November-December 1968

ANTARCTIC JOURNAL
of the United States

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Vol. III **November-December 1968** **No. 6**

Prepared jointly by
Office of Antarctic Programs, National Science Foundation
and
U.S. Naval Support Force, Antarctica, Department of Defense

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(Continued)

Antarctic Journal of the United States is published bimonthly by the National Science Foundation with the assistance of the Department of Defense. It is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The subscription price is $2.50 per year in the U.S. and Canada, and $3.25 elsewhere. The price of single copies varies.

Communications, other than those concerning paid subscriptions, should be addressed to:
Information Officer, Office of Antarctic Programs
National Science Foundation, Washington, D.C. 20550

Use of funds for printing this publication approved by the Director of the Bureau of the Budget (October 13, 1965)

Greenwich Mean Time is used, except where otherwise indicated.

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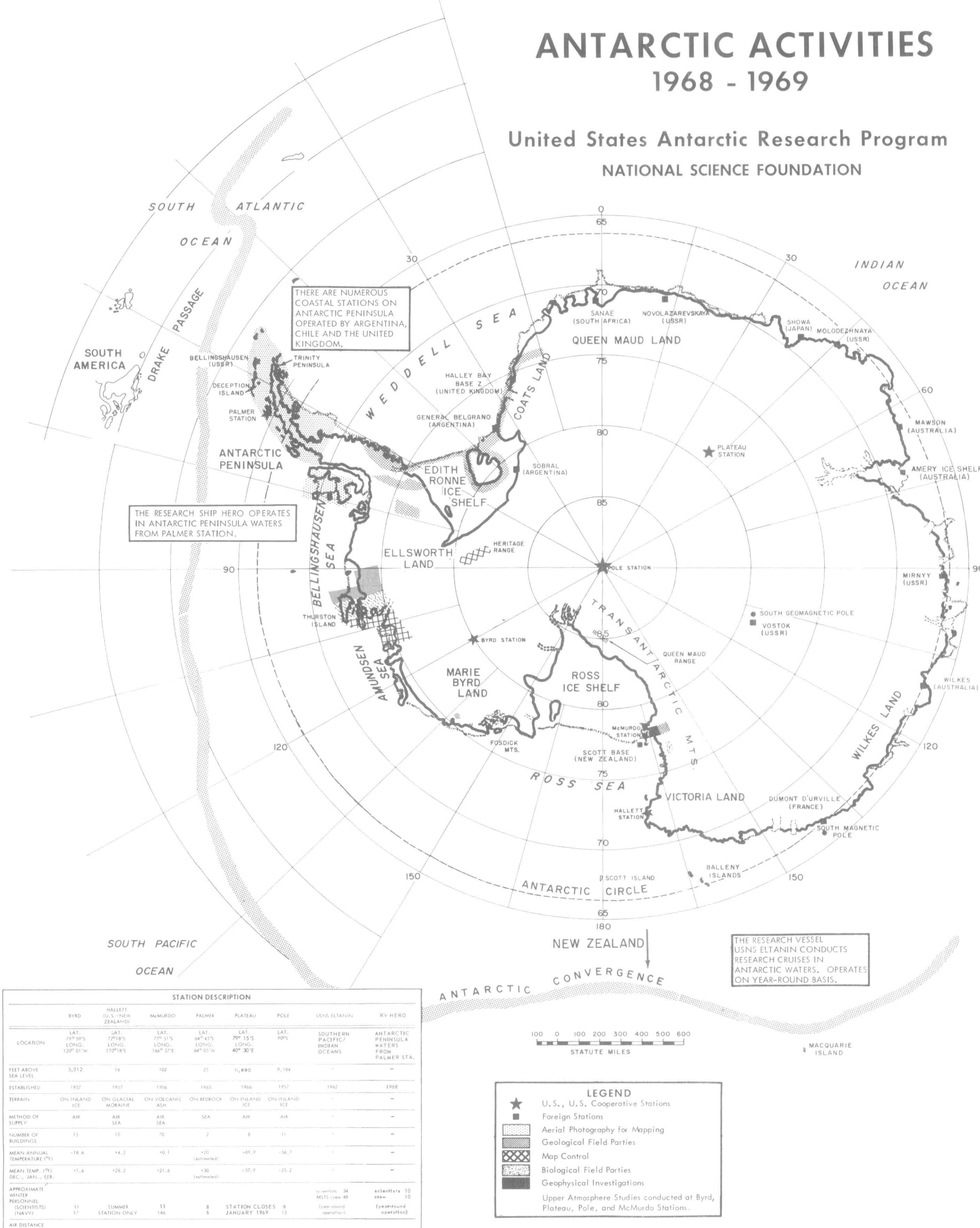
ANTARCTIC ACTIVITIES
1968 - 1969

United States Antarctic Research Program
NATIONAL SCIENCE FOUNDATION



STATION DESCRIPTION

	BYRD	HALLETT (U.S.-NEW ZEALAND)	McMURDO	PALMER	PLATEAU	POLE	USNS ELTANIN	RV HERO
LOCATION	LAT. 79° 59'S LONG. 120° 01'W	LAT. 72°18'S LONG. 170°18'E	LAT. 77° 51'S LONG. 166° 37'E	LAT. 64° 45'S LONG. 64° 05'W	LAT. 79° 15'S LONG. 40° 30'E	LAT. 90°S	SOUTHERN PACIFIC/ INDIAN OCEANS	ANTARCTIC PENINSULA WATERS FROM PALMER STA.
FEET ABOVE SEA LEVEL	5,012	16	102	25	11,890	9,184	-	–
ESTABLISHED	1957	1957	1956	1965	1966	1957	1962	1968
TERRAIN	ON INLAND ICE	ON GLACIAL MORAINE	ON VOLCANIC ASH	ON BEDROCK	ON INLAND ICE	ON INLAND ICE	-	–
METHOD OF SUPPLY	AIR	AIR SEA	AIR SEA	SEA	AIR	AIR	-	–
NUMBER OF BUILDINGS	15	10	70	2	8	11	-	–
MEAN ANNUAL TEMPERATURE (°F)	-18.6	+4.2	+0.1	+20 (estimated)	-69.9	-56.7	-	–
MEAN TEMP. (°F) DEC., JAN., FEB.	+1.6	+28.2	+21.6	+30 (estimated)	-37.9	-25.2	-	–
APPROXIMATE WINTER PERSONNEL (SCIENTISTS) (NAVY)	11 17	SUMMER STATION ONLY	11 146	8 6	STATION CLOSES JANUARY 1969	6 13	scientists 34 MSTS crew 48 (year-round operation)	scientists 10 crew 10 (year-round operation)
AIR DISTANCE FROM McMURDO (STATUTE MILES)	885	380	-	2,360	1,350	820	-	–

Plans for the 1968-1969 Season

The season's opening flight from New Zealand to McMurdo Sound, made on October 7, signalled the increase in tempo that summer annually brings to United States activities in the Antarctic. In the 1968–1969 phase of the U.S. Antarctic Research Program (USARP), which is funded and coordinated by the National Science Foundation (NSF), more than 150 scientists and technicians from universities and government agencies across the United States will be engaged in a variety of research projects on the Continent, on offshore islands, and aboard ships.

To support these scientific endeavors, the U.S. Navy is conducting *Operation Deep Freeze 69,* which involves the deployment of Coast Guard icebreakers, naval supply ships, and aircraft of the Army, Navy, and Air Force. All told, about 2,000 support personnel will participate. In addition to station, ship, and aviation personnel, there will also be a naval construction unit, augmented by Air Force engineering specialists, and a cargo-handling detachment. Assisting in the transportation of personnel and cargo between New Zealand and McMurdo will be a C–130H of the Royal New Zealand Air Force, and the tanker HMNZS *Endeavour.*

Based as they are on 13 years of continuous experience, the plans for both the scientific investigations and support operations in 1968–1969 are similar to those of recent years, but, while the patterns have become fairly standardized, they are by no means unchanging. In the current season, the research vessel *Hero* will commence operations in the Antarctic Peninsula area, the number of year-round U.S. stations will be reduced from five to four by the closing of Plateau Station, and C–141 Starlifters will enter regular service on the key Christchurch-McMurdo route.

A fuller description of U.S. plans for the forthcoming season is presented below, prefaced by a summary of activities through October 15.

Operations Through Mid-October

Several of the preparatory steps in *Deep Freeze 69* were taken from Rhode Island. Two commercial ships, SS *Australian Gem* and SS *Australian Galaxy,* began the movement of cargo to New Zealand from Davisville, R.I., the winter headquarters of Antarctic Support Activities and of Naval Construction Battalion Unit 201. Aboard those ships was some material to be flown from New Zealand to Antarctica by Air Development Squadron Six (VX–6), which—under the command of Commander Eugene W. Van Reeth, USN—began deployment of its aircraft from the Naval Air Station, Quonset Point, R.I., in early September.

Having departed Washington on September 22, the commander of the U.S. Naval Support Force, Antarctica, Rear Admiral J. Lloyd Abbot, Jr., arrived at McMurdo Station aboard the first flight, so as to direct operations on the Continent. He was accompanied by Mr. Jerry W. Huffman of NSF, who served as USARP Representative, Antarctica, until November, when he was relieved by Mr. Kendall N. Moulton of NSF. Among the first tasks in the now-familiar pattern was the reopening on October 10 of Hallett and Brockton Stations. Located on the Ross Ice Shelf at 80°10′S. 178°25′E., Brockton is an important source of meteorological data for air operations between McMurdo and such inland sites as Byrd Station, the first flight to which was scheduled for October 15, but had to be cancelled because of unfavorable weather.

Further Deployment Plans

The other two inland stations, because of colder climates, will have to wait longer for the resumption of air service—South Pole until about November 1, and Plateau until mid-November. Palmer Station, off the Antarctic Peninsula, has no air facilities, so its relief will be effected by ship in December.

Most personnel are carried from the United States to New Zealand in either naval aircraft—principally C–121J Super Constellations—or planes provided by the Military Airlift Command (MAC). It is expected that such trans-Pacific flights will carry about 1,300 passengers during the course of the season, with the peak deployment period being in October and November.

The majority of these individuals continue on to Antarctica. At the same time, a considerable amount of high-priority cargo must also be flown from Christchurch to McMurdo Station. To handle these airlift needs, the two Super Constellations and four LC-130F Hercules of Air Development Squadron Six will be supplemented by a C–130H Hercules of the Royal New Zealand Air Force, which plans to make three round trips, and by C-141 Starlifters of the Military Airlift Command, scheduled for six to eight turnaround flights. These will be the first regularly scheduled Starlifter flights to the Antarctic.[1]

Individuals who have passed the winter in Antarctica will be relieved as rapidly as possible, starting, of course, with those at McMurdo, the largest station. A notable exception, however, is the crew of the PM–3A nuclear power plant at that station: its 24 mem-

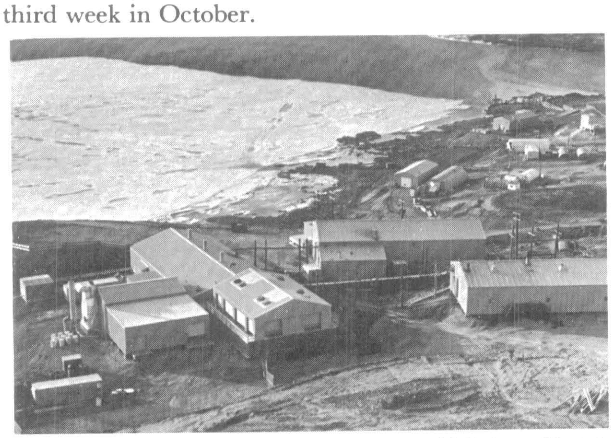
[1] The C-141 flight to Williams Field in November 1966 (*Antarctic Journal,* vol. II, no. 1, p. 21) was a feasibility test.

(U.S. Navy Photo by C. L. Abramson)

C-141 taking off from Williams Field in 1966. This season, Starlifter flights will be included in the regular intercontinental schedule.

bers must conduct a rigorous training program for their replacements in Crew VIII, each of whom must demonstrate his operational proficiency and satisfactorily answer the oral questions of a qualification board before assuming his duties. Changing the entire crew—a practice unique to the PM-3A—requires approximately a month, so the members of Crew VII can expect to leave for home at about the time of the initial flights to Plateau Station.

Besides bringing relief personnel and others to support such summer activities as construction, the ski-equipped Hercules of VX-6 will make routine resupply flights to the inland stations throughout the season. Such intracontinental flights will move an estimated 3,300 short tons of cargo from McMurdo, requiring over 2,000 hours of flight time. (Some of those hours may be contributed by VX-6's fifth Hercules, due to be delivered in November.) If all goes well in these early stages, it should be possible to start placing scientific parties in the field by the third week in October.



(U.S. Army Photo)

Because of its antarctic setting, the PM-3A is the only shore-based nuclear power plant that routinely changes its entire crew at one time.

Remote Scientific Field Parties

The principal field effort of the season will be a continuation of the survey of the coastal areas of Marie Byrd Land and Ellsworth Land in West Antarctica, now in its third year. Six different institutions will conduct as many projects in the survey, and a total of 16 or 17 scientists will be active in the field at various times, aided by a USARP field assistant. They will be transported by VX-6 to two field camps to be erected by naval personnel from McMurdo Station. The first camp will be located to the southeast of the Canisteo Peninsula (73°40'S. 101°00'W.) and the second at 73°30'S. 90°21'W., in the vicinity of the former Camp Minnesota.[2] The planned establishment date for the first camp is October 21, and about 150 short tons of equipment will be flown into the field. The move to the second camp will occur about December 10 and will require the airlift of approximately 140 tons from McMurdo. (Another 12 tons, mostly scientific equipment, will be lifted between the two locations.) A third, a tent camp, may be set up for a short period on Thurston Island. Transportation from the camps to sites in the field will be provided by a U.S. Army aviation detachment using three UH-1D helicopters. In the past, these machines with their experienced crews have proved ideal for this type of support. Motor toboggans will also be available for use in the vicinity of the camps themselves.

During the first part of the season, a team of three men from Texas Technological College, led by Mr. Kerby LaPrade, will continue the geologic survey initiated by Dr. F. Alton Wade. They will investigate the Hudson Mountains, the Canisteo Peninsula, and nearby islands. When the shift is made to camp 2, this party will return to McMurdo for deployment to the Roberts Massif at the head of the Shackleton Glacier, there to complete geologic mapping begun in 1962 by Dr. Wade. Work at this site should terminate about January 20.

While with the survey in Ellsworth Land, Mr. LaPrade will also act as chief scientist. He will be replaced in this capacity by Dr. Campbell Craddock of the University of Wisconsin when the move to the second camp occurs. Dr. Craddock will head a team of four carrying out a geologic reconnaissance of the Jones Mountains during the period December 10 to January 30. Through the entire season, Dr. Gareth Gilbert of Ohio State University will continue a survey of the flora along the coastal areas of West Antarctica. His party of three will work closely with the geologists and with four topographic engineers from

[2] Camp Minnesota consists of a Jamesway hut installed in November 1961 at 73°30'S. 94°30'W. It was last visited in January 1965.

the U.S. Geological Survey led by Mr. Karlheinz Eissinger, who hope to establish 43 control points using electronic measuring equipment. This effort will require about 940 miles of traverse. It is hoped to put this party into the field about October 20 in the vicinity of Mount Siple, which the survey did not reach last year. If this proves possible, the topographic team can then join the main scientific party when it reaches the field about November 1.

The other survey participants will be Mr. Akira Shimoyama of Washington University, St. Louis, Missouri, who will continue the paleomagnetic work begun two years ago by Dr. H. LeRoy Scharon [3] of the same institution, and a Chilean exchange scientist, Mr. Fernando Munizaga. Dr. Boris Lopatin, the Soviet exchange scientist who spent last winter at McMurdo Station, may also join the survey for part or all of the season.

Another remote field party will operate in the Fosdick Mountains. Three men, headed by Mr. William J. Voss of the Bernice P. Bishop Museum in Honolulu, will continue a study of terrestrial arthropods, such as mites. To be flown by LC-130 to a field site at approximately 76°29′S. 145°35′W., the team will use motor toboggans in its survey of the surrounding area. The Hercules of VX–6 will also support two projects to be conducted in Queen Maud Land by foreign scientists. About November 6, six Norwegian geologists, led by Mr. T. S. Winsnes of Norsk Polarinstitutt, will be flown from McMurdo Station to the Kraul Mountains by way of the South Pole. They will be accompanied by two members of the British Antarctic Survey. After landing the Norwegians, the aircraft will proceed to the British station at Halley Bay to refuel and pick up two additional scientists and their equipment. This field party of four will then be dropped off in the Shackleton Range. Because of the distance between the Norwegians' field site and McMurdo Station, it is possible that they, like the British party, will maintain a communication guard with Halley Bay until both groups are picked up at the end of January. As part of their field work, the Norwegians will establish control for aerial photography to be flown by VX–6.

Scientific Activities Around McMurdo Sound

During this austral summer, 19 field projects will be conducted in the vicinity of McMurdo Sound.[4] Considering that this area has proved to be one of

[3] During the past winter, Dr. Scharon pursued his studies at Molodezhnaya Station as exchange scientist with the Soviet Antarctic Expedition.

[4] Several other projects in the McMurdo area started in early September, aided by limited helicopter support. See insert, next column.

Winter Flights Support Research

On September 3, 13 scientists and a supporting 7-man helicopter detachment were transported to McMurdo Station by two LC–130Fs of Air Development Squadron Six. The Hercules aircraft, which arrived and departed Williams Field the same day, also delivered scientific equipment and high-priority supplies, as well as the first mail and fresh provisions to reach the winter parties at McMurdo and Scott Base since February.

The flight was the third made to Antarctica in winter on a scheduled basis, but in the June and September 1967 flights, only one Hercules flew to McMurdo, while another stood by at Christchurch in case of an emergency. (On its return trip, the Hercules that made the September 1967 flight rode a 100-knot tail wind and set a record for propellor-driven aircraft of 6 hours 2 minutes.) This year, the complete 24,000-mile trip from Davisville, R.I., to McMurdo and back was made by both planes. Each was equipped with an internal fuel tank to increase its operating range.

Three of the five projects aided by the special winter flight are in marine biology. Dr. Robert Elsner of the University of California at San Diego, with two associates, is continuing an investigation of cardiovascular adaptation in diving seals, using instrumentation to record data while the seals are underwater. Another researcher from the same university is Dr. Gerald L. Kooyman; he and an assistant are studying the physiology and deep-diving behavior of seals and penguins. A University of Washington investigation of fish and seal predation on inshore benthic organisms is being continued by Mr. Paul Dayton and an assistant. The latter two projects involve scuba diving beneath the ice of McMurdo Sound.

The site of the fourth project is the ice-free valleys on the other side of McMurdo Sound. There, Dr. Robert Benoit and two assistants from the Virginia Polytechnic Institute are engaged in studying the physiology of microorganisms. In the fifth project, two University of Texas researchers will reactivate the geodetic-satellite monitoring station at McMurdo Station for geodetic and ionospheric-physics studies.

Comdr. Arpad J. Toth, then Air Operations Officer on the staff of the U.S. Naval Support Force, Antarctica, was officer-in-charge of the winter fly-in. The VX–6 helicopter detachment was headed by Lt. Comdr. Thomas J. Chider.

the most interesting in Antarctica for biological, geological, and glaciological research, it is intriguing to note that McMurdo Station was not one of the stations the scientists requested for the International Geophysical Year. (The Navy added it to the program as an aerial logistics base essential to the construction and support of South Pole Station. When Little America V was closed at the end of the IGY in 1958, some of its scientific functions were transferred to McMurdo. With the addition in the post-IGY period of biology and geology to the antarctic research program, McMurdo emerged as an important scientific center.)

Of the 19 projects, 7 are in biology, 9 in geology, and one each in glaciology, hydrology, and upper atmosphere physics; several of them are continuations of investigations begun in previous years. To support this field work, VX–6 has programmed its LH–34 helicopters—which can operate within about a 200-mile radius of McMurdo Station—to provide 650 flight hours. The UH–1Ds of the Army Aviation Detachment are expected to contribute another 50 hours, and some assistance may be rendered by the helicopters based on the icebreakers operating in McMurdo Sound. The effectiveness of several of the field projects will be further enhanced by the availability at McMurdo Station of modern, well-equipped laboratories for the biological and earth sciences. These make it possible for scientists to alternate periods in the field with laboratory review and analysis of their findings.

