

Commentary

AN APPROACH TO POLAR RESEARCH*

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LIKE the attainment of the Poles, the development of a co-ordinated program for the scientific exploration of the polar regions has not occurred overnight. In fact more than a century has passed since Matthew Fontaine Maury first proposed an international scientific assault on the unexplored parts of the earth. His contemporaries did not heed his advice and at times it has required the zeal and courage of such eminent explorers as the late Admiral Richard E. Byrd to keep the spark of United States polar interest burning. However, only the concerted efforts of many nations could have made possible the massive programs of scientific exploration witnessed during the International Polar Years and the International Geophysical Year.

The National Science Foundation has supported specific projects in polar research since its establishment in 1950, including the study of specimens and data collections from earlier expeditions. Not until the IGY, however, did the Foundation engage in substantial financial support for arctic and antarctic research. During this period, its support of polar research was provided through a special appropriation on a project basis to areas of research not otherwise sponsored, but necessary to balance the United States research effort.

The conclusion of the IGY confronted United States efforts in Antarctica with a problem. The initial success of IGY Antarctic Program in establishing a sound foundation of observational results about the physical features of the continent would have been impaired if the program had come to an abrupt end. To close the stations even for a short time would have jeopardized their value for future use and the long term research projects would have been irretrievably disrupted.

The U.S. Antarctic Research Program

In developing plans for a United States Antarctic Program, it soon became evident that it would be impracticable for universities and government agencies to embark on a multiplicity of separate programs—each

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financing, supporting, and arranging for its own operations. The sensible course of action was to develop a uniformly planned and singly funded program based on a policy of long-term scientific exploration of Antarctica.

With this in mind, those departments and agencies of the government with interests in Antarctica reached an understanding with Dr. Alan T. Waterman, Director of the National Science Foundation, that the Foundation would assume responsibility for the development, co-ordination, management, and funding of the United States research effort in Antarctica. The Navy, which had so ably carried out the logistic support of these efforts throughout the IGY first under Rear Admiral George J. Dufek, from 1959 to 1962 under Rear Admiral David M. Tyree, and now under Rear Admiral James R. Reedy, agreed to continue logistic support responsibilities.

These arrangements were formalized by direction of the President through a Bureau of the Budget circular. The co-ordinated national research program concept was thereby officially recognized, and the United States Antarctic Research Program (USARP) was established. Today, the Departments of State, Defense, Interior and Commerce and the National Science Foundation keep each other informed of their antarctic interests and plans through the good offices of the Department of State, which has the responsibility for ensuring interdepartmental co-ordination. Through this forum mutual problems are aired and resolved, plans are exchanged, and adherence to the obligations of the Antarctic Treaty is insured.

Federal support for antarctic research has grown from a modest \$2 million in 1958, to \$7 million in 1963. With the hard core of geophysical investigations and synoptic results of the IGY as a foundation, new areas of research have been added, particularly in geology and biology. A systematic mapping program has been developed, based on the support capability of Naval aircraft. This program provides maps for the planning of scientific projects, for the aid of logistic support operations, and for recording results of investigations. The National Science Foundation also serves as the clearinghouse for information about United States antarctic activities, including the location of data and specimens, bibliographies of research results, and related items of historical and scientific record.

The potential of Antarctica as a research laboratory is now open to full realization, and no facet of scientific endeavour is excluded from consideration. The direction of future research in Antarctica can be characterized as movements away from the surface of the continent, vertically upward and downward, and horizontally outwards. The addition of data obtained by means of rockets and satellites is expected to enhance greatly the value of studies in meteorology and upper-atmosphere physics. A coring technique now in development will permit ice cores to be retrieved from great depths in the ice cap thus providing an insight into the history of antarctic glaciation. Likewise, coring from research vessels on the continental shelf and in adjacent deep waters should provide information on the history of Antarctica, not only during the Pleistocene but also during the time when the continent was eroded by free flowing water. Among the most important will

be studies on the physical and biological properties of the oceans north of the continent. The production of nutriment, the circulation of air and water around Antarctica, and the effect of the seasonally variable ice cover on the total heat budget of the earth, are antarctic problems of global significance.

An increasing number of participants in the United States Antarctic Research Program are coming from universities and other private institutions. At present some 250 scientists are involved with an annual field complement of 180, representing 8 federal agencies and 25 private institutions. Of the total, some 100 are members of educational institutions; of these, 69 are doctoral candidates and 37 are permanent members of the staffs and faculties.

Two institutes or centres devoted to polar studies have grown out of the antarctic program: one at the University of Wisconsin, the other at Ohio State University. At other educational institutions, such as Stanford University, the University of Southern California, the University of Minnesota, the University of Michigan, Columbia University, Florida State University, and Texas A. and M., interest in polar areas is nurtured by the research carried out under Foundation grants. From groups of young people such as those now preparing for their professional careers by working on the scientific problems of the Antarctic will come the next generation of the nation's scientists. That they are now receiving their intellectual training under the aegis of USARP is ample cause for satisfaction.

