NORWAY

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NORWAY has a special situation among the nations that are carrying out scientific research in the Arctic, since nearly half of the mainland is located north of the Arctic circle. Thanks to the warming effects of ocean currents, however, Norway is not an arctic country in the climatic sense of the word. Her fjords and harbours are open all year around even in the northernmost part of the mainland. The extreme northern location has given Norwegians great economic and scientific interests in the Arctic. The maximum zone of the auroral belt runs across northern Norway, thus making it possible to carry out polar geophysical research from stations on the mainland. This may be one of the reasons why Norway's scientific activity in the arctic area *north* of the mainland has included relatively little activity in cosmic physics and related sciences.

Norway's first national effort in the exploration of the arctic seas took place in Viking times (A.D. 800-1000) when Iceland was settled, and Greenland and the American mainland (Vinland) were discovered. In the east, the arctic coast of Russia to the White Sea (Bjarmeland) was explored. The first reports of the Svalbard (Spitsbergen) island date from this period, when it was considered to be a part of Greenland.

Interest in the Arctic by the Norwegians was renewed in the early part of the nineteenth century, when Norwegian seal- and walrus-hunting vessels explored the arctic seas from Greenland to Novaya Zemlya, discovering, for example, Franz Josef Land. At the same time, Norwegian trappers began exploiting the Svalbard area. In the summer seasons 1876-78 the government of Norway sent an oceanographic and biologic expedition to Iceland, Jan Mayen, and Spitsbergen. At the end of the century, Fridtjof Nansen accomplishing the first crossing of the inland ice of Greenland and by drifting with the specially constructed ship *Fram* across the polar basin (1893-96), opened a new and great era of Norwegian contribution to the knowledge of the Arctic. The most important results of Nansen's research were the discoveries of the deep ocean basin and proof of the nonexistence of land in the central Arctic Ocean as well as the demonstration of the ocean-current system in the arctic seas, which he had predicted before

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setting out on his daring enterprise. The meteorologic observations from the first *Fram* expedition gave, for the first time, reliable information as to the meteorologic conditions over the Polar Basin. Besides giving such important scientific results, Nansen's polar expeditions revolutionized polar expedition technique in a great number of ways. While Nansen carried on oceanographic research in the northern seas, his example sparked off a series of Norwegian expeditions to the Arctic, the most important of which were Otto Sverdrup's second *Fram* expedition to the Canadian Arctic (1898-1902), Roald Amundsen's crossing (as the first successful one) of the North West Passage by *Gjøa* (1903-6), the *Maud* expedition (1918-25), and his two famous aerial expeditions, 1925 and 1926, the latter of which — by the dirigible *Norge* — was the first transarctic crossing that finally proved the complete lack of land in the central Arctic Basin. The second *Fram* expedition also gave important contributions to the geography and geology of the Canadian arctic archipelago by discovering and mapping the large Sverdrup Islands and other unknown areas, and by bringing back a wealth of geologic information. Indeed, the *Maud* expedition, under scientific direction of Harald Ulrik Sverdrup, although unsuccessful in its attempt to repeat the *Fram* crossing of the central Arctic Basin, carried out a great amount of scientific research, particularly in oceanography, meteorology and ethnography, when staying for seven years in the ice north of Eastern Siberia and the Bering Strait.

The tidal data collected during the *Maud* expedition were prepared by J. E. Fjeldstad, who predicted the existence of submarine barriers across the Arctic Ocean, such as the Lomonossov Ridge, later found by Russian scientists.

Sverdrup's work on the *Maud* expedition represents one of the most fundamental contributions to arctic meteorology. It may be mentioned that by means of recording instruments carried aloft by kites, he succeeded in giving a detailed picture of the inversion over the pack ice. Furthermore, by means of pilot-balloon soundings, he obtained valuable information about the wind conditions at different levels of the arctic troposphere. In 1931 H. U. Sverdrup returned to the Arctic as scientific leader of H. Wilkin's expedition with *Nautilus,* the first attempt of a polar expedition with a submarine. In 1934 he took part in a glaciologic expedition to Spitsbergen, and gave an important contribution to the knowledge of the heat exchange of large snowfields.

The investigations of Nansen, together with other oceanographers such as J. Hjort and B. Helland Hansen, in the Norwegian Sea and other parts of the North Atlantic Ocean, greatly changed the theories of the circulation of waters in these areas.

