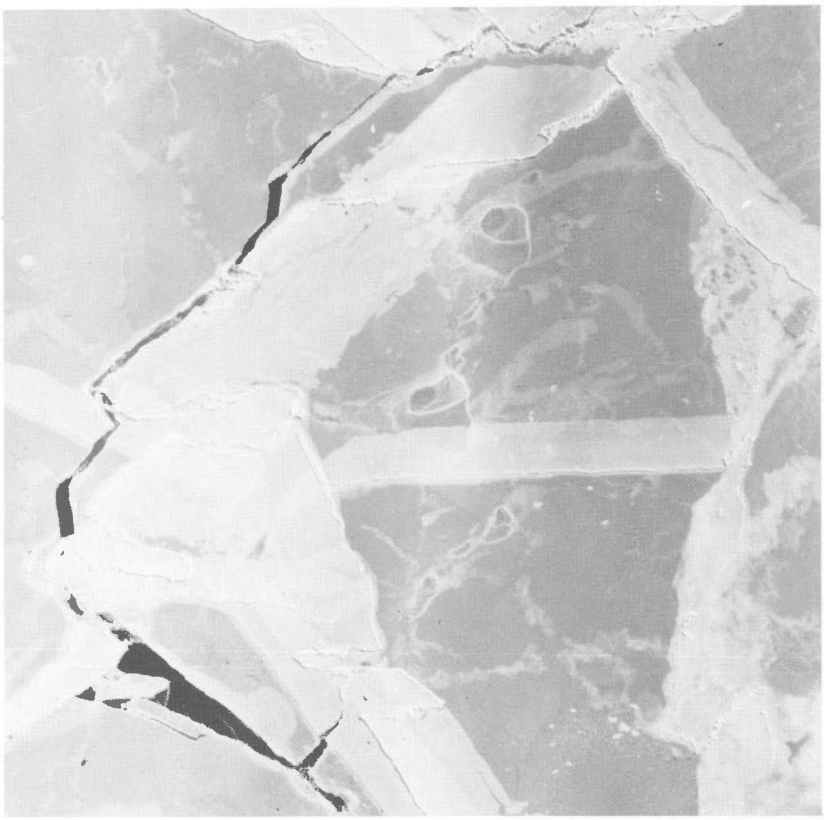


Figure 3

The young ice was covered by a layer of linear snowdrifts. A thaw followed giving rise to the pebbled appearance of the ice surface. Recent snow is not adhering to the surface of smooth ice, which is under pressure. Scale 115' to 1 inch.

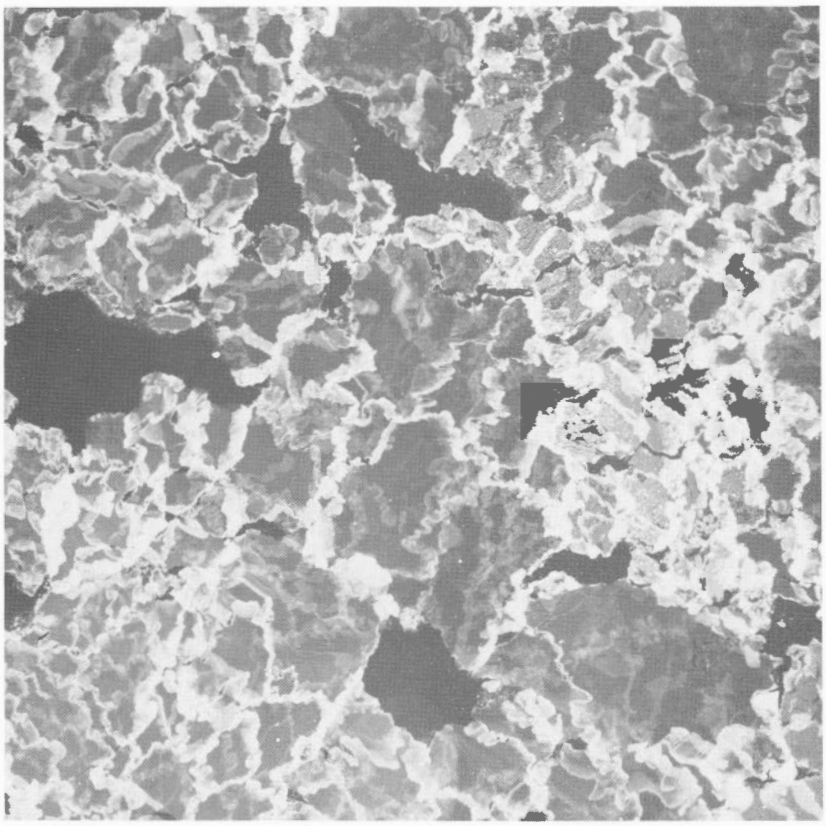


Figure 4

Young ice from the St. Lawrence River has a different 'tone' than that from the Gulf. In addition to recent shelving, outlines of earlier shelvings are apparent, with pressures of different intensities coming from various directions.

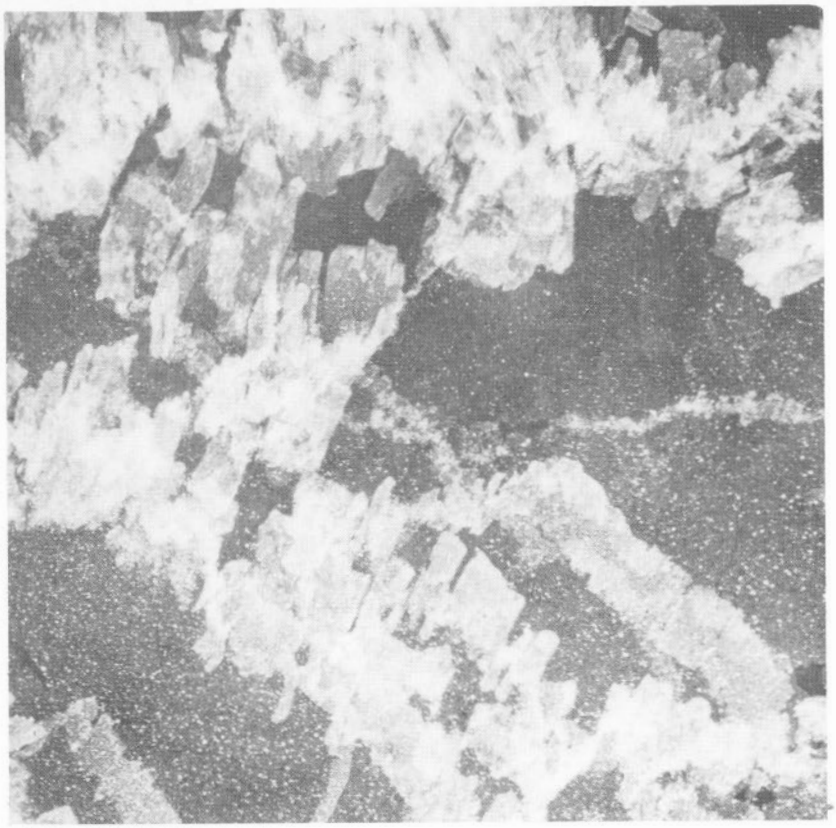
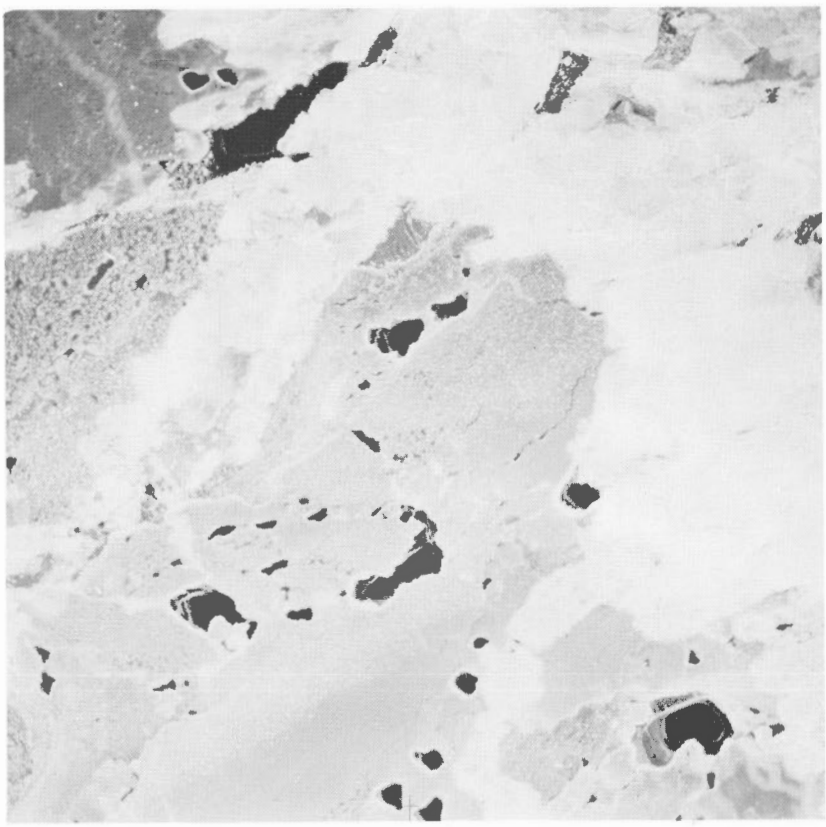


Figure 5

Young ice containing scattered slush and sludge is in the process of shelving. Shelving of the ice indicates that the scattered sludge is not brash.

Figure 6

This young ice contains scattered slush with localized areas of sludge. Slush gives young ice a grey appearance. The dark 'eyes' are areas of open water. Pressure is being exerted from the left or right side.



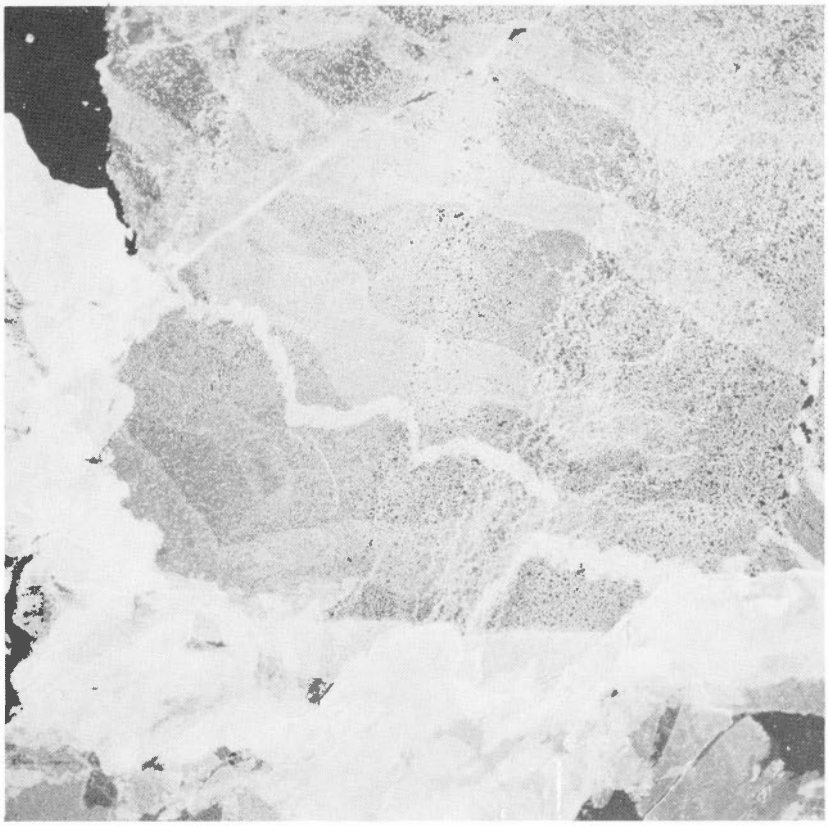
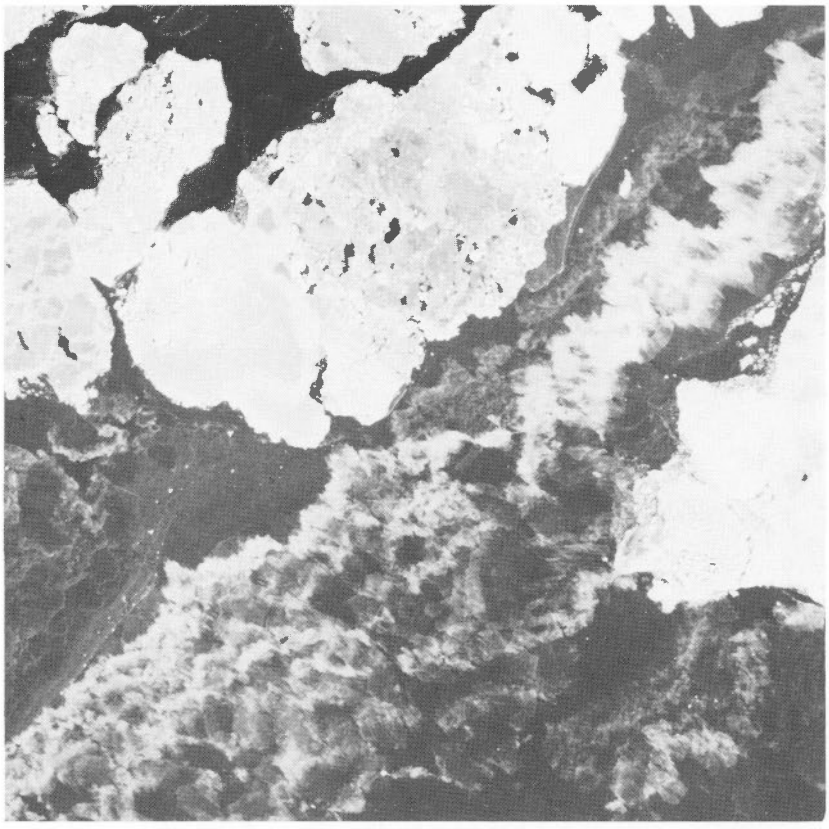


Figure 7

Young ice has bonded together an area of sludge. The sludge cakes are of uniform size throughout the area. Shelving is now in progress.

Figure 8

The diagonal band of young ice between the two larger flows has been subjected to intense pressure. The shelving has added considerably to the thickness of the ice. Young ice has covered the water areas among the older floes.



