

Arctic Research Activities in the Federal Republic of Germany

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Germany's active interest in the Arctic has been relatively recent when compared to other nations. It cannot boast of a single famous explorer who searched for a passage to the Pacific Ocean, discovered new arctic shores, or reached the pole. Since the beginning about a hundred years ago, arctic exploration has meant scientific investigation rather than spectacular discoveries.

The names of A. Petermann, E. v. Drygalsky, K. Koldewey, K. Weyprecht, and G. v. Neumayer are representative of the early period. Because of these scientists, Germany became involved in initiating and preparing for the First International Polar Year, 1882-83, and with the German expeditions sent to Baffin Island and northern Labrador. F. Boas arrived in Cumberland Sound on the boat relieving the Baffin group. As a by-product of a geographical survey, he wrote one of the first scientific monographs on the Eskimos. Germany's exploration efforts

culminated in the Greenland expedition of A. Wegener in 1929-31. This was the first time a scientific team wintered on an ice cap (J. Georgi, F. Loewe, and E. Sorge at the Eismitte station). The approach and the results of this undertaking significantly influenced worldwide glaciological investigations for a long time.

About the same time, Germany played a role during the initiating of the Second International Polar Year, 1932-33, although only two parties actually participated in the field program. Smaller expeditions to Greenland and Spitsbergen followed, prior to World War II. The war interrupted all scientific activities, except for a few arctic weather stations operating for military purposes. After the war, it was awhile before German scientists became involved in the various arctic research fields.

This article summarizes all West Germany's current and planned arctic activities as completely as possible. Space limitations do not

permit description of the close cooperation with colleagues in Austria, Switzerland, and non-German speaking countries. Also, research performed in the antarctic and alpine regions is not addressed. Finally, it is not possible to provide details on approaches and results of scientific investigations by German researchers in the Arctic nor to assess German contributions by international standards.

Earth and Physical Sciences

Geology and geophysics

Since 1961, H. J. Schweitzer of the Institut für Paläontologie der Universität Bonn has led five expeditions to different parts of Spitsbergen and Bear Island, Norway. The emphasis of this work has been on the stratification and paleobotany of the Permo-Carboniferous, Devonian, and Tertiary formations. At the same time, floristic and even ornithological investigations were performed. The Geologisch-Paläontologisches Institut der Universität Hamburg, under H. Lehmann, began working on Spitsbergen in 1968 when Triassic ammonites were collected and preliminary glacio-morphological observations were made. A second field investigation in 1972 searched for fossil mammals to more accurately date the terrestrial Tertiary deposits and to provide evidence on faunal migration routes between North America and Europe in lower Tertiary times. Important Triassic ammonite and vertebrate material were collected, although the primary objective was unsuccessful.

The Institut für Geologie und Paläontologie der Universität Tübingen under R. German plans extension of work on recent and Quaternary fluvio-glacial arctic till, preferably in the eastern Canadian Arctic.

Research in Iceland by M. Schwarzbach and his staff of the Geologisches Institut der Universität Köln requires mention. Since 1954, repeated investigations have been performed on the paleoclimatology and the Tertiary stratigraphy of northwestern Iceland.

H. Bonatz, Institut für Theoretische Geodäsie der Universität Bonn, participated in the International Astro-Geo-Project at Spitsbergen, 1969-70, to measure some partial-tides in the horizontal earth-tide-spectrum in both main directions. The data are being evaluated.

Extensive gravimetry was done in northern Iceland by A. Schleusener and W. Torge of the Institut für Theoretische Geodäsie der Technischen Universität Hannover.

Geomorphology

Geomorphological work has attracted substantial attention since resumption in 1959. In 1959, 1960, and 1967, J. Büdel and his staff of the Geographisches Institut der Universität Würzburg led three "Stauferland" expeditions to southeastern Spitsbergen. Even though most of the landforms prevalent in central Europe were created in a periglacial environment and previously were thoroughly examined, the actual processes leading to these forms were never studied and measured in situ. Therefore, unglaciated southeastern Spitsbergen was chosen as an area comparable in endogenous conditions to certain well investigated areas in Germany.

