

## *Scientific Research in the Arctic*

### ALASKA

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**I**N A SHORT report on the U. S. National Arctic Research Program, prepared about a year ago by the Department of State, Office of International Scientific Affairs, it was stated: "Over sixteen U. S. agencies, including five departments and two autonomous agencies, are engaged in Arctic research. In F.Y. 1964 their total budget, including administrative support, was about \$17 million. 400 to 500 civilians were employed in this work plus a large number of contracted scientists and technicians from 33 U. S. and foreign universities, foundations, and institutions." Although mention was made of cooperative programs with the Government of Canada in the Queen Elizabeth Islands and with the Government of Denmark in Greenland, it was pointed out that this effort was almost entirely within Alaska and the surrounding seas.

Figures of this sort may, of course, be misleading when taken out of context and given without definition. Much depends on the criteria of research, on the arbitrary division between investigation and application, on where the distinction is drawn between the acquisition and interpretation of information and its application in terms of technology, management, and regulation. But, nevertheless, they give some sense of proportion. How does such effort compare with the situation elsewhere? Despite significant growth in available funds and manpower during the past two years, it must still seem small when compared with the multi-billion research and development bill met annually by the United States, possibly not so small when laid against the Alaskan population of less than a quarter of a million people, but again very small in light of the vast area encompassed and the backlog of scientific ignorance of the northern latitudes and the phenomena therein.

In peoples' minds, Alaska is commonly associated with the Arctic and arctic problems and here, indeed, lies much of the challenge to the scientist. But many do not realize the diversity of the geography within the State, the environmental extremes that offer singular opportunities for study and call for variety in approach and a degree of effort not yet realized. The seasonal range of 0 to 24 hours of daylight is well known but annual temperature variations of up to 170°F. in a single locality are less generally acknowledged, and between-year differences of as much as 80°F. on a given day are often viewed incredulously. Changes with distance are no less spectacular than changes with time; geomorphology apart, rainfall for example varies from an average in excess of 200 inches on the western edge of the southeastern archipelago to a few inches in the semiarid interior.

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Notwithstanding the legitimate plea that research effort in Alaska is still sadly lacking in view of the variety of problems, any attempt to cover all the projects currently under way — even by title — within the scope of this short statement would be impracticable.

An up-to-date summary of Alaskan research in the life-sciences is to be found in the May 1964 issue of *BioScience*, published by the American Institute of Biological Sciences, where some forty odd pages were devoted to a collection of articles on Arctic Biology. Various authors give accounts of the biological programs conducted, or supported by, the U. S. Atomic Energy Commission, the National Science Foundation, the Department of the Army, the Office of Naval Research, the U. S. Fish and Wildlife Service, the U. S. Geological Survey, the University of Alaska, the Arctic Institute of North America, the U. S. Public Health Service at the Arctic Health Research Center, by the Office of Naval Research at the Arctic Research Laboratory, and by the U. S. Air Force at the Arctic Aeromedical Laboratory. In the space available here, little can be added to these accounts other than possibly to mention a few of the more recent developments.

Although many must feel a sense of disappointment or even frustration, at the experiment in nuclear excavation at Cape Thompson (Operation Chariot) not materializing, the value of the related bioenvironmental survey supported by the U. S. Atomic Energy Commission is not to be underestimated. A great deal was learned through this concentrated effort. Studies on the cycling of radio-nuclides continue, particularly in terms of the short, well-defined cycle of  $\text{Sr}^{90}$  from atmospheric fallout to lichens to caribou to man. Levels are monitored by various teams under support of both the U. S. Atomic Energy Commission (A.E.C.) and the U. S. Public Health Service (U.S.P.H.S.). The Commission, also, sponsors two long-term programs at the University of Alaska, which, although basic in concept, are very relevant to the ultimate fate and distribution of radioisotopes that may find their way into the ecosystem. One deals with the cycling of elements in Arctic lakes, the other with the extent to which marine sediments may constitute a reservoir for potentially hazardous isotopes. It can be readily demonstrated that clay-mineral particles and other suspensoids will, through cation-exchange, concentrate certain metals at the expense of others and that this process can be greatly enhanced when organic molecules are associated with the particles. The systems in southeastern Alaska, where large quantities of glacial-flour pour into the estuaries, offer excellent opportunity to study cation replaceability series under various situations, flocculation and precipitation of the particles, and the availability of the associated isotopes to the biota.