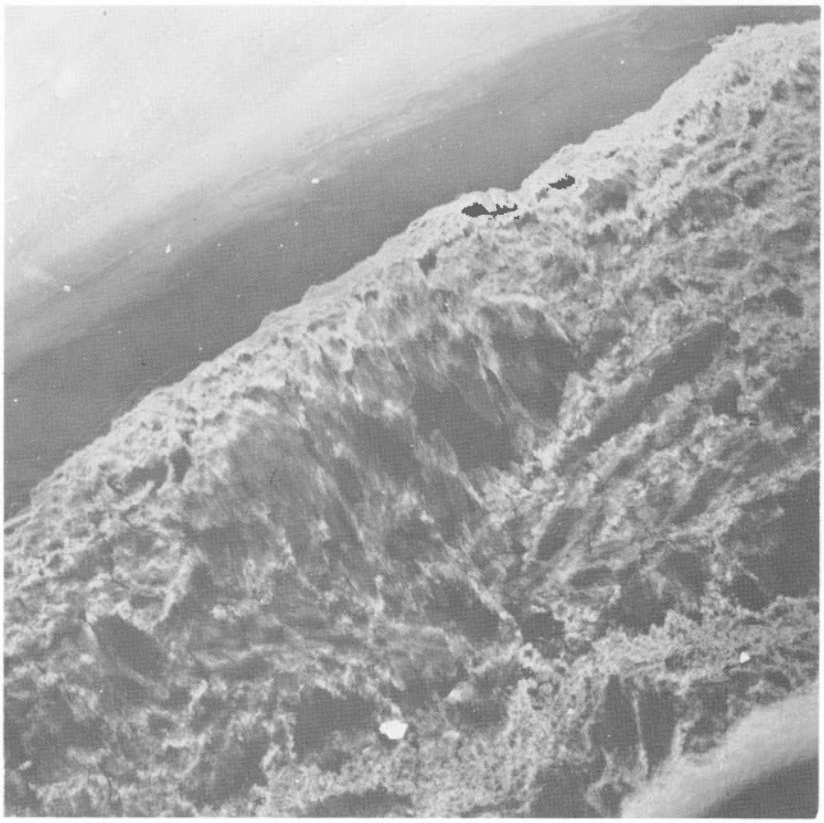


Figure 9

In the upper left a large band of brash and sludge is faced with a diagonal band of young ice. On the lower right the young ice is in process of intense shelving brought about by the increasing pressure from a sea swell from the lower right.

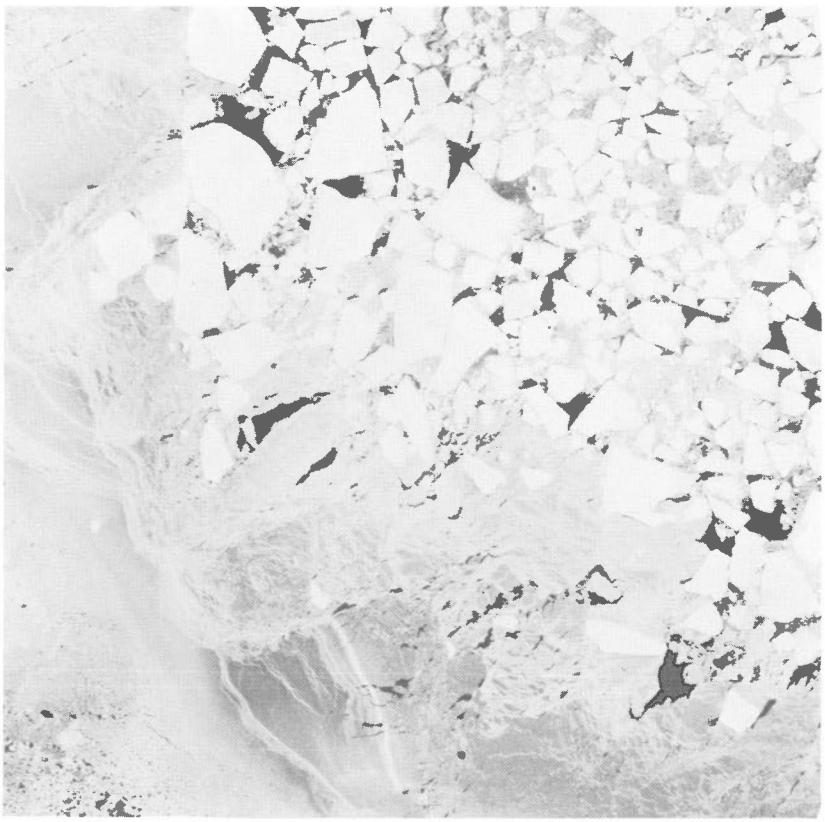


Figure 10

Young ice formed by the compaction of slush and sludge has been shattered by advancing pressure from a mass of broken winter ice. Consolidation is now in progress.

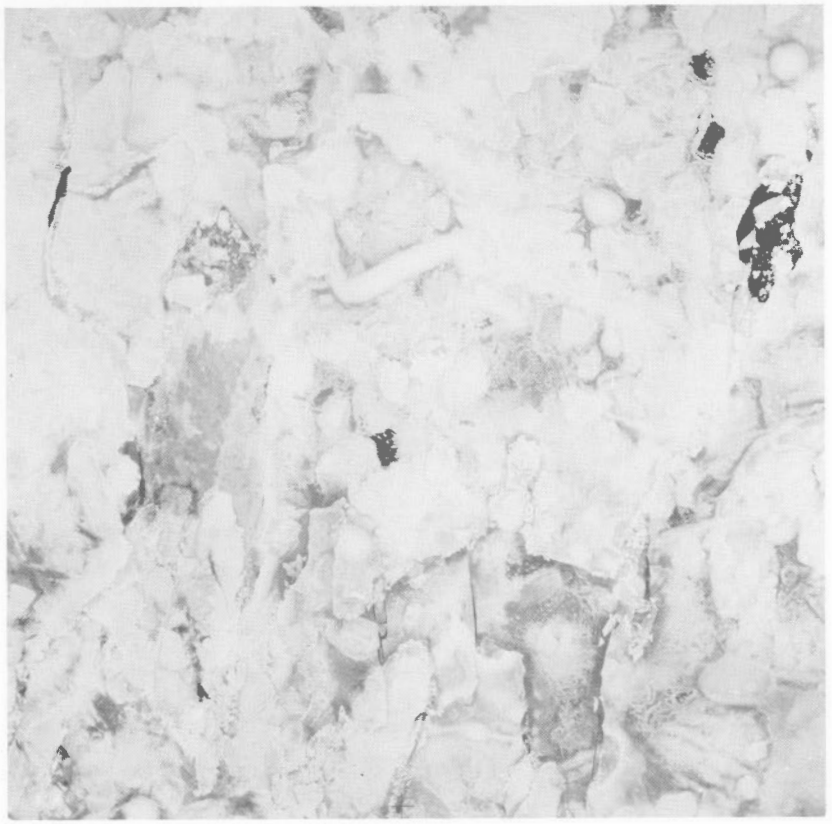


Figure 11

Young ice, consisting principally of slush and sludge has been consolidated through the process of shelving after which there was a light snowfall, followed by a thaw. With falling temperatures the resulting surface is smooth and glassy.

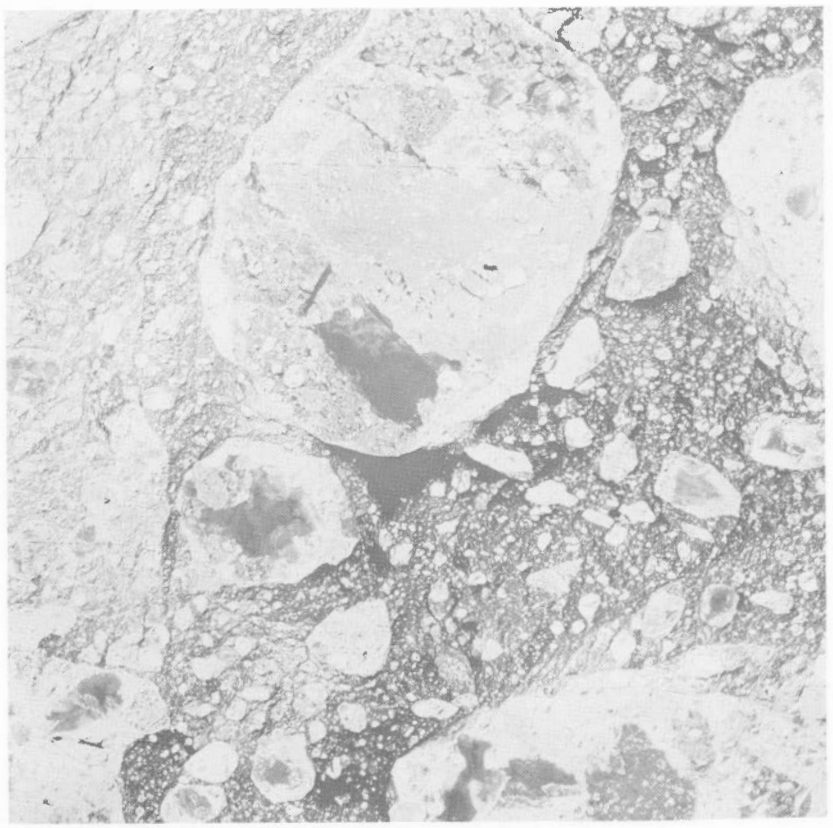


Figure 12

The 'working' or grinding action of the ice has produced the rounded edges on the large floes and the mass of brash and block separating the floes of young ice. With low temperatures this ice could become consolidated into a single ice sheet.

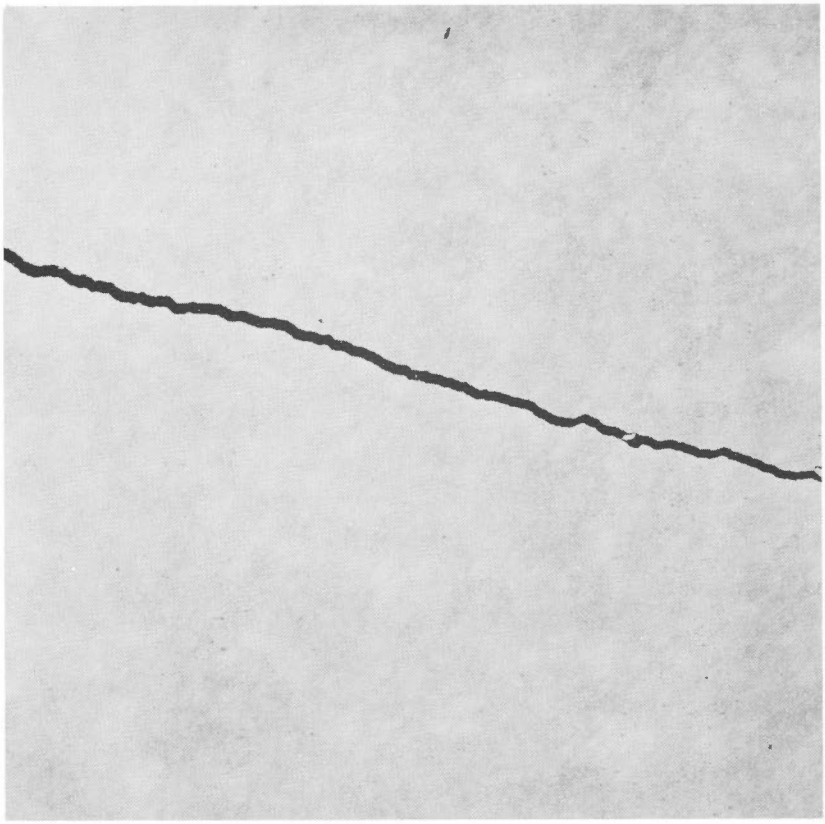


Figure 13

The sharpness of the crack in the young ice indicates that the ice is hard and of considerable thickness. This ice has also received a light coat of snow. A thaw followed which resulted in the ice having a grey appearance.

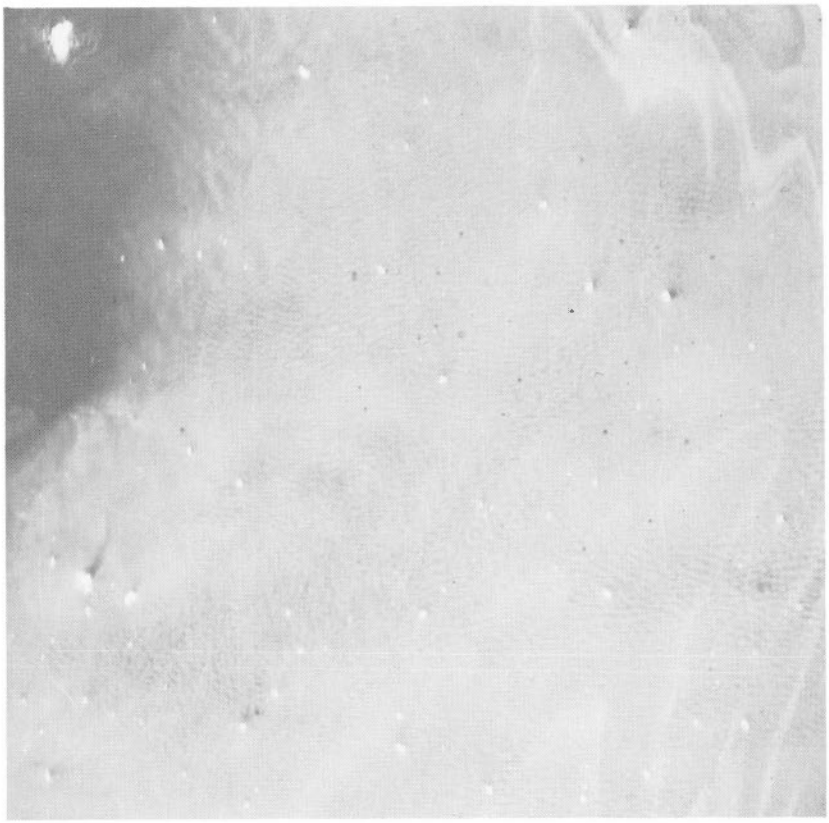


Figure 14

Wave and wind action have produced this accumulation of soft ice. The slush is being buffed into a mosaic of small pieces of sludge. This ice is soft, but with low temperatures a crust will develop.

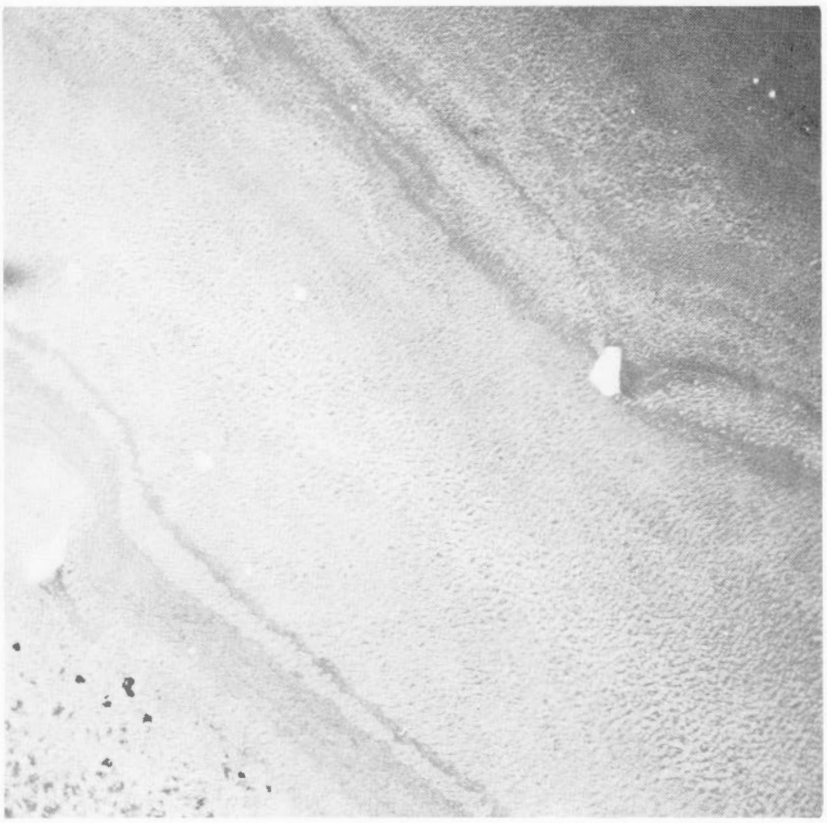


Figure 15

The soft ice is largely arranged in uniform pieces of sludge. The sludge is dense and the pattern results from the combined action of wind and wave. Such ice is generally bordered by open water on the windward side. The drift of the white pieces suggests that the ice may not have a crust.

