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... THE ARCTIC ENVIRONMENT ...

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THE ARCTIC ENVIRONMENT TODAY AND TOMORROW

The melting and disappearing of the Polar pack ice over the Arctic Ocean is a process which, when it is completed, will have the most important consequences for the transportation of oil and minerals out from the Arctic regions to the U. S. and markets of the world. It will also open up new shipping lanes from Europe to the Far East; it will save the distance traveled now by an average of about 60%.

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It will also affect the climate of the surrounding land areas with colder and heavy snowfalls during the winters, with a water deficiency in the latitudes of the United States and similar latitudes in Europe and Asia.

The North American interest in the Arctic regions must be seen from the geographic position of these areas as the center of the populations and the industries of the Northern Hemisphere. The three important points are: the economic, the military and the climatic. Involved in each are:

The economic - exploitation of oil and minerals.
Transpolar shipping lanes between Europe and the Far East.

The military - defense against air and seaborne attrition across these regions.

The climatic - serious consequences of the vanishing of the pack ice shield over the Arctic Ocean.

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In 1953 Professor H. W. Ahlmann of the University of Upsala in Sweden presented a paper at the geophysical conference in Sweden stating that due to the continual inflow of carbon dioxide to the air over the Arctic Ocean, which is mainly caused by the volcanic eruptions in the Northern Hemisphere over the last 1500 years, the icecover over the Arctic Ocean is degrading. The polution of the Arctic air binds heat from the sun's rays thus warming up the air with consequent melting of the pack ice.

Professor Ahlmann predicted that if this trend continues the Arctic Ocean will be ice free by the turn of this century, and it will remain an open ocean. This prediction has been supported by the following scientific authorities: Plass in 1956; Callender, 1958; Kaplan, 1960; Mitchel, 1965 and Quam, 1968. [1]

The albedo of 60% to 80% limits the absorption of the incoming heat to keep the icecover in balance; it acts as an inhibitor of the heat exchange between the overlaying air and the underlaying water. Heat budget calculations give rise to the belief that a reduction of summer albedo of the pack ice from 70% to 60% would melt it in 9 to 10 years - a reduction to 50% would do so in 2 to 3 years. A summer air temperature increase of 10^{o} F. would melt the ice in no more than 2 years and an increase of 5^{o} F. would do it in a few decades.

In the last 29 years (I started my work for the U. S. Air Force in the Arctic in 1941), Thule opened up for resupply by sea from about the middle of August to mid September. Today Thule is open from about the latter part of June until November.

Observed ice conditions on a flight from Thule AFB to Point Barrow July 4, 1968:

Thule to East Side Devon Island - Slush ice with large basins of open water; Lancaster Sound open to Brodeur Peninsula and to Bear Bay in James Sound.

Devon Island to West Side Banks Island - Solid ice cover, long cracks, large melt pool, whole ice surface is waterlogged and cored. Estimated Albedo is 50%, fast deteriorating surface.

Banks Island to Point Barrow - Large, open leads running East to West. Some of them 10 to 12 miles wide and up to 100 miles long; ice is thin with numerous melt pools and waterlogged with slush and open pools over most of the surface.

This type of ice, when pushed by wind, opens up larger leads. With a southerly wind it could leave an open passageway all along the Northern coastline into the Beaufort Sea. This is a situation which I had never seen up there before nor heard of, but which happened this year.

Looked at in connection with the large flush out of ice between Spitsbergen and Greenland in March this year. It can lead to a possible opening up of the Arctic Ocean in the near future.

In July, 1969, there was completely ice free water all the way up to the Arctic Ocean through Baffin Bay, Kane Basin and Robeson Channel along the west coast of Greenland.

On July 10, 1969, on a flight from Thule to Point Barrow, Lancaster Sound was open from Baffin Bay until West of Cornwallis Island. Slush ice covered the Melville Sound area; McClure Strait had slush ice with open leads - it was open to the Beaufort Sea; Prince of Wales Sound open along the shores and with floating slush in the center. Amundsen Gulf and Beaufort Sea had large bodies of open water. From here and to Point Barrow, the water was covered by floating pack ice which should not be of any consequence to ice reinforced ships.

Another factor has come up lately which can accelerate the melting of the Polar icepack much faster than the pollution of the air; the upwelling of the warmer Atlantic water from depths of 600 feet under the colder Arctic waters to about 30 feet below the ice. The warmer water - the Atlantic water - has now been observed in the Arctic Ocean at a Soviet station at 80° North and 180° longitude. It has also been observed outside Spitsbergen the last couple of years. The Atlantic water has been found at depths of around thirty feet and on the surface.

The ice thickness over the Arctic Ocean is now at a critical stage; average thickness of about 6 to 8 feet covering an area of from 5 to 3.5 million square miles in winter and summer.