In 1959, extensive topographical mapping was accomplished; the recent oscillations of the glaciers were studied; and the extent of the postglacial uplift was examined. At the same time, geological and botanical reconnaissance field work started. During the 1960 season, three objectives were achieved: (1) the extent of the Würm glaciation of the archipelago was determined, (2) the frost soil pattern was recognized as the result of 16 different physical processes in a currently unknown combination, and (3) a detailed division of the periglacial relief sequence was achieved. (A. Wirthmann, now affiliated with the Geographisches Institut der Technischen Universität Karlsruhe).

On the last "Stauferland" expedition in 1967, these results were confirmed and supplemented through further detailed investigations. U. Glaser dealt with local differences of the postglacial

uplift; J. Büdel and H. Späth (now with Geographisches Institut der Universität Köln) studied effects of the "Eisrinde," the uppermost 1 meter thick layer of the permafrost found especially rich in ice. Soil, sedimentological, and weathering processes investigations were performed by A. Semmel (presently at Geographisches Institut der Universität Frankfurt), G. Furrer (Geographisches Institut der Universität Zurich) and G. Stäblein (now with Geographisches Institut der Universität Marburg). The results of these three expeditions will be made available in a special series of 10 publications, six already published, and in numerous articles.

After the "Stauferland" expeditions terminated in 1967, the geomorphological work at Spitsbergen continued with smaller scale investigations by Glaser, Stäblein, and Semmel. Büdel and Späth plan to extend investigations into a more continental periglacial environment, possibly in the Canadian arctic archipelago. They also plan work in eastern Siberia, where Büdel visited in 1969 at the Soviet Academy of Sciences' invitation.

The work of G. Sommerhoff (Geographisches Institut der Universität München) falls partly into oceanography. Since 1966, he has done a geomorphological relief analysis of the southeastern Greenland shelf. His investigations are based on morphographic-morphometric criteria and are supplemented by sedimentological and geomagnetic studies. Similar research on the southwestern Greenland shelf is in progress.

At the invitation of Louisiana State University in 1971-72, W. Fürbringer (Geographisches Institut der Universität München) participated in an interdisciplinary project on the morphology and hydrology of the Colville River delta in northern Alaska and was engaged in research on the sedimentology of delta deposits.

K. Bleich (Fachgruppe "Ökologische Standortskunde der Universität Hohenheim) investigated soil patterns in the Canadian archipelago in 1973 to obtain data for interpretation of fossil soils in southern Germany and to contribute to the

paleoecology of the pre-Dorset archaeological site on Banks Island in western Canada. Continuation of this work is planned.

Glaciology

In writing about arctic glaciological research, one should begin with the great international glaciological Greenland expedition, the *Expédition Glaciologique Internationale au Groenland* (EGIG), although main field activities were in 1959, 1967, and 1968. During 1959, postwar West Germany re-entered arctic glaciology as well as geomorphology. Geophysical and geodetic measurements were performed on a profile across the ice cap. Meteorological and climatological observations and radiation measurements were taken at a station on the traverse's eastern part. The last remeasurements of geodetic markers in the western part of the ice cap's marginal zone were conducted in 1971 to study the ice movement.

Most of the data evaluation of the main activities in 1967 and 1968 is in

progress, and results are to be published in the next few years. Among the institutions still involved in the EGIG are Geodätisches Institut der Technischen Universität Karlsruhe, H. Lichts and staff; Institut für Geophysik der Universität Münster, B. Brockamp (dec), F. Thyssen and H. Kohnen; Glaziologische Kommission der Bayerischen Akademie der Wissenschaften, München, O. Reinwarth; and Institut für Photogrammetrie und Kartographie der Technischen Universität Karlsruhe, W. Hofmann and staff. W. Hofmann is the coordinator of the German part of the EGIG.