Glaciers have played so important a role in the creation of land forms that their study is of interest to geologists as well as glaciologists. During the coming season, Dr. Wakefield Dort, Jr., of the University of Kansas, and two field assistants will continue an investigation of the chronology and internal structure of local mountain glaciers in southern Victoria Land. They will study the recent advance and retreat of four types of glaciers found in the area: (1) small alpine glaciers flowing from isolated simple cirques, (2) alpine glaciers nourished by névé, (3) outlet glaciers draining the polar ice cap, and (4) piedmont glacier tongues invading the lower parts of dry valleys. Each of these types has undergone fluctuations which the investigators propose to document by mapping features (such as recessional moraines) that are associated with glacial retreat.

An Ohio State University party of five under Dr. Gerald Holdsworth will concentrate on studying the mechanics involved in the formation of surface waves on small glaciers, seeking to explain this phenomenon in terms of the way in which "cold" ice flows. Most of this work will be done at Meserve Glacier, which has well-developed surface waves. There, the investigators will occupy a Jamesway hut that was constructed in 1965 for another Ohio State group and will reinvestigate bore holes made at that time. For the purpose of comparison, they expect also to visit nearby Goodspeed Glacier, where the wave phenomenon is not found.

Another Ohio State project will be conducted by Dr. Parker Calkin, Mr. Robert Behling, and a field assistant. They will investigate the surface geology and glacial history of Wright Valley. In the process, they will attempt to apply weathering criteria developed from earlier detailed studies of the Meserve Glacier morainal system to adjacent glaciers, with the hope of producing a mineralogical weathering index valid for the entire Wright Valley, and perhaps for all deglaciated areas in southern Victoria Land.

Weathering is an important factor in soil formation, and both these processes will be studied by Mr. George Linkletter from the University of Washington, and an assistant. They will concentrate on the Taylor Valley, where other detailed geological investigations are already under way. By examining both the upper and lower valley, they should be able to obtain a sufficiently wide range of material of different ages and from various altitudes to permit assessment of the many weathering and soil-forming factors involved. More specialized in its approach is another University of Washington project under Dr. Fiorenzo C. Ugolini who, with an assistant, will expand a long-term study of the role of antarctic lichens in the weathering of rocks by also examining the part played by mosses and penguin guano in the same process.

Dr. Scott B. Smithson of the University of Wyoming will lead a party of four in a continuing detailed geological and geophysical investigation of rocks of Paleozoic and Precambrian ages (*i.e.,* 250 million years or older). This year, the team will study the stratigraphy and metamorphism of the Koettlitz group in an effort to determine its relationship to older rocks in the area and will examine the Granite Harbor intrusives. Further gravity surveying will be done also. At the same time, Dr. George H. Denton of the American Geographical Society and an assistant will continue the study begun last year of the glacial geology of the McMurdo Sound region. Among other things, they intend to map in detail the uppermost Taylor Valley, date numerous samples associated with glacial deposits, and use the results to relate antarctic glacial episodes to worldwide Pleistocene and pre-Pleistocene events (*i.e.,* events occurring within the last 50 million years). Age determination is also an objective in the investigation of the Mawson Tillite of West Antarctica being carried on by the University of Maine. Dr. Harold Borns and three assistants will visit Allan Hills, Carapace Nunatak, Mount Littlepage, Mistake Peak, and other sites where tillites are known to exist. A third geologic project is the long-term study of patterned ground being conducted by Dr. Robert F. Black of the University of Wisconsin. In this project, the growth rate of the wedges, which are a feature of patterned ground, is used to measure the time since the surface was covered by a glacier. With an assistant, Dr. Black will conduct field studies on Ross Island and in the dry valleys. Servicing of the year-round recording equipment at Mount Nussbaum and Crater Hill will be performed in conjunction with these field trips.

Dr. Johannes Schroeder, of George Washington University, and an assistant will conduct a geochemical survey at several sites in southern Victoria Land. At Lake Vanda, Dr. Irving Friedman of the U.S. Geological Survey will study the origin of the salts and the sources of heat in the lake. He and his assistant will carry out their work in cooperation with New Zealand scientists at the new Vanda Station.

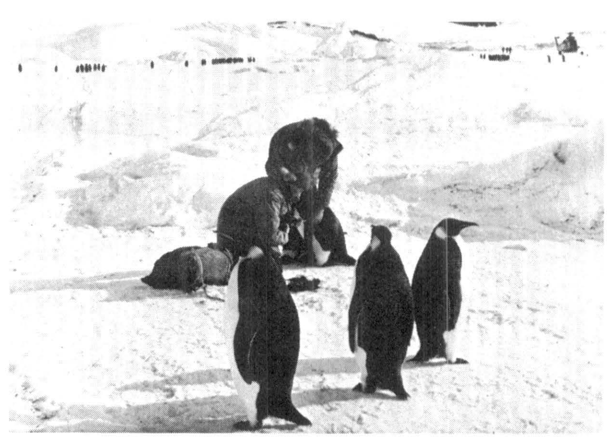
Dr. H. J. Harrington, University of New England, Australia, is well known for his studies of fossils in Tertiary deposits of the McMurdo area. This season, he and an assistant will collect fossils at Minna Bluff and Brown Peninsula and in the dry-valley area for further evidence of continental drift.

Scarcity of moisture is one of the factors that inhibit plant growth in most of the Antarctic. As such, it enters into Dr. Emanuel D. Rudolph's study of essential elements and environmental factors in the establishment, distribution, and growth of lichens and terrestrial algae. With three assistants, he will lay out rectangular plots at Cape Crozier and in the ice-free valleys. These quadrats are to be monitored during this and future summers, and organisms from them will be sent to Dr. Rudolph's laboratory at Ohio State University for analysis of nitrogen and mineral composition.

As part of a long-term study begun last season in the Weddell Sea, Dr. Donald B. Siniff of the University of Minnesota and two assistants will study the status and population dynamics of seals in McMurdo Sound from mid-October to mid-December.[5] In addition to helicopter support, the project will require some 20 hours of flights in Super Constellations to make seal surveys.

Following termination of the sleep studies which have been carried out on human subjects at South Pole Station during the past two years, an attempt will be made at McMurdo to conduct similar studies on seals. Dr. Jay T. Shurley, principal investigator on the Oklahoma Medical Research Foundation study, and Mr. Albert T. Joern, who carried out the work at Pole in 1968, will obtain sleep records and related physiological information on one or two Weddells temporarily confined to an enclosure.

The ubiquitous penguin will again receive his share



(U.S. Navy Photo by J. W. Richards)

Banding of emperor penguins at the Cape Crozier rookery.

of attention. Mr. Robert Wood of Johns Hopkins University and a party of five will return to Cape Crozier to band penguins and skuas and to observe previously banded birds. Working at Cape Crozier and at McMurdo Station, Dr. Richard L. Penney will conduct further experiments into how birds navigate. He expects to extend his investigation from penguins to skuas to determine whether this flying bird has the same orientation capabilities as the plodding penguin. Both Adélie penguins and cold-adapted antarctic fishes will be studied by Dr. Robert E. Feeney of the University of California at Davis. He and five assistants will inquire into the biochemical properties of blood-serum proteins in these animals.

To permit more extensive research into some of the above subjects, 74 penguins, 30 skuas, and 2–4 Weddell seals will be airlifted from McMurdo to the United States in December. Studies that will be facilitated in this manner are avian navigation (New York Zoological Society), avian population (Johns Hopkins University), and seal diving (University of California, San Diego). Some of the seals and birds are destined for the Cincinnati, Detroit, Milwaukee, and St. Louis Zoos.

The precipitation of protons and electrons will be measured with balloon-borne instrumentation in January and February. Dr. Martin Pomerantz of the Bartol Research Foundation, who has conducted cosmic-ray studies in Antarctica for many years, will be in charge of the project. The 10 balloons to be released are expected to reach heights in excess of 100,000 feet.

Hallett Station Research

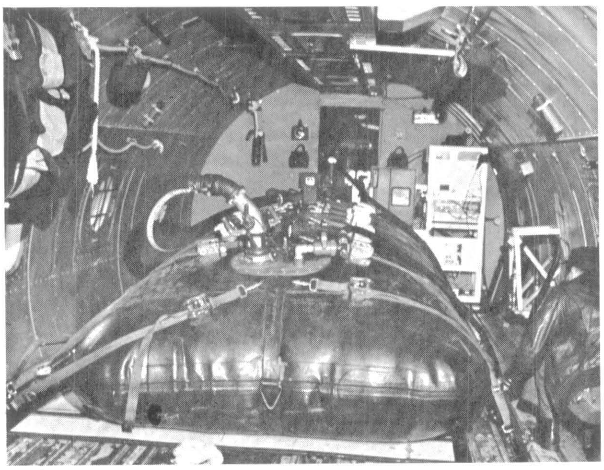
At Hallett Station, which is well situated for biological investigations, Dr. John R. Baker of Iowa State University will continue his study of Adélie penguin embryology. It is hoped that this research

[5] Additional data on the seal population of the Weddell Sea will be collected by a second University of Minnesota group aboard *Glacier*.

will illuminate the ancestry of penguins, specifically answering whether they evolved from flying birds or from reptiles. About 50 eggs will be returned to the United States for further study. Also working at Hallett, but for a longer period, will be Dr. Raymond D. Dillon of the University of South Dakota. He and his assistant will make a survey of the one-celled animals called Protozoa. Either prior to or after the work at Hallett, Dr. Dillon and his assistant will complete a similar study begun at McMurdo two years ago.

Aerial Photography

In addition to the support which it furnishes to field parties and station scientific activities, VX-6 participates directly in the scientific program by taking aerial photographs for use by the U.S. Geological Survey in its program to map Antarctica. For this purpose, the squadron has two aircraft configured to carry trimetrogon cameras—a Hercules and a Super Constellation. This year, the Hercules will concentrate on the Antarctic Peninsula, including Alexander Island, Coats Land, and the Shackleton Range. Vertical coverage has also been requested of Anvers and Deception Islands.



(U.S. Navy Photo by W. A. Black)

Usefulness of the C-121 for photomapping and other long-range missions is increased by installing a rubber fuel cell in the fuselage.

Special aerial photography for use in various scientific projects will also be obtained. To assist the penguin-population studies being carried on by the Johns Hopkins University, the Super Constellation will photograph the Adélie rookery at Cape Crozier during the egg-laying period (November 12 to 16), when the population is most stable. For use in geologic interpretation, trimetrogon color photography of the Queen Maud Mountains and the Queen Alexandra and Britannia Ranges has been requested.

Station Operation, Construction, and Maintenance

Antarctic Support Activities, commanded by Captain Hugh A. Kelley, USN, is responsible for the operation and maintenance of United States antarctic stations, while construction is carried on by Naval Construction Battalion Unit 201, headed by Lt. J. R. Finn, CEC, USN. As last year, the five officers and approximately 200 men of NCBU 201 will be augmented by a special detachment of Air Force engineers consisting of one officer and about 30 enlisted men.

The construction program for *Deep Freeze 69* will be substantially as set forth in a previous issue of this journal,[6] with special emphasis on the continuing rehabilitation and improvement of McMurdo Station. Some construction is also scheduled for Byrd and Hallett Stations, and a certain amount of work remains to be done to complete the new Palmer Station on Anvers Island.

Routine maintenance and related minor construction at all stations are done by the personnel of Antarctic Support Activities, who are also responsible for the maintenance of vehicles and civil engineering support equipment. They will also set, move, and, at the end of the season, dismantle the field camps to be used by the scientists in the Marie Byrd Land Survey.

During the coming season, Plateau Station will be deactivated after three years of successful operation. Scientific equipment will be removed, but the other facilities will be left in such a state that the station may be reoccupied in the future with a minimum of effort.

Ship Operations

The routine of ship operations as established over the years will again be followed with one notable exception: There will be no picket ships maintaining a storm-tossed and lonely vigil beneath the air route linking Christchurch and Williams Field. Their absence will testify to technological progress—two years of successful experience have demonstrated that weather satellites are a reliable source of meteorological information for antarctic flight forecasting. The picket ships' former role in resupplying New Zealand's station on Campbell Island will be assumed by icebreakers.

As it did last year, the Coast Guard has provided four icebreakers, and each is equipped with two UH-2B helicopters. *Glacier, Burton Island,* and *Southwind* will operate in the Ross Sea beginning in late November. *Burton Island* and *Southwind* will leave Wellington on November 23 while *Glacier* will sail

[6] Vol. III, no. 4, p. 142.

from Port Lyttelton the following day. The three ships will cooperate in breaking a channel into McMurdo Sound. About December 5, *Glacier* will be detached to proceed to Valparaíso, Chile, and then on to the Weddell Sea, where she will work with the Argentine icebreaker *General San Martín* in the second year of the International Weddell Sea Oceanographic Expedition.

After *Glacier* has departed, *Burton Island* and *Southwind* will remain in the Ross Sea to maintain the channel and escort supply ships in and out of McMurdo Sound. *Burton Island* will operate continually in this area until she leaves for New Zealand about February 20. *Southwind,* however, expects to have a brief period for resupply and crew rest at Port Lyttelton late in January, after which she will return to the Ross Sea and carry out an oceanographic project.

The fourth Coast Guard icebreaker, *Edisto,* will operate in the Antarctic Peninsula area, arriving for the first time at Palmer Station on December 16. During the season, she will assist the cargo ship *Wyandot* of the Military Sea Transportation Service in the annual resupply of Palmer Station. From Palmer, *Wyandot* will sail directly for McMurdo Station, to arrive there about January 24. *Wyandot* is expected to remain at McMurdo until February 5, when she will leave for Port Lyttelton and home.

The first resupply ship to reach McMurdo Station, about December 26, will be the tanker USNS *Alatna,* which will make three subsequent trips between New Zealand and Antarctica with bulk petroleum products. In this aspect of the resupply, she will be assisted by HMNZS *Endeavour.* This Royal New Zealand Navy tanker is scheduled to make two trips to McMurdo Station, one in January and another in February. Together, the two ships will deliver about 6 million gallons of aviation and diesel fuels. (Palmer Station's petroleum needs will be met by the icebreaker *Edisto,* which will deliver 125,000 gallons of marine diesel oil.)

In addition to *Wyandot,* USNS *Pvt. John R. Towle* will make a single trip to McMurdo Station with dry cargo. Her schedule calls for departure from Port Lyttelton on December 26 and arrival at McMurdo on the first day of the new year. In all, it is expected that about 15,000 measurement tons of dry cargo will be delivered to McMurdo and Palmer Stations. Cargo operations in the Antarctic are pretty much a one-way affair, but it is expected that the two cargo ships will backload about 4,500 measurement tons for return to the United States.

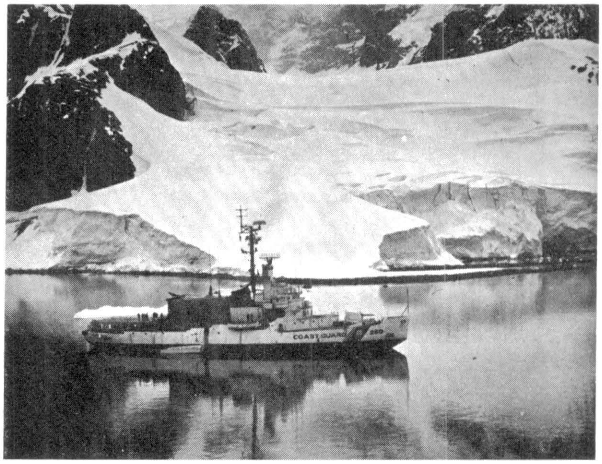
Antarctic Peninsula Activities

When the icebreaker *Edisto* first arrives at Palmer Station on December 16, she will disembark a detachment of one officer and 31 men from NCBU 201. They will have until the end of March (when *Glacier* will call at Palmer to pick them up) to finish the station building erected last year, construct a combined garage-warehouse-recreation building, and complete the boat-landing area.

During the summer, several parties of biologists will carry out investigations from Palmer Station, collecting samples from islands in the vicinity of Arthur Harbor or from the National Science Foundation's new research ship, *Hero.*[7] *Edisto* will also provide small-boat and helicopter assistance to the scientists.

Dr. James R. Rastorfer, of Ohio State University, and an assistant will study the mosses in the area in

[7] For details on *Hero,* her equipment, and intended use, see *Antarctic Journal,* vol. III, no. 3, p. 53-60.



(*U.S. Coast Guard Photo*)

Icebreaker Southwind *(shown in Paradise Harbor, near Argentina's Almirante Brown Station) operated in the Antarctic Peninsula area last summer. This season, she is assigned to the Ross Sea.*

(*U.S. Navy Photo by J. T. Perkins*)

Since this photo was taken, the ice-conning tower (visible at far left) has been removed from the tanker Alatna.

order to relate differences in their physiology to the environmental factors in their particular habitats. Concurrently, Dr. Rudolf Schuster of the University of Massachusetts will study antarctic hepaticas; his objective is to evaluate the part the liverworts play in the ecology of the local land flora. In the field of marine biology, Dr. Joel Hedgpeth of the University of Oregon will continue his study of pycnogonids (sea spiders), while Dr. Edvard A. Hemmingsen will investigate the Chaenichthyidae, a strange family of fishes whose distinguishing characteristic is the lack of hemoglobin in their blood. Dr. Hemmingsen began his work two seasons ago at McMurdo Station and hopes by comparison with other fishes to gain further insight into the respiratory mechanisms of "water-breathing" animals in general. Dr. Jesse C. Thompson of Queens College, Charlotte, North Carolina, will carry out a systematic investigation of ciliated protozoans. Dr. Arthur DeVries, University of California (Davis), will study the comparative biochemistry of proteins. His studies will complement Dr. Feeney's in McMurdo Sound.

Some of these biologists expect to extend their investigations to Deception Island—150 miles north of Palmer Station—and perhaps to Trinity Peninsula. Studies at those locations will be supported by the recently launched *Hero,* which is scheduled to arrive at Palmer Station in late December. After first trawling along the continental shelf within 100 miles of the station, *Hero* will carry five USARP biologists from Palmer to Deception Island, where a December 1967 volcanic eruption forced the evacuation of Argentine, British, and Chilean research stations.

The effects of the volcanic eruption on the microorganisms in the island's soil will be assessed by Dr. Robert E. Benoit of the Virginia Polytechnic Institute and Dr. Roy E. Cameron of the California Institute of Technology, whose work is related to the development of life-detection devices. The other biologists will study sea spiders and fishes while *Hero* is en route to the island and in Port Foster, the volcanic island's caldera.

In addition to the ship-based biological studies at Deception Island, three glaciologists from Ohio State University will be put ashore at a site still to be selected. It is expected that *Glacier* will be called upon to evacuate the glaciologists while en route to Palmer from the Weddell Sea in late March. The glaciological party will be led by Dr. Jean-Roland Kläy.

Hero also will support two geological studies on Livingston Island, at the northern end of the Antarctic Peninsula. There, an Ohio State University party led by Dr. K. R. Everett will seek information about soil formation, and hopefully will date glacial events. The second study, sponsored by the Lamont Geological Observatory of Columbia University and headed by Dr. Ian Dalziel, is concerned with the structure and geologic history of the Scotia Arc—the submarine ridge that extends from South America to Antarctica in a sweeping loop marked by South Georgia Island, the South Orkneys, and the South Sandwich Islands. Studying the basement rocks of the Antarctic Peninsula's mountains is relevant to our understanding of island arc systems, such as the Aleutians and the West Indies.

If *Hero* does not encounter unforeseen difficulties during this first year of operation, she will follow a repeating pattern of two or three weeks at Deception Island, after which she will devote a couple of days to relocating the scientists working on the Trinity Peninsula, followed by a brief return to Palmer Station for maintenance and reprovisioning. It may, however, prove necessary to call upon *Edisto* and *Glacier,* which will be passing nearby at times during the season, to assist the parties on Deception Island and the Trinity Peninsula.