We have the following information on the degradation of the ice:

1893 - Nansen, wintering at the New Siberian Islands: The measured thickness of Arctic pack ice flow adjacent to ship was 43 feet. Source of information: Professor H. U. Sverdrup's reply to an inquiry from Professor Ahlmann at Oslo in 1951.

1937 - Professor Otto Schmidt, head of the Soviet Arctic Institute. He had just returned from a flight to the North Pole with four Soviet aircraft. I had a conference with him at his office in Moscow in July, 1937. He told me that they had measured ice 22 feet thick as a typical pack ice floe.

1961 - Actual measurements of the pack ice during the International Geophysical year 1957-1958, reported in Rand Study R-44.

1962 - Measured thickness at Soviet ice station at 6 feet, 11 inches, on April 4, 1962.

1967 - Measured thickness from surface and submarines in SCAR report. This data is plotted in graph Fig. 1.

A listing of the breakup and closing times at Point Barrow as given:

Breakup of ice	- 15th of June, early 22nd of August, late.
Freeze up of ice	- between the 2nd of September and the 17th of December. Average between the 1st and 5th of October.
Breakup, 1968	- in March
Freeze up	- in November.
Breakup, 1969	- in February.

In February, 1968, there was a large outflow of heavy Polar-pack ice between Greenland and Spitsbergen. This outflow blocked the Northern coast of Iceland from March to May. It blocked Greenland's East coast the whole summer till late in the fall and prevented shipping to Spitsbergen, Bear Island, Jan Mayen and the eastern coast of Greenland till late fall. The Norwegian Polar Institute estimated that 30 to 40% of the Polar pack ice had drifted out into the Greenland Sea.

The climate of the Arctic Regions is, at the present time, a desert climate with a yearly precipitation of around $9\frac{1}{2}$ inches a year. It is also very much milder than the surrounding Arctic and Subarctic land areas. The reason being the presence of open water leads occurring all the time, even at the North Pole in mid-winter. This presence of open water is the ameliorating temperature factor.

The ice plate which has up until now covered the Arctic Ocean, with a relatively cold surface, has caused a high pressure area to be situated over the Arctic all year-round. This Arctic high pressure deflects the cyclonic systems originating over the North Pacific to a more southerly pass across the agricultural areas of the U. S. and Canada.

Calculations indicate that if the pack ice were to disappear, the following conditions would probably prevail:

1. The Arctic Ocean surface temperature in the coldest months would be about 42° F. The pack ice cover would not form again.

2. Mid latitude climates would be 20° to 25° F. warmer than now. Low latitudes 10° F. cooler in winter.

3. The cyclones of the North West Pacific would be deflected northward into the Arctic Ocean and form a low pressure system. The moist air from these lows would dump a great amount of snow over the Arctic and Subarctic land areas. Annual snowfalls would increase another 8 to 10 feet in these areas. It would affect Alaska, Northern Canada, the Atlantic Northern Seaboard, Central Greenland and Scandinavia. The Soviet Union would be similarly affected. Cold winters would be expected in northern United States and Canada. [5] The central part of the United States would get dry winters with a large water deficiency.

The last two winters have been very severe over the belt indicated in paragraph 3. Norway has had two of the most severe winters on record with heavy snowfalls and low temperatures. Spitsbergen and Northern Greenland have had light snowfalls and mild temperatures.

The ecology of the Arctic Regions with its low density of human and animal populations, will be expected to follow the history of the intrusion of the modern technological and aerospace age, and stone age culture will have to give way to the new age.

The 5½ million square miles of Arctic Ocean - up till now 75% or 4 million square miles, ice covered all year-round, is now estimated to have an all year-round ice cover of around 3½ million square miles or 63.5% in 1969.

An ice-free Arctic Ocean, with heavy snowfalls over the litteral zones and also cold winters in these areas will bring operational problems, such as docking and navigating in these areas. They should be well within our technological capabilities to solve.

An ice-free Arctic Ocean between the North American continent and the Soviet Union creates a military responsibility of defending these areas against sea and air attrition across here and operational control should such a requirement arise in the future. It should require a close study of what type of weapons systems - naval vessels reinforced for operations in these environments and aircraft to meet their new tasks in the high Arctic - will be needed in the near future.

January 8, 1970

Bernt Balchen

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(1) AINA: Arctic, June, 1967 - Page 101.

(2) AINA: Arctic, December, 1968 - Page 278
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(3) Arctic Drifting Stations, Page 226

(4) AINA: Arctic, December, 1967 - Page 263
Soviet Arctic Drifting Station
North - 67 - 2M - thick

(5) Largely extracted from Rand Corporation
Report, R-44-P, October, 1965