

Institute of Polar Studies

Report No. 35

# **The Scientific Exploration of Greenland from the Norsemen to the Present**

by

**F. Loewe**

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OF GREENLAND FROM THE  
NORSEMEN TO THE PRESENT

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## CONTENTS

	PAGE
TWO KINDS OF SCIENTIFIC EXPLORATION	1
THE REASONS FOR EXPLORATION	1
HISTORY OF THE EXPLORATION OF GREENLAND	3
The Time of the Vikings	3
The Start of Systematic Exploration	5
From Discovery to Systematic Study	8
Exploration of the Inland Ice	9
The Crossings	9
Stations on the Inland Ice	11
SCIENTIFIC INVESTIGATIONS TODAY	12
REFERENCES	14

## TWO KINDS OF SCIENTIFIC EXPLORATION

The scientific exploration of a region like Greenland can proceed in two ways. In one way the phenomena peculiar to, or characteristic of, the region to be explored can be recorded as they occur and their distribution in space and time determined. Then after the facts are established, an explanation is sought within the framework of the existing knowledge. The aurora is an example of this kind of exploration. Its distribution and its typical features were known and had been described and classified for a considerable time. But an explanation had to await the knowledge of the behavior of discharges in highly evacuated gases; only much later, about 60 years ago, was an acceptable explanation forthcoming. One may sometimes doubt whether the first step, i.e. the accumulation of facts, in itself represents scientific work, e.g. the counting of the number of seals in a Greenland fjord. But, in any case, the collection of such basic material is indispensable for scientific progress.

The other possibility is that knowledge gained in a better known region leads to the expectation that a certain phenomenon will be found elsewhere, and exploration is then undertaken to prove or disprove its existence in the polar regions. The search for the southern magnetic pole of the earth is an example. The northern magnetic pole had been found 140 years ago, and it was known that all magnets have two poles. The probable position of the southern pole was calculated, and the Antarctic expeditions of Dumont d'Urville, Wilkes, and Ross tried to verify the calculation (Kirwan, 1960). The expectations are not always realized; the protracted search for Terra Australis, the big southern continent to match the northern continents, is an example.

We have to distinguish further between the discovery of facts which were unknown to everybody, and facts which are well known to the inhabitants of the region but have not been recorded in the western world. Among the generally unknown facts, the thickness of the Greenland ice sheet or the strange breeding habits of the emperor penguins in Antarctica may be mentioned. Facts unknown to western science but well known to Eskimos were the existence of coal seams near the glaciers and the separation of Greenland from North America.

## THE REASONS FOR EXPLORATION

Since the beginning of the exploration of the Arctic regions by Pytheas of Massilia more than 2,000 years ago, many people have explored the Arctic for different reasons (Victor, 1962). In earlier times the polar explorer might necessarily have been different from the ordinary human being; today the technical means for transport and normal living are so developed that in many cases polar exploration is simply a continuation of normal work, scientific and otherwise, at another place. The new map of Greenland, constructed mainly from aerial photographs, is

a case in point. But it should be remembered that even in the classical times of exploration neither the explorer nor his time were simple. Many strands might be interwoven in the making of an explorer, and unconscious drives might be more powerful than conscious and generally acceptable reasons.

What do people seek in the ice and cold of the Arctic and Antarctic? About 700 years ago the Norseman who wrote a didactic work, the King's Mirror (Larson, 1917) gave the answer: "If you wish to know what men seek in this land, or why men journey thither in so great danger of their lives, then it is the three-fold nature of man which draws him thither. One part of him is emulation and desire of fame, for it is man's nature to go where there is likelihood of great danger, and to make himself famous thereby. Another part is the desire of knowledge, for it is man's nature to wish to know and see those parts of which he has heard, and to find out whether they are as it was told him or not. The third part is the desire of gain, seeing that men seek after riches in every place where they learn that profit is to be had, even though there be great danger in it." (Nansen, 1911, I, p. 3).

One of the reasons for polar exploration throughout the centuries has been the urge to know; but the scientist who goes to the poles only to get an answer to a scientific problem is rather rare among polar explorers. The wish for knowledge is frequently combined with the tendency to do something uncommon, to gain that knowledge with a special effort of the body or under dangerous conditions.