In 1972, at the request of the AG "Weser" shipyard at Bremen, the Federal Ministry of Science and Technology in Bonn sponsored a German-Canadian expedition to northern Baffin Island. The purpose was to investigate ice pressures, elasticity, strength, and friction of metal against ice, and meteorological and oceanographic conditions related to the construction of ice-strengthened bulk carriers.

F. Thyssen and H. Kohnen coordinated the German part of the expedition. Participation included staff members of the Geodätisches Institut der Technischen Universität Karlsruhe and members of the Institut für Geophysik, Physikalisches In-



Figure 1. This is one of the 18m glaciological and geodetic markers (Haefeli-Balise) planted on the EGIG traverse profile for long-term observations. The geodetic survey tower and accumulation stake are to the left.

R. Guillard

stitut, Geologisch-Paläontologisches Institut, Institut für Mineralogie and Institut für Geographie at the University of Münster. Scientists from the Schiffbau-Versuchsanstalt at Hamburg, the Versuchsanstalt für Wasser- und Schiffbau at Berlin and the Arbeitsgruppe für Angewandte Materialforschung der Fraunhofer Gesellschaft at Bremen also took part. A continuation of the glaciological work started on this expedition is planned for 1975 at a different location.

The Deutsches Hydrographisches Institut at Hamburg maintains a permanent sea ice survey (K. Koslowski and K. Strübing) in its geophysical subdivision concerned chiefly with the ship routes in the northern Atlantic and the Baltic Sea. Besides routine survey work, this team does research on iceberg fluctuations, sea ice distribution from satellite observation, and routing studies for ships in ice areas.

H. Kaminski of the Institut für Weltraumforschung der Universität Bochum also is studying the fluctuations of ice and snow masses and sea ice movements in the northern hemisphere from satellite observations. Of particular interest is the detection of ablation areas from the infrared imagery. It is believed this will be useful in compiling a worldwide ice inventory.

A small EGIG field party left Germany for Greenland in late June 1974 to extend the accumulation stakes on the traverse profile (M. Stober and A. Karsten, Institut für Geodäsie der Technischen Universität Karlsruhe). Besides this routine work, gravity and magnetic measurements are performed across the ice cap (F. Thyssen, Institut für Geophysik der Universität Münster), and snow samples are collected from shallow drill holes for isotope studies (C. Lorius, France). The aim of the gravity measurements, for instance, is to investigate changes of the surface elevation between 1959, 1967, 1968 and 1974.

Participation in the Greenland Ice Sheet Program (GISP) drilling program is planned for 1975. The emphasis will be placed on studying the variation of physical parameters

of the ice cores with depth. Surface geophysical studies will provide additional information about the ice and the underlying bedrock in the vicinity of the drilling site (F. Thyssen and H. Kohnen, Institut für Geophysik der Universität Münster).

Meteorology

Apart from the investigations mentioned in connection with glaciological expeditions, the few meteorological activities in West Germany are more or less theoretical, i.e., without arctic field parties.

I. Haupt (Institut für Meteorologie der Freien Universität Berlin) and her staff study polar ice conditions and their dependence on the general circulation by using satellite pictures made in 1966-73. The influence of the arctic regions and especially the arctic pack ice stability regarding the climatic model evaluations are being studied by H. Flohn (Institut für Meteorologie der Universität Bonn).

Oceanography

There are many North Atlantic activities, mostly coordinated by the Deutsches Hydrographisches Institut Hamburg and performed on its research vessels. Between 1961-69, the radioactive isotope content of the Barents Sea surface waters was investigated. In 1972, radiological measurements were made in the Barents Sea and the North Atlantic as part of a physical-oceanographic and geological research program. This included measurements of salinity and temperature, determination of vertical and horizontal radioactive fission product distribution, and core sampling of bottom sediments.