The Office of Naval Research (O.N.R.) and the National Science Foundation (N.S.F.) now provide considerable support to the Institute of Marine Science at the University both in terms of the operation of the R/V *Acona*, a modern 80-ft. vessel, and the research conducted from her. Emphasis is in the field of biogeochemistry with the marine cycles of nitrogen, silicon, and boron being prime objectives. Denitrification and the relative use of

ammonia, nitrite, and nitrate by phytoplankton is being investigated with  $N^{15}$  labelling techniques and the use of a sea-borne mass spectrometer. Parallel work in a lake is being done under support of U.S.P.H.S. A new start has been made into the kinetics of the metabolism of marine psychrophilic bacteria; the capability of these organisms to achieve maximum growth near  $0^{\circ}\text{C}$ . temperatures holds much of interest.

The Institute of Arctic Biology at the University and the Arctic Research Laboratory (O.N.R.) at Barrow have continued to grow along the lines indicated; while plans for the new facility for the Arctic Health Research Centre (U.S.P.H.S.) at College are now well advanced.

Two areas of "applied" biology, that because of the idiosyncrasies of the Alaskan environment require no less "basic" research than other topics, received little mention in the *BioScience* presentation: forestry and agriculture. The State, of course, holds vast forestry resources in its subarctic territory and in southeastern Alaska. As most of the stands are on federal land, major responsibility for inventory and management rests with the U. S. Department of Agriculture (U.S.D.A.). The U. S. Forest Service, with its local headquarters at the Northern Forest Experiment Station in Juneau and its newly completed facility on the University campus, has vigorous research programs in forest biology, including pathology and entomology and watershed investigations which it carries out with a very small staff. Quite recently, through support from the Hill Family Foundation and U.S.D.A., the University has started research on soil-type distribution and its interaction on tree growth, and a study into the economic aspects of the logging industry in Alaska.

Research in agriculture is conducted almost exclusively through the Agricultural Experiment Station, which is operated jointly by U.S.D.A. and the State through the University. The experimental farms are in the Matanuska Valley, near Palmer, and at College on the campus. The program is fairly extensive, by Alaskan standards, embracing most of the areas usually covered by such stations associated with land-grant universities. A great deal of the effort is devoted to developing strains of grasses, fodder crops, fruit, and vegetables best suited to the unusual climate; to enhancement of milk and beef production by selective breeding and diet; to studies of factors inhibiting and enhancing tuber sprouting; control of insect pests; and to the unusual implications of the engineering and economics of Alaskan agriculture. The fact that despite — or because of — its low population density the area grows only a small fraction of its consumption of farm produce is largely an economic problem of the present. Extensive research is nevertheless of vital importance if future needs are to be met.

In the area of animal husbandry, a project under way on the campus, has attracted much interest both nationally and internationally. With substantial long-term support from the Kellogg Foundation, what appears to be a successful attempt is being made to domesticate musk oxen. Although, heretofore, little work has been done with these primitive animals, it is thought that because of their natural hardiness, their frugal dietary require-



Young musk oxen in a domestication experiment being undertaken by the University of Alaska in collaboration with the Institute of Northern Agricultural Research. The project is supported by the W. K. Kellogg Foundation.

ments, and the potential value of their very fine wool (qiviut) they may well form the base of an economy in native villages. By ingenious and somewhat rugged methods from the viewpoint of the capturers, thirty-three yearlings have been taken from the stock on Nunivak Island and transported to the campus farm. There they are growing well and are fast assuming the predicted docility.

A new but highly significant area of endeavour is in the interdisciplinary field of water-resources research. In 1965, U.S.P.H.S. built a substantial facility on the University campus to house one of the seven national Water Laboratories. At about the same time the University established an Institute of Water Resources Research under P.L. 88-379. These two units will work in close collaboration and a broad spectrum of projects have been started, ranging from the kinetics of microbial activity and the categorization and treatment of dissolved organics to physical studies of stream freezing, the properties of interstitial water in permafrost, and desalination by natural freezing. Other projects entail the relationship between water quality and the biota, the capabilities of salmon to negotiate "fish ladders", and the economics of water supply and demand.