Among the explorers of Greenland, this combination is best shown by Fridtjof Nansen, the first man to cross its ice sheet and the discoverer of the Arctic Basin. Even in his old age, world famous as a diplomat and humanitarian, a winner of the Nobel Peace Prize, he praised, in the Rectorial Address delivered at St. Andrews University, 3 November 1926, the spirit of adventure as the strongest force in the advance not only of polar exploration, but of humanity in general (Nansen, 1927). Alfred Wegener was another great scientist who gave his life in the scientific exploration of Greenland and first gave a thorough scientific basis to the theory of continental drift. He wrote in his diary: "Nobody has accomplished anything great in life who did not start out with the resolve: 'I will do it or die'."

Another reason for polar exploration was the wish for monetary gain. Sealers and whalers acquired much valuable information concerning the coasts of Greenland (Gad, 1946). Great efforts were made from the 16th to the 19th centuries to open a trade route to the East through the Northwest Passage west of Greenland.

In recent times national prestige has been a driving force in polar exploration. The history of the efforts to reach the North and South Poles confirms the force of this impulse. "Nailed the stars and stripes to the pole" was Peary's first message after making the North Pole in 1909 (Green, 1926).

The wish for national prestige is frequently, but not always, combined with the wish for personal fame. A good example among the explorers of Greenland is Peary. Another case is that of Greely. When Greely was found in 1886 not far from Greenland's shore, near death and with only six of his original 25 companions alive, his first words were "Did what I came to do, beat the best record" (James 1940, p. 301, original source not found). He had completely forgotten or suppressed the fact that his expedition was part of the first International Polar Year which had been organized with the particular purpose of conducting studies at fixed stations rather than making individual dashes to high latitudes.

Finally, the wish to escape problems of living in a community has been a motive for polar explorers. Among Greenland explorers, Nansen, a truly great and rich personality, shows this trend quite clearly in his diary (Nansen, 1897), and it is plainly stated in the autobiography of the Greenland explorer Peter Freuchen (Freuchen, 1953) that, for this reason, he abandoned the study of medicine and started on his life as an explorer in East and North Greenland and on the Greenland ice sheet.

#### HISTORY OF THE EXPLORATION OF GREENLAND

##### The Time of the Vikings

Greenland was first visited by Europeans almost exactly 1,000 years ago. However, they were not the first to come to Greenland; Eskimos had been there at least 1,500 years before (Birket-Smith, 1959). The first white settlers in Greenland were Vikings, partly from Iceland and partly from Scandinavia (Nansen, 1911; Nørlund, 1936; Sauer, 1968). Vikings settled in the mildest region of Greenland, the southwest, in two districts near Julianehaab and near Godthaab (Figure 1). We have direct evidence of their presence from the ruins of their farms, from their churchyards and from their skeletons; we also have reports from Iceland and Norway (Larson, 1917; Kongelige Nordiske, 1838-1845). The Vikings made hunting trips northward along the west coast, mainly to get ivory from the tusks of walrus and teeth of the narwhals which, in Europe, were believed to come from the unicorn and were highly valued. We know from a runic stone found near 73°N that Vikings have visited and probably wintered at this place. Although they made their first landfall from Iceland on the east coast, they probably came ashore there rarely, because of the pack ice that blocks this part of the coast most of the time. But little of the knowledge which the Vikings once had of Greenland and of the American continent has survived.

The Vikings knew that the interior of Greenland was largely covered with ice. We have a Norwegian description from the middle of the 13th century, in the King's Mirror, in which it is said of Greenland: "But since you asked whether the land is thawed or not, or whether it is covered with ice like the sea, you must know that there are small portions of the land which are thawed, but all the rest is covered with ice, and the people do not know whether the country is large or small, since all the mountains and valleys are covered with ice, so that no one can find