Upon completion of the austral-summer work, *Hero* will support a survey of marine resources off the Antarctic Peninsula. To be carried out by the Bureau of Commercial Fisheries under the direction of Mr. Miles S. Alton, the survey is planned for the period April-June 1969. The activity involves recently developed exploratory fishing techniques and an automatic data-processing system for assessing the fish resources. To assure optimum utilization of the specimens obtained, liaison has been established with the Smithsonian Oceanographic Sorting Center, which will be represented aboard by its director, Dr. H. A. Fehlmann.

Byrd Station Projects

Most scientific projects at the inland stations are year-round activities or—like auroral research—are carried out only during the winter. At Byrd Station, however, the U.S. Army Terrestrial Sciences Center[8] will carry on two summer projects, one of them in cooperation with the University of Bern, Switzerland. Both projects are designed to follow up on last year's successful drilling of a hole to the bottom of the ice cap. In one, a device developed at the University of Bern will be lowered into the drill hole to collect carbon-dioxide samples. At several depths, a portion of the drill hole will be sealed off and a large quantity of ice adjacent to the hole melted so that carbon dioxide released by the melting ice can be collected. The samples will be analyzed at the University of Bern for C^{14} isotope content, an indication of age. The resulting dates will be basic to an understanding of ice deposition and flow in Antarctica. The work at

[8] Formerly the U.S. Army Cold Regions Research and Engineering Laboratory.

Byrd Station will be performed by a party of five led by Drs. Hans Oeschger and Chester C. Langway.

The drill hole will also serve a project of a different character: a very-low-frequency transmitter and receiver will be operated at various levels in the hole to determine the dielectric and loss properties of ice as functions of depth and frequency. This experiment will be conducted by Mr. James Rogers of the University of Washington. Mr. George Webber of the same university will measure phases and amplitudes of the very-low-frequency groundwave radiated from the long-wire antenna at Byrd's substation.

Mr. Anthony Gow of the Terrestrial Sciences Center will return to the station with an assistant to continue the analysis begun last year of the ice cores from the drill hole. Priority will be given to the physical, structural, and geochemical properties of the ice. They will periodically redetermine densities, examine crystal growth as a function of depth, and start a comprehensive study of the entrapped dirt at the bottom of the ice sheet.

It is also expected that the original Byrd Station will be revisited during the season, and the rate of closure of the drill hole made there 10 years ago remeasured. Two long lines of snow-accumulation stakes laid out in 1962 will likewise be reexamined.

Working at both McMurdo and Byrd Stations, Dr. P. V. Angus-Leppan of the University of New South Wales, Australia, and an assistant will investigate the possibilities of using gyro-theodolites in high latitudes.

Summer Work at Pole and Plateau

Following completion of their work in Ellsworth Land, the four U.S. Geological Survey topographic engineers will proceed to the South Pole, where they will make determinations of the station's location by means of daylight star observations. Such location determinations, now available over several years, enable plotting of the station's drift and will permit optimum positioning of a replacement station.

After a week at the Pole, the topographic engineers will move to Plateau Station, from which they will execute four radial traverses to a distance of about 15 miles. These traverses, which will give accurate measurements of the surface slope around the station, have been requested by the analysts of the meteorological data.

Temperatures in the shallow drill hole at Plateau Station will be remeasured using a quartz thermometer. The work will be done by a member of the Ohio State University party investigating the Meserve Glacier. Another glaciologist, from the Army Terrestrial Sciences Center group at Byrd Station, will travel to South Pole to establish a depth-temperature profile and an ice-flow profile. These profiles are required in developing plans for drilling through the ice sheet at Pole or in East Antarctica.

(U.S. Navy Photo by S. Kelley)

As she did last year, Glacier *will help cut a channel to McMurdo before proceeding to Chile and the Weddell Sea.*

International Weddell Sea Oceanographic Expedition

Upon leaving the McMurdo area, *Glacier* will sail to Valparaíso, arriving there about December 18 for a 10-day upkeep period. After that, she will proceed via Punta Arenas to the Weddell Sea to begin the second phase of the International Weddell Sea Oceanographic Expedition.[9] During the expedition, *Glacier* will meet with the Argentine icebreakeı *General San Martín*—probably at General Belgrano Station on the Filchner Ice Shelf—so that the two ships may cooperate in the ensuing investigations.

Features of the 80-day research expedition will include retrieval of four Norwegian submerged buoy stations set out last year, probes into the perennial ice cover in the extreme western portion of the sea, and occupation of approximately 25 oceanographic stations to fill in gaps in the grid begun last summer. Further oceanographic stations will be taken along a northeast—southwest depression and in the eastern region.

In all, some 35 scientists from Argentina, Norway, and the United States will participate in the expedition, including groups from three U.S. universities. Dr. Albert W. Erickson will head a party of four collecting seal-population data for a University of Minnesota study; Dr. Sayed Z. El-Sayed's study of plankton will be continued; and Dr. John S. Rankin, Jr., University of Connecticut, will continue his investigations of benthos. A marine geological program will be carried out by a representative of the University of California (Los Angeles), while the Coast Guard Oceanographic Unit will again be in charge of the

[9] The accomplishments and findings of the first year were reviewed in the *Antarctic Journal,* vol. III, no. 4, p. 80-88.

hydrography and bottom-photography programs. The two Norwegian participants, Dr. Thor Kvinge and Mr. Jan Strømme, will, in addition to carrying out their own oceanographic program, represent an oceanographic program of Massachusetts Institute of Technology. The Norwegians participated also in the first phase of IWSOE (1968).

General San Martín is expected to occupy 20 stations over a period of 40 days. Aboard the Argentine icebreaker will be one USARP group: Dr. Luis R. A. Capurro and four assistants from Texas A&M University who will study water masses, currents, and the origin of bottom waters.

Halfway through the cruise, *Glacier* will rendezvous with *Edisto* in order to refuel and exchange scientific personnel. On her way out of the Weddell Sea, *Glacier* will call briefly at Deception Island, Trinity Peninsula, and Palmer Station. She will thus—about April 1—become the last U.S. ship to clear the Antarctic.

Continuing and Winter Projects

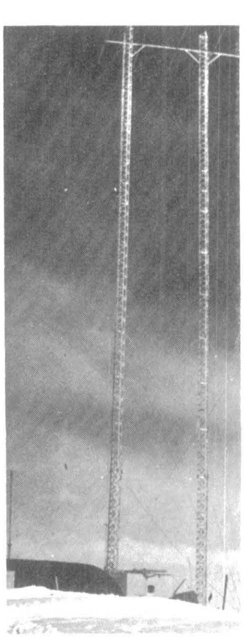
Some 35 persons will remain in Antarctica beyond the conclusion of the operating season to engage in scientific work at the stations. This is slightly fewer than in previous years, the reduction being partly due to the planned termination of the forward-scatter program that has been in existence at Byrd, South Pole, McMurdo, and Vostok Stations and partly a result of the closing of Plateau Station. One new activity will be introduced—an extension of the National Geodetic Satellite Program to Antarctica. This program, which calls for the accurate positioning of approximately 50 stations in a worldwide network, is divided into two phases: a geometric, or passive, phase and a dynamic phase.

The passive phase—commonly called PAGEOS, an acronym for Passive Geodetic Satellite—will be carried out during the 1969 winter at four stations in the Antarctic: McMurdo and Palmer and two Australian stations, Mawson and Wilkes. Cameras at these points and at others outside the Antarctic will simultaneously photograph the satellite (orbiting at an altitude of 2,300 miles) against a background of stars. From the photographs, analysts will determine the directions between the stations and develop a network. The second, or dynamic, phase involves the monitoring of Doppler signals from satellites in lower orbits in order to adjust the network to the center mass of the Earth. This phase is the simpler of the two and can be carried out in two or three weeks during the 1969-1970 summer, regardless of visual conditions.

The PAGEOS phase requires dispatching four-man teams with 13,000 pounds of equipment to each of the four selected stations. The Coast and Geodetic Survey will be responsible for those at Mawson and Wilkes, while civilians from the Army Map Service will conduct the program at McMurdo and Palmer Stations. Additional equipment for the second phase will have to be sent to Palmer, but the Doppler equipment is already in place at McMurdo and will be operated by University of Texas personnel who intend to use it during the winter for upper-atmosphere studies.

The Coast and Geodetic Survey also maintains magnetic and seismological observatories at Byrd and South Pole Stations, while the Stanford Research Institute investigates PKP seismic waves at the first of these two locations. Meteorology at these same locations is the responsibility of the Weather Bureau, a part of the Environmental Science Services Administration (ESSA), while naval personnel take weather observations at McMurdo and Palmer Stations. ESSA's Research Laboratories conduct the riometer programs at Byrd and South Pole, while the McDonnell Douglas Astronautics Company operates a conjugate-point riometer facility at McMurdo. The ESSA Research Laboratories also plan to conduct very-low- and ultra-low-frequency radio studies and an investigation of transient ionospheric phenomena at Byrd and South Pole Stations. In other aspects of upper atmosphere physics, the Bartol Research Foundation studies cosmic ray intensity variations at McMurdo and South Pole Stations, while Stanford University carries on studies of the magnetosphere at Byrd using both ground and satellite data. At the Byrd long-wire facility, located about 11 miles from the station, an investigator from the University of Washington will continue the inquiry into extremely-low- and very-low-frequency radio-wave phenomena.

The upper atmosphere investigations that have been in progress at U.S.S.R.'s Vostok Station for several seasons will be continued in cooperation with similar studies by Soviet scientists. Mr. F. Michael Maish from the Environmental Science Services Administration Research Laboratories has been selected as the U.S. exchange scientist for the 1969 winter. In addition to the micropulsation and riometer equipment presently at Vostok, high-frequency receiving and recording equipment will be operated as part of the ionospheric transient phenomena program.



(Photo by V. P. Hessler)
Forward-scatter antenna masts at Vostok Station.

Medical Aspects of the U.S. Antarctic Program

PAUL E. TYLER [1]

Commander, MC, USN
Bureau of Medicine and Surgery
United States Navy

The word "logistics" is quickly associated with such functions as transportation, construction, procurement, and storage, but not so readily with medical matters. Yet a glance at a dictionary will show how encompassing that word is, and an examination of the medical activities conducted in support of the U.S. Antarctic Research Program (USARP) will reveal their significance in the selection and maintenance of a most important ingredient of the program—personnel.

The Antarctic still presents a harsh and demanding environment that can at any time demand from an individual the utmost in physical stamina and mature judgement so that he may act quickly and positively in order to survive. This requires men in excellent physical condition, well trained and with a stable, mature personality. They must also have the ability to adapt psychologically to a strange, adverse environment and to be congenial with others in a small group if they are to pull their share of the load, not only in their specific job area or scientific endeavor, but in the general maintenance and operation of the station. For those reasons, the United States Navy Medical Department conducts a program to screen personnel under consideration for deployment to the Antarctic.

Personnel Screening Procedures

Two procedures are employed—one to screen the military personnel who perform the support functions, and one for the civilian scientists. To obtain military support personnel, the Navy annually solicits, on a service-wide basis, applications from personnel desiring antarctic duty. Each request is forwarded with the report of a general physical examination and a medical history to the Bureau of Naval Personnel by way of the U.S. Naval Support Force, Antarctica.

At Support Force headquarters, the staff physician reviews the reports of physical examination. The applications of those personnel who appear to meet the physical standards established for antarctic duty are endorsed as conditionally physically qualified. From this group, the Bureau of Naval Personnel then selects the men best qualified in each of the required job specialties. These men are ordered to report (in March or April) to selected screening centers where they are again given a complete physical examination, including a dental examination. Those found to be physically qualified are then screened psychiatrically.

The psychiatric screening consists of a written test and a clinical interview by a psychologist and a psychiatrist. The written test elicits relevant standardized information concerning the subject's personal history, motivations, values, and personality self-descriptions. The clinical interviews are designed primarily to identify those candidates who manifest psychopathology of such magnitude as to preclude their selection to winter over. For those personnel considered qualified to winter over, an attempt is made to describe and evaluate the attitudes, motivations, personality traits, defense mechanisms, and behavior patterns that affect work motivation, social influence, and personal adjustments in a small isolated group.

In the case of USARP personnel, the procedure is essentially the same, except that mass screening is not done. Instead, an appointment is made for each individual at the screening center (a designated naval hospital) nearest his residence. At the hospital, the scientist undergoes a complete physical examination, and, if he is to winter over, he is psychiatrically tested and interviewed in the manner described above.

The results of the scientist's physical examination are provided directly to the staff medical officer of the Naval Support Force, Antarctica for review, while the psychiatric examination report is sent to the Psychiatric Division of the Bureau of Medicine and Surgery, where it is evaluated and the subject's acceptability determined. This evaluation is then forwarded to the Support Force medical officer, who, having reviewed the medical records, notifies the National Science Foundation whether the applicant is physically and psychiatrically qualified.

An Evaluation of the Screening Program

Although these procedures have generally worked very well, there are some inherent difficulties. One is the use of many different examiners, especially in the psychological testing. Not only are several hospitals used because of the number and geographic distribution of the candidates, but the individual examiners at each hospital change from year to year because of the nature of the military assignment system. Also, most examiners are unfamiliar with conditions in the Antarctic and the limitations imposed by that region. Consequently, they are somewhat vague as to exactly how the candidates should be screened and just what strengths or weaknesses should be watched for. These disadvantages have been partially compensated for by

[1] Formerly Medical Officer on the staff of the Commander, U.S. Naval Support Force, Antarctica.

distributing a résumé that explains to examiners the areas of concern and the types of individuals desired. Further compensation comes from the review of all examination results by a senior psychiatrist who has had several years of experience in the *Deep Freeze* selection program.

Proper evaluation of the selection process depends in large part upon accurate feedback from the antarctic stations of information on the individuals' performance: did they meet predicted achievement levels? Each year, the station complements fill out questionnaires during the wintering-over period and at the end of it. These questionnaires elicit information from each individual on his motivations, his values, and the changes that have taken place in his attitudes toward his environment; the respondent also provides a personality self-description, his current job description, and a rating of his peer group. Additionally, the officer-in-charge and the station scientific leader each complete an overall, end-of-year assessment of each member of the group. The questionnaires and assessments are returned to the United States for comparison with the results of the screening examinations, the main areas of interest being the individual's ability to get along in the group and the level of his performance.

Some Findings

A large number of biographical and psychological variables, including the ratings by clinical examiners, have been related to various performance criteria. While the analytical phases of these studies are far from complete, a few significant facts have been noted. Some correlations confirmed subjective expectations. For example, in the case of naval personnel, length of service was positively related to leadership ability as rated by superiors and peers. Another unsurprising finding was that evidence of repeated nonconformity—as indicated by a delinquency-truancy record—has been consistently predictive of less-than-satisfactory performance at both large and small stations.

One of the unexpected findings was that expressed motivation at the time of screening was *not* directly related to motivation or satisfaction at the end of the wintering-over period. To the contrary, high motivation scores during the screening period have negative implications for performance in the Antarctic. It has also been noted that significant relationships between the various criteria vary from one occupational subgroup to another: while certain characteristics are relevant to performance in one occupation, entirely different characteristics may be relevant in another occupational subgroup. Over the years, most of this information has been fed back into the selection process, with the result that personnel possessing high-risk personality traits are now eliminated.

New Approach to Compatibility Problem

Assessment of group compatibility is one of the major difficulties in our present screening program. Although each candidate is evaluated in terms of his individual personality traits, defense mechanisms, and behavior patterns—all of which are considered to affect his personal adjustment to prolonged isolation—it has not been possible to evaluate candidates in relation to each other for group cohesiveness and compatibility. The heart of the problem is defining the potential social environment. This would be comparatively easy to do if one were dealing with a relatively small number of personnel to be assigned to only one or two stations, but the U.S. program involves a large number of individuals with a possibility of assignment to any of several stations ranging in size of winter population from 8 men at Plateau to over 200 at McMurdo. Such numbers and circumstances not only defy easy analysis, but also make some group incompatibility almost inevitable, and, unfortunately, there has been some.

The answer appears to be the application of computer technology, a promising possibility that is currently under consideration. Once developed, a data-processing program based on psychological and manpower criteria could be used to quickly arrange the candidate pool into groups of the proper size, occupational composition, and compatibility characteristics. It is hoped that this approach can be tested in the near future.

At-Station Care

The second major aspect of antarctic medical logistics is direct support for the personnel at the stations. Each year, the Navy assigns medical personnel to serve the antarctic stations. During the past austral winter, Plateau, Byrd, South Pole, and McMurdo Stations each had a doctor, and a senior enlisted hospital corpsman was assigned to Palmer Station. Byrd and Pole also had one hospital corpsman each, and there were four at McMurdo.

In general, the physicians have just completed their medical training and are on their initial Navy assignments. Most have completed one year of internship while a few have had residency training in some specialty. Upon assignment to the antarctic program—usually in late July—they receive a period of naval orientation followed by a course in cold-weather medicine at the Naval Medical School, Bethesda, Md., during which they are instructed in the treatment of injuries in Antarctica and in the conservative management of acute surgical conditions.

The primary criterion in the selection of hospital corpsmen is experience. When possible, men who already have had several years of independent duty are chosen for the outlying stations. For the dispensary at McMurdo, corpsmen are desired who have strong backgrounds in such areas as X-ray technology, clinical laboratory technique, and operating-room assistance. The four corpsmen at McMurdo should be able to provide the doctor with the basic services he would expect at any hospital. The special training they are given is dictated to a great extent by their collective knowledge as a group. In general, all of them are given additional training in the areas of cold-weather medicine, operating-room technique, basic laboratory and X-ray techniques, and general nursing.

Station Medical Facilities

The medical facilities available at U.S. antarctic stations vary from a fully equipped 10-bed dispensary at McMurdo Station to an 8- by 9-foot room at Plateau Station that served the doctor as office, laboratory, and storage area. (Had a need for surgery arisen at Plateau, it would have been necessary to use the living area, with the dining table serving as an operating table and other members of the station complement acting as assistants.)

The dispensary at McMurdo is fully equipped to meet most emergencies and to accommodate a complete program of general medical care. Its laboratory is fitted for the performance of all routine blood analyses and other basic laboratory procedures, and there is a 100 KVP X-ray machine for routine roentgenography, adequate space for patient examinations, a complete pharmacy, administrative offices, an eight-bed ward, two private rooms for isolation, a sitz bath and whirlpools for physical therapy, and a surgical suite adequate for most surgical procedures. The operating room has gas anesthesia apparatus, but the gases used are restricted to nonexplosive types because of the low relative humidity and the resultant high static electricity. Presently, the anesthesia machine is equipped with a fluorane adapter, and this is the only gas anesthesia available at McMurdo. At the outlying stations, spinal anesthesia or local nerve blocks would have to be used as no facilities are currently available for administering gas anesthesia.

Fortunately, only minor surgery has been required at the outlying stations up to the present time, and the only major surgery performed at a U.S. station has been appendectomies, the last being at McMurdo Station in August 1964. Since then, conservative management has been stressed, and the few cases of appendicitis that have been seen have been treated successfully by conservative therapy until the patients could be evacuated to a hospital outside the Antarctic.

Medical Evacuation

Perhaps the most difficult problem in the area of medical logistics is the evacuation of sick and injured personnel. So many times, the rules and procedures to follow must be made up as the situation develops, requiring a mixture of judgement and innovation—the prime example being that the first midwinter fly-in was accomplished to evacuate an injured man.

During each operating season, 25 to 30 U.S. personnel must be evacuated from the Antarctic for medical reasons. Most of these cases come out of the McMurdo area, and the experience thus gained has made evacuation from this area rather routine. But evacuations from remote sites or in other seasons pose new and varied problems each time. The risks involved to the planes and crews must be weighed against the risk to the patient, and time is always a pressing factor.[2] One of the problems currently under study is how to prepare for timely evacuation of personnel from the Palmer Station and Weddell Sea areas, in which long-range aviation resources are scarce and difficult to apply.