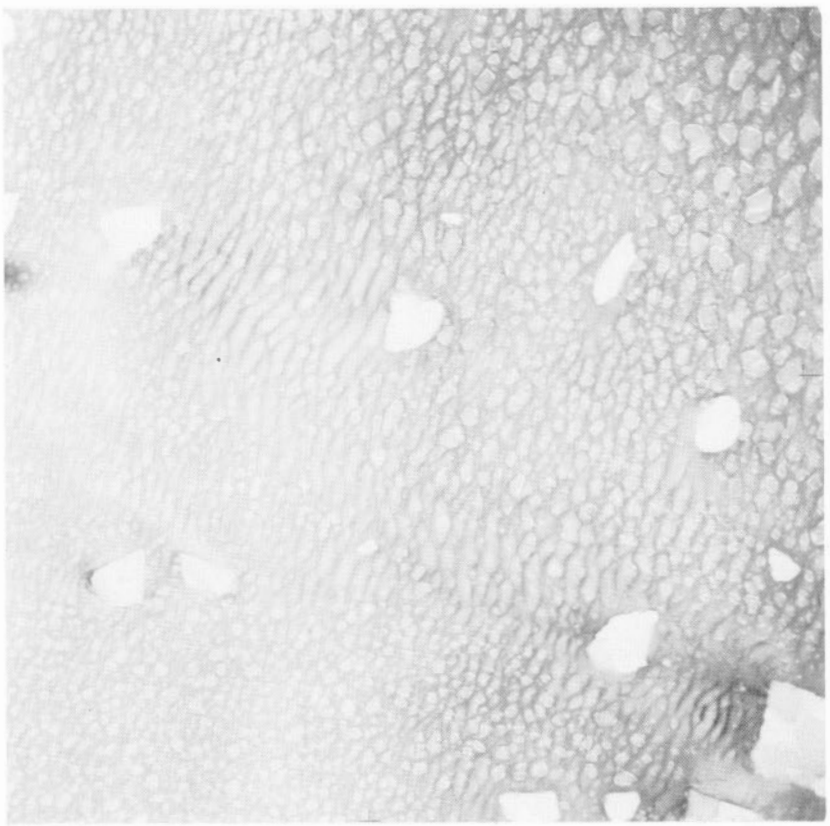


Figure 16

An area of soft ice containing brash and block, slush and sludge. The buffing action of the waves is apparent. The mass is soft and contains considerable water. In such a condition the floes usually develop the raised edges of the well-known pancake ice.

Figure 17

The braided pattern results when soft ice, consisting of slush, sludge and brash, is buffed into a dense mass by wave action. A crust appears to have formed, consolidating the ice surface. Scale 115' to 1 inch.

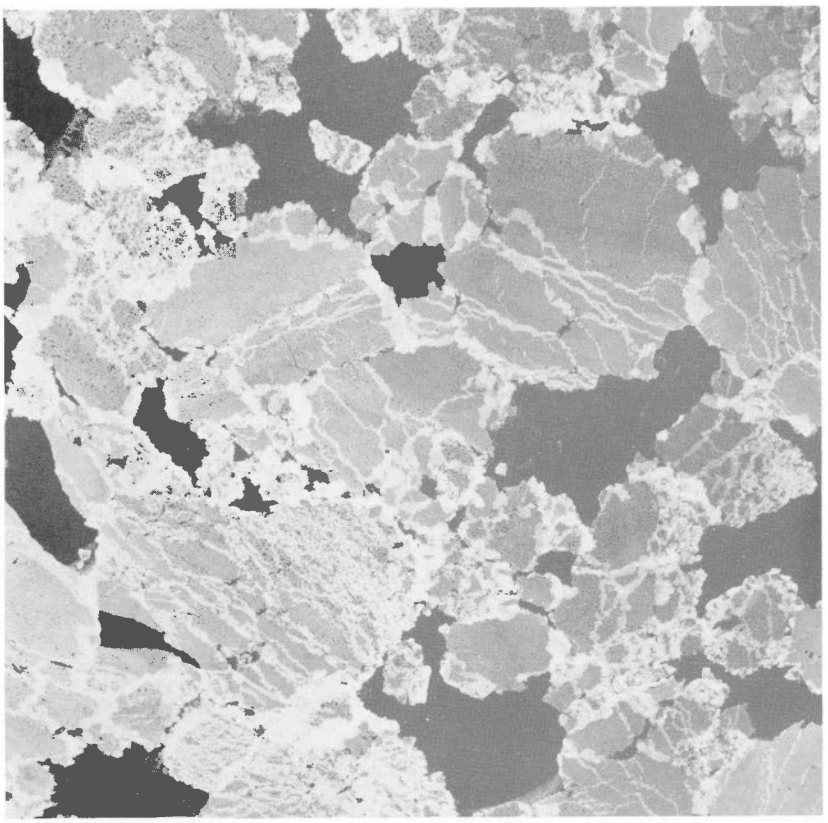


Figure 18

Young ice, consisting of newly formed slush and sludge sufficiently hardened to break into small to medium floes, is now being consolidated by the formation of very young ice in the areas of recent open water.

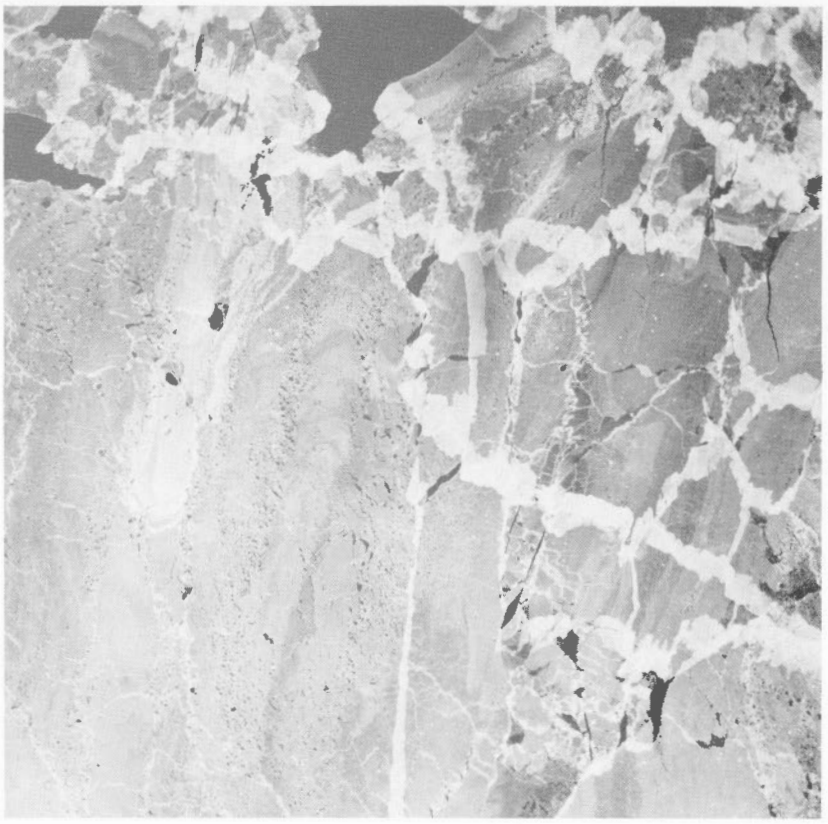


Figure 19

Young ice consisting chiefly of slush and sludge, and very young ice in the black areas, is becoming rigid as evidenced by the initial stages of shelving.

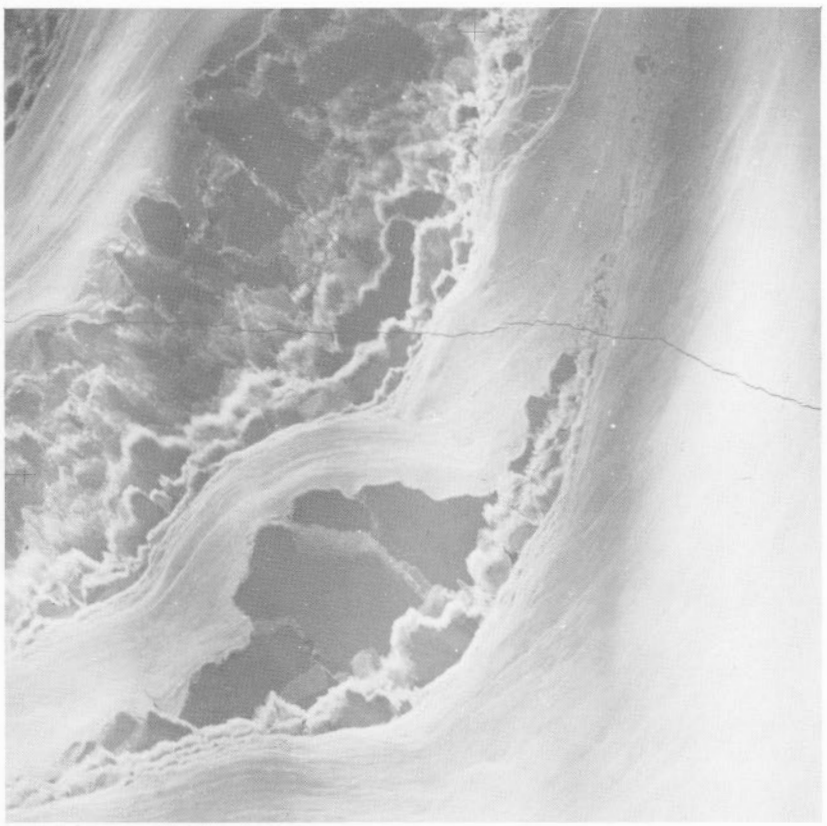


Figure 20

Young ice, consisting of closely pressed bands of slush and sludge, is the result of the buffing action of the waves. The clear ice has developed in calm water. The sharp crack indicates that the ice has consolidated and a hard, rigid crust has formed.

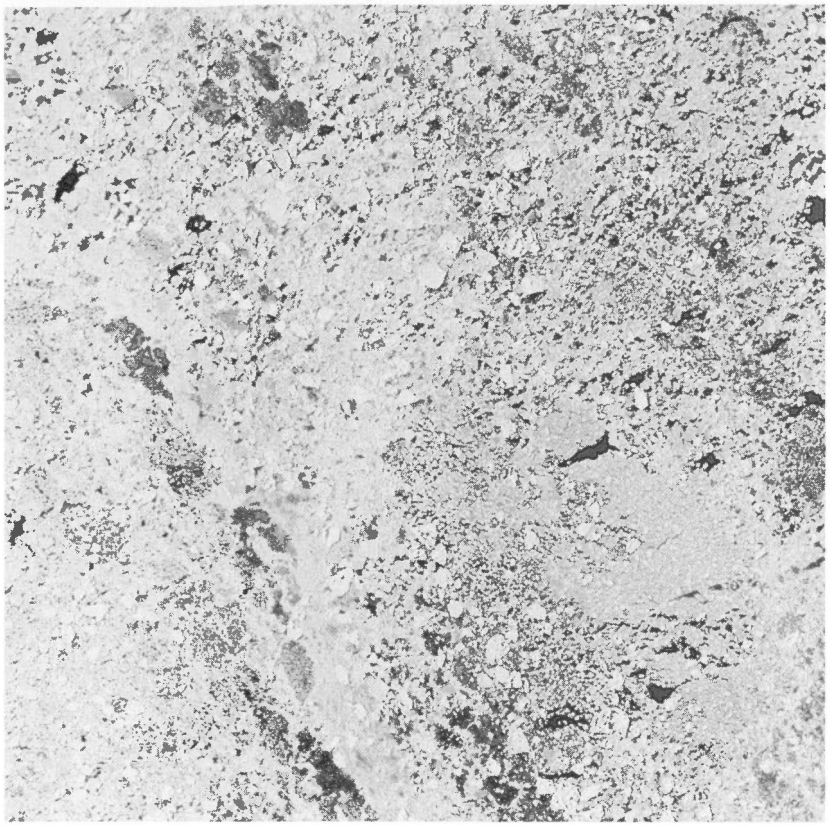


Figure 21

Young ice consists of angular brash and block together with slush and sludge. The presence of areas of very young ice suggests that the ice is in the process of consolidation.

Figure 22

A band of brash and block is being consolidated by the formation of young ice. The young ice contains slush. The ice surface is marked by frequent small 'eyes' of open water.

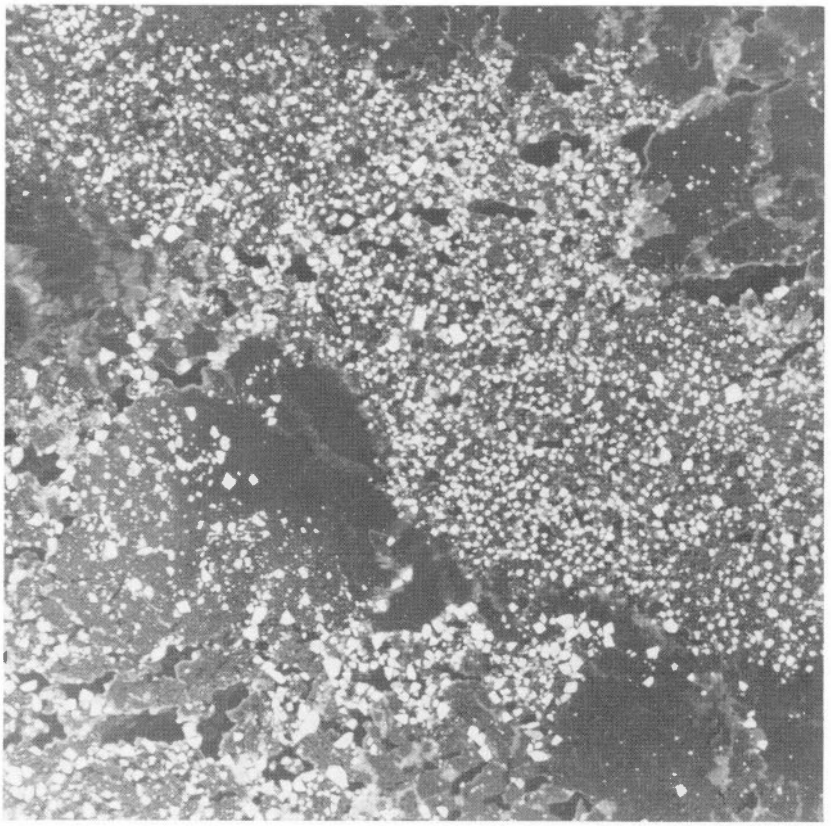


Figure 23. Sludge is an accumulation of small pieces of soft ice; the surface of this ice is hardening into an ice crust.