The Foundation has adopted a basic philosophy in regard to antarctic research that differs from the governing principle of the IGY period. During the IGY the nature of the scientific effort dictated that the program be organized centrally. The investigations were "mission-oriented" or "directed", in relation to the department or agency sponsoring the project and providing financial support. In the post-IGY era, antarctic research supported by the Foundation has been largely non-directed; that is, the Foundation does not lay down research requirements and go in search of people and organizations to meet them. General program areas of interest are suggested by an advisory committee, the Committee on Polar Research of the National Academy of Sciences under the chairmanship of Dr. Laurence M. Gould. USARP's chief scientist, Dr. Albert P. Crary, has developed five-year and ten-year research plans of basic objectives in general terms, to serve as guides in the long-term planning of the science and logistic support programs. During discussions with scientists, many ideas and areas for research come forward. Nevertheless, the basic aim of the USARP program is to support the individual scientist doing his *own* research in his *own* way, and the basis for putting together each year's program is determined by the research proposals received in the Foundation. These expressions of the research interests by the investigator himself are the life blood of our program.

The Foundation reviews the proposals received for antarctic research for scientific quality, contribution to knowledge, and logistic feasibility. In conducting this review, the Foundation staff invites the opinions of scientists

cognizant with the proposed research and their recommendations aid us in determining appropriate action.

An investigator whose ideas are adjudged worthy of financial support must be provided adequate means of putting his ideas to work in the antarctic environment. It would be the height of irresponsibility to advance to an investigator a sum of money for his expenses and those of his assistants and then plant him in these hostile surroundings without further consideration. The Foundation therefore is involved in the welfare of the scientist in this program to a high degree. Elements of the Department of Defense, specifically the U.S. Naval Support Force, Antarctica, are depended upon for much of the logistic support required by the scientific program.

However, in establishing the conditions and services necessary to pursue research efforts in Antarctica, more is required than transportation, housing, and sustenance. Not only do the researchers need freedom from the burden of the struggle for survival and the distractions of housekeeping, but they also require the tools of their particular trade and special kinds of assistance. These services fall largely outside the normal responsibilities of Defense Department agencies.

For this reason, the Foundation finds it necessary to establish and manage, through contracts, transfers of funds and grants, laboratories such as the biological facilities at Hallett and McMurdo Stations and the upper-atmosphere research facility at Eights Station. These laboratories feature equipment comparable to that found in many university laboratories in the United States. Vehicles especially selected or modified to meet the transportation needs of the program are also provided and maintained for the investigator. Specialized field equipment, office materials and supplies, and up-to-date reference libraries are as essential as the heavy laboratory equipment. For the provision of these items the researcher must look to the Foundation's service contractors.

At the conclusion of the IGY the United States continued to maintain four of the original seven IGY antarctic stations: Byrd, Pole, Hallett, and McMurdo. To this network has recently been added a fifth station, Eights, a semi-mobile facility designed to accommodate programs in upper-atmosphere physics. Located in the Ellsworth Highland region of West Antarctica, Eights Station is conjugate to Great Whale River, Canada. In addition to these continental research facilities, the USARP research vessel, the *Eltanin*, is operated for the Foundation by the Military Sea Transportation Service. For more than a year the MSTs has demonstrated, under the command of Rear Admiral Gano, an admirable capacity for maintaining this floating research station. Four cruises have been completed in antarctic waters and the fifth is under way. Research programs are conducted in upper-atmosphere physics, physical oceanography and marine biology.

In order to satisfy the requirements of the U.S. scientific community, particularly those related to marine and terrestrial biology, the Foundation is actively considering ways and means to establish a new temporary and mobile research facility in the vicinity of the de Gerlache Strait in the

Palmer Peninsula. The location under consideration is in a fertile biological area, conjugate to Northeastern United States, and half-way between the tip of South America and Eights Station.

International co-operation

Much of the success that we have experienced in Antarctica can be ascribed to the high degree of co-operation that has taken place among the twelve nations with active interests there. This co-operation in the conduct of scientific exploration, inaugurated with the IGY, was placed on formal basis by the negotiation of the Antarctic Treaty, which became effective June 23, 1961. This Treaty designates the first large area of the globe to be used exclusively for peaceful purposes. Likewise, it is the first international treaty to call for, and to base its provisions upon, the concept of free and open inspection. The Treaty calls upon participating nations to exchange expeditionary plans, scientific personnel, and scientific results for the mutual benefit of all parties. Under these terms, it is possible for each country carrying on scientific research in Antarctica to conduct programs and pursue problems of its own special interest and at the same time to co-operate to the fullest extent with other countries similarly engaged.