Clinical Statistics and Observations

During the austral summer (October 1 to February 29) of 1967-1968, medical department personnel treated approximately 6,000 patients. Most common of the complaints were upper respiratory infections (URIs). During the month of October, the incidence of URIs was 28 percent of all cases seen. In November, the incidence dropped to 16 percent and remained consistently at this level for the rest of the season. These infections were predominantly viral in origin and responded poorly to treatment initially. Personnel with severe symptoms and high initial fever were admitted to the dispensary and treated symptomatically with bed rest, fluids, and antipyretics. A good response was obtained in all cases after about four days of hospitalization, and, in contrast to previous years, there were only two cases of pneumonia confirmed by roentgenographic evidence of diffuse pulmonary infiltrates.

The true incidence of upper respiratory infections, however, is unknown; many persons suffer the symptoms but fail to report to the dispensary for treatment, preferring to treat themselves or put up with the minor inconvenience. Also, the exact part that the climate plays in this disease is unknown, but undoubtedly the severity of the symptoms and the spread of the disease is influenced by the crowding of living spaces during the summer, the low relative humidity

[2] For accounts of some notable evacuation flights, see *Antarctic Journal,* vol. I, no. 4, p. 163, and no. 6, p. 274-275; vol. II, no. 3, p. 87-88; vol. III, no. 1, p. 14-15.

found in the heated spaces, and the exposure of people to new environmental conditions to which they are not yet adapted.

Accidents—mostly minor lacerations, sprains, and strains—accounted for 10 percent of all sick-call visits. While less than two percent of the accidents resulted in ankle sprains, these cases accounted for a significant loss of manpower because they all required hospitalization for approximately two weeks before the ankles healed sufficiently for the patients to walk and return to duty.

Many of the wounds and lacerations observed did not require sutures, but there was the distinct impression that wounds—even apparently trivial ones—not given prompt and adequate treatment become secondarily infected, leading to more complicated problems. This was especially true of wounds to the hands and feet. It has also been a clinical impression that wounds take longer to heal in Antarctica. This has been the repeated observation of many physicians at the U.S. stations, but no accurate statistics are available as to the increased healing time, nor are the reasons for this increase established. While it is known that vasoconstriction of the peripheral circulation can take place when the patient is subjected to cold, what part this may play in delayed healing is at the present time purely conjectural.

Contrary to what one might expect, the incidence of frostbite and other cold injuries is very low. Only three cases of frostbite were observed at McMurdo during the 1967–1968 austral summer, while several minor cases were reported from Byrd and Pole Stations. All were of only first or second degree and responded well to conservative therapy. This low incidence has been attributed to a vigorous program of lectures given to all personnel on the prevention of cold injuries and secondarily to the adequacy of the cold-weather clothing.

The currently used thermal boot—a double-layer rubber boot that is considered excellent for the prevention of cold injuries—has, however, been the source of other skin diseases. Because of its outstanding thermal insulating properties, it not only prevents the loss of heat, but also prevents the evaporation of moisture from the foot. People who perspire profusely or wear the boot for prolonged periods in a heated environment accumulate moisture in the boot, resulting in softening and masseration of the skin. Additionally, this soft, moist, warm skin can become an ideal culture medium for fungi and bacteria, producing numerous secondary infections. The education program in the use of this boot has not been nearly as effective in preventing infections from prolonged or improper use as it has in preventing cold injuries.

The number of minor complaints such as ear infections, eye injuries and infections, dermatological problems, and gastrointestinal illnesses are what would be expected in normal medical practice anywhere.

Medical Supply Procedures

Providing the antarctic physician with the tools of his profession requires farsighted planning and much coordination. Basic to our system are standard lists of drugs and supplies required for each station. These quantified lists have been developed empirically over the years and are updated annually. Resupply action is based on those stock lists and the periodic inventory and consumption reports submitted by the stations. Most items are received at Davisville, R.I., for sea transport to McMurdo, but items needed earlier in the season are flown to Antarctica.

Special handling requirements and expiration dates present problems in drug shipment. Many drugs cannot endure freezing, but biologicals require a constant cold temperature. To facilitate special handling, all medical supply boxes are distinctively marked (painted black with red cross bands on each side) for ready identification.

Of serious concern is the long interval from the time a drug is ordered, through its receipt at the station, to final use by the doctor. Because of the discontinuous nature of antarctic resupply operations, a drug should still have a long shelf life when delivered, but the normal practice of drug suppliers is to attempt a continuous flow on a first in, first out basis that consumes some of the potency period. This necessitates special efforts to insure that drugs are shipped with the longest possible potency times. (Of course, where there is a choice of drugs, the one without a potency limitation or with the longest potency period is chosen.) Improvements have been realized, yet—due to the long lead time, the size of the supply system, and the number of personnel involved—drugs are still received that are outdated or have only a short useful life.

Research Activities

Relatively little medical research has been conducted in connection with the U.S. effort in Antarctica, and most of what has been accomplished was directed primarily at determining tolerance limits and adaptability to environmental stresses, both physiological and psychological. There are, therefore, many questions awaiting competent medical investigation.

Although logistics and research are institutionally distinct areas in the United States organization, they may more nearly coincide in the medical field than any other. For one thing, the physicians at the stations are Navy doctors assigned there largely in anticipation of contingencies that hopefully will not occur.

The high physician-to-population ratios involved (the extreme being 1:7 at Plateau Station) indicate that time should be available for research. Thus, economics alone dictates that the possibility of applying their professional curiosities and abilities in a productive, directed manner should be considered. Such application would also have value in maintaining professional morale. It is gratifying to note that this potential actually has been realized in several instances, largely on personal initiative.[3]

The interest that logistics and research share in the field of medical biology is not limited to pure research. Continued habitation of Antarctica also calls for applied research to answer questions raised in caring for the stations' populations, such as the matter of healing time mentioned above. Research of this type is a necessary complement to the effort of providing, on a day-to-day basis, the best medical care for the personnel at our antarctic stations, and it is our hope that the fundamental research protocols will soon be established.

[3] A report on recent studies at Plateau Station is presented *infra* by Dr. A. B. Blackburn. Dr. Robert B. Hunt described the work that he did at Byrd Station during the winter of 1966 in "Clinical Observations on Adaptation to Antarctic Life," *Military Medicine*, August 1968, vol. 133, no. 8, p. 625-628.

Medical Research at Plateau Station

A. B. BLACKBURN*

Lieutenant, MC, USN
Armed Forces Examining and Entrance Station
Dallas, Texas

Plateau Station, the smallest and most inaccessible of all U.S. antarctic stations, offers unusual opportunities for observations in physiology and psychology. Severe climate, high altitude, prolonged isolation, and other factors combine to form a unique environment. Located at 79°15'S. 40°30'E., approximately 700 miles north of the Geographic South Pole in the direction of South Africa, the station is completely isolated except for radio communications from mid-February to mid-November. Living in close quarters with a few other men for such a long period is as real a stress as the physical environment where outdoor temperatures never exceed 0°F.—and awareness of the impossibility of survival without fuel and functional equipment cannot be obscured, even by exceptional confidence and self-reliance.

The role of the Navy medical officer at Plateau Station is varied. As the officer-in-charge, he is responsible for the overall operation and safety of the station, with specific responsibility for the military component's support of the scientific work, and, of course, he is available to render professional management of medical emergencies. In addition, he has the opportunity to record several parameters of physiological and psychological information.

* Dr. Blackburn was officer-in-charge of Plateau Station from November 22, 1966, to November 17, 1967.

Earlier Studies

The first medical studies accomplished at Plateau Station were reported in 1966 by Pratt and others in U.S. Naval Aerospace Medical Institute Document No. 964, "Studies on the Response to Acute Altitude Exposure with Special Reference to the Possibility of Early Detection of High Altitude Pulmonary Edema." In this study, construction personnel and the Navy members of the first winter-over party were evaluated initially at the Naval Aerospace Medical Center, Pensacola, Florida, and subsequently at Plateau Station. Evaluation techniques included biochemical tests, electrocardiograms, and pulmonary function studies. In addition to the baseline studies, simulated altitude studies were conducted at Pensacola in a low-pressure chamber. Both the pre- and post-deployment evaluations were accomplished during the brief austral summer.

The significant positive findings in these studies were those expected with movement to high altitude. For example, elevated hemotocrits were noted, which is consistent with the increased red blood cell count expected in rarefied air. Hyperventilation to compensate for the lack of oxygen in the air was indicated by decreased partial pressures of carbon dioxide in the blood. The partial pressure of oxygen was, as expected, still below sea-level values. Electrocardiographic changes were nonspecific and inconsistent among the subjects tested. No pulmonary edema was encountered among the subjects, either in the simulated altitude experiments or at Plateau Station.

The 1967 Studies

Because of the paucity of medical data available on personnel at U.S. antarctic stations, it was believed that a battery of routine medical studies on members of the Plateau party would be a useful basis for the establishment of medical-research protocols in subsequent years. Because the initial studies had been directed by the U.S. Naval Aerospace Medical Institute, there was specific interest in the physiologic changes that might occur at Plateau's high elevation (11,890 feet) and even higher pressure altitude (approximately 13,500 feet). Therefore, the following physiological and psychological measurements were obtained during the 1967 winter-over period (November 1966—November 1967):

(1) Hemoglobin concentrations, white blood cell counts, WBC differential counts, and reticulocyte counts were determined in November, December, March, October, and after return to sea level.

(2) Urinalyses were performed at the same times as the blood counts. Ames Hemo-Combi-Stix were used to evaluate the urine semiquantitatively for blood, protein, and glucose, and to determine the pH. A microscopic examination of the centrifuge sediment was also done.

(3) In conjunction with the other laboratory studies, blood and urine specimens were obtained and frozen for later analysis in the United States. The blood is to be analyzed for a variety of serum constituents, *e.g.*, blood urea nitrogen, glucose, sodium, and potassium. The urine will be analyzed for catecholamines, which are the breakdown products of the adrenal gland's epinephrine (or adrenalin).

(4) In February, July, and October, pulmonary function studies were carried out. To determine tidal volume and estimate the basal metabolic rate, spirograms were obtained during quiet breathing with the subjects at rest. Expiratory and inspiratory capacities and the vital capacity were measured. A maximum expiratory flow-rate curve was obtained and a maximum breathing capacity test performed.

(5) Electrocardiograms were obtained monthly from January through October and after return to sea level. Tracings from the standard limb leads, the unipolar limb leads, and six percordial leads were made at rest, immediately following exercise, and five minutes after exercise. Graduated exercises were performed beginning with 20 steps per minute for one minute on the standard 20-inch step. The maximum exercise performed was 30 steps per minute for about five minutes at the end of a year's residence at Plateau Station.

(6) A daily record of hours of sleep and of body weight was kept from December through October.

(7) The Minnesota Multiphasic Personality Inventory was administered early and late in the year, and Navy Neuropsychiatric Research Unit questionnaires were given on two occasions—near the beginning and the end of the winter.

(8) A complete medical history and physical examination was performed on each subject in January and again in September. These data and general interviews with the personnel individually and as a group were recorded on magnetic tape.

(9) Finally, in conjunction with the Oklahoma Medical Research Foundation's psychophysiological study at South Pole Station, sleep-activity cards were filled out on four occasions during the year.

Preliminary Findings

A full report of these studies must await further evaluation and interpretation of the data, but certain comments can be made now. Of interest is an apparent delay in the rise of hemoglobin concentration. The average sea-level concentration was a normal 15.1 g/100 cc of blood. Near the end of the year's residence at Plateau Station, the concentration had risen to an average of about 20.0 g/100 cc, but this level was approached only after four to eight months. On the basis of previous reports, this adaptation to altitude had been expected to be 90 percent complete in six to eight weeks.

During residence at Plateau Station, white blood cell counts decreased from a normal average of 7,350 cells/cc blood prior to deployment to the Antarctic to a subnormal average of 3,660 cells/cc in October. The counts on return to sea level at Christchurch, N.Z., averaged 7,630 cells/cc. This finding is probably indicative of the near-sterile environment of the south polar plateau: the lack of repetitive stimulation of the body's defense mechanisms must result in a decrease in circulating white blood cells. The rapid rise in white blood cell counts on return to sea level and civilization discounts a pathologic decline in this defense mechanism. The decrease in the white blood cell count was accompanied by a reversal in the usual ratio of neutrophils to lymphocytes. This condition probably represents an absolute decrease in circulating neutrophils rather than an absolute increase in lymphocytes.

Urinalyses were generally unremarkable. Pulmonary function studies, though not completely evaluated, have revealed increased lung volumes consistent with the increased respiratory demands caused by the low oxygen content of the air.

Serial electrocardiograms taken at rest and following exercise were remarkable in that essentially no change occurred. Upon return to sea level, there was observed in all eight personnel a shift of the horizontal QRS vector (a projection of the electrical depolarization of the heart's ventricles) anteriorly and of the horizontal T-vector (a projection of ventricular repolarization) posteriorly. Inasmuch as the data collection at sea level employed different equipment operated by different technicians, the significance of the comparison is subject to doubt. Nevertheless, the lack of more apparent electrocardiographic changes with one year's sojourn at a pressure altitude of 13,500 feet is noteworthy.

The records revealed an average of 7.5 hours of sleep per day, with a maximum average of 8.1 hours for one station member and a minimum of 6.5 hours for another (the oldest, age 47). Winter averages exceeded summer averages by as much as 2.3 hours a day. Although average weights increased during the winter months, they varied no more than 5–6 pounds throughout the year, with the exception of a gain of 12 pounds by one man.

The results of psychological testing and interviews have not yet been interpreted, but many interesting subjective impressions can be reported regarding the experiences of a very small, isolated group in the Antarctic. The general health of all personnel was excellent throughout the year. A few, probably psychophysiologic, complaints, such as headache and gastrointestinal disturbances, were encountered. Physical examinations were remarkable only in that there was a consistent increase in thoracic circumference during the year. Inspiratory dimensions increased about one inch while expiratory dimensions became smaller. This finding suggests that rib-cage flexibility increased in response to the added respiratory work load.

Extension of the Studies

To increase the significance of the data obtained in the 1967 studies described above, it was proposed that the 1968 winter party be studied in essentially the same manner (except for attempting determination of hemoglobin concentration by a more sophisticated technique), and this is being done by Lt. Jerome F. Johnson, MC, USNR. As Plateau Station is now in its last year of operation, the current studies represent the last opportunity to obtain medical information there, but it appears that sufficient data will have been collected during the two years to give some insight into the physiological and psychological changes that occur in personnel wintering at a small, isolated station on the high polar plateau.

Record Low Temperature at Plateau Station

Plateau Station, which is to be deactivated this summer, experienced a record low temperature on July 20, 1968: —86.2°C. (—123.1°F.), the coldest ever recorded at any U.S. station. Plateau's previous low, —85.2°C. (—121.4°F.), was recorded on August 24, 1966, six years to the day after the present world record of —88.3°C. (—126.9°F.) was recorded at the Soviet Union's Vostok Station.

Sulphate and Carbonate Salt Efflorescences from the Antarctic Interior

PAUL TASCH

Department of Geology
Wichita State University

and

E. E. ANGINO

Geochemical Section
State Geological Survey
University of Kansas

Reports of the past decade on antarctic evaporites as efflorescences, crusts, or deposits generally have come from areas relatively close to the sea (up to 30 miles from the coast). Data are now available on saline lakes, glacial moraines, soils, and glacial ice (Angino *et al.*, 1965; Ball *and* Nichols, 1960; Bowser *and* Black, 1967; McLeod, 1964; Smith, 1965; Tedrow *and* Ugolini, 1963, 1966; Autenboer, 1964). For the more remote interior regions of Antarctica, reports are wanting. This paper treats salt efflorescences on bedrock in interior areas far from the sea, where saline lakes and soils are absent. One of the sulfate minerals of our study does not appear to have been reported previously.

Rock samples bearing salt efflorescences were collected by Tasch during the austral summer of 1966–1967 in the course of geological exploration in the Sentinel and Ohio Ranges. Diffraction patterns were prepared and mineral identifications were made by Angino. X-ray diffraction patterns of efflorescent materials were obtained on a Philips-Norelco X-ray diffractometer using Cu $K\alpha_1$ radiation with a crystal monochrometer.

Along the slopes of Mount Weems (Sentinel Range), white efflorescences, beady in appearance, coated joints and fractures in the graywacke sandstone bedrock of the Polarstar Formation. These also formed very thin crusts. Touched by a hammer, they crumbled into a powdery form. Equivalent efflorescences were found at nearby nunataks to the south. They were sparse or absent at other Sentinel Range localities.

Besides the quartz, plagioclase, and mica components of the Polarstar Formation graywackes, there are fragments of volcanic and metamorphic rocks in a fine matrix of sericite/chlorite/clay minerals (Craddock *et al.*, 1964, 1965). Diffraction analysis of efflorescent material from Mount Weems indicated only calcite.

Calcium carbonate salts have been reported previously in Antarctica as a layer in soil, in rock cracks and fissures, as oolitic flow forms and microstalagmites or surficial calcite crusts, as secondary calcite in altered minerals of boulders in the dry valleys (Tedrow *and* Ugolini, 1966), and in depressions within glacial moraines (Johannesson *and* Gibson, 1962; Smith, 1965).

The presence of soluble carbonate salts in the Sentinels raised the question as to the possible source of free water, in view of the marked aridity. Where efflorescences were collected on Mount Weems, the dark bedrock was ice-free. Elsewhere on Mount Weems there was a sizable cover of ice.

Small, frozen glacial meltwater pools in shallow depressions of moraines, larger ponds in which scattered dark boulders were entrapped and surrounded by thinner surficial recrystallized ice, and occasional rows of finger-sized icicles hanging from roofs and fractures in bedrock were observed in the Sentinels. These evidenced some restricted and temporary accumulations and movements of free water. Localized melting of snow and ice occurs (at restricted times) during extended periods of sunlight (as long as 24 hours daily). The result is an enhanced calorie value per square centimeter of snow surface and an elevated surface temperature of exposed rock (Tedrow *and* Ugolini, 1966).

The sparse and spotty occurrences of calcitic efflorescences in the Sentinels may reflect the equally slight evidence of free water. Obviously, little moisture is held in voids between mineral grains in the rock. Presumably, an interior temperature-moisture gradient sponsors the development of soluble salts within the rock, while their migration to the periphery appears to be initiated during periods of prolonged solar radiation reaching rock surfaces (Tedrow *and* Ugolini, 1966).

The lack of other evaporitic constituents in the Sentinel Range contrasts with previous reports concerning efflorescences elsewhere. In a sulfate suite in the dry-valley area of Victoria Land, for example, calcite was a minor component (Smith, 1965). Although disseminated pyrite is evidenced by numerous pyrite casts in argillites along the east slope of Polarstar Peak (Sentinel Range), this mineral and others are apparently more important in a mechanical sense (as sediment components) than in a chemical context (as potential sources of sulfur), as the extreme and prolonged aridity tends to leave the bulk chemical and mineralogical composition of bedrock and its debris virtually unchanged (Kelly *and* Zumberge, 1961).

White, powdery efflorescences, small crusts, and conglomerations coat portions of some of the white-weathering argillites of the Mount Glossopteris Formation, Mercer Ridge, Ohio Range. These argillites were analyzed for whole-rock composition in another study (Tasch *and* Gafford, 1968). The sparsity of calcite was noted. Clay mineral components (percentage of less than 2μ fraction) were as follows: illite/montmorillonite mixed layer, greater than 90 percent in all samples; chlorite, less than 5 percent in sample 021.10; and phosphates, minute amounts.

Samples of efflorescences were collected at the following locations: Station 0 (021.10 and 021.2, geologically older and younger beds, respectively; Tasch, 1967); 20 feet north of Station 0; Station 1 (one sample); and a considerable distance below the Station 0 beds (sample 018). Examination of the diffraction patterns indicated that both of the last-named samples were very pure gypsum, while samples 021.2 and 021.10 were mixtures of gypsum and magnesium sulfate hexahydrite. A third compound, which we have been unable to identify, is present in sample 021.10.

This hexahydrite appears to be the first reported from Antarctica (Stewart, 1964). Comparative data for the mineral are given in the table. It is colorless, monoclinic, and is inferred to have high solubility. Its presence is probably another indicator of the extreme desert climate in interior Antarctica.