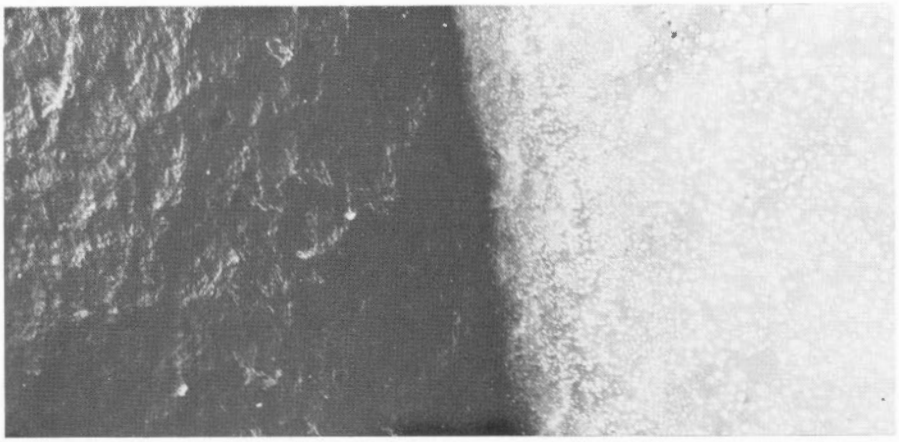


Figure 24. This accumulation of sludge is mixed with slush. The ice edge of the sludge is well defined.

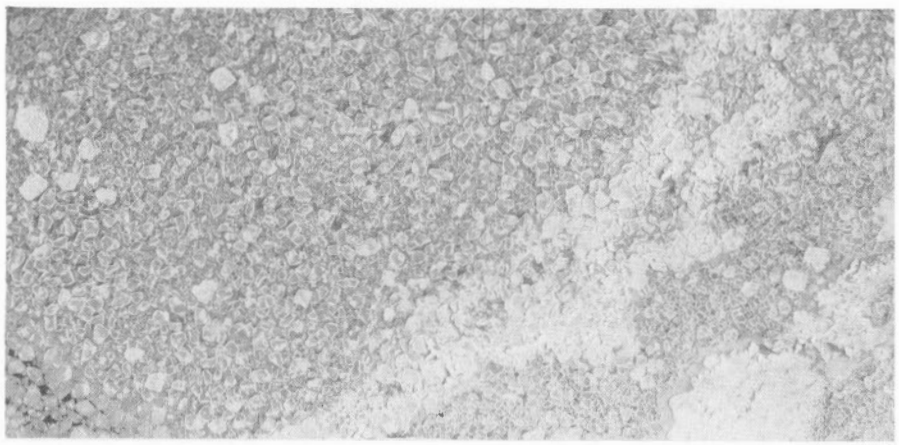


Figure 25. The raised edges of sludge or brash on the small floes of young ice are characteristic of pancake ice. Scale 115' to 1 inch.

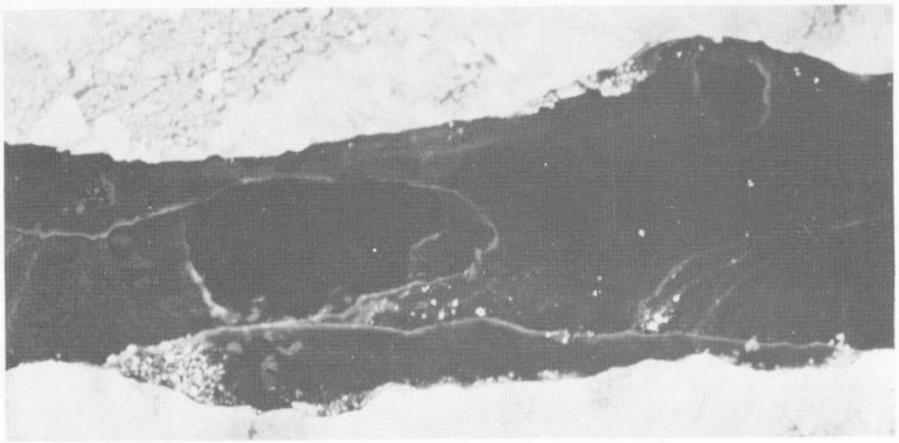


Figure 26. A band of young ice is forming in an opening between an ice sheet of consolidated brash, block and small floes. The contracting edges of the water are visible in the opening

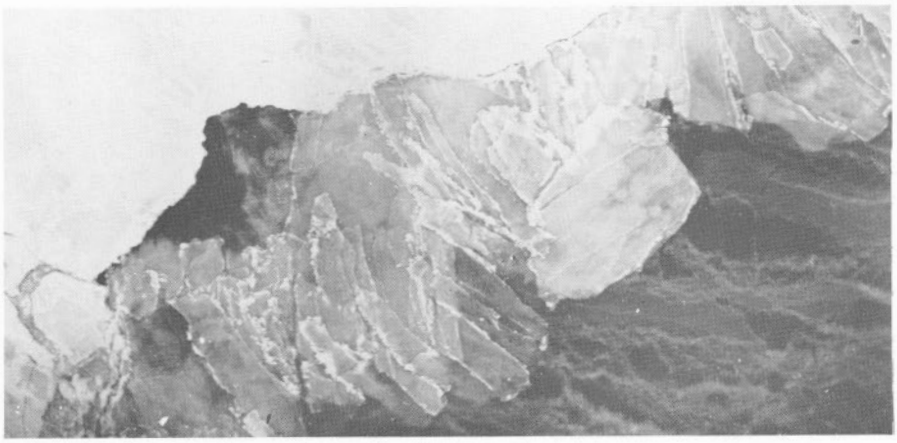


Figure 27. Young ice, forced against the winter ice at the top, has been subjected to intensive shelving. At the lower right micro-shelving of very young ice is in progress.

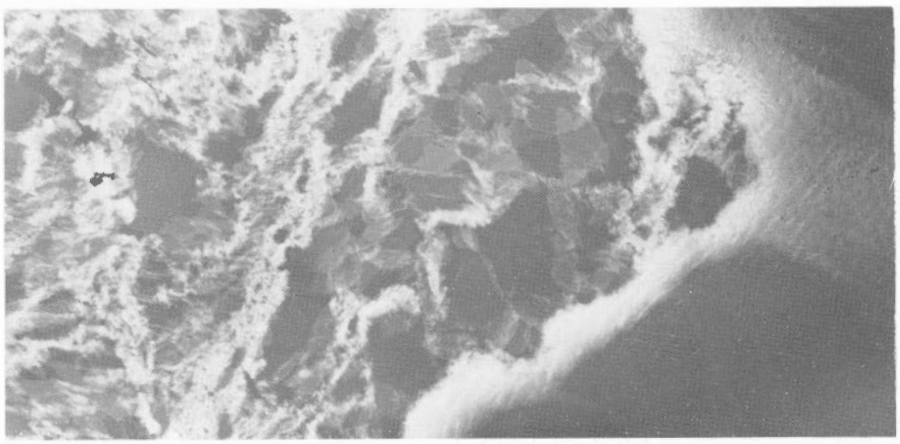


Figure 28. Ice wreckage marks the ice edge of the young ice on the right. Shelving is in progress.

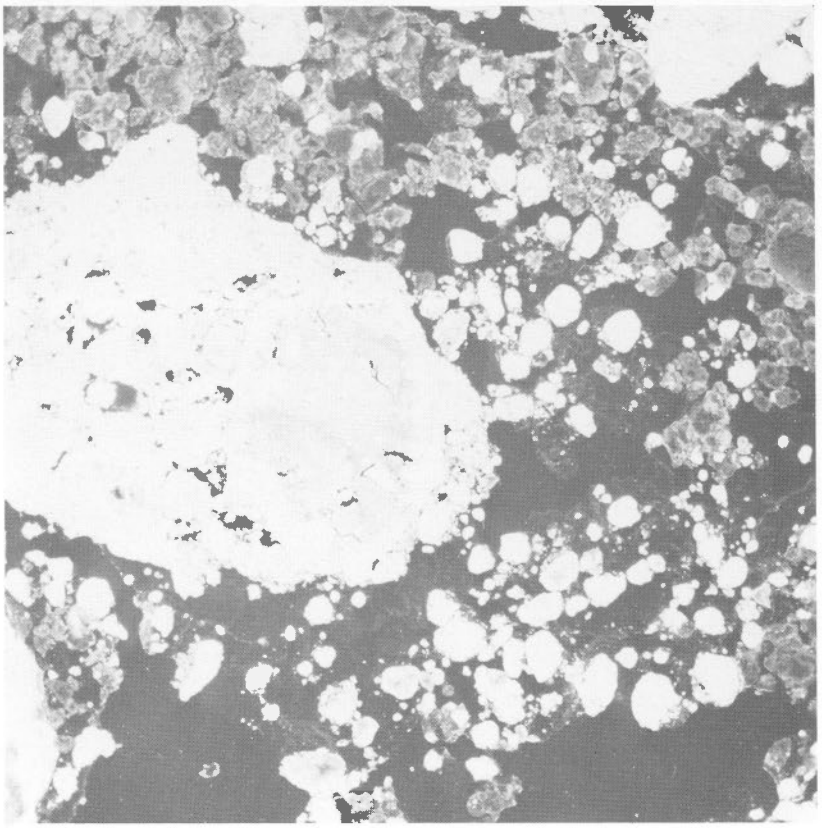


Figure 29

Drifting floe ice is being consolidated by the formation of very young ice. The dark areas are remnants of open water in the young ice surface.

Figure 30

An area of brash and small winter floes, together with slush and sludge is being consolidated by the formation of young ice.

Figure 31

The edge of winter ice in the central part of the photograph consists of consolidated floes with recently formed snowdrifts New ice (bottom) is composed chiefly of tightly bonded slush and sludge. The dark area is composed of very young ice.

Figure 32

Pancake ice, marked by raised edges, occupies the upper part of the photograph. A band of sludge occupies the lower right. The formation of young ice, a part of which is under pressure, indicates consolida - tion is in progress.

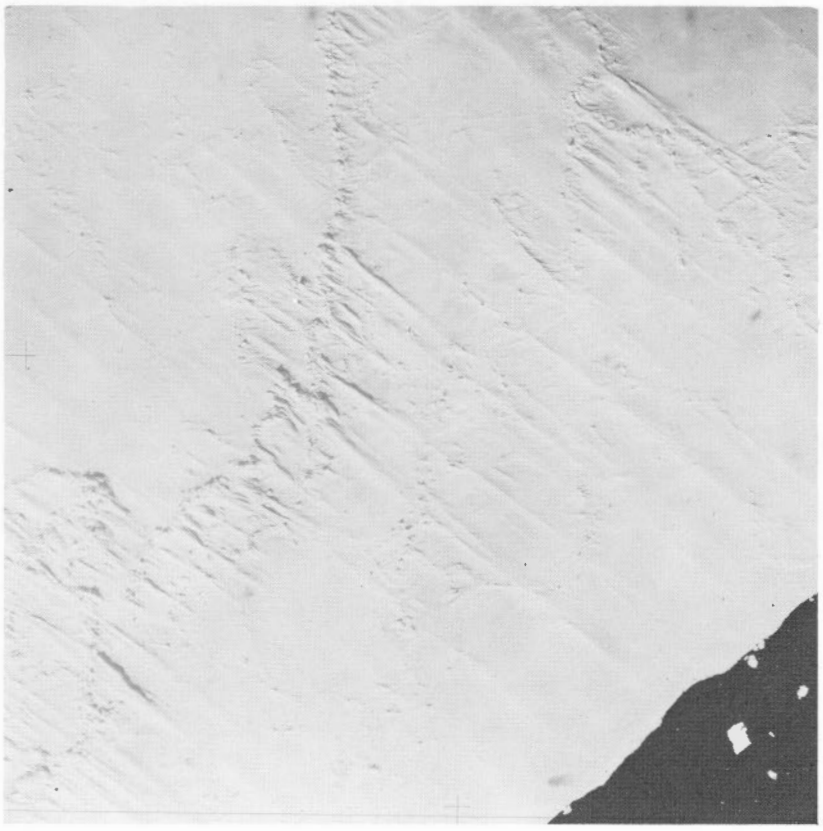


Figure 33

The heavy layer of snow and linear drifts obliterate the details of the formation of the ice sheet. Winter ice forms are considered to exist wherever the ice can support a snow cover. without the cover becoming grey from water seepage.

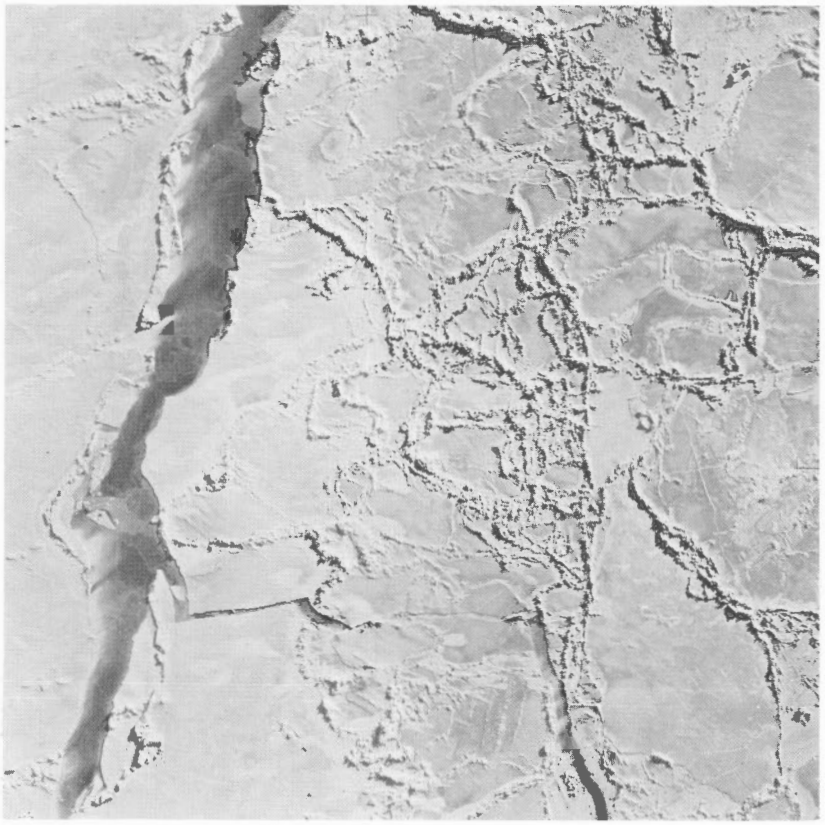


Figure 34

The sharpness of the details that compose the pressure ridges indicates that the winter ice has been subjected to recent pressure. The formation of young ice in the area of open water is indicative that consolidation of the ice field is now in progress and that the disruption of the ice surface has been retarded.

Figure 35

A field of ice consisting of brash, block and small floes is in the process of consolidation as evidenced by the formation of young ice in the area of recent open water. Micro-shelving of the young ice is in progress. Scale 115' to 1 inch.

Figure 36

A field of brash and small floes is in process of consolidation. Surface details are rough. The ice consists chiefly of winter ice and heavy young ice. The grey colour indicates that this ice is younger than the surrounding ice. Scale 115' to 1 inch.