Internationally, research in Alaska is most commonly associated with the earth sciences, and understandably so. Geographically the area is strategically located for studies in upper-atmosphere energy-phenomena, seismology,

glaciology, geomagnetism, geomorphology, geochemistry, vulcanology, and meteorology. A number of agencies are involved in these activities, both through "in-house" and "contractual" arrangements, including the U.S. Coast and Geodetic Survey, the U. S. Weather Bureau, the U. S. Bureau of Mines, the U. S. Geological Survey, the U. S. Army, Navy and Air Force, while the National Aeronautics and Space Administration and the National Science Foundation are generous in their support of such research.

The acquisition of synoptic data on conventional meteorological parameters, on seismic disturbances, and survey functions both on land and at sea require little amplification here other than possibly to say that much more effort is desirable. The problems of establishing recording stations over such a vast area with such poor communications are formidable. Particular mention may be made of the inadequacy of the survey program of the Bureau of Mines, which is sadly lacking both in funds and personnel in the face of an inventory requirement far exceeding that in any other part of the U.S.A.

In terms of synoptic observations, it is again understandable on geographic considerations that data acquisition facilities for polar-orbiting satellites have been installed near Fairbanks by the U. S. Weather Bureau and the National Aeronautics and Space Administration. The first internationally operated station of this type is now under construction in the same locality.

The center of earth-sciences research in Alaska is the Geophysical Institute at the University of Alaska. The Institute was established by Congressional authorization in 1946. It now employs some fifty scientists based on the main building at College; however, much of the work is conducted at a number of specialized field stations scattered throughout the State but mostly in the interior.

Again space precludes more than a categorization under general headings of the wide variety of projects under way. The Geophysical Institute publishes an Annual Report giving brief technical summaries of research in progress, copies of which are available in most libraries.

Because of location, much emphasis is placed on auroral studies and upper-atmosphere energy-phenomena. Sophisticated instrumentation is used for spectrophotometric properties and for direct measurement of ionization from the ground and from satellites, rockets, and balloons. Of particular significance is the development of an image-orthicon television system to record and analyze the rapid movement of auroral arcs and to provide high-speed spectrographs. Theoretical studies of potential energizing mechanisms of auroral electrons and laboratory experiments on proton-nitrogen collision effects are also involved. Extensive studies, both observational and theoretical, of noctilucent clouds are being undertaken.

On the broader scale, comprehensive investigations of geomagnetic storms are under way, using telluric current, magnetic, and auroral techniques in the Arctic and at magnetically conjugate points in the southern hemisphere. Under collaborative programs, micropulsations are being



Aurora rays silhouette a radio telescope on the University of Alaska campus.  
(Photograph by courtesy of Vic Hessler.)

measured near the South Pole (Vostok), on S.S. *Eltanin* in antarctic seas, in Finland, Greenland, Hawaii, and from the drifting ice-islands in the Arctic Ocean.

Other studies involve the emission of VLF radio waves and the absorption of VHF waves during magnetic storms, and the mechanism behind ionospheric scatter.

In the area of meteorology, earlier work done in Antarctica on katabatic winds generated on the coastal ice-slopes, is being extended to Alaska by the installation of a recording anemometer on Douglas Island. The physics, chemistry, and causes of ice-fog is a topic of long standing and more recently, with the acquisition of an electron microscope, potential nuclei for fog droplets and ice-crystals are being examined. The size spectra of snowflakes and rain droplets are being compared with other meteorological data,

particularly in respect to the melting process during precipitation. Studies on snow accumulation, stratigraphy, facies parameters, and surface flow, together with measurement of volcanic heat flow, are being undertaken at a field station atop the 14,000 ft. peak of Mount Wrangell.

The geochemical program centers largely around analyses of basaltic rocks and their inclusions, and the properties of olivine. Particular attention is being given to the geochemistry and petrology of volcanoes in combination with seismic and gravity studies in the active Katmai area, the object being to locate plasma areas and to develop prediction techniques and estimates of energy-release during eruptions. As is to be expected, in view of the high activity of the Aleutian fault, considerable attention is given to analyses of records from the seismic network. Attempts are being made to record microseisms on the floor of the Aleutian Trench using "pop-up" seismometers.

In the view of the writer, it is in the general area of behavioural and socioeconomic studies that effort in Alaska is most lacking, and this is probably due to the vicissitudes of funding. Despite great efforts by individual workers, there has apparently been little opportunity for coordinated programs on broad fronts. Over recent years the deaths of Geist, Giddings, and Skarland have seriously reduced research in anthropology and archeology; the experience of such authorities is not readily replaced.