The core sampling was to give information on the sedimentation rate during the Pleistocene and, combined with palaeo-geographic work at Spitsbergen, provide more information about continental drift. This research was a cooperative effort of Deutsches Hydrographisches Institut at Hamburg; II. Physikalisches Institut der Universität Heidelberg; Bundesanstalt für Bodenforschung

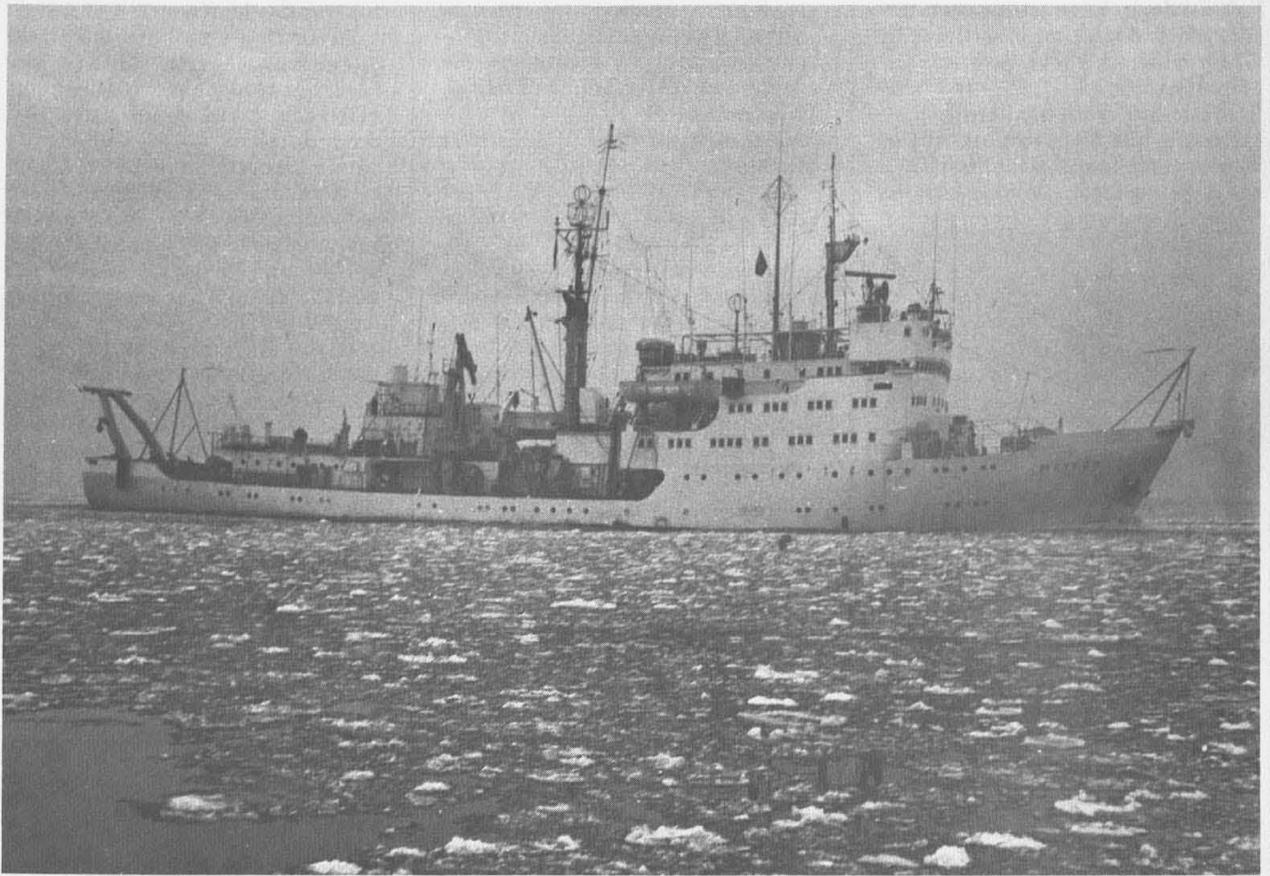
at Hannover; and Geologisches Institut der Universität Hamburg.