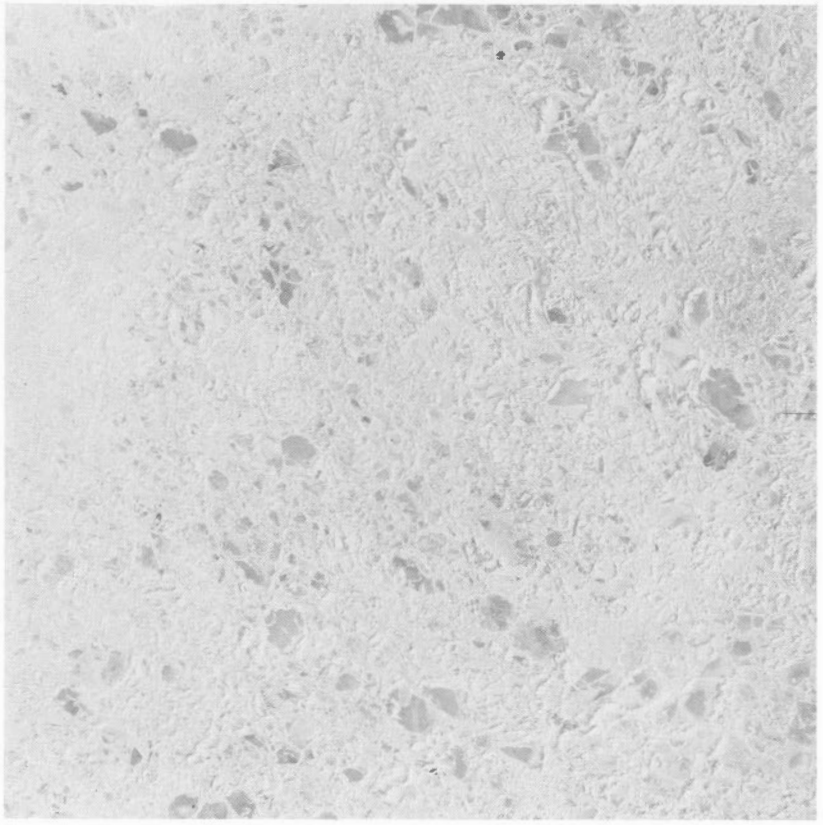


Figure 37

A field of young ice consisting of brash, block and small floes is being consolidated into a single ice sheet. The ice has been shattered by the wave action of a storm.

Figure 38

Winter ice, showing the earlier outlines of a brash and block area, has the details of the individual flows partially concealed by a recent snow cover.

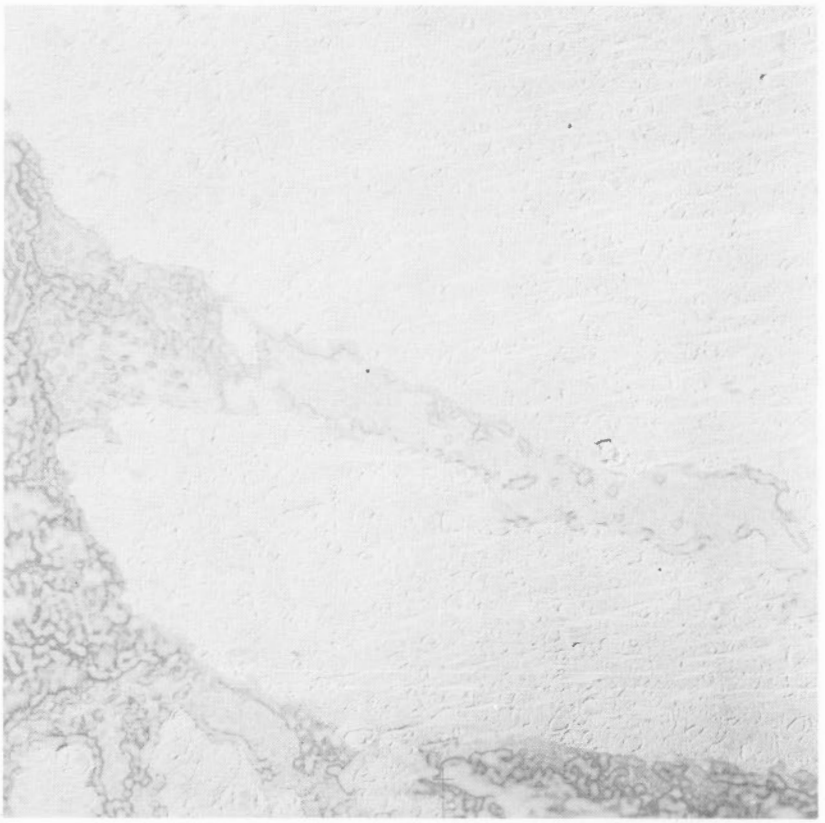


Figure 39

An area of brash and block in which the details of individual floes have largely been subdued by a recent snowfall. Consolidation has recently begun.

Figure 40

An area of young and winter ice which has been disrupted by wave action but is again in the process of consolidation. A recent snowfall has contributed to the formation of young ice. In detail, the winter ice is rough whereas the young ice is smooth.

Figure 41.

A consolidated brash and block field on which, after a recent rainfall followed by freezing, a 'glassy' surface has been produced. Drifting snow is beginning to accumulate on the ice surface.

Figure 42.

A consolidated brash and block field which, after a brief thaw period, has begun to accumulate a load of snow. The straightness of the snow lines indicates the high velocity of the winds that sweep over the ice.

Figure 43.

This ice carried a heavy layer of snow, which after a brief thawing period, produced the mottled surface. The details of the underlying ice surface are completely obscured. The ice surface is likely to be soft. Scale 115' to 1 inch.

Figure 44.

Rain and freezing conditions produced this pattern on an ice surface covered by a layer of snow. The white opaque blobs are ice-coated snow. Recently fallen snow is accumulating in drifts.

Figure 45

Snowdrifts have accumulated on a surface of winter ice. A rain followed, but not sufficient to reduce the snowdrift pattern to blobs. Low temperatures have checked the thawing process.

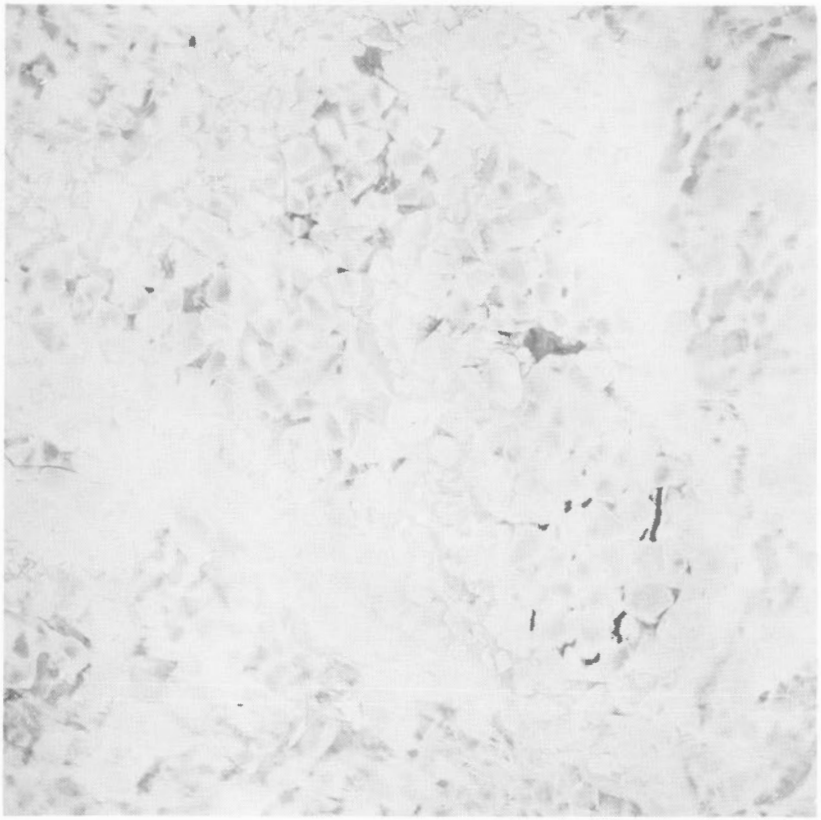


Figure 46

A new ice surface consisting of consolidated block and small floes. The surface of the floes is smooth and glassy. Low temperatures are bringing about a consolidation of the ice.

Figure 47

A new ice surface, which has been subjected to pressure after a recent snowfall, is in the process of breaking. Since the snowfall the winter ice has been disturbed, so that each floe is in a different position than at the time of the snowfall.

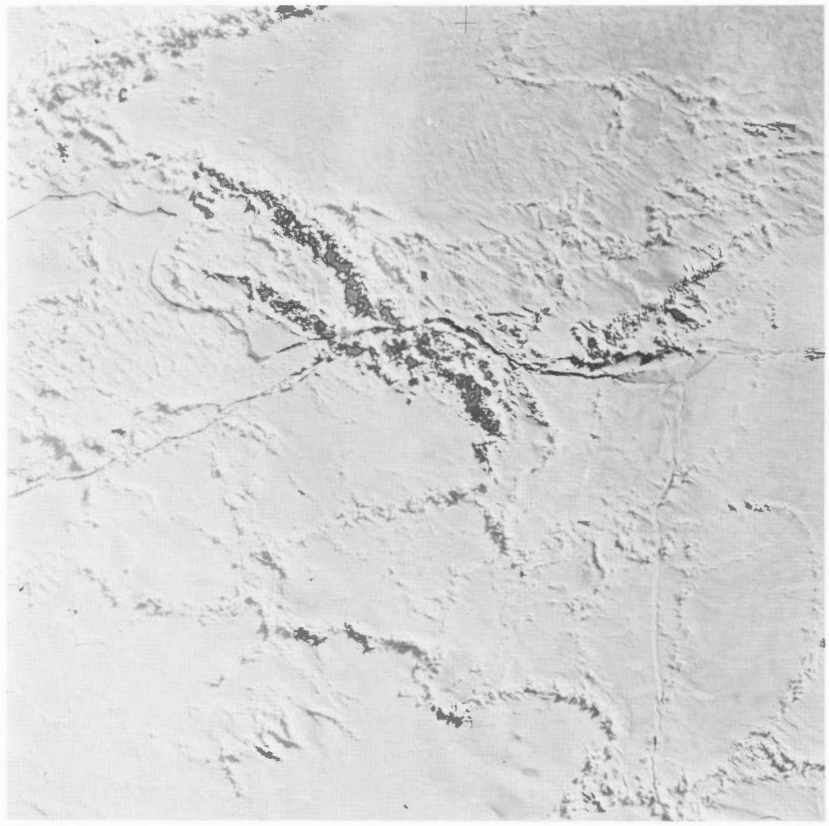


Figure 48

Though pressure ridges are adding to the thickness of the winter ice in localized areas, the ridges as well as cracks represent zones of weakness in an icefield.

Figure 49. This pressure-ridged winter ice field covers 8/10 of the ice surface. A release of pressure could result in ice types ranging from brash to medium floes. The crack is evidence that the ice is still subject to destructional forces. Scale 115' to 1 inch.

Figure 50. This rectangular pattern of ice blocks results when a sheet of relatively young ice breaks up under a gentle sea swell. Scale 115' to 1 inch.

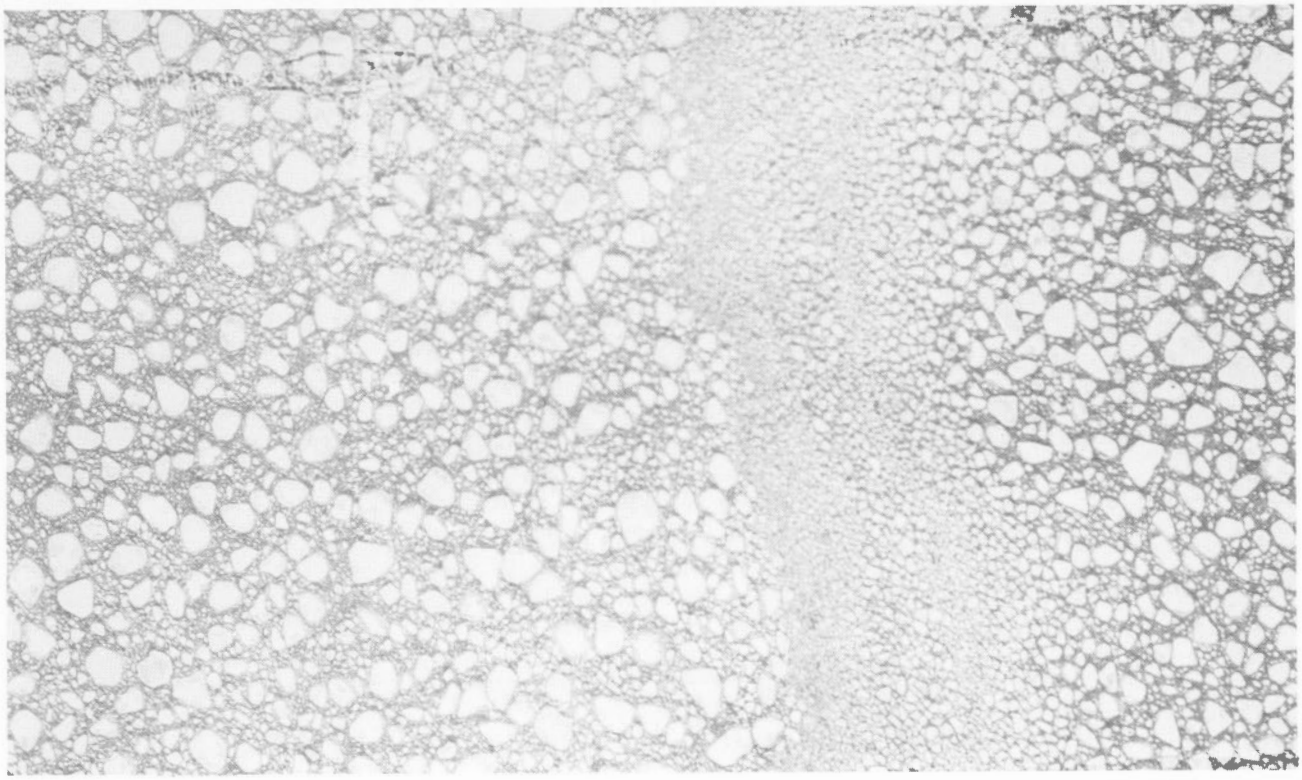


Figure 51. Brash occupies 6/10 and block 4/10 of the ice surface. Total concentration is $\frac{10}{1000}$. The sorting of the ice is the result of wind and wave action. Scale 115' to 1 inch.