Addendum. Since the foregoing paper was written, additional information on antarctic evaporites previously unknown to the writers has been noted, viz:

1. In the Buckley Coal Measures of the Shackleton Glacier area, gypsum occurs in the upper 100 m in beds with *Glossopteris* flora; thin sections of the upper sandstone had 30–40 percent anhydrite cement (cf. Grindley *et al.*, 1964).

Antarctic efflorescences: d-values for diffraction patterns of magnesium sulfate hexahydrite

Card 1-0354 [1]	Samples [2]		
	021.2	021.10	021.2 (Rerun)
5.5	5.47	5.47	5.47
5.1	5.12	5.12	5.12
4.9	4.89	4.93	4.90
4.4	4.6	4.6	4.41
4.04	4.04	4.04	4.05
3.61	3.61	3.65	3.62
3.42	3.40	3.39	3.46
3.20	3.20	3.18	3.20
2.92	2.90	2.90	2.91
2.77	2.77	2.78	2.77
2.67	2.68	2.68	2.69
2.28	2.28	2.28	2.30

[1] X-ray powder data file published by the American Society for Testing Materials, 1960.
[2] Mount Glossopteris Formation, Mercer Ridge, Ohio Range (Tasch, 1967).

2. Gypsiferous rock encrustations (1–4 mm thick) were reported in a study of the glacial geology of the Sør-Rondane Mountains and Queen Mary Coast (Autenboer, 1964).

3. Middle Cambrian fossiliferous beds of the Queen Maud Mountains contained a few feet of gypsum in a repetitive sequence of thin, green shales. Anhydrite cement was observed above the Pagoda Tillite.

Acknowledgments. This study was supported by National Science Foundation grant GA-519. Air support for the field work was provided by the U.S. Navy.

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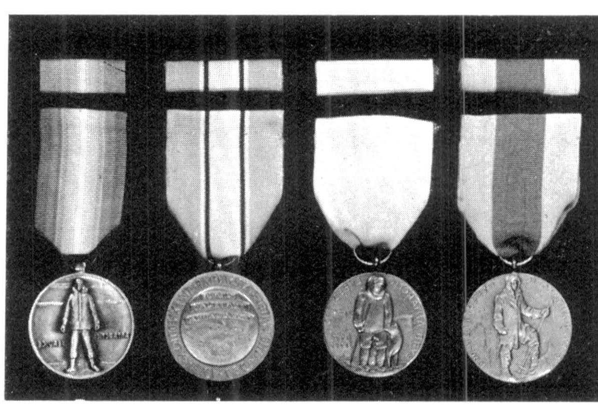
Antarctic Medals of the United States

EDWARD K. MANN

Captain, USAF
U.S. Naval Support Force, Antarctica

and

S. J. VERLAUTZ
Lieutenant Colonel, USA
U.S. Military Assistance Command, Viet Nam



Of the four medals that the United States Government has authorized in recognition of antarctic expeditionary service, only one—the Antarctica Service Medal—is presently awarded. But, whether a medal is currently bestowed or not, its commemorative and honorific functions are well served by occasional recital of its purpose and symbolism.

The Byrd Antarctic Expedition Medal

The first U.S. medal established specifically to recognize participation in an antarctic expedition was the Byrd Antarctic Expedition Medal. In Public Resolution No. 75, approved on May 23, 1930, Congress empowered and directed the Secretary of the Navy to "cause to be made at the United States mint such number of gold, silver, and bronze medals as he may deem appropriate and necessary respectively to be *presented to the officers and men of the Byrd antarctic expedition to express the high admiration in which the Congress and the American people hold their heroic and undaunted services in connection with the scientific investigations and extraordinary aerial explorations of the Antarctic Continent* . . . ."[1]

In implementing this resolution of the 71st Congress, the Secretary of the Navy found it "appropriate and necessary" to have 82 medals issued to members of the 1928–1930 expedition: 66 gold, 7 silver, and 9 bronze. Gold medals were presented to recognize full participation in the expedition; silver medals were awarded to those individuals who had not served during the entire expedition, but who had been on its rolls when it was terminated; and bronze medals went to those who had been serving with the expedition when it started but were released prior to its conclusion.

Second Byrd Antarctic Expedition Medal

The second antarctic expeditionary medal was authorized by the 74th Congress on June 2, 1936. Public Resolution No. 98 directed that this silver medal be awarded to "the deserving personnel of the Second Byrd Antarctic Expedition [1933–1935] that spent the winter night at Little America or who commanded either one of the expedition ships [*Bear of Oakland* and *Jacob Ruppert*] throughout the expedition." On the recommendation of Admiral Byrd, the Secretary of the Navy designated 57 recipients.[2] As in the earlier instance, the inscription on the medal's reverse drew heavily on the wording of the authorizing congressional resolution, stating that the medal was "Presented to the officers and men of the Second Byrd Antarctic Expedition *to express the* very *high admiration in which the Congress and the American people hold their heroic and undaunted accomplishments for science, unequaled in the history of polar exploration*."[3]

[1] Italics added to indicate those words (or portions thereof) in the resolution that appear on the reverse of the medal.

[2] Several expedition members received military decorations: one, the Distinguished Service Medal; three, the Navy Cross; and two, the Distinguished Flying Cross.

[3] Italics added to indicate those words in the inscription that appear in the authorizing resolution.

U.S. Antarctic Expedition Medal, 1939–1941

The U.S. Antarctic Expedition Medal, 1939–1941—to give it its full name—while the third in this series of congressionally authorized commemorative medals, was the first to reward a government-sponsored expedition to Antarctica. (Admiral Byrd had obtained private backing for his two earlier antarctic expeditions, but the one he led forth in 1939 was under the auspices of the U.S. Antarctic Service, which Congress had established that year.) In 1940, this expedition established two antarctic bases: West Base, or Little America III, on the Ross Ice Shelf, and East Base, on Stonington Island, off the Antarctic Peninsula. Both bases were to have been permanently occupied, but the calamitous events in Europe prompted evacuation in the early months of 1941.

In addition to disrupting the work of the U.S. Antarctic Service Expedition, World War II also delayed recognition of the participants. Congress, preoccupied with other matters, did not authorize a medal for this expedition until September 24, 1945, several weeks after the end of hostilities. Then, in Public Law 185, the 79th Congress gave authority to the Secretary of the Navy to award gold, silver, and bronze medals for service with the 1939–1941 expedition. Sixty gold medals were awarded for wintering over, and 50 silver medals for participation in the summer operations of both 1939–1940 and 1940–1941. Another 50 individuals who had made only one summer trip received bronze medals. Recipients included the commanding officers of the expedition's ships—Commander Richard Cruzen, USN,[4] of USS *Bear*,[5] and Lt. Comdr. Isak Lystad, USNR, of USMS *North Star*—for their "meritorious service in transporting and evacuating [the men of the two] bases through treacherous, uncharted, ice-covered seas."

As stated on its reverse, the medal was presented "By Act of Congress of the United States of America to [name of recipient] in recognition of invaluable service to this nation by courageous pioneering in polar exploration which resulted in important geographical and scientific discoveries."

Fifteen Years to Fourth Medal

The United States resumed antarctic operations after the war with the first U.S. Antarctic Developments Project, the famed *Operation Highjump* of 1946-1947, still the largest expedition ever sent to Antarctica: over 4,000 men and 13 ships were involved. In 1947-1948 came the Second Antarctic Developments Project, the two-icebreaker summer ef-

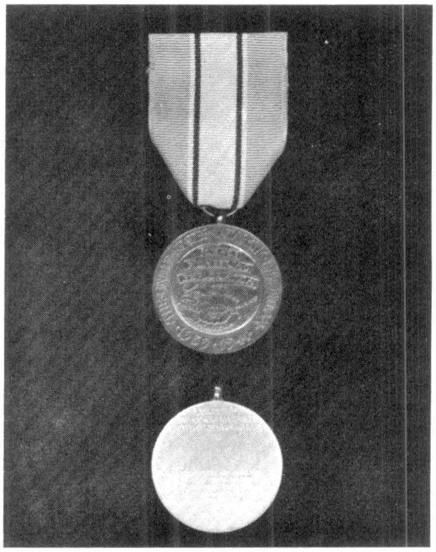
[4] As a rear admiral, Cruzen commanded Task Force 68 in *Operation Highjump*.

[5] The former *Bear of Oakland* of Byrd's 1933-1935 expedition.

(Top) Medal for the (first) Byrd Antarctic Expedition, designed by Francis H. Packer, shows on obverse Admiral Byrd in a parka and holding a ski pole, with ice formations to left and right. Reverse bears a sailing ship and (below inscription) a tri-motored airplane. The ribbon has a Saxe blue center band on an eggshell field.

(Center) Obverse of the medal for the Second Byrd Antarctic Expedition also portrays Admiral Byrd. Reverse displays (clockwise) radio towers at Little America II, an airplane, a sailing ship, and a dog team and sled. Designed by Heinz Warneke. Ribbon is all white grosgrain.

(Bottom) Preliminary design for the U.S. Antarctic Expedition Medal, 1939-1941, is said to have been done in the heraldic office of the War Department. Obverse of the final design—which was modeled in plaster by Paul Manship —shows outline of Antarctica on a partial globe, with these names: South Pacific Ocean, Little America, South Pole, and Palmerland. Above is a three-part scroll inscribed "Science, Pioneering, Exploration." Around the circumference appear the expedition's name and years. The ribbon has wide bands of Sistine blue at each edge and a white center band, on which are thin stripes of Old Glory red.



fort dubbed "Windmill," and there was Finn Ronne's private wintering-over expedition of those same years. Then the United States was absent from the Antarctic until the approaching International Geophysical Year prompted the scouting cruise of USS *Atka* in the summer of 1954-1955. With the IGY, Antarctica experienced an unprecedented "population explosion," in which the United States was well represented.[6]

Noting that plans were being made to continue U.S. scientific programs in the Antarctic beyond the IGY, the 86th Congress in 1959 examined the question of medals for antarctic service. In its report, the responsible committee said that, "At the present time the Secretary of Defense has no authority upon which he may issue a special commemorative medal to recognize the achievements of those persons who participated in the various [antarctic] expeditions since January 1, 1946." In unanimously recommending passage of House of Representatives Bill 3923, the committee noted that it would provide recognition to an estimated 14,650 personnel who had served, or were serving, in Antarctica. The bill was favorably received and, on July 7, 1960, it was approved as Public Law 86–600.

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[6] See population table, *Antarctic Journal,* vol. I, no. 6, p. 269.

The currently issued medal bears on its obverse the words "Antarctica Service" and a figure, clad in polar clothing, whose stance is intended to signify determination. The reverse displays the words "Courage, Sacrifice, Devotion" on an outline polar projection of the Antarctic Continent, all encircled by a border of penguins and marine life.

Shown with medal are "Wintered Over" clasps of bronze, gold, and silver—which are attachable to the suspension ribbon—and the lapel device worn by civilian recipients. The small (5/16" diameter) disc bearing a raised outline of Antarctica may be worn on the ribbon bar by military recipients who have wintered over. Like the clasps, the disc may be of bronze, gold or silver, to signify the number of winters spent on the Continent.

Antarctica Service Medal

That law provided for a medal to be awarded to "each person who serves, or has served, as a member of a United States expedition to Antarctica between January 1, 1946, and a date to be subsequently established by the Secretary of Defense." [7] It added that the necessary regulations as to eligibility might provide for award to both civilian and uniformed members.

In general, eligibility requirements are participation in a U.S. expedition below 60°S. during the specified period.[8] Service with another nation's antarctic expedition, if coordinated with a U.S. expedition, or if sponsored by the United States Government, also qualifies for the award. Among the beneficiaries of Public Law 86–600 are the members of the Ronne Antarctic Research Expedition, which—besides being the last privately sponsored U.S. expedition to the Antarctic—included the only two women to have spent a winter in Antarctica: Mrs. Ronne, wife of the leader, and Mrs. Darlington, wife of the expedition's pilot.

Unlike the earlier medals, the Antarctica Service Medal is struck only in bronze, but clasps attachable to the suspension ribbon distinguish individuals who have wintered in Antarctica, a bronze clasp representing one winter; a gold clasp, two winters; a silver clasp, three or more winters. Military recipients may wear a ribbon bar to represent the medal, while civilian recipients are provided a lapel device that is a miniature of the medal's obverse.

The ribbon of the Antarctica Service Medal is elaborate in its symbology. The outer bands of black and dark blue comprise five-twelfths of the ribbon's width, representing five months of antarctic darkness; the center portion, by its size and colors—grading from medium blue through light blue and pale blue to white—symbolizes seven months of solar illumination, and also the *aurora australis*.

Although the former rigors and dangers of antarctic exploration have largely been banished by technology, the words on the reverse of this medal are yet a wise injunction to those who go to the Antarctic:

COURAGE
SACRIFICE
DEVOTION

Acknowledgments. Medals lent by the Office of the Chief of Naval Operations and the Bureau of Naval Personnel; ribbon bars and refurbishing of suspension ribbons courtesy of H. M. Dondero, Inc., Arlington, Va. Other assistance and information provided by: Bureau of Naval Personnel; Bureau of the Mint, U.S. Treasury Department; U.S. Army Institute of Heraldry; Library of Congress. Special photography by U.S. Naval Photographic Center.

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[7] No termination date has yet been announced.

[8] Eligibility requirements are broadly outlined in Department of Defense Instruction 1348.9 of November 22, 1960, and are more specifically defined in SECNAV Instruction 1650.14.

Eltanin Cruises 33 and 34

Cruise 33

The objective of Cruise 33 was a return visit to the western Bellingshausen Basin (Southwest Pacific Basin), part of which *Eltanin* had explored several years earlier. The ship departed Wellington, New Zealand, on March 22, 1968; steamed to Campbell Island, where she attempted to land; then proceeded to 67°S. 165°W. From this point, she took a zig-zag course to 70°S. 120°W., followed the 120° meridan to 55°S., then turned westward and returned to Auckland, New Zealand, via the USARP Fracture Zone and the vicinity of Chatham Island.

The 30-man scientific party carried out the following seven research programs: physical oceanography (Lamont Geological Observatory), plankton and bird collection (Australian National Antarctic Research Expedition), geophysics (Lamont Geological Observatory), meteorology (Weather Bureau, ESSA), marine geology (Florida State University), biological sampling (University of Southern California), and primary productivity and plankton (Texas A&M University). Mr. T. B. Armstrong was the U.S. Antarctic Research Program Representative.

Lamont's physical-oceanography program was aimed at obtaining measurements across the Antarctic Convergence; data on surface and bottom-water circulation, temperature, and salinity; and information on bottom topography in certain areas. Bottom photographs were also obtained, and 88 gallons of surface-water samples were collected for D.S.I.R. of New Zealand for C^{14} analysis. In all, 26 hydrographic stations were occupied. A series of 700-m bathythermograph measurements from 69° to 55° S. seemed to confirm the concept of a double convergence system (primary and secondary). The secondary front was found to be better defined than the primary front.

Lamont's geophysical program consisted of seismic profiling and continuous recording of the Earth's gravity and magnetic fields along the cruise track. Data were obtained on all the major geological provinces crossed during the cruise, including those of the southwest Bellingshausen Basin.

Plankton was collected by a biologist from the Australian National Antarctic Research Expedition for ecological and physiological studies of distributional variations in the crustacean fauna. He also collected 30 birds at 7 stations for information on feeding habits and dispersal.

In continuation of a long-existent program of investigations of the marine fauna, two biologists from the University of California made 46 collections by means of Isaacs-Kidd and Blake trawls, Phleger and piston corers, and "camera grabs."

In the marine geology program carried out by a representative of Florida State University, 22 cores were obtained of the following sediment types: radiolarian ooze, brown clay, foraminiferal ooze, and coccolith ooze. In addition, rock samples were collected at two stations by University of Southern California bottom trawls.

Two biologists from Texas A&M University made determinations of primary productivity and standing crop of phytoplankton between the surface and 200 m depth at 24 stations, collected surface samples at 45 locations, and measured the depth of the euphotic zone and the amount of solar radiation.

Two representatives of the Weather Bureau made synoptic upper-air and surface meteorological measurements, the upper-air data being obtained by means of 53 radiosonde flights to an average height of 28,761 m. In addition, they collected air samples for the Centre des Faibles Radioactivités, Centre National de la Recherche Scientifique, France, and carbon-dioxide samples for the Scripps Institution of Oceanography.

Cruise 34

This cruise began on May 28, 1968, with *Eltanin*'s departure from Auckland, New Zealand, for station sites along the 170°E., 160°E., 145°E., and 135°E. meridians as far south as 60°S. After completing her first station, at about 38°S. 170°E., *Eltanin* called briefly at Campbell Island; passed Macquarie Island, where an unsuccessful landing attempt was made; stopped on several occasions at Hobart, Tasmania; and concluded her voyage at Port Adelaide, Australia, on July 31. Forty-four oceanographic stations were occupied.

Six scientific programs were carried out: physical oceanography (Lamont Geological Observatory), geophysics (Lamont Geological Observatory), survey of benthic and pelagic vertebrates and invertebrates (University of Southern California), distribution of plankton and birds (Australian National Antarctic Research Expedition), marine geology (Florida State University), and meteorological observations (Weather Bureau, ESSA). Mr. John R. Twiss, Jr., was the U.S. Antarctic Research Program Representative.

The physical-oceanography program was carried out by five scientists from Lamont Geological Observatory and two from Flinders University, Australia. They made 28 hydrographic casts and 330 bathythermographic casts (250 conventional and 80 expendable). Also, deep-water data were obtained by lowering an instrument-carrying tripod system to the ocean bottom on the hydrographic line. Among the data collected were bottom photographs of excellent resolution. At most stations, bottom-water samples were taken by Niskin and/or Nansen bottles; temper-

Eltanin *tracks, Cruises 33 and 34.*

atures were recorded at depths of 60, 160, and 360 m; and information on currents was obtained. Phosphate, silicate, nitrate, and O_2 analyses were made on samples from each station.

The geophysical program, carried out by three scientists from Lamont Geological Observatory and two from the University of New South Wales, Australia, consisted of making magnetic and gravity measurements and determining features of the bottom sediments by seismic profiling. Data were obtained from more than 95 percent of the magnetic soundings and 90 percent of the gravity soundings. A major event in the geophysical program was the crossing of the Hjort Basin, the first one made by a ship equipped with a seismic profiler, a gravimeter, and a magnetometer. The data obtained revealed no sediment cover. They suggest that the Puyseger Trench, the Macquarie Trench, and the Hjort Basin are tectonically related features, all striking in a southwesterly direction and each having a ridge associated with it.

In the marine geology program of Florida State University, samples were obtained in 23 piston cores, 26 trigger cores, and 2 Phleger cores. Eighteen of the piston cores ranged in length from 3.9 to 24 m. Preliminary examination of the cores shows ooze to be the predominant substance on the ocean bottom at the sites investigated. Several indications of submarine volcanism were noted.

Three investigators from the University of Southern California collected midwater organisms at 44 locations at depths of 100, 500, and 1,000 m in order to determine the vertical and horizontal distribution of species. Benthic collections were made at six stations.

The study of the distribution of plankton and birds, carried out on earlier *Eltanin* cruises by a member of the Australian National Antarctic Research Expedition, was continued. Plankton samples were taken at 22 locations, Isaacs-Kidd midwater trawls were made at 12 sites (in cooperation with the University of Southern California), a bottom trawl was carried out near Macquarie Island, and birds were collected at two stations.

Two representatives of the Weather Bureau obtained upper-air and surface meteorological data for synoptic and other research applications. Surface synoptic observations numbered 233; rawinsonde observations, 17 (the instruments being carried to an average height of 11,244 m); and radiosonde observations, 51 (to an average height of 25,978 m). Severe-weather balloons were used for 20 of the 51 radiosonde flights. In addition, 18 carbon-dioxide samples were taken for the Scripps Institution of Oceanography and 16 oxygen samples for the National Bureau of Standards.

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The following seven articles describe research performed during 1967-1968 as part of the U.S. Antarctic Research Program. Normally, they would have been included in the July-August or September-October issues, which are specifically devoted to reviews of the preceding year's activities. For various reasons, it was not possible to include them in those issues, and they are presented here as an appendix.