According to international agreement, the Deutsches Hydrographisches Institut at Hamburg takes depth soundings around Iceland for the compilation of the General Bathymetric Chart of the Oceans. In addition, a joint marine geophysical and geodetic research program was established in the area between Iceland and 70°N. to study the relation of the Iceland-Jan Mayen Ridge to Iceland and the Reykjanes Ridge. Three measuring cruises began in 1971. This project is a cooperative effort of the Deutsches Hydrographisches Institut at Hamburg (O. Meyer and D. Voppel), the Bundesanstalt für Bodenforschung at Hannover (H. Closs), and the Institut für Vermessungskunde der Technischen Universität Braunschweig (K. Gerke).

In 1973, West Germany participated in the international oceanographic research project, "Overflow 73," operating partly in arctic waters. The major purpose was to study warm and cold water exchange mechanism over the Greenland-Iceland Ridge, the Iceland-Faeroe Ridge, and the Faeroe-Scotland Ridge between the Atlantic and the polar basin. Eight nations participated, with 13 research vessels. West Germany's contributions consisted of physical and chemical-oceanographic, biological, and microbiological studies in the waters between Greenland and Iceland and between Iceland and the Faeroes. Participating were Bundesanstalt für Fischereiwesen and Deutsches Hydrographisches Institut at Hamburg; Institut für Meereskunde der Universität Kiel; and Institut für Meereskunde der Universität Hamburg.

Upper atmosphere and polar aurora

Several German research institutes are active in the International Magnetospheric Study (IMS). The main field program is planned for 1975-78. Ground, balloon, and rocket observations will be taken for investigating upper atmospheric phenomena at stations in northern Scandinavia, Iceland, Greenland,



F. Krüger

Figure 2. The German RV *Meteor* supports arctic research (length, 82.2m; breadth, 13.5m; draught, 5.2m; gross register tons 2,615; speed, 13.5 knots). The RV *Meteor* is handled by the German Hydrographic Institute (Deutsches Hydrographisches Institut) and used with the German Research Association (Deutsche Forschungsgemeinschaft). The ship has a crew of 55, with accommodation for 24 scientists.

Spitsbergen, the Faeroe Islands, and Bear Island.

A major project will be polar electrojet research in northern Scandinavia perpendicular to the auroral zone on a north-south profile with digital magnetometers (W. Kertz and H. Maurer, Institut für Geophysik und Meteorologie der Technischen Universität Braunschweig). It will also include studying the electrojet's three-dimensional structure with analog magnetometers on a grid through northern Norway, Sweden, and Finland (J. Untiedt and F. Küppers, Institut für Geophysik der Universität Münster). These will be supplemented by optical aurora investigations and VHF auroral backscatter observations, obtaining information that cannot be acquired

by the geomagnetic method alone (G. Lange-Hesse, Max-Planck Institut für Aeronomie, Institut für Ionosphärenphysik, Lindau/Harz). Further emphasis is being given to the observation of curtains of strong irregularities in the polar F-region by HF backscatter measurements (H. G. Möller, Max-Planck-Institut für Aeronomie, Institut für Ionosphärenphysik, Lindau/Harz) from sites in West Germany and southern Finland.

Geomagnetic micropulsations will be investigated on a north-south profile in northern Scandinavia and on Spitsbergen (M. Siebert and H. Völker, Institut für Geophysik der Universität Göttingen). More information about the source and the excitation mechanism is expected from these

measurements. A. Korschunow (Geophysikalischen Observatorium Fürstentfeldbruck der Universität München) plans to support the micropulsation observations by measurements at Fürstentfeldbruck in southern Germany. K. Wilhelm and J. W. Münch (Max-Planck-Institut für Aeronomie, Institut für Stratosphärenphysik, Lindau/Harz) will record these micropulsations on two north-south profiles crossing the auroral belt, including Faeroe Islands, Iceland, Greenland and northern Norway, Spitsbergen, and Bear Island. Special emphasis is given to investigating the relation between these micropulsations and time variation of particle fluxes.