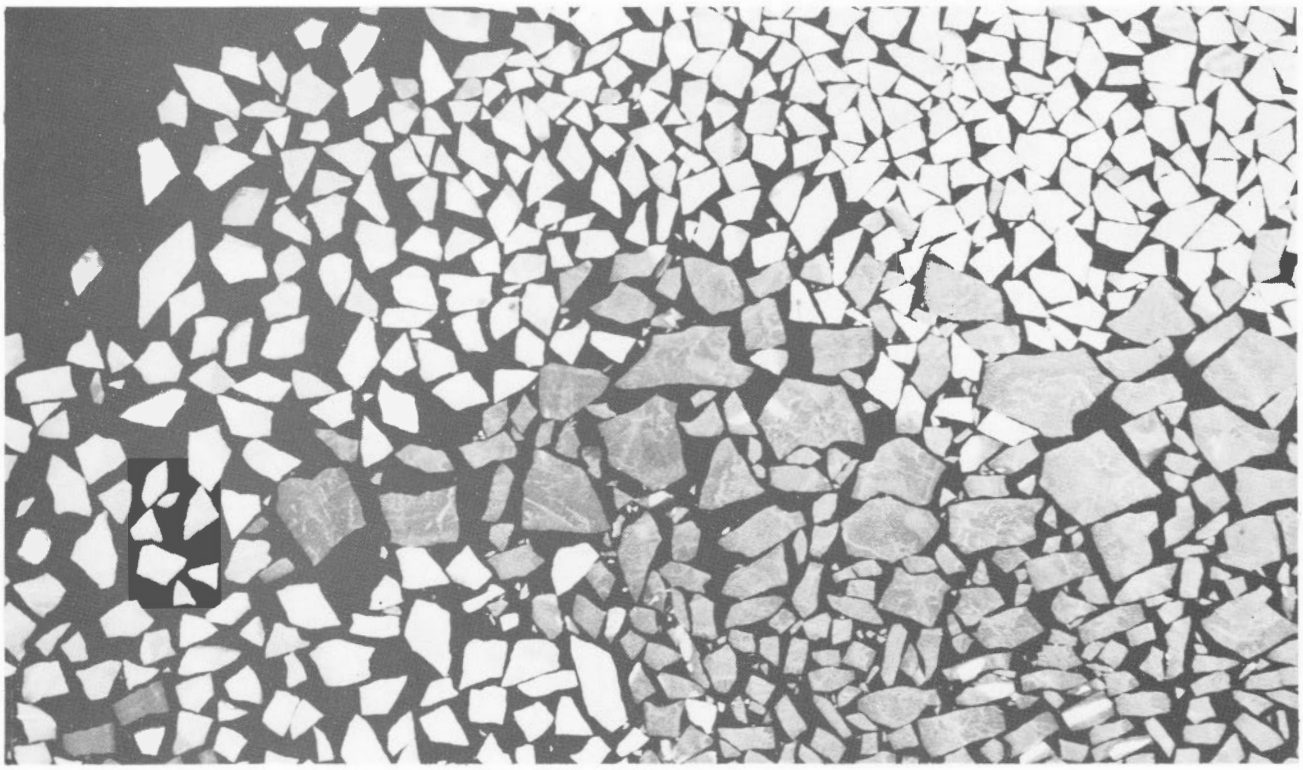


Figure 52. Block ice occupies 8/10 of the ice surface: white winter ice covers 5/10; grey young ice 3/10 of the ice surface. Total concentration is $\frac{8}{800}$. Scale 115' to 1 inch.

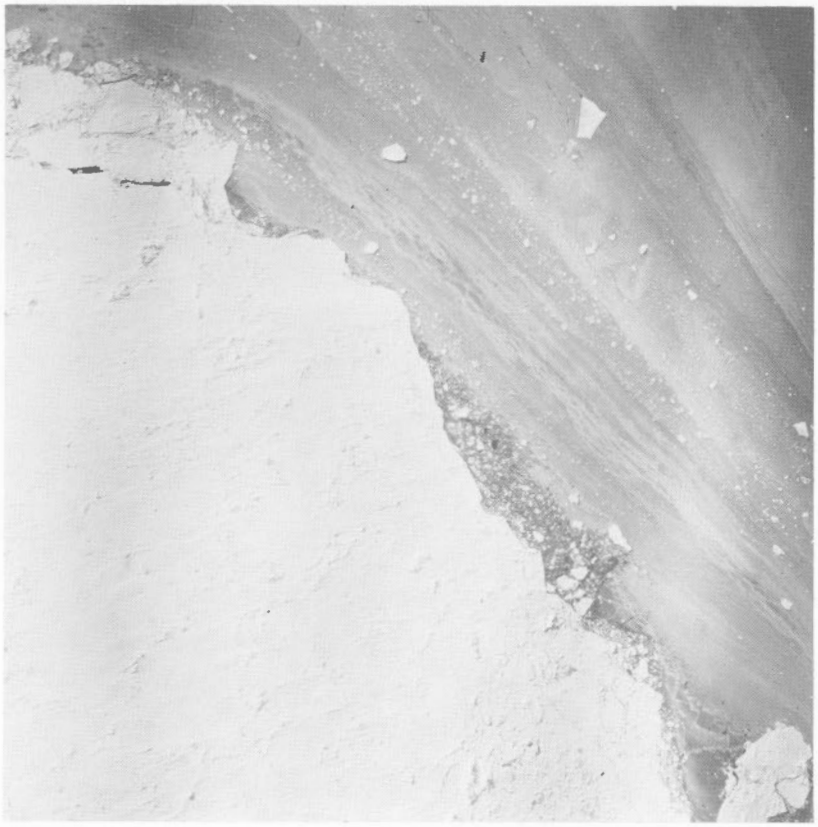


Figure 53

Ice along the edge is continuing to break from the heavy winter floe. Part of the wreckage, in the form of brash and sludge, is held against the ice edge by the force of prevailing wind and wave.

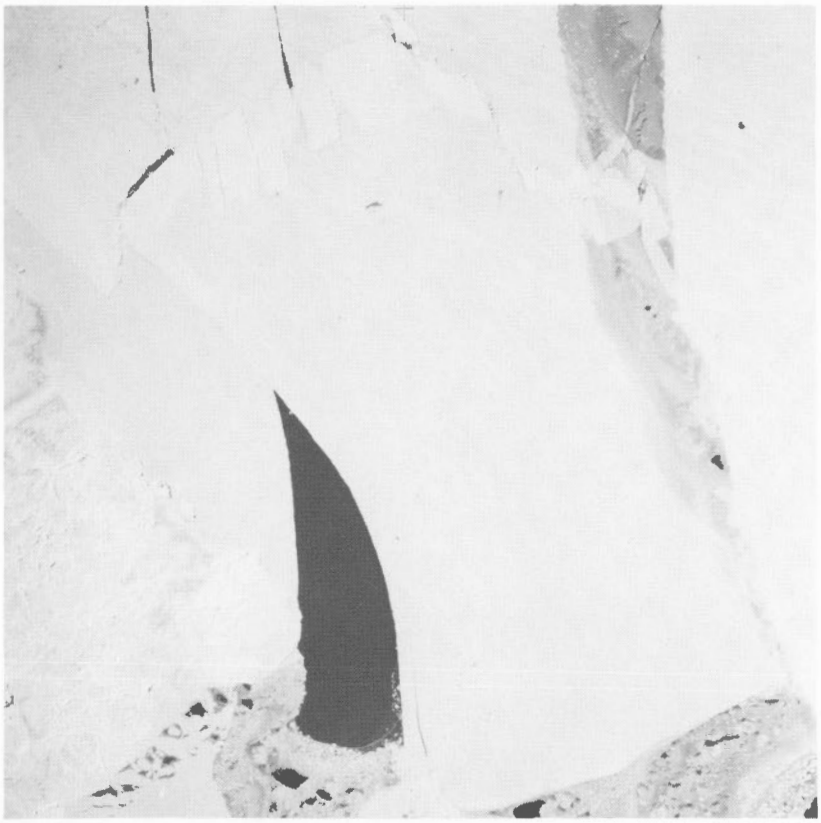


Figure 54

Young ice covered by a layer of snow is in process of breaking into large floes. The rectangular patterns along the line of shelving are clearly indicative that the ice has not passed into winter ice forms.

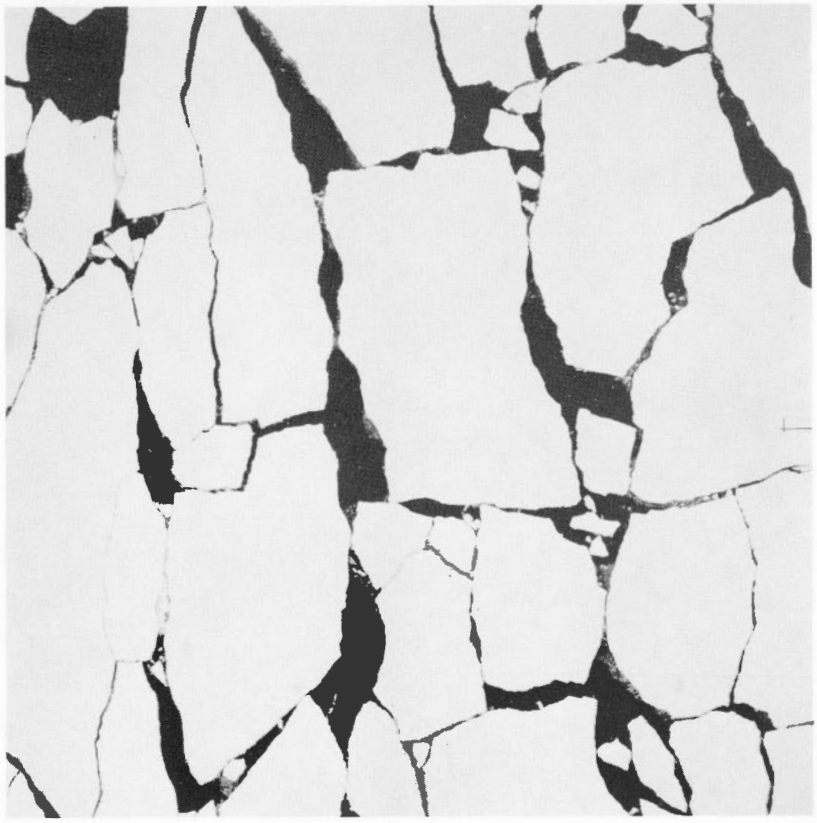


Figure 55

Medium floes of winter ice, are forming from the break-up of a substantially larger ice sheet.

Figure 56

The recent breakup of a winter ice sheet formed these angular shapes of small floes and brash and block.

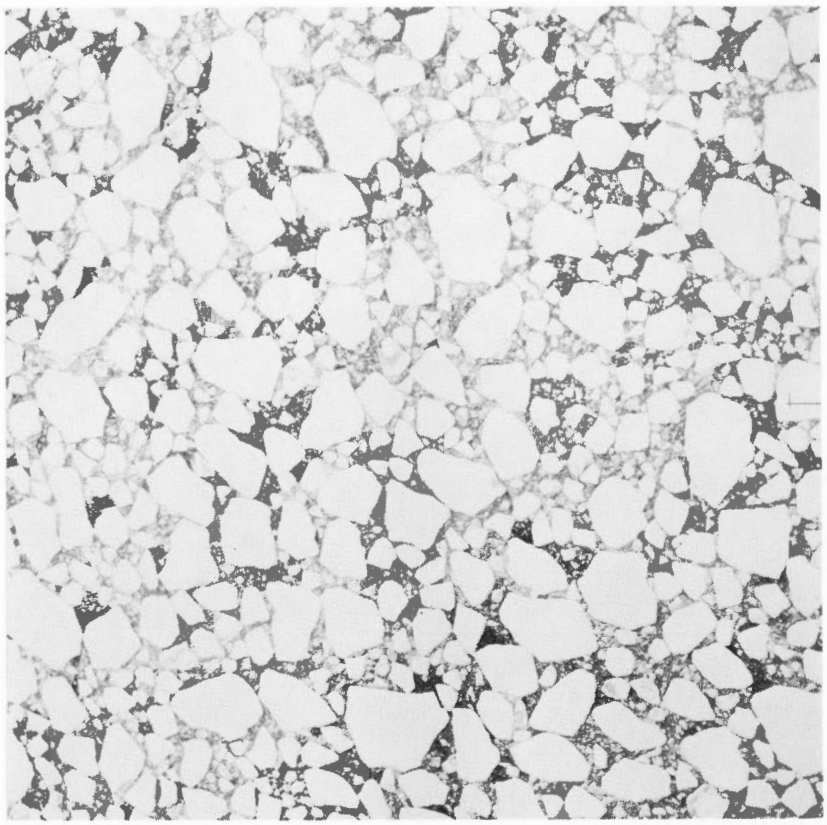


Figure 57. The edge between landfast winter ice, right, and drifting ice, left, is usually clearly indicated. The landfast ice may contain marks of earlier ice edges. Considerable ice wreckage borders the edge when the wind is blowing inshore, or is relatively free when offshore winds prevail.

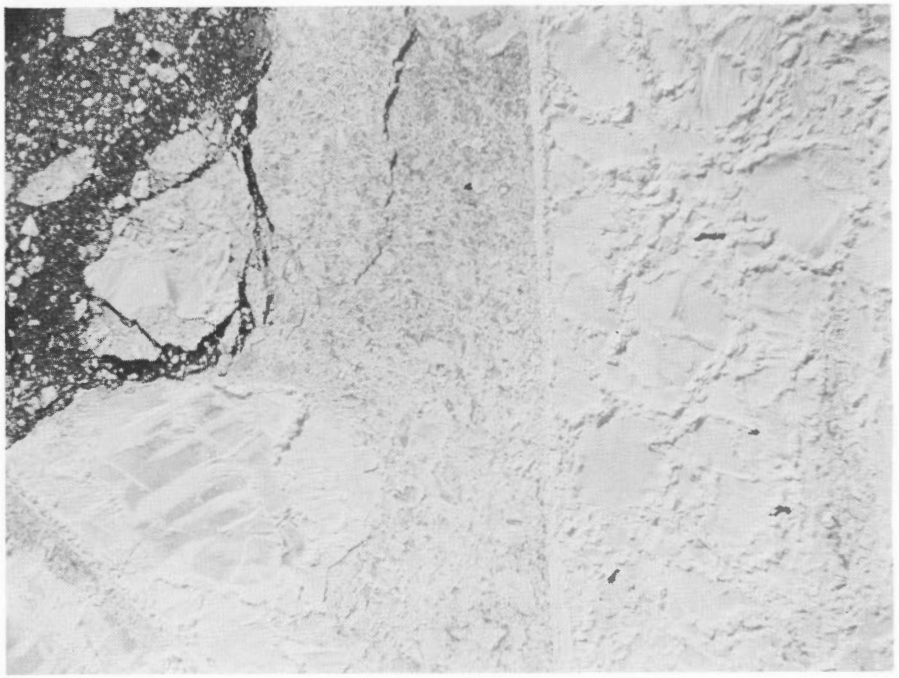
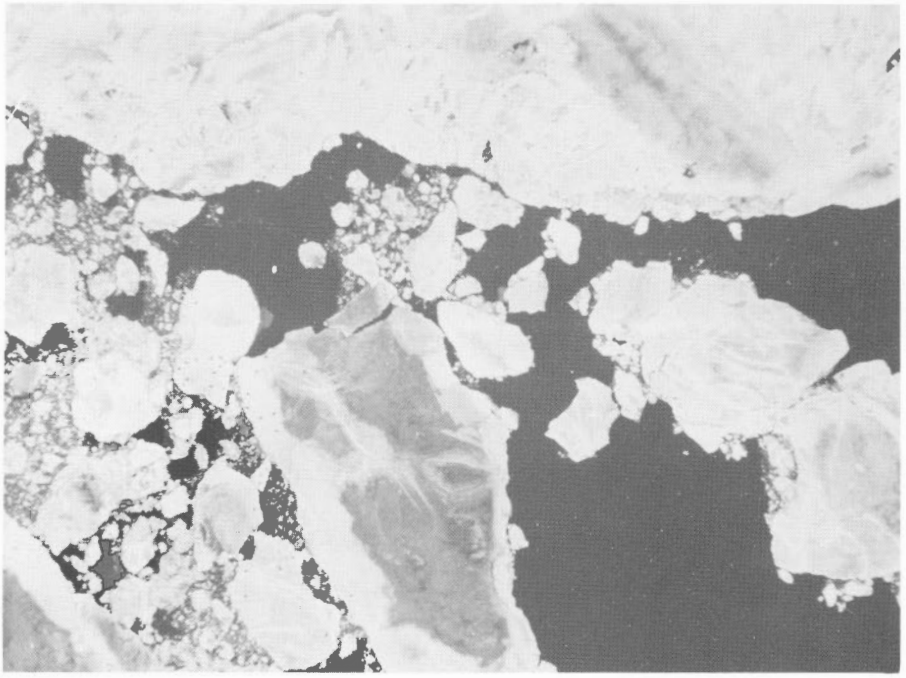


Figure 58. The edge between the landfast young ice on the right and the floating ice on the left is clearly marked.