Antarctic Avian Population Studies, 1967–1968

WILLIAM J. L. SLADEN,
ROBERT E. LeRESCHE,

and

ROBERT C. WOOD

Department of Pathobiology
Johns Hopkins University

The 1967-1968 summer marked the seventh consecutive season of the USARP Bird Banding Program, a long-term study on the ecology and social behavior of the Adélie penguin, *Pygoscelis adeliae,* and the south polar skua, *Catharacta maccormicki.* The study is being carried out in a rookery of about 300,000 penguins and 2,000 skuas at Cape Crozier, Ross Island (Sladen *et al.,* 1966; Wood *et al.,* 1967). The Johns Hopkins biologists were at Cape Crozier from October 19 to February 14. Through the SCAR Working Group on Biology's Subcommittee on Antarctic Bird Banding, cooperation is effected with other nations working in antarctic ornithology (cf. Sladen *et al.,* 1968). The table summarizes banding activities in the Ross Sea area, Adélie Coast, and the Falkland Islands.

At Cape Crozier, where a total of 32,748 Adélies have been banded since the study started (all but 2,665 as chicks), observations were made of 948 birds of known age ranging from 6 to 2 years. In addition, approximately 250 other banded Adélies were followed for comparative purposes. These adults were either from two control colonies, or birds that had bred with known-age penguins in previous years.

The percentages of Adélies of each age group marked as chicks that returned to the rookery in subsequent years remained low, confirming heavy mortality during early life in this species, with fewer than 10 percent of fledged chicks surviving until the third year. Of those that did return to the rookery, the proportion of each cohort breeding (producing at least one egg) increased with age, from about 4 percent of 3-year-olds to more than 20 percent of 4-year-olds, 40 percent of 5-year-olds, and over 60 percent of 6-year-olds.

The productivity of fledged young increased similarly with age, but showed a definite upward inflection between the fifth and sixth year. Evidence that most breeding 6-year-olds had at least one year's previous breeding experience, whereas few younger birds were experienced, suggests that an experience factor is operating. This factor does not appear to affect the earlier stages of breeding (*i.e.,* pairing, egg-laying, and incubation) nearly as much as it does the chick-rearing stage, when most of the 4- and 5-year-old breeders lost their young.

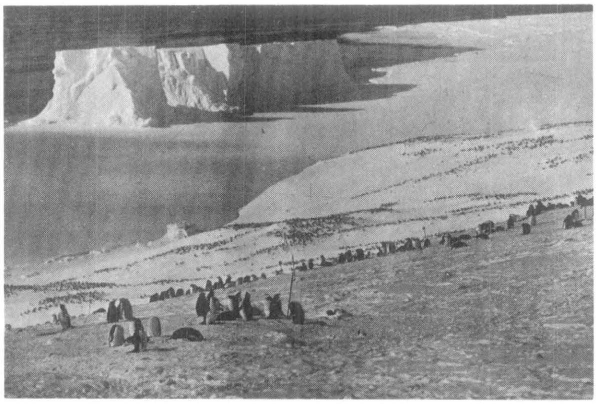
In marked contrast to adults, young breeders exhibited only minimal faithfulness to mate and territory. After breeding at one site, young males returned to the site for their next breeding nearly 100 percent of the time, whereas young females *changed* sites more than 60 percent of the time, returning to within 1 meter of their former site in only 40 percent of the cases observed. In contrast to the 83 percent of adult breeders that reunited when both birds returned in Penney's (1964) study, only about 30 percent of young breeders retained their mates in subsequent years, the "divorce" rate being 70 percent as compared to 17 percent in Penney's supposedly established adults.

A method has been perfected at Crozier for accurately determining the sex of the Adélie by cloacal examination with a special instrument, the "cloacascope." The great majority of known-age breeders were females. The percentage of males in the total number of known-age breeders increased with age from 0 in 3-year-olds (*i.e.,* all were females), to 17 percent of 4-year-olds and up to 36 percent of 6-year-olds.

The above indications that Adélies are still not maturely "established" breeders by the age of 6 years are corroborated by birds that have been followed for as many as 4 consecutive seasons. These, as 6-year-olds, bred less successfully than fully established breeders and changed mate and nest more frequently than the latter.

The nearly 85 percent of known-age birds that did not breed provided extensive data on the behavior of young birds in the years before breeding, and indicated the steps involved in the development of breeding behavior consistent with the population norm (Sladen, 1958). Young birds return later to the rookery after winter than do the older ones, and consequently pair and lay later. Nonbreeders (all 2-year-olds, about 96 percent of the 3-year-olds, and almost 80 percent of the 4-year-olds) wander through the rookery, establish territories and "keep company" but do not produce eggs, either because of physiological inability (preliminary examination of gonads collected from 3-year-olds indicate breeding capabilities at this age, however), late arrival at the rookery, or behavioral limitation. The general sequence of behavioral development from pre-breeder to pre-established breeder to established breeder seems to be one of wandering in a large area, wandering in a more restricted area, holding territory (males) or "keeping company" (males and females), breeding temporarily and often unsuccessfully with more than one mate and, finally, breeding permanently with a single mate at a single site with maximum productivity.

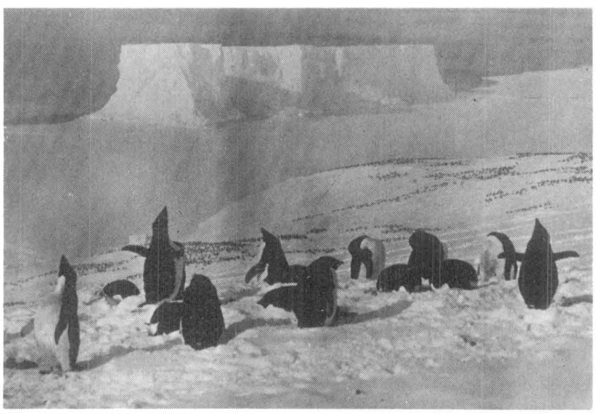
In conjunction with studies of parental care, the

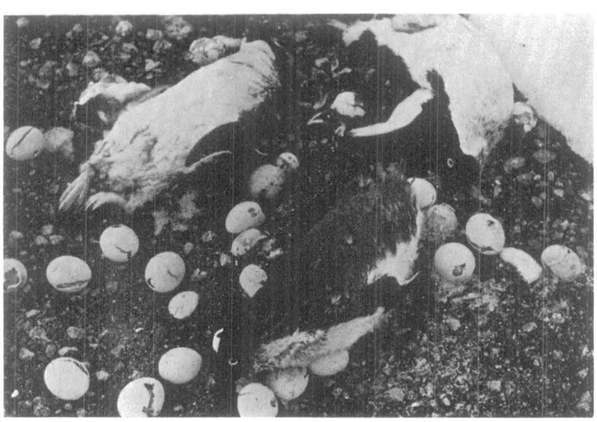


(Photo by W. J. L. Sladen)

Adélie penguin rookery at Cape Crozier, November 1967. (Above and below)

(Photo by W. J. L. Sladen)





(Photo by W. J. L. Sladen)

Aftermath of the storm: dead Adélies among frozen eggs.

Adélie chicks' metabolic demands and physical tolerances to acute hypothermia were studied in the field. Core-temperature and cardiac and metabolic responses were measured in chicks less than 10 days of age that were acutely exposed to ambient temperatures near 0°C.

Body core-temperatures (T_b) decreased to nearly ambient (T_a) in all chicks exposed before the ninth day of age, with the rate of decline decreasing with age. Lag time between lowering of T_a and the first decrease in T_b increased with age until, by the ninth day, chicks maintained normal T_b at 0°C.

Pronounced bradycardia and eventual cardiac arrest occurred in all (4) chicks less than 9 days old, yet all chicks recovered normal function following rewarming. Cardiac cessation occurred when T_b reached 6–12°C., and recovery of heartbeat occurred at 12–22°C.

Metabolic rates measured indirectly in an open-flow system decreased with decrease in T_a, T_b, and heart rate at relatively constant rates through the fourth day; BMRs at normal T_b increased from 0.023 cc O_2/g/min at one day of age to 0.045 cc O_2/g/min at 3.5 days, then decreased to 0.015–0.018 cc O_2/g/min in partially fledged chicks. The comparative adult BMR measured in the field was near 0.012 cc O_2/g/min.

Predation by the leopard seal, *Hydrurga leptonyx,* was observed for an average of about two hours daily from November 24 until the end of the season. The results indicate that the seals are taking far fewer Adélies than reported by Penney and Lowry (1967) from the same area. The time of the season (*i.e.,* in terms of Adélie activities) and shoreline conditions contributed much to this variability, as did the behavior of the seals, which seemed to eat to satiation and then hunt less intensively for one to several days afterwards.

Data were gathered on the behavior and on the frequency and location of sighting of 275 different known-age skuas (2 2-year-olds, 29 3-year-olds, 37 4-year-olds, 156 5-year-olds, and 51 6-year-olds), representing about 25 percent of the chicks originally banded. Almost no skuas return to their natal area (Cape Crozier) in their first year, and only a few return as 2-year-olds. The percentage of return increases rapidly in the third and fourth years and levels off through the fifth and sixth years. Sixteen known-age skuas bred at Crozier in 1967-1968, one of them a 9-year-old hatched at Cape Hallett. Of the other 15, 8 were 5 years old and 7 were 6 years. All were unsuccessful breeders; only 3 were known to hatch an egg and all 3 chicks were lost within 2 weeks of hatching. Two of the 6-year-old breeders that had bred the previous season retained the same mate and nested in the same territory, a faithfulness equal to that of the great majority of older, experienced breeders. Only 2 of the 16 breeders had mates with a known breeding history (the majority was unbanded). Since about 80 percent of the Crozier breeding population is banded, it may be assumed that most of these unbanded mates had not bred previously.

The extent of interchange of Adélies and skuas between rookeries is still largely unknown. Young birds, 2 to 5 years old, wander widely as shown by observations of a Crozier-banded Adélie at Cape Hallett, 565 km (320 miles) from Crozier, and a Crozier-banded skua at Dumont d'Urville Station, 2,000 km (1,250 miles) coast-wise from Crozier. Searches made of rookeries within 160 km (100 miles) of Crozier have in the past few years given sightings of 22 skuas and 46 Adélies, all banded as chicks at Crozier. None of these birds was breeding, so to date, we have no evidence of emigration of Crozier birds from their natal rookery. That this could occur is indicated by the 9-year-old Hallett skua that bred at Crozier after being observed at Crozier as a nonbreeding 4-, 7- and 8-year-old.

A skua that was known to have bred in 1963-1964 at Crozier was found breeding at Cape Evans, 71 km (44 miles) away, in 1967-1968. Unfortunately, nothing is known of this bird's birthplace or its breeding experience prior to 1963-1964.

Unusual bird records at Crozier were a silver-gray fulmar, *Fulmarus glacialoides,* on December 19, and a great skua, *Catharacta skua lonnbergi,* noosed and banded on December 12. The fulmar was a first record for Crozier; the skua had been seen for the first time last season. The first known observation of a Weddell seal, *Leptonychotes weddelli,* killing and eating an Adélie penguin was made on January 31 when the young penguins were departing.

Weather was unusually bad at Crozier early in the season. One storm with winds reaching over 100 mph was experienced on October 26, but had little effect on the Adélies. Another, on November 9-10, with winds estimated at 140 mph, forced Adélies to abandon their nests during egg-laying. Many hundreds of adults were killed and many thousands of eggs destroyed. A storm of similar severity must have occurred during the winter, for last season's two ice-shelf fingers and their sea-ice enclaves where the emperor penguins, *Aptenodytes forsteri,* had bred, were gone. On October 19, about 500 adult emperors were seen in a small, newly formed ice enclave close to the Crozier land cliffs, but there were no chicks, indicating a total loss of all offspring for 1967-1968.

We are most grateful to William R. Harrison and Frederick J. Pitzman for assistance during the season at Crozier, and to D. Greegor and S. Mackey for assistance in the banding.

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Birds marked with USARP bird-banding program bands, July 1967 to June 1968.[1]

Species	Organization [2]	Area	Bander [3]	Banded as: Chick	Banded as: Adult or Sub-Adult	Total
Emperor penguin	USARP	Cape Crozier	WS, RL		33	33
Adélie penguin	USARP	Cape Crozier	WS, RL, RW, FP, DG, SM	5,000	446	5,446
do.	EPF	Adélie Coast			195	195
do.	USARP	Hallett Stn.	DT		296	296
do.	NZARP	Cape Bird	EY		292	292
do.	NZARP	Hallett Stn.	TC	100	110	210
Black-browed albatross	USARP	Falkland Is.	RN	279		279
Giant petrel	USARP	Cape Crozier	RW, FP, RL		2	2
Great skua	USARP	Cape Crozier	RW		1	1
South polar skua	USARP	Cape Crozier	RW	49	277	326
do.	USARP	McMurdo Stn.	RW		46	46
do.	USARP	Cape Royds	RW		17	17
do.	USARP	Cape Evans	RW		69	69
			Totals:	5,428	1,784	7,212

[1] All bands used were provided by USARP in the interest of international cooperation. They bear the address: "Advise Fish and Wildlife Service, Write Washington, D.C., U.S.A." The expeditions using them are responsible for publishing their own recovery data.

[2] EPF, Expéditions Polaires Françaises; JHU, Johns Hopkins University; NSF, National Science Foundation; NZARP, New Zealand Antarctic Research Programme; OSU, Ohio State University; USARP, United States Antarctic Research Program; UWis, University of Wisconsin.

[3] DG, D. Greegor (OSU); DT, D. Thompson (UWis); EY, E. Young (NZARP); FP, F. Pitzman (JHU); RL, R. LeResche (JHU); RW, R. Wood (JHU); SM, S. Mackey (NSF); TC, T. Choate (NZARP); WS, W. Sladen (JHU); RN, R. Napier (JHU).

NOTE. The following totals were received after publication of the 1966-1967 summary (Wood *et al.*, 1967):

19 Adélie penguins, adults (Feeney, USARP, Crozier)
75 Adélie penguins, adults (Young, NZARP, Cape Bird)
137 Adélie penguins, adults (Choate, NZARP, Hallett)

Studies of Material in Polar Ice

E. L. FIREMAN

Smithsonian Institution
Astrophysical Observatory

The high-elevation regions of the polar ice sheets are the most remote places on Earth. In these regions, sediments accumulate at the lowest rate on Earth (McCorkell *et al.*, 1967), and the annual accumulation layers in the ice sheet provide excellent time markers for determining the deposition rate. Sediments that accumulate at the lowest rate should contain the highest percentage of extraterrestrial material. However, even the most slowly accumulating sediments may be predominantly terrestrial. Fine-grained dust is carried by winds over large distances from its locality of origin. On the other hand, very little is known about the extraterrestrial material arriving at the Earth. The only substances definitely identified as extraterrestrial are meteorites. What is known from a variety of studies (Whipple, 1961) is that interplanetary material ranging in size from less than 1 μ to more than 1 km in size enters the Earth's atmosphere and that much of it wholly or partially disintegrates into dust before reaching the Earth's surface. If we could collect dust with a significant extraterrestrial component in sufficient amounts to apply many analytical techniques, including isotope analysis, we might be able to demonstrate which fraction is extraterrestrial and learn about its chemistry, mineralogy, amount in space, history, and origin. Since some of these studies require grams of material, we undertook the collection and study of material from large volumes of polar ice.

Collections. We collected the soluble material from 5 million liters and the insoluble material from more than 10 million liters of melted ice. This was not too difficult because we were able to use two subsurface wells at Camp Century, Greenland, from which 10^5 l/day of water could be processed. Camp Century is located at 77°10′N. 61°08′W. at an elevation of approximately 2,000 m. One well (Fig. 1), used for the camp's water supply, was made by jets of steam. The melted water was almost immediately pumped into three 5,000-gal aluminum storage tanks. Our first collection was made by removing about 400 g of material from the bottom of the tanks after more than 10 million liters of water had been stored in the tanks. Next, we installed a filter system between the well and the tanks and passed 5 million liters of water through cellulose and nylon filter papers of 8-, 3-, and 0.45-μ pore size. The material was later removed from the filter paper by dissolving the paper in an appropriate solvent and centrifuging; 2.6×10^{-4} g of material was obtained per liter of water. Most of this material was organic: oil from the pump, rubber from the hose, and undissolved filter paper. The weight was reduced to 6×10^{-5} g/l by low-temperature ashing. There was no difference between the collections made with different pore sizes or between those made on cellulose and nylon papers.

The second well (Fig. 2) was made by a heat exchanger used to eliminate waste heat from the camp. After the camp stopped using this well, we installed a pump and an electrical heater at its bottom and pumped the water through either a filter unit identical to that used in studies at the first well or two ion-exchange columns in series. Approximately 5 million liters of water were passed through the filters, and about the same amount was passed through the ion-exchange columns. One column contained 40 liters of cation exchange resin; the other contained 30 liters of an anion-cation mixture. The dissolved constituents were collected from these columns with 50 percent or more efficiency.

Chemical and mineralogical description. The particulates consist mainly of fine-grained clay, illite, and montmorillonite, but include small amounts of magnetite, quartz, and feldspar (Marvin *et al.*, 1967). The material collected from the settling tank is quite different; it contains an appreciable amount of magnetite and hematite. Certain heavy minerals, such as magnetite, would have concentrated on the bottom of the settling tank; however, the increase in concentration is so marked that it is difficult to explain on the basis of the amount of water stored in the tank, unless there was a higher concentration of "heavies" in the ice layers above a depth of 70 m (less than 200-year-old ice) compared with the 80-m layer (250-year-old ice). The illite appears to be wind-blown dust from the continents; the "heavies" appear to have an extraterrestrial component. The concentrations of oxides collected on the filter papers are SiO_2 (51 percent), Al_2O_3 (23 percent), Fe_2O_3 (14 percent), MgO (4 percent), K_2O (4 percent), Na_2O (2 percent), CaO (2 percent), and NiO (<0.1 percent). (These concentrations are similar to those of illite except for higher Fe and Na contents.)

The most interesting feature of the dissolved material is that it contains a much higher concentration of Ni than the particulates and has a Ni/Co ratio of 17, which is close to that in meteorites. The positive ion concentrations in 10^{-8} mole/l are: Al, 37; Na, 200; K, 21; Ca, 22; Mg, 31; Fe, 3.5; Ni, 0.14; Co, 0.0064; Mn, 0.3; Cr, <0.05; and Ti, <0.13. The Ni/Fe and the Ni/Co ratios are much higher than in common materials of the Earth's crust. The dissolved material does not contain unusual amounts of chromium or manganese; hence, contamination by steel seems unlikely. To explain the nickel

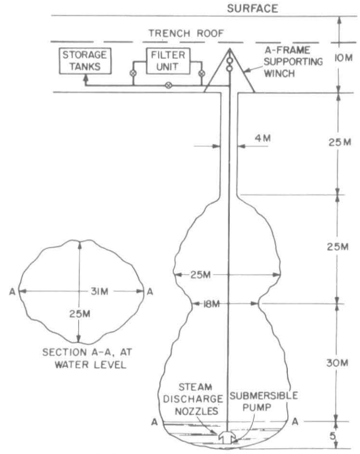

Figure 1. Water well for collection of particulates.

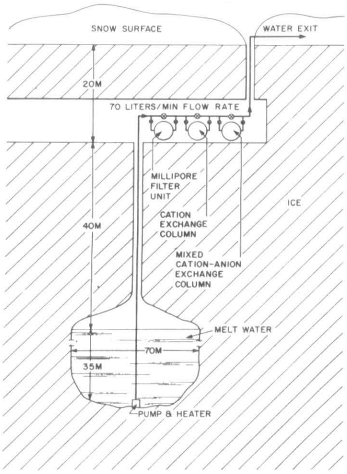

Figure 2. Water well for collection of dissolved material and particulates.

concentration on the basis of an influx of carbonaceous chondritic-type material would require an influx of one million tons per year over the Earth. Recent results (Barker *and* Anders, 1968; Hanappe *et al.*, 1968) indicate smaller influx rates for this type of material. If the high nickel concentration in this sample of melted ice is due to extraterrestrial material, then a single large event, such as the Tunguska event, or a few large events during the past 300 years raised the nickel concentration of the sample. This sample integrates the precipitation from approximately 50 to 300 years ago. There is excess Na^+ over what would be expected from dissolved illite and chondritic material. The probable source is wind-blown sea spray.