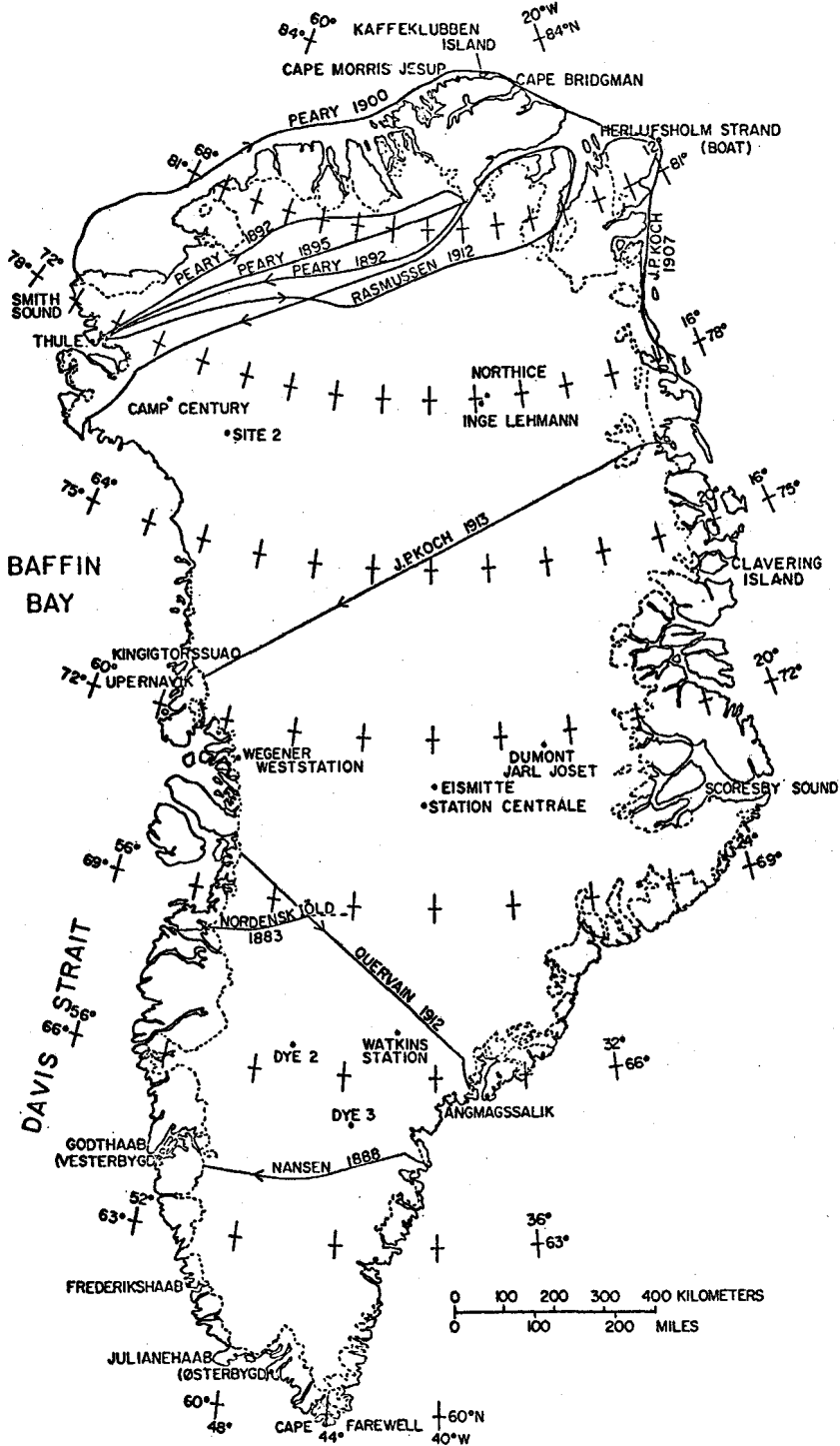


Figure 1. Map of Greenland showing routes of explorers and place names mentioned in text and ice-sheet stations maintained for at least one year.

his way in...But men have often tried to go up the country, upon the highest mountains in various places, to look around them, to see whether they could find any part that was thawed and habitable, but they have not found any such, except where people are now living, and that is but little along the shore itself." (Nansen, 1911,II,p.246).

It was our belief that the Vikings knew, and consequently Europe could have known, the outline of Greenland from about 70°N on the west coast to the southern tip and a bit of the east coast. It was also believed, as recently as the 18th century, that Greenland was part of a great Arctic land which was joined north of Spitsbergen with the "Land of the Tartars", Russia and Siberia (Cranz, 1765; Crone, 1966; Haugen, 1966). But 10 years ago a map was found on a kind of paper and with a style of writing of about 1440, before the revival of travel in the North Atlantic Ocean at the end of the 15th century (Skelton, Marston, and Painter, 1965) (Figure 2). On it Greenland appears as an island with an outline strikingly similar to the actual one. Even some of the details of the coast can be identified, e.g. Scoresby Sound and the trend of the east coast. Two problems arise: Is it possible that the Vikings in Greenland could have had knowledge of these remote parts? If so, how did the knowledge get into a map which was probably made in southern Germany when the last Vikings in Greenland were just dying out and practically no connection with Greenland existed?