In 1906 systematic scientific exploration by Norwegians started in the Svalbard area, still "No man's land," by Gunnar Isachsen, an outstanding cartographer and polar explorer. He was followed in 1909 by Adolf Hoel, who carried on the state-supported Norwegian Spitsbergen expeditions (De norske statsunderstøttede Spitsbergenekspedisjoner) until Norway was

Smeerenburgfjorden and Danskøya, Svalbard.

given the sovereignty of the area by the Spitsbergen treaty (signed in 1920 and put into effect in 1925). Hoel's organization was then converted to a state institute for exploration of the Svalbard area and the Arctic Ocean (Norges Svalbard- og Ishavs-undersøkelser (N.S.I.U.)). By 1930 the activity was expanded to include East Greenland and the island of Jan Mayen.

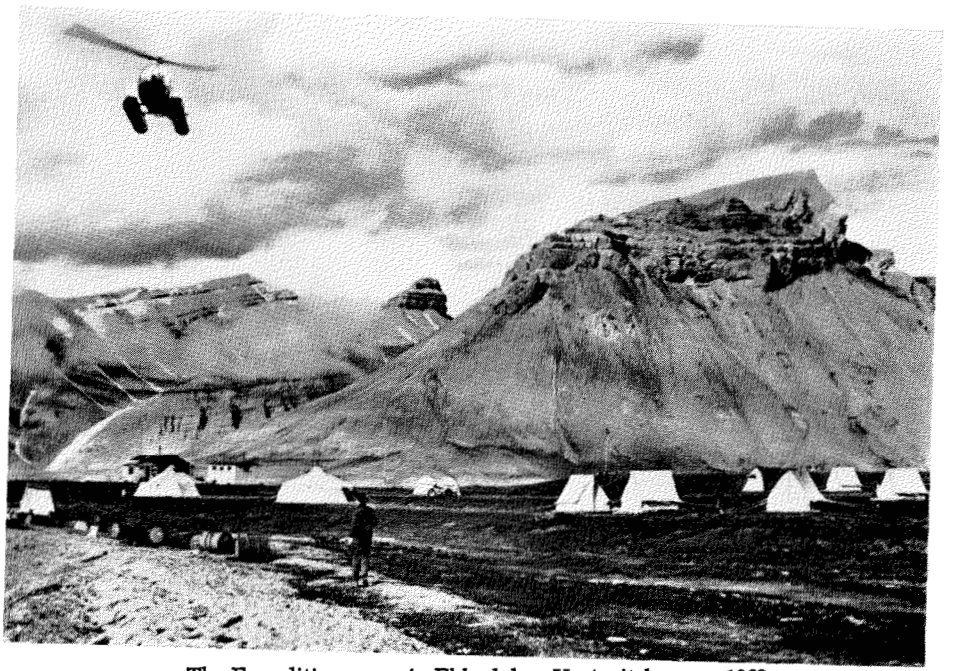
In 1948, under the leadership of H. U. Sverdrup, the institute was reorganized, renamed Norsk Polarinstitutt, and given the responsibility for exploration and research of the Norwegian claims in Antarctica as well as in the Arctic. Today, about thirty people are permanently employed by the Institute, which has sections for topography, geodesy, hydrography, geology, and geophysics. The headquarters are in Oslo, where the Institute recently moved into a modern building with good working facilities. The library contains a great collection of polar literature. The Institute is responsible even for the logistic support of its expeditions. It sends annual summer expeditions to the Svalbard area, at the present time numbering seventy to eighty men, including the crew of expedition ships and helicopters.

The work of the Institute in the Arctic has to a large extent consisted of topographic and hydrographic mapping and geologic exploration. As a result of oblique aerial photography undertaken by the Institute in the middle 1930's, trigonometric and tellurometric measurements were taken of the Svalbard area (which includes the Spitsbergen islands and some smaller islands north of the Norwegian mainland) and topographic maps in the scale of 1:100,000 were produced. At the present time about one third of

Vestspitsbergen has been covered by maps of this scale. In addition, maps of smaller scale covering the whole area have been produced. The hydrographic work was until recently carried out by the expedition ship, which also had to take care of the logistic support of other expedition parties. Since 1962 the Institute has hired a special ship for hydrographic work, and by using the Decca Hi-Fix electronic system, the sea-charting has been carried out regardless of weather conditions and is now making good progress. Charts are produced in the scale of 1:100,000 and smaller. Ice conditions in the eastern part of the Svalbard area have to a large extent prevented hydrographic work. Tide measurements and geomagnetic work have also been carried out by the hydrographers.