The finely divided clay, mainly illite, was carried by winds from the continents; approximately 10^{-4} g/l was deposited at Camp Century. The approximately 10^{-4} g/l of NaCl was probably carried by winds from sea spray.

Al^{26}, Be^{10}, and Ar^{39}. Sufficient amounts of material were collected to make searches for isotope anomalies profitable. If an extraterrestrial component of the material originated from small particles (less than 5 cm in diameter) of chondritic composition, it would contain appreciable amounts of Al^{26} and Ar^{39} produced by action of solar flares and cosmic rays (Wasson, 1963). Since some Al^{26} is produced in the atmosphere, only an excess Al^{26} over that expected from the atmosphere can be attributed to this extraterrestrial source. Another radioactive isotope, Be^{10}, which is produced in the Earth's atmosphere by cosmic rays, gives a measure of the amount of Al^{26} and Be^{10} in the dissolved material and in the particulates. In the former, $(3.2 \pm 0.9) \times 10^{-7}$ Al^{26} and $(18.4 \pm 6) \times 10^{-6}$ Be^{10} dmp/l were found (McCorkell *et al.*, 1967). Only upper limits for Al^{26} and Be^{10} were found in the particulates (McCorkell *et al.*, 1967; Fireman *and* Langway, 1965); their additions to the dissolved activities are insignificant. By combining the activities with the precipitation rate, which is known to be 30 cm^3 of water/cm^2/year, the Al^{26} and Be^{10} production rates are calculated to be $(1.7 \pm 0.5) \times 10^{-4}$ and $(3.6 \pm 1.1) \times 10^{-2}$ atoms/sec/cm^2. The low Al^{26} to Be^{10} ratio is consistent with the production of these isotopes in the Earth's atmosphere (Lal, 1963). The result disagrees with those of Lal and Venkatavaradan (1966) but agrees with those of Tanaka *et al.* (1968) on ocean sediment.

If the Ni and Co contents indicate an influx rate of chondritic-type material of one million tons/year, the low Al^{26} content indicates that the extraterrestrial material arrived in the form of bodies that were greater than 5 cm in diameter and that were shielded from solar flares.

An upper limit for the radioactive isotope Ar^{39} of 0.04 dpm was observed in a 15-g sample of material taken from the storage tanks. This limit corresponds to 2 dmp/kg. The low Ar^{39} could be explained either by shielding of the extraterrestrial material or by dissolution of the component containing Ar^{39}.

Rare-gas anomalies. Rare-gas anomalies exist in meteorites and serve as a test for material of extraterrestrial origin. The two common types of rare-gas anomalies are (1) spallation, evidenced by high He^3/He^4, Ne^{21}/Ne^{22}, and Ar^{38}/Ar^{36} ratios, and (2) primordial, evidenced by He^3/He^4 ratios of 10^{-3} to 10^{-4} and Ar^{40}/Ar^{36} ratios of less than 300. Searches for spallation anomalies were made in the samples collected from the filter papers and storage tanks by examining the release pattern of the rare gases as a function of temperature. There was no evidence for He^3/He^4, Ne^{21}/Ne^{22}, or Ar^{38}/Ar^{36} ratios indicative of spallation. There was, however, evidence for primordial anomalies.

In a dense fraction (>3.2 g/cm^3) from the storage-tank collection, the Ar^{40}/Ar^{36} ratio was 230 ± 5 in 10^{-6} cm^3/g of Ar released at $\approx$1,200°C. after 1-hour heating at 500, 800, and 1,000°C. (Tilles, 1967). In another sample of this dense fraction, the Ar^{40}/Ar^{36} ratio was 240 ± 5 in 2×10^{-6} cm^3/g of Ar released in 1-hour heatings at 1,200°C. After 1-hour heating at 700°C., the $Ar^{36/38}$ ratio in this argon was 5.2±0.1. This argon is similar to that first found by Merrihue (1964) in ocean sediments and to the primordial argon in meteorites. This argon is conclusive evidence for extraterrestrial material. In two samples from the filter-paper collections, the amount of primordial argon was less than one-tenth the amount in the dense fraction. The primordial argon is concentrated in the dense fraction that consists largely of magnetite; the magnetite is probably extraterrestrial.

Approximately 10^{-10} cm^3/g of He^3 was found in the second sample of the dense fraction. At the temperature at which the He^3 was released, 700°C., the He^3/He^4 ratio was 1.5×10^{-5}. This helium could have a component similar to the primordial helium in gas-rich meteorites.

Acknowledgments. Parts of the work reported in this article were done in collaboration with R. H. McCorkell, C. C. Langway, Jr., and U. B. Marvin. This work was supported in part by National Science Foundation grant GA–855.

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Investigations of Cosmic Ray Intensity Variations in Antarctica

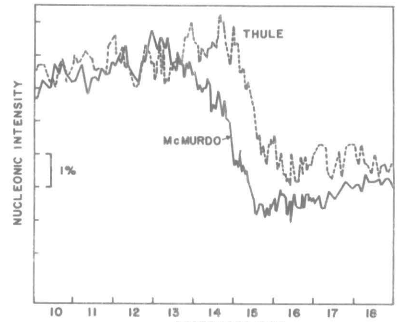
MARTIN A. POMERANTZ

Bartol Research Foundation of The Franklin Institute

Spatial anisotropies are studied with ground-based cosmic ray instruments by relating observed time variations in the intensity to directions in space by means of highly sophisticated analytical procedures. This technique provides the only available means for probing the gross features of the interplanetary medium, as well as the electromagnetic conditions in regions of space that are not accessible to spacecraft. Portions of the celestial sphere that lie appreciably far outside the ecliptic plane can be viewed only by instruments located at very high latitudes, hence polar stations are crucial for investigating the three-dimensional spatial characteristics of the interplanetary medium.

Last year, the discovery of a new type of cosmic ray intensity variation, characterized by a north-south asymmetry, was reported. This discovery stimulated a concerted search for other events manifesting anisotropies perpendicular to the ecliptic plane. Several have been identified and are now being studied in great detail. Although there are notable differences in the characteristics of the individual events, the observed intensity fluctuations at the different stations appear to be in general accord with the predictions of a theoretical model based on a diffusion mechanism.

An unusual event followed the sequence of solar disturbances in September 1966 (see figure). The cosmic ray flux at the antarctic stations started to decrease on September 14 and, on September 15, reached a minimum value about 4 percent below the pre-event level. However, the intensity reduction at the arctic stations Thule and Alert did not begin until September 15. In an effort to understand the



Nucleonic intensity recorded at McMurdo and at Thule, Greenland, following solar disturbances on September 14, 1966.

mechanism that produced this remarkable intensity gradient along the Earth's rotational axis, a detailed analysis is being carried out.

The detection of a long-term north-south asymmetry, if it exists, is of fundamental importance for understanding the solar-controlled modulation mechanisms. Although data covering a complete solar cycle are not yet available from our antarctic stations, preliminary analysis of the observations made between 1961 and 1967 have revealed that the yearly average intensity difference between the Arctic and the Antarctic is less than 0.5 percent.

Another investigation involving the data from McMurdo and South Pole Stations has led to the important finding that the long-term (solar cycle) modulation of cosmic rays is symmetric, *i.e.,* the net reduction in the primary flux in the vicinity of the Earth (below the unmodulated galactic level that prevails beyond the boundary of the solar magnetic regime) is the same in the equatorial plane as it is in the direction perpendicular to it. This fact is relevant in determining the shape and extent of the magnetic cavity carved out of the galactic magnetic field by the frozen-in magnetic fields transported by the solar wind.

No ground-level events, marking the arrival of solar cosmic rays having energies greater than about 5×10^8 eV, have occurred since January 28, 1967.

New equipment for continuously recording the intensity of multiple events was installed at South Pole and McMurdo Stations in 1968. It allows comparison, with a single instrument, of time variations of different portions of the energy spectrum of the incident primaries.

Ionospheric Forward-Scatter Program in the Antarctic

MARTIN A. POMERANTZ

Bartol Research Foundation of The Franklin Institute

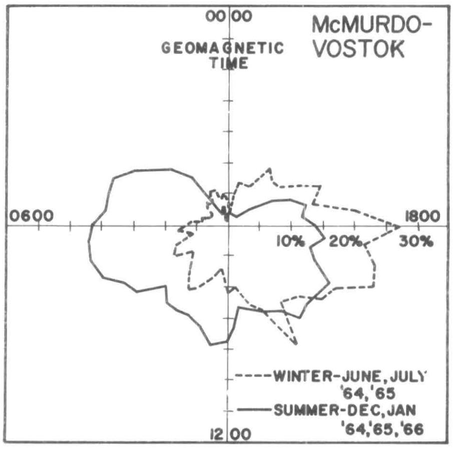
The ionospheric forward-scatter network was designed to study low-energy solar particles during a period of minimum solar activity (1964–1965). However, despite the fact that the chosen frequency, near 24 MHz, was optimal only under quiet-sun conditions, it has also been possible to derive meaningful results from data recorded during the subsequent epoch. For this reason, the operation of the links between Byrd and South Pole, Byrd and McMurdo, and McMurdo and Vostok has been continued.

Analytical attention has been devoted to studies of the development and occurrence of sporadic-E in the polar cap. The unique advantage of the forward-scatter technique in this type of investigation is that the recording is continuous, thus making it feasible to study E_s of any duration. This is not possible with ionograms that sample the ionosphere routinely at discrete intervals (15 minutes). Furthermore, the standardization of the forward-scatter method enables quantitative intercomparison of records obtained at different locations.

While the transmitted signal is normally reflected by a scatter process from heights in the range of 70–85 km, the transmitter and receiver antenna patterns illuminate the area between 50 and 120 km above the midpoint of the path. Consequently, a sporadic-E layer at about 100 km, for example, will enhance the received signal, generally sufficiently to mask the regular scatter signal.

Under these conditions, and for the path lengths and propagation frequencies of the highest latitude links (Byrd-McMurdo, 1,485 km, 23.280 MHz; and McMurdo-Vostok, 1,312 km, 23.900 MHz), a minimum plasma frequency of 5 MHz is required to reflect the signal. The data from these links were studied to determine the variations in E_s occurrence as a function of K_p, K_{Vostok}, season, and time of day (see figure). It was found that, for both links, sporadic-E propagation is associated with events that last longer than one hour. At L>20 (McMurdo-Vostok), there are diurnal, seasonal, and K_p-dependent variations. The diurnal variations depend on the season. They are most notable in the longer-lasting E_s events. There is a tendency for the E_s events to persist longer in summer than in winter. At L=14.4 (Byrd-McMurdo), the variations are similar to those for L>20 except that the K_p-dependence seems less marked and the diurnal distribution does not depend on the season.

Theoretical calculations aimed at identifying the nature of the precipitating particles with which sporadic-E is associated have been carried out. It appears that forward-scatter E_s propagation may be produced by moderate-energy protons.



Variations in E_s-*occurrence as a function of season and time of day.*

Air Sampling at Plateau Station

WAYNE L. HAMILTON

Institute of Polar Studies
Ohio State University

Between December 21, 1966, and January 26, 1967, an air-sampling experiment was conducted at Plateau Station. By means of a vane-type vacuum pump, air was pulled through Millipore membrane filters attached to the top of a 5.5–m mast about 300 m from the main station and about 75 m from the summer camp.

The filters, of 0.8-μ pore size, were changed every two days. At the end of the season, the filters were returned to the Institute of Polar Studies for microscopic study. Particles larger than about 3 or 4 μ in diameter were counted under reflected light according to a classification based on simple optical and morphological properties (cf. table).

Some of the filters were contaminated by stove smoke and engine exhaust fumes from the main station and the summer camp. These contamination sources were identified through a comparison of the wind-direction and particle-count records, which revealed that the particle-collection rate increased by a factor of 10 to 100 when the wind blew from those locations. The contaminating particles were mostly black, opaque angular grains.

The number of particles collected during the cleanest sampling intervals exceeded the contamination originally present on the unexposed filters by a factor of about 10. On the average, the background of original contamination was relatively much smaller.

Particle counts on the filters that were uncontaminated by smoke were compared with the precipitation record. (This record consisted of observations of the occurrence of precipitation, rather than accumulation, because accumulation over a time interval of 48 hours would be very difficult to measure at Plateau Station, where the total annual accumulation is only about 3 cm in water equivalent.) The presence or absence of snow, ice fog, and ice crystals in the air was noted every three hours.

Although there is a rather large scattering of points on the graph comparing total particle-collection rates (all classes of particles) with precipitation rates, the points for uncontaminated samples generally conform to a straight line passing near the origin (Fig. 1). A doubling of the precipitation rate was accompanied by a doubling of the total particle-collection rate. This result was consistent with a precipitation mechanism that requires each observed dust particle to be associated with a relatively constant number of precipitation particles. The result

Classification of particles collected at Plateau Station

Class	Description
I	Opaque spherules with metallic luster
II	Opaque spherules with nonmetallic luster
III	Transparent and translucent spherules and discs
IVA	Transparent angular particles with vitreous luster
IVB_1	Translucent, colorless or amber, angular particles with dull luster
IVB_2	Translucent and transparent colored particles
IVC	Translucent blebs with attachments and inclusions
VA	Opaque angular particles in clusters with nonmetallic luster
VB	Opaque angular particles with nonmetallic luster
VC	Opaque angular particles with metallic luster
VI	Spherule clusters included in a matrix

was not consistent with either extensive "dry" fallout or spontaneous nucleation of water vapor.

Collection rates of the various classes of particles were also compared with precipitation rates (Fig. 2). In several cases, the points conform well to straight lines with slopes (number of particles per observation of precipitation) indicative of the changing abundances of the particular classes in a variable precipitation flux. The slope of the curve is about equal to 3 for Class I spherules, 10 for Class III spherules, 20 for transparent angular particles, 20 for translucent angular particles, and 7 for opaque angular particles. The data for other particle classes exhibited too much scatter to be interpreted. However, it appears that the sum of the slopes for the other classes should be nearly equal to minus 10; that is, they may become less abundant at higher precipitation fluxes.

The most interesting result concerned the abundance of Class III (transparent) spherules relative to other particles. In Fig. 3, the percentages of Class III spherules are plotted against the precipitation

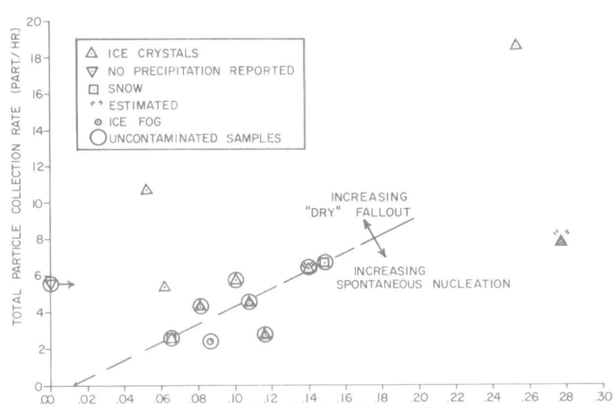


Figure 1. Total particle collection rate vs. precipitation rate for all but the most highly contaminated sampling intervals. The types of precipitation observed during the interval are indicated by symbols. The sample representing the interval when no precipitation was reported should be moved to the right, as other evidence indicates that the station was enveloped in clouds at that time.

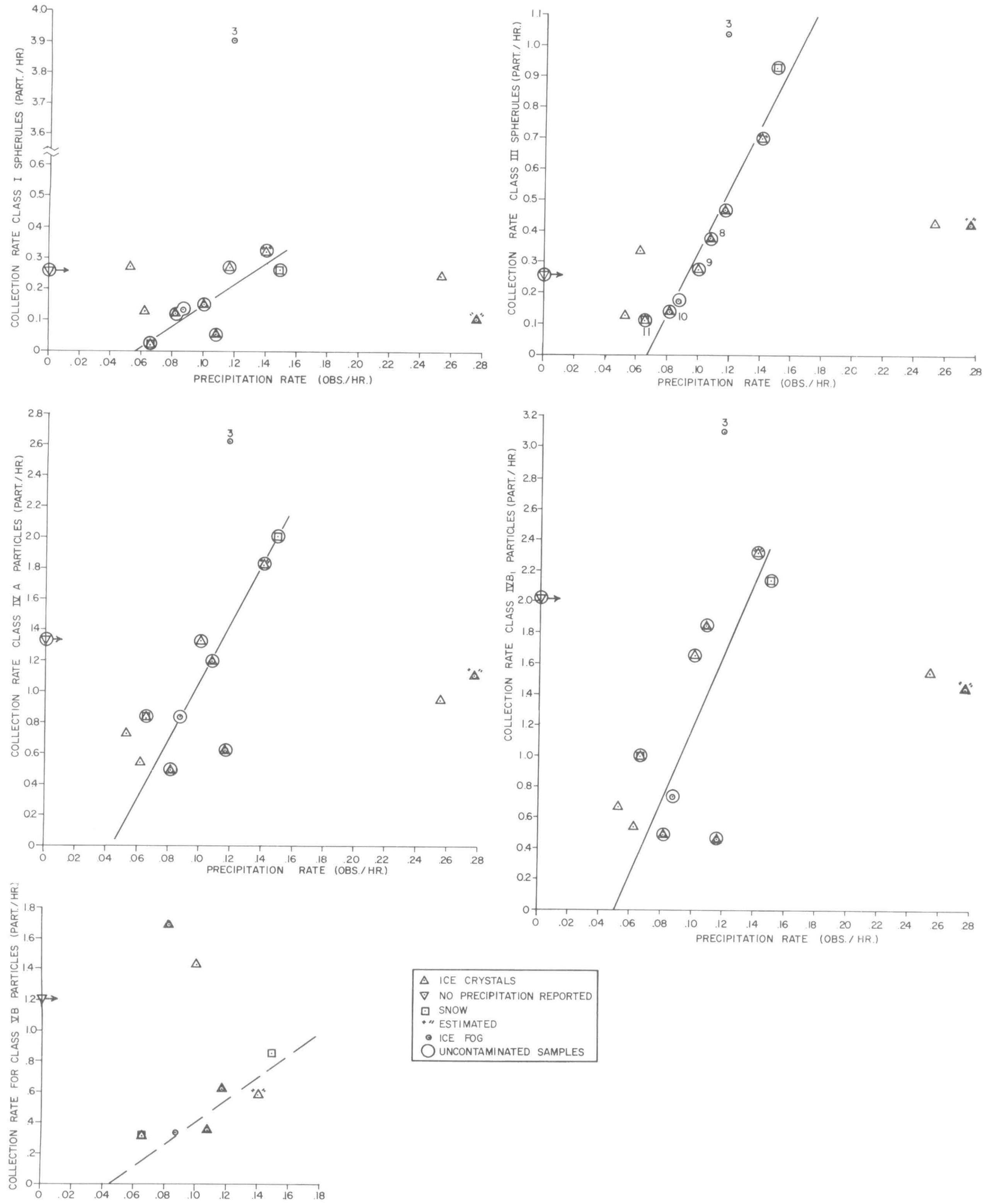


Figure 2. Collection rate of Class I, III, IVA, IVB_1, and VB particles vs. precipitation rate. Highly contaminated samples are not plotted, with the exception of filter 3, which is identified by number.

rates. A doubling of the precipitation rate was accompanied by a five-fold increase in the relative abundance of Class III spherules.

This unusual increase may be the result of one of the following aspects of nucleation. At times of low precipitation rates, water vapor will sublimate onto only the most favorable ice nuclei, provided that the lack of vapor is the factor limiting precipitation. An increase in the humidity, leading to a higher precipitation rate, will deplete the supply of favorable nuclei in a limited reservoir, and less favorable nuclei will begin to be used in increasing numbers. In this case, it seems that transparent spherules may be considered unfavorable nuclei as compared to other classes of particles.