Clearly the existence of so many semi-isolated communities of native peoples of different ethnic origins presents tremendous opportunities for cultural and physical anthropology. Work is proceeding on blood-group analyses and on the immunology of Aleut islanders and on the languages of certain Indian tribes. But the opportunity for genetic and linguistic studies will soon disappear; need for additional activities in such directions is urgent.

As has often been pointed out by Dr. George Rogers and his colleagues, Alaska, because of its location and present state of economic development, offers a unique laboratory for investigators in the whole range of social and behavioural disciplines. In common only with Hawaii amongst American States, Alaska can be considered as isolated and self-contained; and, because of its size and sparse population, the emergent processes and problems of community organization and adaption can be studied under the nearest approach to controlled conditions. Furthermore, a different spectrum of stresses affect the population, those of the natural environment rather than of modern civilization. It is therefore essential to study the *status quo* in terms of the behaviour and psychology of the indigenous and immigrant populations, the present economic parameters and their implications, and, indeed, all that is idiosyncratic of the present situation, in order to understand the impact of the changes that will surely occur on a more compressed time-scale than experienced elsewhere.

To the research worker, whether he is prepared to admit it or not, motivation stems not only from the desire to learn and understand — to add to knowledge — but also from the thought that through the process of understanding he may improve the potential lot of mankind. We may ask

then: Whither should future research in Alaska be directed? Where should emphasis lie? Should it be planned? And if mission-oriented, what should be the objectives?

To a relative newcomer, there is a fascinating diversity about the philosophies of Alaskans, and indeed of non-Alaskans, whenever future developments of the State are mooted. Few question that, in Alaska, America holds a tremendous potential. But the nature of the asset and the time and manner of its realization is a matter of lively conjecture.

At present, strategic considerations based on geographical location may well be most significant; and these, because of the source of funds, are reflected in the research effort. However, such factors as proximity to other influential nations, location in terms of global transport patterns, which declare military importance during periods of tension, will become no less significant in happier times of international cooperation.

In projections for the immediate future, economic development tends to receive most attention. Again, there can be no doubt about the wealth of raw materials. Traditionally, these are generally thought of as minerals, fish, and timber. The question of whether, with more people and power, these and other resources can be exploited economically is a topic of lively discussion, the outcome of which depends largely on the point of view of the protagonists; on whether they forecast or hindcast, on whether they base their assumptions on past experience or in confidence of change. Inevitably the appreciation lacks basic premises owing to insufficient information about the extent of the resources, their management, future developments in technology, and changing economic needs. Clearly, greatly enhanced research effort to provide such information is urgently needed if opportunities are not to be lost, or "progress" is not to be misguided.

Another group see in Alaska the prime asset of a varied natural environment heretofore unchanged, or unspoiled, by civilization and, thence, an opportunity for the grand experiment in living; an experiment of great challenge in face of growing population pressures. This point of view is full justification for an intensive program of objective research into multiple land-use; and opportunity for such research is readily available in Alaska. Circumstances still permit the withdrawal of vast tracts of undeveloped land of widely divergent geography and environment. Broad areas could be left under virgin conditions, others could be improved from the wild-life standpoint, and yet others could be developed for multiple use, the impact of which could then be compared with the controls.

However, longer-term projections on the future of Alaska, or northern territories as a whole, must be obscured by our inability to forecast the direction in which civilization and advancing technology will take us. One would be bold, indeed, to predict on existing knowledge, or historical experience, the location, geography, or economics of the most valuable territory of the future. What will mankind need or desire? Will emphasis be on modifying the environment to suit man as he is now constituted physically and mentally? Or will man change, and require some different and so far



unpredicted milieu? Will changes in our mode of living be designed, be dictated by circumstances, or arise fortuitously? Will changes in civilization be so rapid and drastic that it becomes more effective to start again in virgin territory than to modify established population centers? The past century has seen human migrations, to Texas for example, that would have been hard to predict on cursory judgement of climate and the undeveloped terrain.

At present, any answers to such questions must be insecure. And it is this realization that dictates a catholic approach to future research needs in Alaska. Despite the sense of urgency for results and action in an underdeveloped region, there is no justification for the assumption that "applied" research will be more effective than "basic" or *vice versa*, or that emphasis on any one discipline is likely to be more productive than on any other. The need is for the broadest possible approach to an understanding of the idiosyncrasies of the North and of all it contains. Such can only be achieved by greatly increased effort.