For the geologic exploration that once was carried out in small boats or on foot helicopters are now used. Reconnaissance geologic mapping has been completed, and more detailed work is in progress in various areas. Svalbard is a real paradise for geologists, as it has exposed formations from every era of the geological history, from Pre-Cambrian to Quaternary, and contains abundant fossils. Coal-mining has been going on in the Svalbard area since the beginning of this century, and the Institute has been responsible for advising the Norwegian coal-mining companies in this connexion. At the present time several oil companies are exploring for oil, and the importance of geologic investigations has been steadily increasing.

Glaciological studies have been carried out on the Norwegian mainland as well as in Svalbard. This work is of importance to the hydroelectric



The Expedition camp in Ebbadalen, Vestspitsbergen, 1963.

schemes in Norway, and a number of glaciers have been under constant observation over a long period. Recently the Institute took up systematic studies of sea ice in the Greenland and Barents Seas. Meteorological observations in the Svalbard area are the responsibility of the Norwegian Meteorological Institute. Three meteorological stations have been established in the Svalbard area for routine observations. One such station operates on Jan Mayen. Until 1959, Norway even operated a meteorological station in Myggbukta, East Greenland. Those at Bjørnøya (Bear Island) and Jan Mayen are making radiosonde observations twice a day. At Bjørnøya and Isfjord Radio (Vestspitsbergen) global radiation is measured.

Norsk Polarinstitutt so far has no permanent biological section, but studies have been carried out in cooperation with various Norwegian university institutes as well as with individual scientists. Until now ornithological studies have been the most important, since the bird fauna in Svalbard is exceptionally rich. At the present time studies of the polar bear are being given priority.

The investigations in East Greenland (now interrupted) and the island of Jan Mayen have mainly consisted of aerial photography, topographic and hydrographic mapping, and archeological, geological and biological surveys.

In auroral research Norway has been a leading country since Carl Størmer and Kristian Birkeland took it up in the first years of this century. Størmer, a mathematician, calculated the trajectories of electrons (cathode rays) under the influence of a magnetic dipole. He then applied mathematical methods to moving electrons in the earth's magnetic field and mapped electron trajectories from the sun to the atmosphere of the earth, where they produced aurora. It was a great posthumous triumph for Carl Størmer, having predicted that the earth was surrounded by radiation belts, when the Van Allen belts were proved to exist by the satellite observations fifty years later. At the same time a mass of material based on observations of aurora phenomena was collected by Kristian Birkeland from four arctic stations. His material was worked up by Lars Vegard, who about ten years later proved that positive particles also took part in the formation of aurora. The work of the Norwegian pioneers on aurora research led in 1927 to the setting up of the Norwegian Institute for Cosmic Physics, which in the same year established an observatory for aurora phenomena in Tromsø (69°40′N., 18°57′E.). The work of this Institute has been steadily expanding, and research on various aspects of the physics of the upper atmosphere is now being carried out, including the study of the ionosphere by means of radio waves and spectrophotometric investigations of the ozonosphere. In addition to the investigations carried out at the auroral observatory at Tromsø, observations are made by air-borne instruments sent up from a base at Andøya (69°18′N., 16°08′E.), in cooperation between the Norwegian Institute for Cosmic Physics, the Geophysical Institute of Bergen University, and the Defence Research Institute in Oslo. This work has been finan-

cially supported by the Royal Norwegian Council of Scientific and Industrial Research, which at present, under contract with the European Space Research Organization, is setting up a telemetry station in Ny-Ålesund (78°56′N., 11°57′E.) in Vestspitsbergen. The Norwegian contribution during the International Geophysical Year consisted of polar research in Antarctica. In the present IQSY period (International Years of the Quiet Sun), a geophysical program consisting of VLF magnetic observations and aurora research is under way at the Isfjord Radio Station in Vestspitsbergen. The Norwegian Institute of Cosmic Physics and the Defence Research Institute are in charge of the work.

Oceanographic and marine biological work in the Norwegian arctic areas is carried out by the Geophysical Institute of Bergen University, the Norwegian Institute of Marine Research of the Norwegian Fisheries Directorate in Bergen, the State Institute of Whale Research of the University in Oslo, and Tromsø Museum. Special studies are being made of whales and seals.

Ethnographic and other social-science studies by Norway in the Arctic have been rather casual, since no native population is found in the Svalbard area. Individual Norwegian ethnographers have made expeditions to Greenland and other parts of the Arctic. Important research in connection with the Lapps has been carried out by various Norwegian social-science institutes. The main centre of this study is at Tromsø Museum.

The government of Norway is at present studying a proposal to establish in Ny-Ålesund a scientific station operational throughout the year.