It is quite likely that the north coast of Greenland which became known to us only at the start of this century, was known to the Eskimos. Tent rings and even the remnants of an Eskimo boat have been found along the north coast at Herlufsholm Strand (L. Koch, 1925; Knuth, 1952). It is believed that the now-extinct native population of the east coast, north of Scoresby Sound, immigrated by way of the north coast. In 1823 a British whaler at 75°N made contact with two Eskimo families, possibly the last survivors of this population (Clavering, 1830). Even if the Eskimos knew the geography of the north coast there is no definite clue how this knowledge could have reached Europe, presumably by way of the Greenland Vikings. The question remains unsolved, the more so because for the time being, the map cannot be traced back beyond the last owner. We can only hope that another lucky find will help us to arrive at an explanation.

In the later middle ages the Eskimos spread from the north along the entire west coast. They met the Vikings who, however, died out in the 15th century (Nørlund, 1936). From the 17th century, whaling, mainly by British ships, flourished along the west coast of Greenland and some parts of the coast became fairly well known (Gad, 1946). Names such as Baffin Bay and Davis Strait bear witness to these discoveries.

### The Start of Systematic Exploration

The first permanent white settlement in Greenland after the Vikings was established in 1721. It was believed at that time that some Vikings might still survive. It was a Norwegian missionary, Hans Egede, who



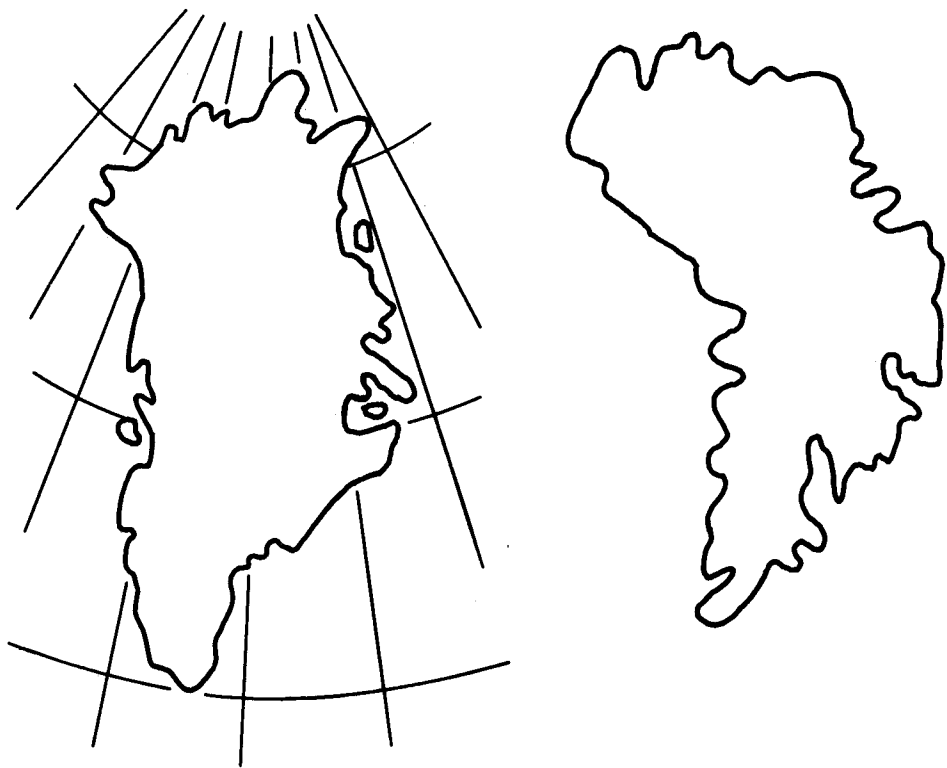


Figure 2. Outline of Greenland.  
Left, recent survey; right, Vinland map.

went to Greenland and found no Vikings, but settled among the Eskimos. During this time nobody went to Greenland for scientific purposes but some of the early missionaries had lively scientific interests. Among them was Otto Fabricius, who was stationed at Frederikshaab (Fabricius, 1780). Fabricius wrote the first scientific book on Greenland, a Fauna Groenlandica, a thorough description of the animals in Greenland. Another missionary, David Cranz, published a description of Greenland which covered the country, the inhabitants, and the animal and plant life (Cranz, 1765). Some meteorological observations were also started in the 18th century.