Figure 59. Brash covers about 1/10, small to medium floes 2/10, and large floes 5/10 of the ice surface. Total concentration is $\frac{8}{125}$. A small herd of seals is visible at the left side of the photograph.



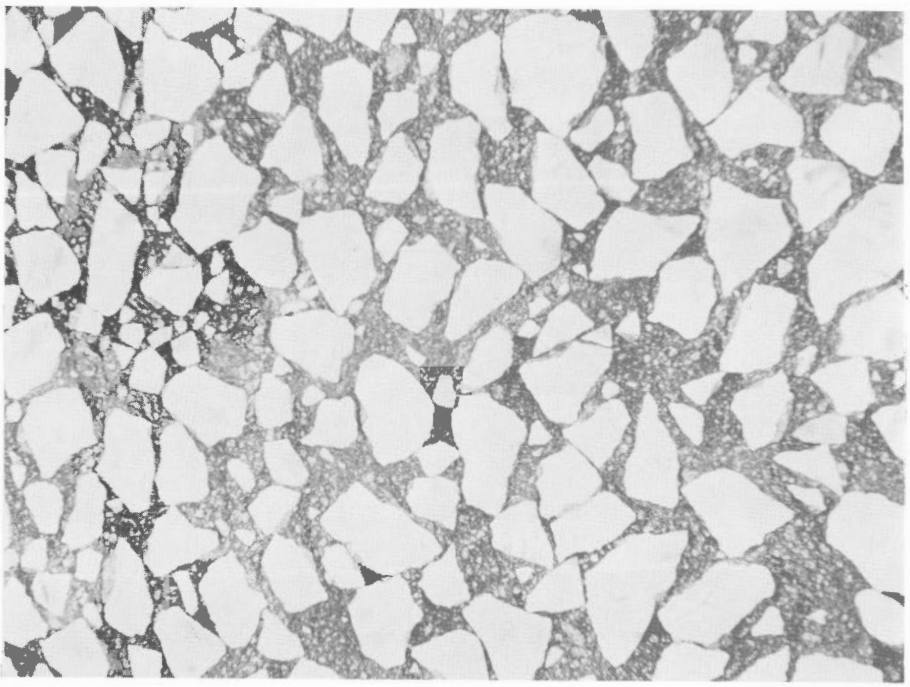
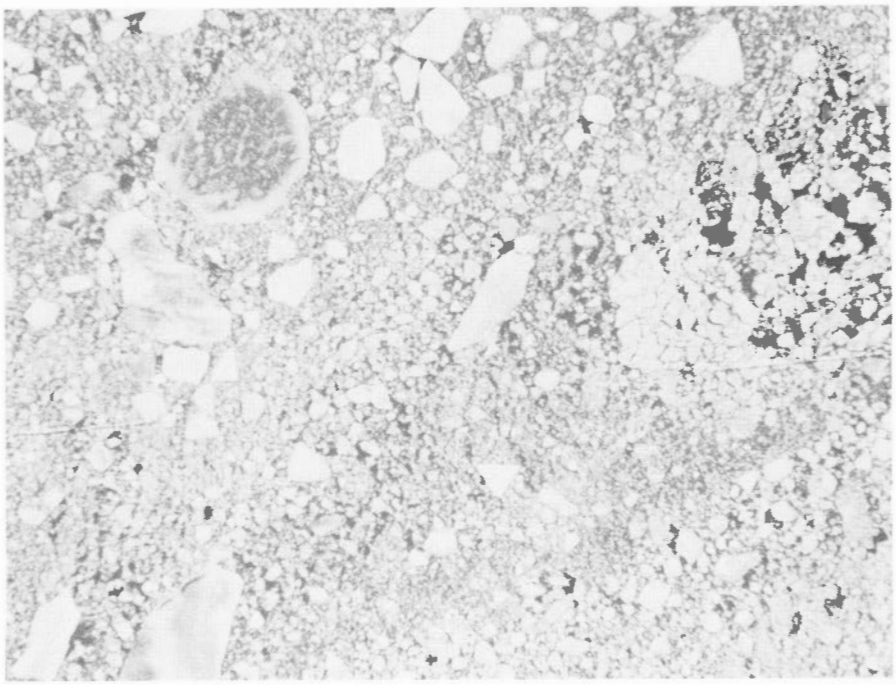


Figure 60. Brash and block cover 4/10 of the ice surface, whereas small to medium floes cover 6/10. Total concentration is $\frac{10}{460}$.

Figure 61. Brash and block cover 8/10 and small to medium floes cover 2/10 of the ice surface. Total concentration is $\frac{10}{820}$. The ice field is in gentle motion.



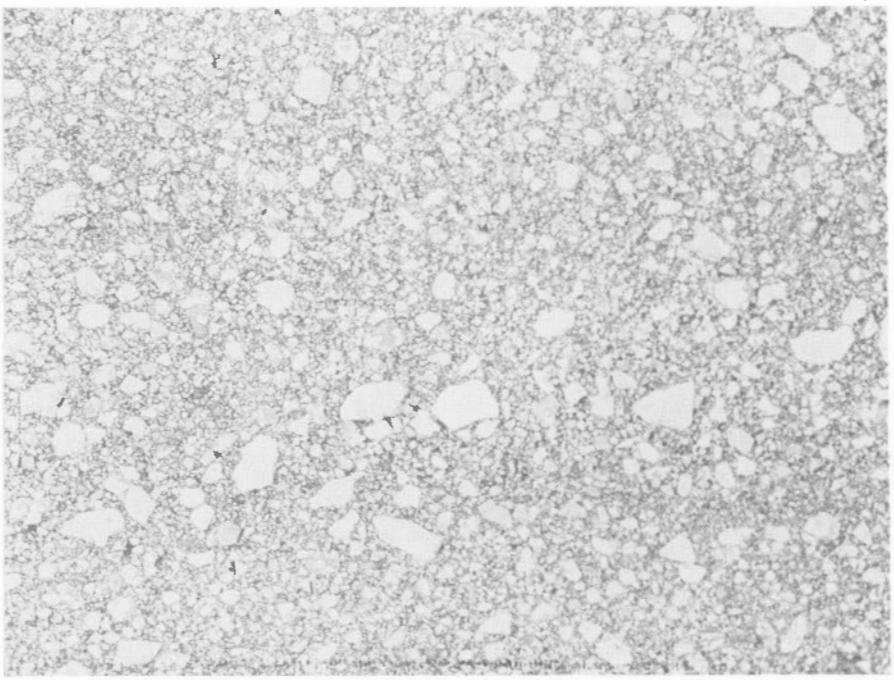


Figure 62. Brash and block occupy 9/10 of the ice surface, whereas small floes occupy 1/10. Total concentration is $\frac{10}{910}$. In a violently moving ice field, floe ice is ground into brash.

Figure 63. Brash and block occupy 6/10, and small floes 3/10 of the ice surface. Total concentration is $\frac{9}{630}$. The pieces of ice are angular in shape resulting from recent shattering.

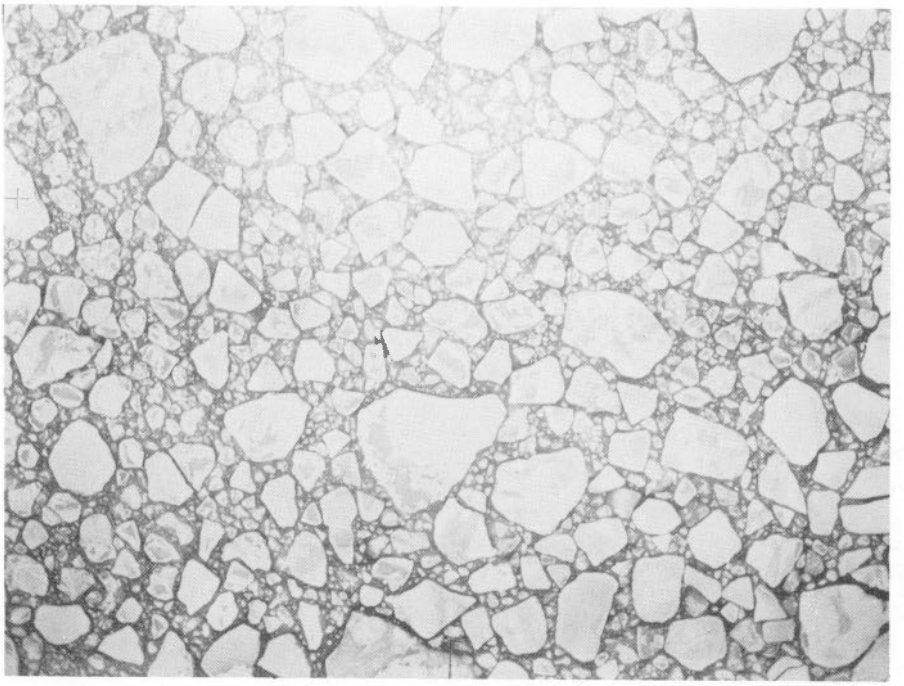


Figure 64. Brash and block occupy 3/10, and small floes 7/10 of the ice surface. Total concentration is $\frac{10}{370}$. The corners of the ice pieces are becoming smooth and rounded resulting from constant jarring together of the ice when water-cushioned.

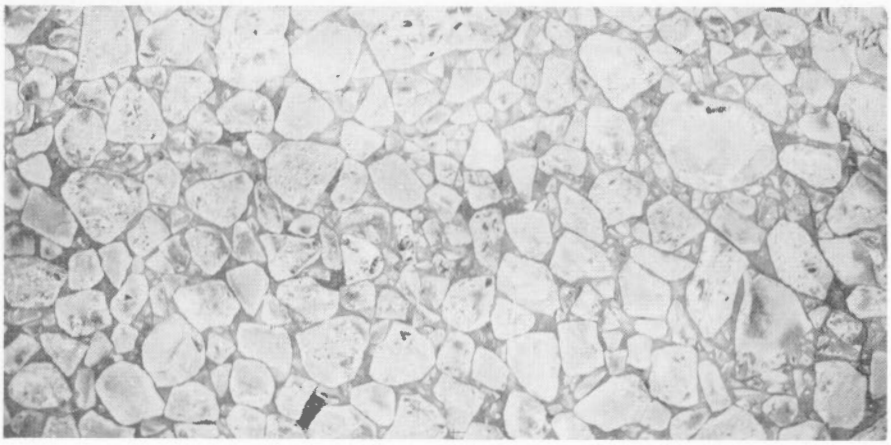


Figure 65. Brash occupies 3/10 and small to medium floes 7/10 of the ice surface, making a total ice coverage of $\frac{10}{370}$. The corners of the ice are well-rounded.

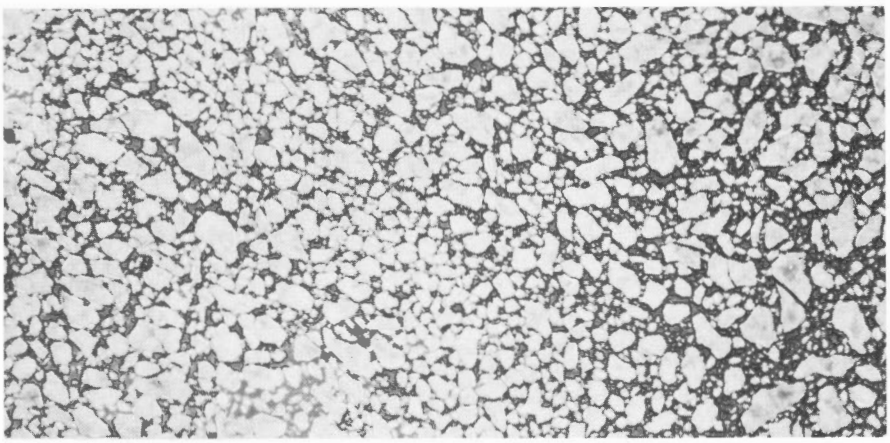


Figure 66. Brash occupies about 3/10 and block 7/10 of the ice area. Total concentration is $\frac{10}{1000}$. The smoothness of the outline of individual pieces results from water acting as a cushion when the pieces are tossed violently against each other.

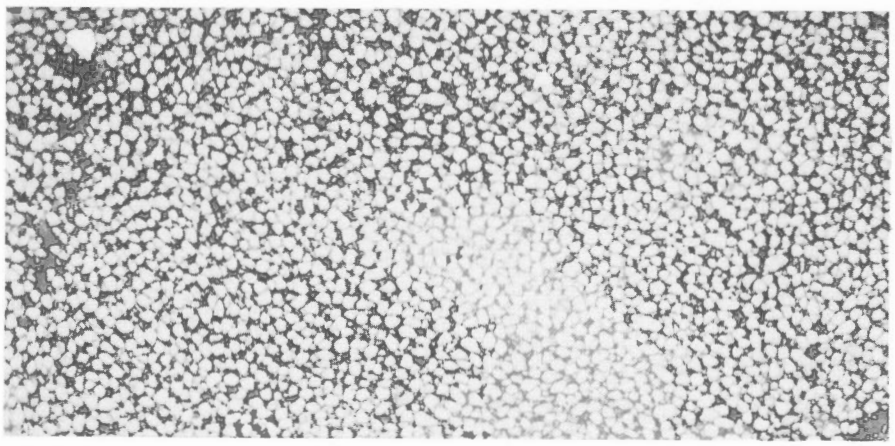


Figure 67. Brash occupies 1/10 and block occupies 9/10 of the ice surface. Total concentration is $\frac{10}{1000}$. The regular size of the block is the result of the sorting action of wind and wave.

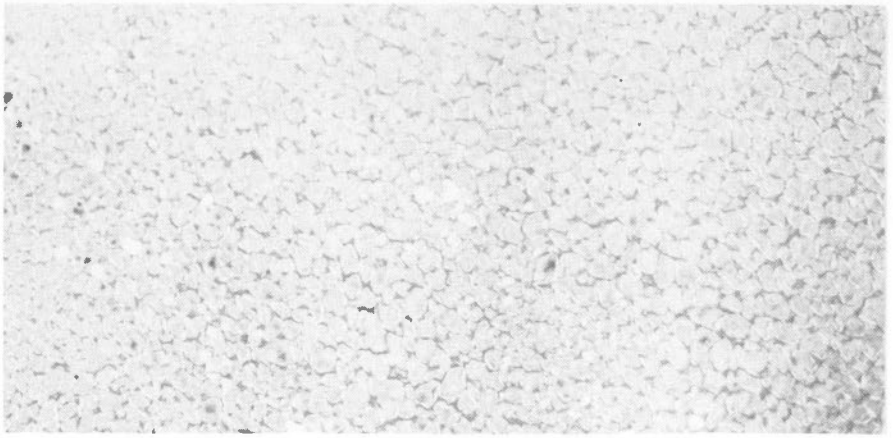


Figure 68. Pancake ice consisting of block has a concentration of $\frac{10}{1000}$. The raised edges of the ice floes are water-logged. When floes come together water rises up between them to spill against the raised edges. This is characteristic pancake ice.