Whistlers and VLF emissions will be observed from three stations in northern Germany (G. Mattern,

Haerendel *et al.*) has performed ion beam experiments (barium clouds) for the last decade at high latitudes, investigating the electric field in the ionosphere and magnetosphere.

For many years, the Institut für Ionosphärenphysik (Max-Planck-Institut für Aeronomie) at Lindau/Harz (G. Lange-Hesse and G. Kremser) has contributed to research efforts by measuring VHF-backscatter from the aurora and investigating x-ray bursts in the auroral zone with balloons.

The research program for geomagnetic micropulsations at high latitudes of the Institut für Geophysik der Universität Göttingen (M. Siebert *et al.*) started in 1960. The interest of the Institut für Geophysik und Meteorologie der Technischen Universität Braunschweig (W. Kertz *et al.*) has concentrated on the polar electrojet and the upper atmosphere heating by incoming particles and ionospheric currents.

Particle distribution and plasma density are the main research projects of the Arbeitsgruppe für Physikalische Weltraumforschung der Universität Freiburg (K. Rawer

et al.). Observations from satellites and rockets at high latitudes have been made regularly by this group.

Biological Sciences

Zoology

Since 1963, teams from the II. Zoologisches Institut der Universität Erlangen-Nürnberg under H. Remmert have spent five summers on Spitsbergen. Other field observations are planned for 1974. The objectives are observations and subsequent physiological laboratory tests on the diurnal rhythm of high arctic animals and analysis of the Spitsbergen ecosystem, consisting of field activities and laboratory work. The second objective includes research into the ecology of invertebrates, the soil's biological processes, and the vertebrates' role. In addition, the primary production was ascertained.

Botany

In connection with the "Stauferland" expeditions of the Geographisches Institut der

Universität Würzburg, botanical work started on Spitsbergen in 1960, with W. Hofmann studying the plant communities of south-eastern Spitsbergen. This plant-sociological research was extended in 1967 by W. Hofmann and G. Philippi (Naturkundliches Museum Karlsruhe), the first to investigate the moss communities of the same area.

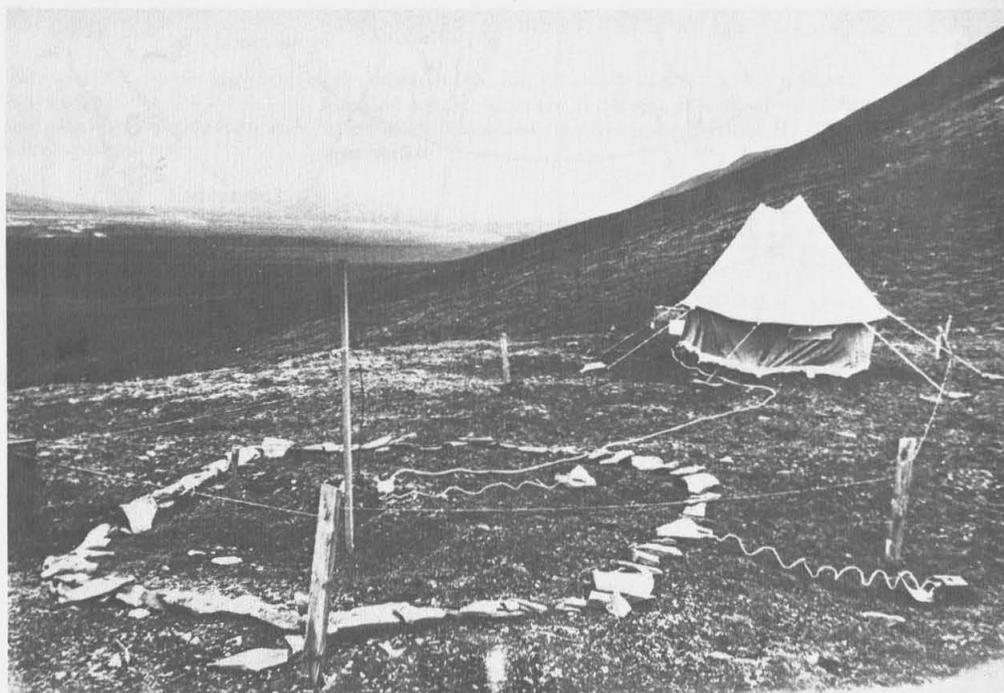
In 1969, W. Hofmann and D. Thannheiser (Institut für Geographie der Universität Münster) did plant-sociological field work in northwestern Spitsbergen. Results have not been published.