The first detailed geological studies were made at the beginning of the 19th century. In 1806 the Danish government, which administered the country, sent a scientist to Greenland to make a report about the possibilities of mining (Giesecke, 1878). The man called himself "Karl Ludwig Giesecke" and claimed to be a "Royal Prussian Mining Councillor"; it is not quite clear whether he was entitled to this title. His real name was Johann Metzler; his father was a tailor in the Bavarian city of Augsburg. He qualified for admission to a university but the next 10 years of his life are rather obscure. For most of the time he was probably an actor in Vienna, and he is possibly the co-author of the text to Mozart's "Magic Flute". At the same time he became an expert amateur mineralogist, and seems to have travelled as such over a considerable part of Europe. Because of the Napoleonic wars he was stranded in Greenland for not less than 7 years and visited the whole known west coast from the southernmost Cape Farewell to 74° N. His comprehensive diaries gave the first account of the geology and petrography of western Greenland. His collections had been captured during the war by an English ship while on their way to Denmark. After the end of Napoleon he travelled to England to recover his collections, got himself a position at a seat of higher learning, was knighted, and ended his life as Sir Charles Lewis Giesecke, Professor of Mineralogy at Dublin, member of five Academies of Science -- a truly remarkable career for an itinerant actor!

The first half of the 19th century saw some extension of the knowledge of Greenland's coasts. With the increase in trade the possibility of a Northwest Passage to the west coast of North America and to the Far East aroused new interest. John Ross, uncle of the discoverer of the Ross Sea in Antarctica, found a group of a few hundred polar Eskimos living in the Smith Sound area of Northwest Greenland (Ross, 1819). Ross referred to these most northerly inhabitants as "Arctic Highlanders". This isolated tribe was almost unique because at that time its members had no definite acquaintance with any other human beings, nor was anybody outside certain of their existence. (Only the inhabitants of the famous Easter Island in the South Pacific may have been in the same situation). But it was still not known whether Greenland was connected to North America until well into the 19th century.

The southern part of the east coast had not yet been visited even though some trading occurred with Eskimos traveling from that region around Cape Farewell. These voyages sometimes lasted for years. There was still some belief until well into the 19th century that the majority

of the Vikings might have lived on the east coast of the island. The reason was that the medieval reports spoke of Vesterbygd and Østerbygd, the western and the eastern settlements of the Vikings. Two regions of settlement were indeed known, one in the district of Godthaab, the other in that of Julianehaab (Figure 1). But these were north and south, rather than west and east of each other, and so they were lumped together as Vesterbygd. The eastern district was supposed to lie on the still unknown eastern side of the island. In 1829-1830 an expedition was undertaken from Cape Farewell along the east coast in so-called umiat or women's boats (Graah, 1832). The expedition reached 65°N and encountered some Eskimos, but found no trace of old Viking settlements. It stopped just short of the isolated and unknown tribe of Eskimos near Angmagssalik. It was then accepted, as had already been suggested by some scholars (Eggers, 1794), that both the eastern and western settlements were on the west coast of Greenland.

### From Discovery to Systematic Study

The scientific exploration of Greenland gained new vigor when Henrik Rink started his long association with Greenland about 1850. Rink was trained as a medical man, but he had wide interests in geology, glaciology, linguistics and ethnology. For 20 years he was connected with the administration of Greenland, mainly as governor. He started his scientific work with a detailed description of the then known parts of Greenland (Rink, 1857). He made profound studies of the Eskimo language and of the origin and development of Eskimo culture. The glaciers of Greenland were also studied by him (Rink, 1877, 1888) and he was probably the first to draw attention to the exceedingly fast motion of some of the big ice streams first measured in detail by Helland (1876) which, as far as we know, is not equalled even in the gigantic glaciers of the Antarctic.