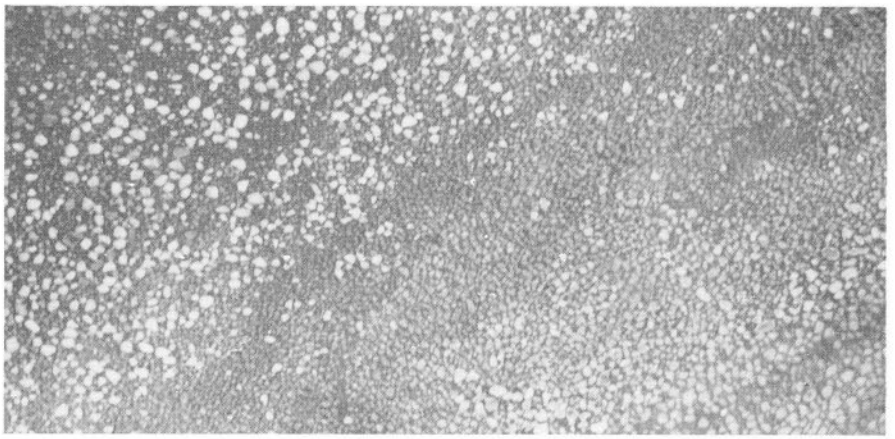


Figure 69. Slush and sludge occupy 7/10 and block 3/10 of the ice surface. Total concentration is $\frac{10}{7s300}$.

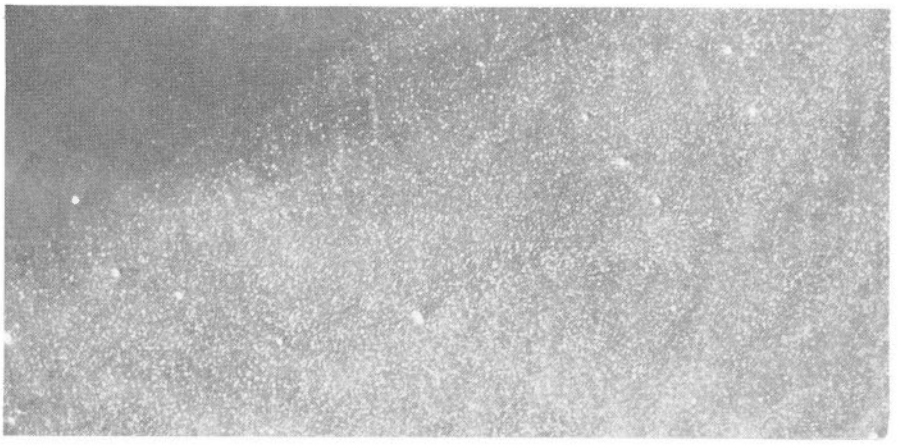


Figure 70. Sludge, consisting of small pieces, and slush comprise 8/10 of the ice surface. Total ice coverage is $\frac{8}{8s000}$.

Figure 71

Consolidated young ice with a total ice concentration of 9/10 consists of medium floes ($\frac{9}{090}$).

Figure 72

Total ice coverage is 9/10 and consists of 4/10 winter ice and 5/10 young ice. Ice concentration is 1/10 brash and block, 8/10 field, making a total of $\frac{9}{108}$.

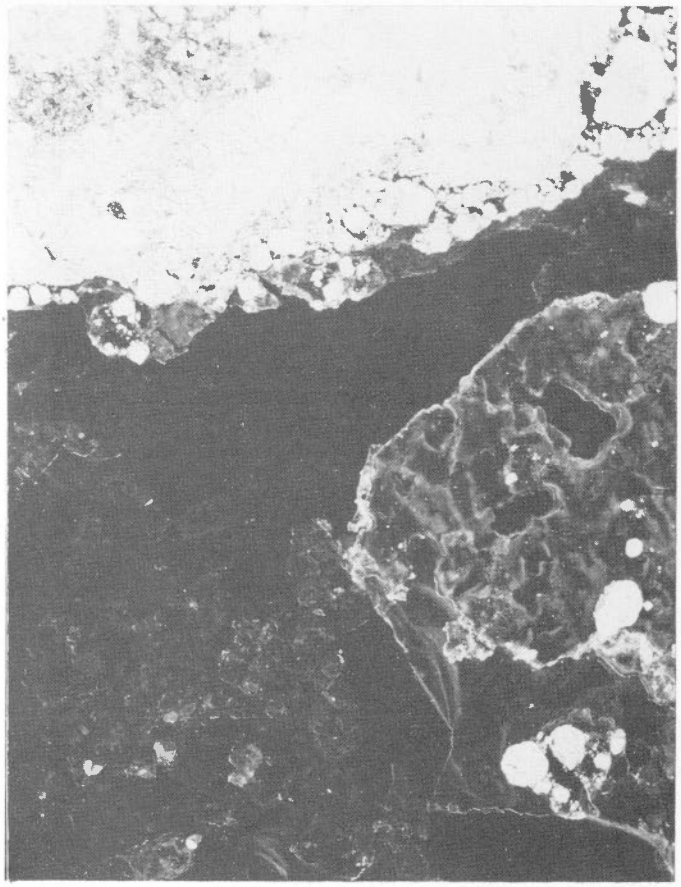


Figure 73

Total ice coverage is 10/10 and consists of 3/10 consolidated winter ice and 7/10 very young ice making a concentration of $\frac{10}{0010}$.

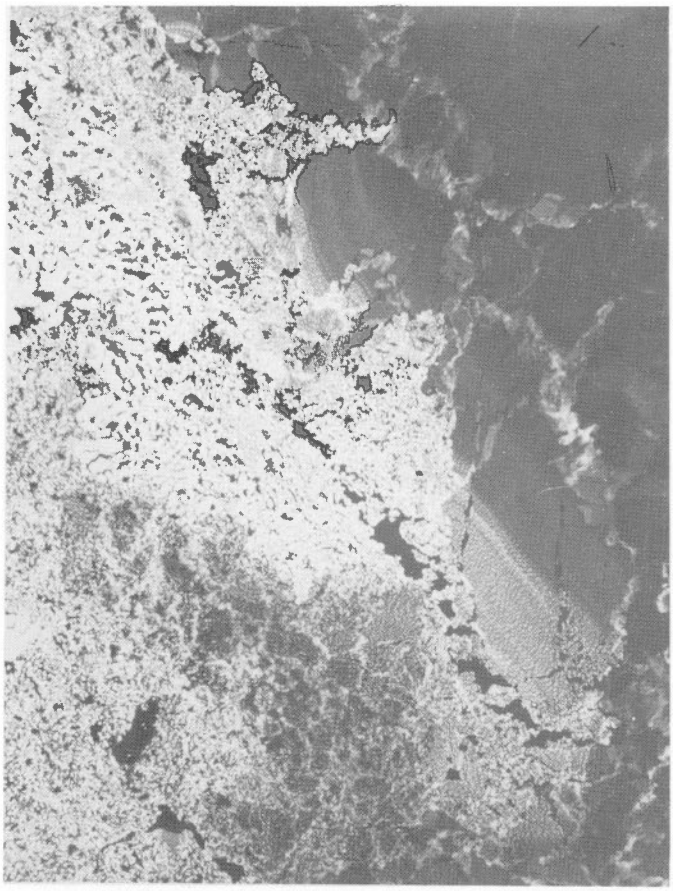


Figure 74

Total ice coverage is 9/10 and consists of 3/10 very young ice and 6/10 slush and sludge. Total concentration is $\frac{9}{6s003}$.

Figure 75

A field of brash and pancake ice that is tightly compressed and appears to be consolidated. Ice coverage $\frac{10}{1000}$. Scale 115' to 1 inch.

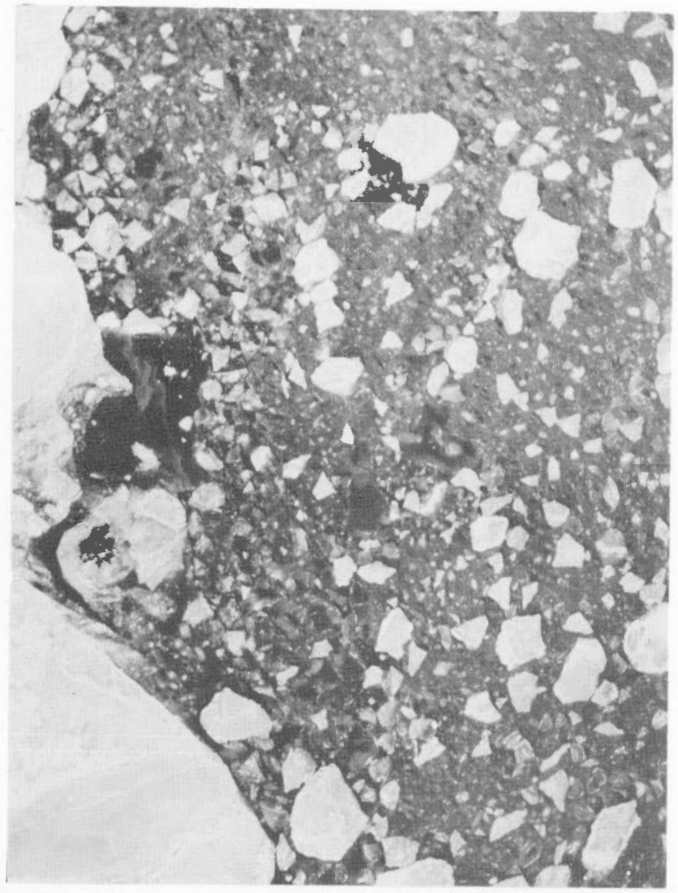


Figure 76

Young ice floes occupy 2/10 and very young ice chiefly in the form of brash occupies 7/10 of the ice surface. Total ice concentration is $\frac{9}{720}$.

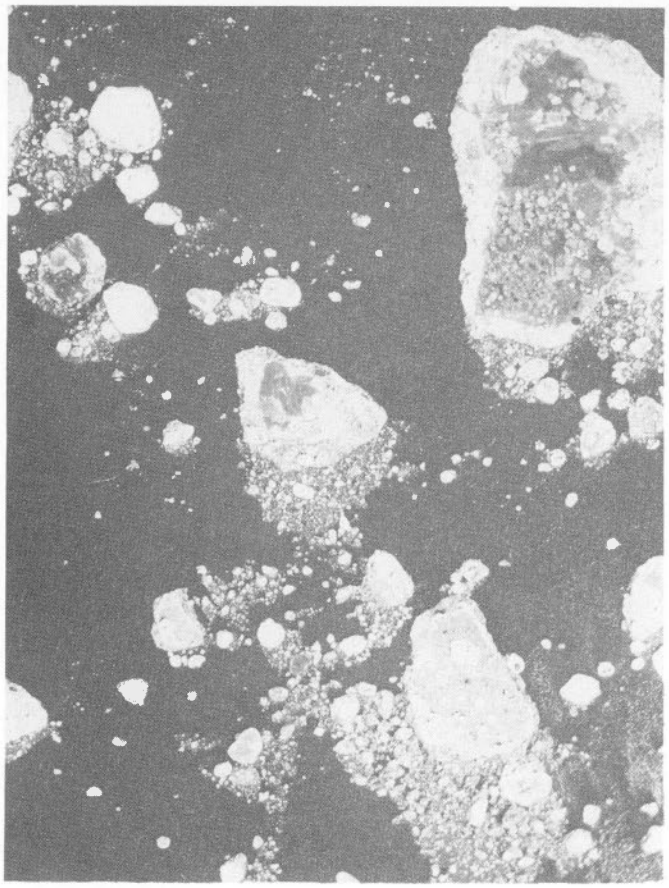
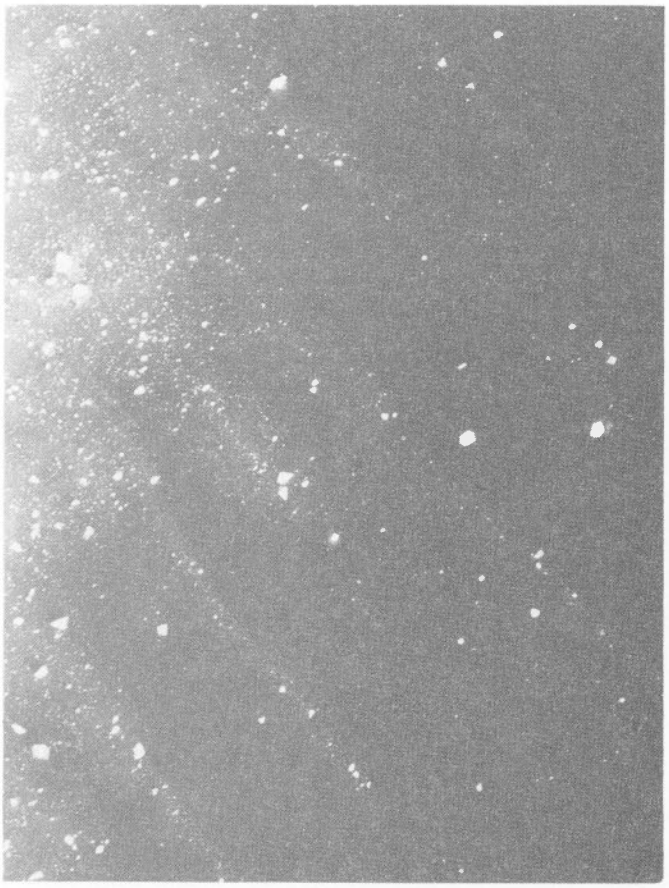


Figure 77

Scattered brash and block occupies 1/10 and small floes occupy 2/10 of the ice surface. Total concentration is $\frac{3}{120}$. This ice is composed of floes of both winter and young ice.

Figure 78

Scattered strings of brash and block in open water have a total ice concentration of $\frac{2}{200}$.



GEOGRAPHICAL PAPERS

*Miscellaneous Papers Series

No. 1. A List of the Place Names of the Island of Newfoundland with their Geographical Positions. Ottawa, 1950. 59 pp., mimeo.

No. 2. Geography in Canadian Universities. By M. R. Dobson. Ottawa, 1950. 51 pp., mimeo.

No. 3. Directory of Canadian Geographers. Compiled by Barbara J. McLeod. Ottawa, 1951. 29 pp., mimeo; 2nd ed., 1953. 34 pp., mimeo.

No. 4. Gazetteer of Northern Canada and Parts of Alaska and Greenland. Compiled by S/L H. A. Forbes, R.C.A.F., Ottawa, 1948. 75 pp., mimeo. *Out of Print*

No. 5. Preliminary Bibliography of Colonization and Settlement in Latin and Anglo-America. By D. K. Doherty. Ottawa, 1952. 70 pp., mimeo.

No. 6. Submissions of the Canadian Delegation to the Third Pan American Submission on Geography. Compiled by B. Cornwall, D. K. Doherty and J. I. Matheson. Ottawa, 1952. 52 pp., mimeo.

No. 7. Extracts Relating to the Navigability of Canadian Inland Waterways. By W. A. Black. Ottawa, 1956. 55 pp., offset. *Price, 50 cents*

No. 8. Notes on Potential Building Sites in the Bathurst Inlet Area, N.W.T. By J. B. Bird and M. B. Bird. Ottawa, 1956. 15 pp., map, offset. *Price, 50 cents*

No. 9. A Report on Sea Ice Conditions in the Eastern Arctic, Summer 1956. By W. A. Black. Ottawa, 1957. 31 pp., maps, photos, offset. *Price, 50 cents*

No. 10. A Preliminary Report on Ice Conditions at Cacouna Island, Que. (bilingual). By B. Robitaille. Ottawa, 1957. 24 pp., maps, photos, offset. *Price 50 cents*

*Title "Miscellaneous Papers Series" discontinued after No. 10.

Available from The Queen's Printer, or from Geographical Branch, Department of Mines and Technical Surveys, Ottawa.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1957.