Important in preserving the effectiveness of a sound scientific research effort in Antarctica is the freedom afforded the scientific community in planning research activities independently of the formal negotiations of the interested governments. Under the International Council of Scientific Unions, a Scientific Committee on Antarctic Research (SCAR) has been established, consisting of delegates of the twelve nations signatory to the Antarctic Treaty. Through this Committee is achieved a harmonious exchange of ideas, data, and results, and it provides a forum for discussing problems relating to the scientific program, logistics, radio communications, and so on. The United States is represented in SCAR by the Committee on Polar Research of the National Academy of Sciences.

One of the most satisfying forms of international co-operation has been the exchange of scientists among the national expeditions. The United States has been host to scientists from Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, the United Kingdom and the USSR. Our own scientists have worked under the auspices of the Argentine, Australian, Chilean, New Zealand and Soviet expeditions. We consider this a healthy and inspiring state of affairs and look for its continuation and growth.

Basis for a co-ordinated arctic research program

It would be easy to jump to the conclusion on the basis of the United States experience in Antarctica that basic research in the Arctic can be pursued and administered in the same manner. Such a conclusion would be erroneous, however, for various reasons. Whereas the Antarctic is an area of unknown economic potential, whose strategic uses have been limited by international treaty and to whose territory the United States recognizes no claimant, the arctic land masses are regions of known economic wealth,

recognized for strategic importance, and demarcated by national boundaries. The Antarctic, furthermore, lies in a sparsely populated hemisphere while the Arctic is the polar hub of the world's population centre. Also, the climate of much of the Arctic is milder than that of the Antarctic.

A co-ordinated research program would, therefore, of necessity be different for the two areas. There are, however, certain scientific problems of common interest, such as conjugate phenomena of the upper atmosphere, glaciology of the Greenland and Antarctic ice caps, and the comparative geophysical properties of the Arctic Basin and the Antarctic Continent. There are also similarities in the conduct of the scientific programs in each region, including the inter-relationship and co-operation between government agencies and organizations of the private research community, the necessity for logistic support of considerable magnitude, and the need for international co-operation. The philosophy and management techniques of a co-ordinated research program as developed in the administration of the United States Antarctic Research Program may prove useful in the conduct of a bi-polar program.

Upper-atmosphere physics presents the most immediately fertile area of scientific study for a co-ordinated program. An important element in executing such studies is co-operation with Canada within whose territory lie the northern conjugate sites to many of the antarctic stations. Supported by NSF and utilizing United States and Canadian logistic facilities, scientists from United States universities and federal agencies are already co-operating with Canadian scientists in carrying out conjugate point experiments in that country. Here, initially are the elements that lend themselves appropriately to application of the co-ordinated research program approach: the need for logistic support, international co-operation, and the participation of both governmental agencies and private institutions.

The Greenland ice cap presents another opportunity for a bi-polar research program. The pursuit of studies in glaciology, including the history of the ice ages, physical properties of ice, and the relationship of great ice masses to the heat and water budget of the earth, requires a knowledge of both polar regions. Glaciological studies in Greenland like those in the Antarctic require heavy logistic support and, above all, co-operation between the United States and Denmark. Here, again, are the elements which call for the co-ordinated research program concept for encouragement and assistance if a sound basic research effort is to be achieved.

Finally, there is the Arctic Ocean. A thorough knowledge of its physical aspects is vital to the study of such disciplines as oceanic and atmospheric circulation on a world-wide scale; and its economic potential as well as navigational possibilities must be explored. Much of the weather that affects the temperate region of the northern hemisphere today is influenced and perhaps controlled by this ocean. Research in the Arctic Basin requires special types of logistic support. A full understanding of the region will require co-operation among a number of countries, many of which are already mutually involved in the exploration of the Antarctic. Particularly

important in such co-operation will be the Soviet Union with its long borderline on arctic seas.

The National Science Foundation has not received a long list of proposals to carry out studies in the North since the important work of the IGY. However, through the Department of Defense and particularly the Office of Naval Research, basic studies have been continued. Some United States scientific efforts in this region have therefore been largely mission-oriented towards necessary but very specific requirements primarily developed on the basis of strategic need. It must be kept in mind, too, that it is sometimes difficult to separate mission-oriented research from basic research because one stimulates the other. In the pursuit of knowledge of the Arctic the legitimate interests of the federal agencies must be considered through a suitable mechanism and supported along with those of the scientific community.

With the experience already gained in the conduct of the antarctic research effort, we have the opportunity to turn our attention also to basic research problems of the Arctic and to aspects of our total environment that are related to the polar regions. The National Science Foundation welcomes and is receiving proposals for this purpose — proposals that will be considered and reviewed, as they have been for the Antarctic, in terms of scientific quality, contribution to overall scientific knowledge, and logistic feasibility. Activities that have already been undertaken in northern regions under this co-ordinated polar program have begun in a spirit of co-operation with the Canadian Government, and we would look forward to further opportunities for scientific co-operation with Canada, Denmark, Norway and the Soviet Union. With the experience of the Antarctic behind us, we are confident that such international co-operation can bring success. In the pursuit of these goals, we are confident also that the United States polar research effort will contribute increasingly to basic scientific research and to our understanding of the world in which we live.