During the second half of the 19th century great strides were made in the scientific exploration of Greenland. The Danish "Commission for the conduct of geological and geographical research in Greenland" was founded. Its publication "Meddelelser om Grønland" (Information about Greenland) (1876-) comprises nearly 200 volumes (Grønland, 1921; Greenland, 1928). Knowledge of the ice-free parts of Greenland was gradually extended all around the coast. From the middle of the 19th century Northwest Greenland became the field of British and American expeditions which used the northernmost accessible land as a starting point for reaching high latitudes and ultimately the North Pole. Most of these expeditions used man-hauling by sturdy sailors and painfully gained a few miles compared with their predecessors. After 1890, Peary adopted the dog sledge and the traveling and hunting methods of the Eskimos. In this way he succeeded in getting beyond Cape Morris Jesup at 83°39.7'N in 1900 (Figure 1), the northernmost point of Greenland and what he thought to be the northernmost point of land on earth (Peary, 1903). But a recent survey has shown that Kaffeklubben Island, 83°40.1'N, 30°37'W is 0.4 of a mile farther north (New York Times, 15 June 1969, p. 70; L. Koch, 1940, 1942).

At the same time knowledge of the east coast of Greenland was gradually extended toward the north, under great difficulties because of the impenetrable belt of pack ice drifting southward along the coast (Koch, 1945) out of the Arctic Basin. In 1884 the tribe of Angmagssalik Eskimos was found at 66°N (Holm and Garde, 1889). They were about 400 people, but were in rapid decline because of famine and intertribal fights. Now their numbers have tripled by natural increase. In the milder climate of the early middle ages this coast had probably been more accessible, as we know from some reports of Norse sailors; but the deterioration of the climate since the 14th century had isolated the population. Gradually the whole east coast became known, access being made easier after the start of this century when the outflow of ice from the Arctic basin diminished. The enormous fjord system of Scoresby Sound, possibly already known to the Vikings and indicated on the 15th century map (Skelton, Marston and Painter, 1965) (Figure 2), was explored. The discoverers, William Scoresby and son, were very remarkable people, the son being a whaling captain, a glaciologist and a professor of theology (Scoresby, 1820, 1823). A German expedition reached almost 77°N just 100 years ago (Geographische Gesellschaft, 1873), but one of their ships was beset by ice and finally crushed. Drifting on an ice flow during the winter the men rounded Cape Farewell and ultimately got ashore at the southernmost settlement of the west coast.

The last gap in the knowledge of the Greenland coast was only closed in 1907. A Danish expedition under the leadership of Mylius-Erichsen established itself at 76°N and a sledge journey led by Johan Peter Koch (J. P. Koch, 1916) reached the northeast corner of Greenland, Cape Bridgman, the farthest point reached by Peary from the west 7 years before (Peary, 1903).

In polar exploration there seems to be an inheritance from uncle to nephew. We have already seen it in the case of John and James Ross; Otto Nordenskjold continued his uncle's explorations in Greenland. Harald Sverdrup followed his uncle Otto Sverdrup, the companion of Nansen. Similarly the nephew of Johan Peter Koch, Lauge Koch, was the first to follow the whole north coast of Greenland (L. Koch, 1925; 1927) and became, for more than 20 years, the leader of almost annual expeditions for the detailed geological exploration of northeast Greenland.

#### Exploration of the Inland Ice: The Crossings

By 1908 the whole coastline of Greenland was known to white people, many hundreds of years after the Eskimos had followed it, as the relics they left behind show. But what lies beyond the narrow coastal belt, hardly anywhere 100 miles wide, consisting partly of hilly country with grass, flowers and, in the far south, some copses of willow, birch and alder, partly of glacerized mountain ranges with enormous glaciers calving icebergs into the fjords, and at some places of broad ice fronts? It was already known by the Vikings (Nansen, 1911; Larson, 1917) and the Eskimos that an enormous ice mass covered at least the greater part of the interior. The importance of this inland ice to the climate was also recognized.

The King's Mirror says: "The land is cold, and the glacier [i.e., the great ice, or inland ice] has this nature, that he sends out cold gusts which drive away the showers from his face, and he usually keeps his head bare. But often his near neighbors have to suffer for it, in that all other lands which lie in his neighborhood get much bad weather from him, and all the cold blasts that he throws off fall upon them." (Nansen, 1911, II, p. 246). The Eskimos feared the "sermerssuaq", the Great Ice, and the white settlers had no particular interest either, although very early after the arrival of Europeans, unsuccessful efforts were made to approach the supposed Eastern Settlement on the east coast from the west across the ice sheet (Gad, 1946). After 1850, when it was more or less accepted that similar continuous ice sheets had covered much of Europe and North America, the ice sheet of Greenland became of great scientific interest. On the other hand, some doubt still existed as to whether the ice sheet of Greenland actually covered the whole interior. Some scientists of the time believed that the ascending air would shed most of its water content in the form of snow in the border regions, and that the air in the interior would be so dry that the very small precipitation would be removed by evaporation and would not accumulate. In other words one expected the conditions which actually exist today in the so-called "dry valleys" of the McMurdo region of Antarctica (Bull, 1966). This opinion was strengthened by the very warm winds which occasionally blow from the direction of the ice sheet. Cases are known of the temperature near the coast, rising from less than 0° F to more than 50° in the middle of winter (Petersen, 1934). It was believed that this was only possible with an ice-free land behind the barrier of the ice sheet. We know now that this is not necessary. If the air is drawn down from the center of the ice sheet at 10,000 feet, it will be warmed by compression more than 50° F and can arrive at sea level with a high temperature even though it is quite cold in the interior.