In 1971 and 1973, D. Thannheiser (Institut für Geographie der Universität Münster) studied plant communities of the western Canadian arctic archipelago. As preparatory work, he did extensive floristic investigations. This project is continuing.

Human and Social Sciences

Archaeology

The Institut für Urgeschichte der Universität Tübingen is the only



H. Remmert

Figure 4. Pictured is the registration tent of the zoology station at Svalbard (Spitsbergen), with the investigation area in the foreground (H. Remmert and staff, Erlangen).

German institution actively investigating the prehistory of arctic peoples. In 1970, this institute started a research project on Banks Island in the western Canadian arctic, excavating a pre-Dorset inland station (H. Müller-Beck, W. Torke, W. V. Koenigswald). In summer 1973, a team from the Tübingen institute headed by H. Müller-Beck continued work on the site, evidently a summer camp belonging to an Eskimo group specialized in seasonal musk-ox hunting. The project will resume in 1974, possibly on a wider interdisciplinary basis.

Ethnology

As far as known, L. Müller-Wille (Institut für Völkerkunde der Universität Münster) is the only German ethnographer engaged in arctic investigations. During 1973-74, field work in Canada and northern Scandinavia has included studying the technological and socio-economic change among population groups in the subarctic and arctic fringe of the ecumene.

Human geography

E. Treude (Institut für Geographie der Universität Münster) started in 1965 with field work in northern Labrador. He has made investigations on recent development and present structure of the settlement pattern and economy of Eskimos in various parts of the Canadian arctic. His

recent 15-month field project ended in spring 1974.

Polar Organizations

When Germany began to take an active interest in polar research a century ago, a society was formed to stimulate and support activities and to make results accessible to the scientific world and the general public. In 1870, the Verein für die deutsche Nordpolarfahrt (Society for German Northern Polar Activities) was founded at Bremen. During its short existence, the first German polar journal was published, *Mitteilungen (Notes)*. In 1876, because of widening interest areas, the society was renamed the Bremer Geographische Gesellschaft (Bremen Geographical Society). The *Mitteilungen* became the *Deutsche Geographische Blätter (German Geographical Journal)* and still exists. An active involvement in polar research was maintained, with the society sending four expeditions into different parts of the Arctic from 1876 to 1889.

In 1926, M. Grotewahl, a geophysicist who led the first German expedition into the Arctic after World War I, founded the Deutsches Archiv für Polarforschung (German Archives of Polar Research). Grotewahl's idea was to establish a central polar research institution. He collected scientific and popular polar literature through purchasing, reviewing, or as gifts. This collection survived the war, and in 1958 was bought by the University of Münster and reconstituted in the Geophysical Institute by B.

Brockamp (dec, 1969) one of the stipulations of EGIG. The archives regularly receives 280 periodicals in all pertinent scientific disciplines, most acquired as exchange publications. In addition, several hundred maps and several thousand books and reprints are available. As a scientific polar library the archives are unique in Germany.

There is no research body serving as a catalyst and coordinator of scientific polar activities at present. The Deutsche Gesellschaft für Polarforschung (German Society of Polar Research), 46 years old, is but a loosely knit bond among the active polar scientists and the institutions. Though the society has never been in a financial position to conduct expeditionary programs, its main objective is to stimulate and maintain general interest in polar research. This is achieved mainly through publication of its multidisciplinary journal *Polarforschung*, the successor to a newsletter started in 1931, and through international polar congresses held every second year. The society is guided by a board of directors and is supported by a scientific advisory board.

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