After several unsuccessful excursions (Gad, 1946; Fristrup, 1963) the first serious attempt to reach the interior was made by Adolf Erik Nordenskiöld in 1883 (Nordenskiöld, 1885), the same man who a few years before had made the first continuous voyage through the Northeast Passage along the coast of Siberia. Nordenskiöld was accompanied by two Lapps from northernmost Sweden, and after Nordenskiöld's advance had come to a halt the Lapps went on a 24-hour march on skis farther inland. They found only an unbroken snow-covered plain and not the snow-free tracts more or less expected by Nordenskiöld.

Then in 1888 the young Norwegian explorer Fridtjof Nansen, with five companions, made the first crossing of Greenland in its southern part (Nansen, 1890; Mohn and Nansen, 1892). Starting from the uninhabited part of the east coast, Nansen practiced the principle of "no retreat" which governed his whole life in its many aspects. Nansen was a champion in skiing and skating, and he and his five companions used skis. Much of his equipment was new. The Nansen sledge and the Nansen cooker represented big improvements in polar travel techniques. Polar exploration enjoyed the same general interest at the end of the last century as space travel now, and it can be stated that the successful use of skis in Nansen's

crossing was the stimulus for the spread of skiing as a means of sport and transport in snow-covered regions all over the globe. Nansen established that in the southern part of Greenland the ice sheet was unbroken and reached a height of 9,000 feet. Nansen was of the opinion that the ice had a very great thickness.

A few years later the American, Peary, crossed the ice sheet twice in the far north (Peary, 1898), and this was repeated by the Dane, Knud Rasmussen (Rasmussen, 1915, 1934) (Figure 1). These crossings gave little information about the nature of the ice sheet which mainly served as an access route to the northeastern part of the Greenland coast. Rasmussen was born and educated in Greenland and was of mixed race. He lived much of his life with the polar Eskimos and was, even according to their standards, a master in dog-sledging. But he was also an outstanding ethnographer, had a deep understanding of Eskimo mentality and rendered their old stories and legends with poetic feeling, not only in Greenland but over the whole vast region from the Bering Strait to East Greenland, almost half the distance around the earth.

The first crossings of the ice sheet with predominantly scientific interest were made in 1912 and 1913, the first by the Swiss, de Quervain (Quervain, 1914, 1920), and the second, across the widest part of Greenland, by Johan Peter Koch, the same who had joined the survey of the east coast to Peary's of the north coast, accompanied by the German meteorologist and geophysicist Alfred Wegener (J. P. Koch, 1914; Koch und Wegener, 1930). It had been realized at that time, a fact at which the King's Mirror had already hinted 700 years ago, that ice sheets have a special type of climate and it was widely believed that they may have an important influence not only upon their immediate surroundings, but also upon that of the arctic and temperate regions in general (Hobbs, 1926). De Quervain used dogs for transport, but Koch had Icelandic horses, the only time that the use of horses in exploration of ice sheets has been really successful. Koch reached a height of nearly 10,000 feet but farther south de Quervain remained at a lower elevation. Both expeditions, particularly that of Koch, did important studies of the climate and the snow and ice conditions of the ice sheet. But they had to cross the ice rapidly in summer; the hours of scientific work had to be stolen from the time needed to accomplish the crossing with the available food and fuel. The temperatures they encountered were very low, considering the time of the year, down to  $-30^{\circ}\text{F}$ . Hence in winter extreme cold could be expected. Nobody had any evidence how thick the ice was and what thickness could, therefore, be expected for the ice sheets of an earlier time. Little was known about the way the ice moved, the growth by snow in the interior and the loss by melting in the border regions. Was the ice sheet growing or dwindling at present?

#### Exploration of the Inland Ice: Stations on the Inland Ice

It became clear that rapid crossings could not give an answer to these fundamental questions. At the same time new methods of transport and scientific research had been developed. Thus 40 years ago a new period of systematic scientific research started on the ice sheet. It had already

been in progress in the coastal regions for a considerable time. In 1930 Alfred Wegener established two stations for year-round studies on the ice cap itself, Weststation near the west coast, and Eismitte (Midice) near the geometrical center of the ice sheet (Wegener, 1932). They had as their program the systematic study of the geophysical conditions of the ice sheet from the rock base below to the free atmosphere above (Deutsche Gronlandexpedition, 1933-1940). At the same time a British expedition led by Watkins maintained an ice cap station farther south with a much more restricted program for half a year (Chapman, 1932; Mirrlees, 1934). Unfortunately Wegener perished on the ice sheet early in winter, and his scientific program had to be considerably curtailed. Nevertheless, the expedition provided the first meteorological observations from an ice sheet for a whole year. The Eismitte station, at a height of 10,000 feet, was at that time by far the coldest station on earth (Georgi, 1933). Its low has since been greatly exceeded by stations on the antarctic continent. Explosions were set off at the surface of the ice, the vibrations were reflected from the bottom, and the time between the explosion and the recorded echo gave the first measurements of the thickness of the ice. Recent studies have revealed a maximum ice thickness of 11,000 feet and a mean of 5,000 feet (Fristrup, 1963). The gravitational attraction of the earth was measured on an ice sheet for the first time. It was shown that the enormous ice mass of Greenland, more than two million billion tons, has depressed the rock base by about 1,800 feet into the yielding layers below. The expedition used mainly dogs but it also introduced the first successful mechanical surface transport in polar exploration, two propeller-driven sledges which, after initial difficulties, performed quite satisfactorily.

#### SCIENTIFIC INVESTIGATIONS TODAY

Then came a break during the war, and at the present the scientific exploration of Greenland, like life in Greenland in general, has completely changed (Brun, 1966; Fristrup, 1963). Research workers fly to and from Greenland in a few hours. They land from helicopters at any desired place. On the coast four-storied apartment houses replace the stone hut of the Eskimo. In most of Greenland the kayak has almost disappeared (Dege, 1964; 1965; Williamson, 1954). Scientific stations on the ice sheet are supplied from the air (Mellor, 1963b) or by tracked vehicles (Mellor, 1963a). The stations on the ice cap are erected mainly for purposes other than scientific and are either enormous boxes raised on stilts above the snow surface to allow the driving snow to pass below them (e.g. Dye 2, Dye 3), or they are underground tunnels (e.g. Camp Century) (Mellor, 1968; Wager, 1962). The height of the ice sheet has been measured from a group of tracked vehicles by optical levelling to an accuracy of about one foot (Malzer, 1964); distances and the flow of the ice are determined by extremely exact radar measurements with an error of a few yards across the 500 miles of the ice sheet (Hofmann, 1964). The thickness of the ice is measured by the time an electrical impulse takes to return from the rock below, measured in billionths of a second (Fristrup, 1963). Such observations can be made from an airplane (Evans, 1967): one flight across the ice sheet gives 100 times more information than could be gathered in one season 40 years ago. Mechanical power-driven drills supply ice cores

to the bottom of the ice sheet, nearly one mile deep (Hansen and Langway, 1966); they give us information about the accumulation several thousand years ago and about the temperatures at various depths. Detailed maps of the whole of Greenland are taken from the air; surveyors, geologists, and prospectors are set down by helicopters. Biological research is carried out on land and particularly in the seas around the island, because with the mitigation of the polar climate in this century, the distribution of economically important animals has radically changed (Brun, 1966). Seals have become rare; cod have appeared in great numbers to 70°N, and cod fishing is now the mainstay of the economy of Greenland. But there are indications that the conditions of the last century might return (Dansgaard and Weidick, 1965) and a close watch has to be kept because this would have the most serious consequences for the livelihood of the rapidly increasing number of Greenlanders.

Thus new scientific problems in the most diverse fields arise continuously, and modern methods of research and transport make it possible to solve old questions which could not even be approached at the time when they appeared. Greenland will continue to be a favored field of scientific exploration for a long time.



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