If, on the other hand, the lack of dust is the factor limiting precipitation, it might reasonably be expected that almost all kinds of particles would serve as nuclei at low precipitation rates. With the arrival of additional dust, the favorable nuclei would overtake the less favorable ones in the formation of precipitation. Here it seems that transparent spherules would have to be considered favorable nuclei.

The availability of data on humidity might enable us to decide which hypothesis to reject. For the present, however, it seems that the transparent spherules are more likely to be unfavorable nuclei because they have extremely smooth, glassy surfaces, perhaps lacking in sites for epitaxial growth of ice. A more detailed discussion of the results of this experiment has been prepared and will be published elsewhere. Another air sampling experiment is now under way at Pole Station.

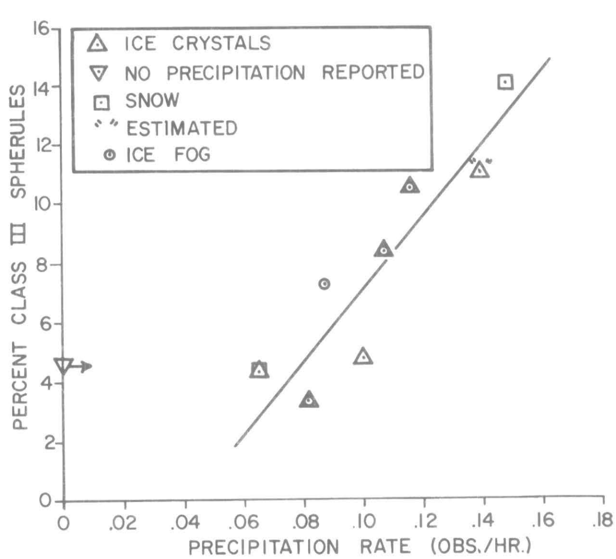


Figure 3. Relative abundance (percent) of Class III spherules vs. precipitation rate. Only uncontaminated samples are plotted.

Electrical Phenomena in Snow Drift [1]

E. R. WISHART

Division of Radiophysics
Commonwealth Scientific and
Industrial Research Organization
Australia

As a field trial for a planned study of drift snow at Plateau Station,[2] measurements of drift-snow concentration, wind, and net electric charge were made at Byrd Station on December 13 and 14, 1967, and on January 9, 1968, by means of newly developed electronic drift-gauge and Faraday-cage equipment. On December 14, charge measurements for individual drift-snow particles were obtained for the first time in Antarctica. On January 9, records were obtained of the currents flowing in a 30-m-long copper wire stretched perpendicularly to the wind direction. Air and snow temperatures and Formvar casts of drift particles were obtained on all occasions.

The surface during the period December 13–14 consisted of fresh, loose snow that was about 1°C. colder than the air and gave rise to complex drift-particle shapes prone to corona discharge effects. The net snow charges obtained during the period December 13–14 ranged from -1.4 to -7.7×10^{-9} coul/g, with individual particle charges ranging from 5×10^{-14} to 5×10^{-13} coul/g. The sensitivity of the measuring system, about 2×10^{-14} coul, limited the charge measurements to approximately 40 percent of the particles caught.

The surface on January 8–9, 1968, consisted of old, crusted snow that was 3–4°C. warmer than the air and resulted in simple, rounded drift particles. Again, the net snow charges were always negative but, by comparison with those measured on December 13–14, an order of magnitude larger—ranging from 3.3 to 5.7×10^{-8} coul/g. This increase in the charges may have been due to the simpler particle shapes that predominated in the drift snow of January 9. The wire currents were found to be closely related to the drift-snow flux.

To interpret these results, a number of different charging processes were considered, only one of which —the ice-temperature gradient effect (Latham *and* Mason, 1961)—appears to provide a satisfactory explanation. However, the maximum wind speed at the 10-m level did not exceed 15 m/sec while the measurements were being taken. Thus the results of this preliminary work apply only to moderate drift

[1] This investigation was carried out as part of the University of Melbourne studies described *infra* by Radok, Schwerdtfeger, and Weller.

[2] Circumstances prevented the Plateau study from being carried out.

and are not necessarily valid for blizzards, which require detailed study with more sensitive charge-measuring equipment.

Reference

Latham, J. *and* B. J. Mason. 1961. Electric charge transfer associated with temperature gradients in ice. *Royal Society. Proceedings,* A, 260: 523-536.

Surface and Subsurface Meteorological Conditions at Plateau Station

U. RADOK,[1] P. SCHWERDTFEGER,[1] *and* G. WELLER[2]

Meteorology Department
University of Melbourne, Australia

A large amount of meteorological data was collected by R. Dingle for the University of Melbourne during the 1967 austral winter and the 1967-1968 summer. Some preliminary results of their analysis are presented here.

Snow temperature. Temperatures were measured at 14 levels between 50 cm above and 10 m below the snow surface. The basic information obtained is summarized in Fig. 1. Apart from some irregularities, such as the "warm" pulse in July, the curves of Fig. 1 show the annual mean temperature at 10 m depth (and hence at all levels) to be close to —60.5° C. The annual temperature amplitude at 10 m is 0.5°C.

Near-surface measurements made during the 1967-1968 summer show that the diurnal amplitude of the temperature is 6°C. at the surface, 0.5°C. at 30 cm depth, and close to zero at 50 cm depth. Temperature gradients just below the snow surface are very steep in summer and change diurnally from —30°C. /m to +30°C./m.

Snow heat flux. The heat flux has been computed from the change in heat content of the snow for the layers 0–0.5, 0.5–1, 1–2, 2–4, 4–6, 6–8 and 8–10 m in depth. The computation gives the total heat transfer in the snow by conduction, convection, and radiation. The evaluation so far has shown that (a) the maximum monthly mean values at the snow surface are +11 cal/cm²/day in December and —9 cal/cm²/day in March, and that (b) the annual snow heat-flux amplitude at 4 m depth is 2.5 cal/cm²/day, and at 8 m depth, 0.4 cal/cm²/day.

Radiation transmission in the snow. The initial radiation-extinction results (Dingle *et al.,* 1967) were generally confirmed by further measurements made during the 1967 winter with a new photocell probe, although variations were found to occur in the top 50 cm because of the presence of compacted surface and subsurface layers. At 50 cm depth, the net radiation is reduced to 1–2 percent of that at the snow surface; at 1 m depth, it is reduced to about 0.5 percent. Owing to the inhomogeneity of the snow, the exponential extinction law does not apply, but the extinction coefficients decrease by an order of magnitude from the surface to the 1–m depth. For the purpose of heat-transfer studies in the snow, radiation effects can be ignored below the 50–cm depth.

Conduction and convection in the snow. Initial measurements made during the past summer in large volumes of snow that had been surrounded by polyethylene sheets to prevent the flow of air gave some interesting, though tentative, results: temperature gradients were changed by up to ±5°C./m down to the 2–m depth. Snow temperature changes of up to ±2°C. were measured when convective effects were eliminated.

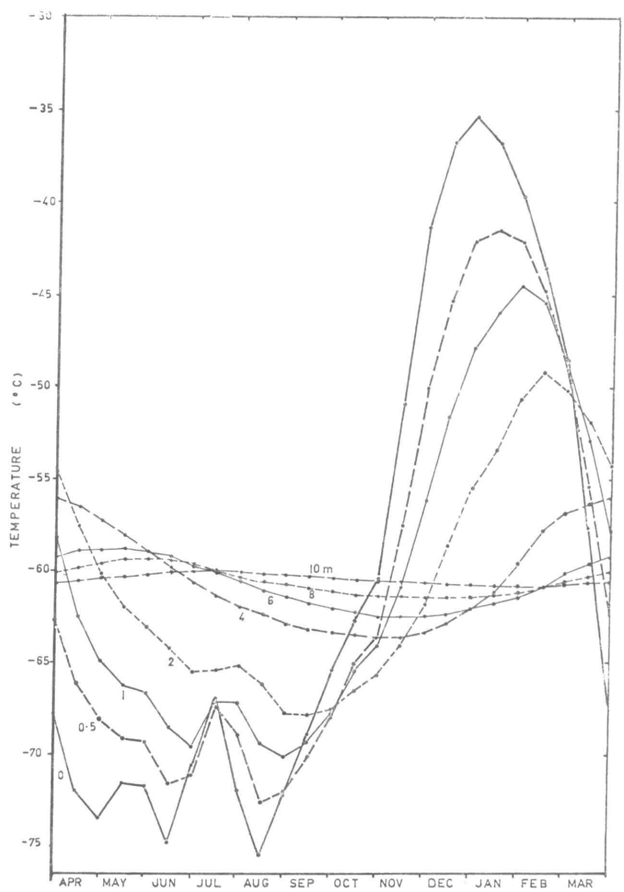


Figure 1. Semimonthly mean temperatures observed in the firn at Plateau Station during 1967-1968.

[1] Principal Investigators.
[2] Now at the Geophysical Institute, University of Alaska.

Levelling of the snow surface by sublimation-deposition processes. Miniature net radiometers were used during the past summer to determine the radiation balance of various types of surfaces. Whereas vertical and sloping surfaces have a daily positive radiation balance, horizontal surfaces have a negative balance. The ratio is about +2: —1. Hoarfrost is likely to occur on the horizontal surfaces, whereas sublimation takes place on the inclined and vertical walls. This process tends to level the surface. Further work and measurements are in progress.

Surface accumulation and snow drift. The monthly accumulation measurements of the previous year were continued throughout 1967 and the following summer. In addition, another field of 25 accumulation stakes was set up and read once or twice weekly, and density sampling was carried out even more frequently on significant surface features (*i.e.*, dunes and barchans) nearby. The statistical analysis of the data obtained will attempt to determine the accumulation due to sublimation alone, by eliminating the effects of cloud precipitation and snow drift.

Snow drift in the lowest 20 cm above the surface has been found to be a common feature at Plateau throughout the year. On 17 occasions during 1967 when winds exceeded 7 m/sec at the 10–m level, appreciable concentrations of drift snow occurred also at higher levels. Fig. 2 shows preliminary drift-snow concentrations for Plateau together with the corresponding information derived from the earlier snow-drift project at Byrd (Budd *et al.,* 1966). There is a strong suggestion that all of the Plateau concentrations lie somewhat above the Byrd curves extrapolated down to Plateau wind velocities. This seems reasonable in view of the low cohesion of the Plateau snow. A definite evaluation of the Plateau drift measurements will be made when the digital micrometeorological records become available.

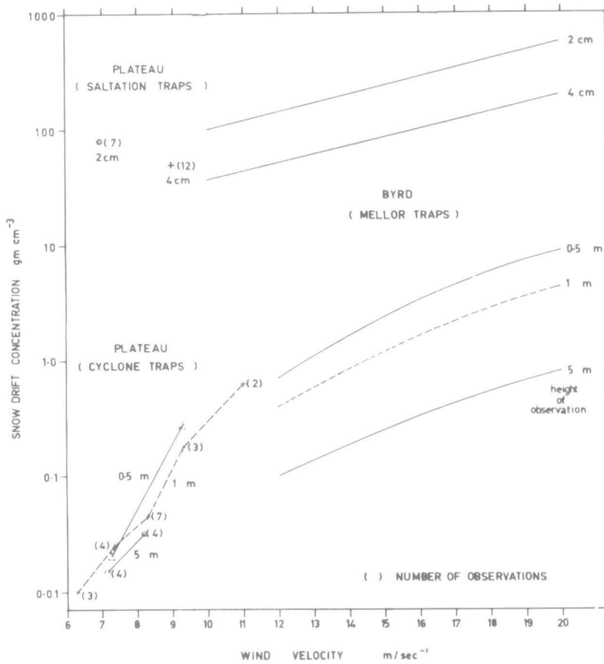


Figure 2. Snow-drift concentrations as a function of wind speed at various levels at Plateau and Byrd Stations. The data are preliminary.

Acknowledgments. Thanks are due to members of USARP, especially Mr. E. E. Goodale and the station scientific leaders at Plateau and Byrd Stations. The work was made possible by NSF grant GA–412 and by the permission of the Radio Physics Division of C.S.I.R.O. for Mr. E. R. Wishart's participation (see article *supra*).

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Dingle, R., U. Radok, P. Schwerdtfeger, *and* G. Weller. 1967. Surface and subsurface micrometeorology at Plateau Station. *Antarctic Journal of the U.S.,* II (5): 162.

New Issue of *SAE Information Bulletin*

Volume 6, issue 6 of the *Soviet Antarctic Expedition Information Bulletin* has been published. The 145-page issue ($7.50) contains English translations of *Bulletins* nos. 65 and 66, both of which were originally published in Russian in 1967. The entire sixth volume, which contains *Bulletins* 55 through 66, is available for $40. Orders should be sent to the American Geophysical Union, Suite 435, 2100 Pennsylvania Ave., N.W., Washington, D.C. 20037.

Folio 10 of *Antarctic Map Folio Series*

Folio 10, entitled *Primary Productivity and Benthic Marine Algae of the Antarctic and Subantarctic,* was prepared by E. Balech, S. Z. El-Sayed, G. Hasle, M. Neushul, and J. S. Zaneveld. The 12-page, 15-plate folio is for sale at $6.00 a copy from the American Geographical Society, Broadway at 156th Street, New York, New York 10032. The series is supported by the National Science Foundation; Vivian C. Bushnell is its executive editor.

James E. Mooney Dies

James E. Mooney, former Deputy United States Antarctic Projects Officer and a longtime friend and associate of Admiral Byrd, died in Bethesda, Md., on October 27, 1968, at the age of 67.

An educator, author, and editor in his earlier years, Dr. Mooney received his doctorate in education from Duquesne University in 1933. He was President of the University of Tampa (Fla.) from 1940 to 1945, after which he spent five years as Director of Aviation for Pinellas County, Florida.

In 1955, when Admiral Byrd was named Officer in Charge, United States Antarctic Programs, Dr. Mooney joined his staff, serving first as a consultant, and then in a full-time capacity. In recommending Dr. Mooney for civil-service appointment, Admiral Byrd wrote, "He has for more than a quarter of a century been a trusted friend and advisor."

Dr. Mooney continued to serve through the reorganization that followed Admiral Byrd's death in 1957, in which year Rear Admiral Dufek succeeded Admiral Byrd with the title of United States Antarctic Projects Officer. In 1959, Dr. Mooney was designated Deputy United States Antarctic Projects Officer, a position he held until the office was abolished in April 1965. He then served as Special Assistant to the Assistant Secretary of Defense (International Security Affairs) for Antarctic Matters until his retirement on December 31, 1965.

Dr. Mooney's honors included doctorates in science and humane letters, the Navy Distinguished Public Service Award, and the Office of the Secretary of Defense Meritorious Civilian Service Award. In 1965, Belgium awarded him the Order of the Crown.

Redesignation of VX–6 and VX–8

Effective January 1, 1969, Air Development Squadron Six (VX–6) will become Antarctic Development Squadron Six (abbreviated VXE–6), and Air Development Squadron Eight (VX–8) will be redesignated Oceanographic Development Squadron Eight (VXN–8).

Although not directly involved in *Operation Deep Freeze,* VX–8 occasionally flies in the Antarctic to collect data for *Project Magnet,* a worldwide aeromagnetic survey sponsored by the U.S. Naval Oceanographic Office. This year, a *Project Magnet* C–121 is scheduled to operate from McMurdo during the first week of November.

Both redesignations were announced on June 27 by the Office of the Chief of Naval Operations.

Chronology of U.S. Navy Support Activities

April 1–December 31, 1967

In Greenwich Mean Time

April

9—PM-3A nuclear power plant shut down due to failure of electrical distribution system.

16—PM-3A resumed power output.

May

5—Radio contact established between McMurdo and 10-man Plaisted Polar Expedition in Canada (at 79°59′N. 85°57′W.)

14—McMurdo water-distillation unit produced its millionth gallon of water. (*N.B.*—Involved use of conventional and nuclear power; millionth gallon produced with nuclear power on July 3, 1967.)

16—South Pole Station evacuated due to accidental release of carbon tetrachloride fumes; personnel returned from emergency camp to main station on the following day.

June

18—First scheduled winter flight to Antarctica; *Winfly I* aircraft arrived and departed Williams Field with R. Adm. J. L. Abbot, Jr., CTF-43, aboard.

23—Lt. A. W. Snell relieved Lt. Comdr. V. Law as Officer-in-Charge, Det. Charlie, Antarctic Support Activities.

August

1—RN-50 Nodwell lost through ice off Hut Point on fourth attempt to reach Cape Royds.

24—Fire destroyed the new lavatory complex (Bldg. 18) at Williams Field.

27—Lowest 1967 temperature recorded at Plateau Station: –84.2°C. (–119.5°F.)

September

3—*Winfly II* aircraft arrived and departed Williams Field.

11—Lt. Comdr. R. W. Sallee relieved Lt. A. W. Snell as Officer-in-charge, Det. Charlie, Antarctic Support Activities.

15—PM-3A nuclear power plant completed power run of 3,643 hours and 15 minutes, surpassing the old record of 3,390 hours and 25 minutes set in October 1966; plant shut down for maintenance and testing.

19—CTF-43, R. Adm. J. L. Abbot, Jr., departed Washington, D.C., in a C-121J for Christchurch, N.Z.

23—PM-3A resumed power output.

24—USS *Calcaterra* arrived Dunedin, N.Z., and reported to operational control of CTF-43.

—Air Development Squadron Six reported to operational control of CTF-43.

25—R. Adm. Abbot arrived Christchurch.

26—USS *Calcaterra* departed Dunedin for ocean station.

30—USS *Calcaterra* arrived on ocean station.

October

1—First LC-130F flight of season landed at Williams Field with CTF-43 aboard.

—Det. Alpha, Antarctic Support Activities, disestablished with the arrival at McMurdo of Commander, Antarctic Support Activities, Capt. H. A. Kelley.

—USS *Mills* arrived Dunedin and reported to operational control of CTF-43.

—First C-121 turnaround flight of season arrived at Williams Field.

3—Hallett Station reopened.

—First helicopter flight of season, by LH-34 of VX-6.

—VX-6 Det. McMurdo disestablished.

5—McMurdo Representative, Commander, U.S. Naval Support Force, Antarctica, established.
—Brockton Station reopened.
—USS *Mills* departed Dunedin for ocean station.
7—USS *Mills* called at Campbell Island.
8—First scientific-support helicopter flight of season, by LH-34 of VX-6.
—USS *Calcaterra* departed ocean station for Dunedin.
9—USS *Mills* arrived on ocean station.
11—First RNZAF C-130H flight of season arrived at Williams Field *(Operation Ice Cube)*.
12—PM-3A reactor shut down for core change.
16—Construction Battalion Unit 201 reported to operational control of CTF-43.
20—First flight of season to Byrd Station; CTF-43 aboard.
21—First reconnaissance flight and landing at Marie Byrd Land camp 1 (75°53′S. 131°45′W.)
—First reconnaissance flight and landing at Roosevelt Island campsite (79°16′S. 162°15′W.).
22—LC-130F landed contingent of ASA and VX-6 personnel to erect Marie Byrd Land camp 1. Party returned to McMurdo same day due to inability to establish radio contact.
23—USS *Mills* departed ocean station for Dunedin.
—First MAC C-130E turnaround flight of season landed on annual-ice runway.
—U.S. Army Aviation Detachment (Antarctica Support) arrived Christchurch, N.Z., and reported to operational control of CTF-43.
—Lt. (jg.) J. R. Clark, CEC, USN, relieved Lt. E. M. Cranton, MC, USN, as Officer-in-Charge of Byrd Station.
24—First landing at Fosdick Mountains campsite (76°35′S. 143°40′W.).
27—First of Army Aviation Detachment's UH-1D helicopters delivered to Williams Field by LC-130F.
28—Construction of Marie Byrd Land camp 1 completed.
—Sixth and last MAC C-130E turnaround flight of the season landed on annual-ice runway at Williams Field.
29—USS *Calcaterra* arrived on ocean station after being delayed by weather.

November

1—First flight of season to South Pole Station.
2—Lt. R. M. Hook, MC, USNR, relieved Lt. R. C. Sullivan, MC, USNR, as Officer-in-Charge of South Pole Station.
4—PM-3A resumed power output.
6—Bust of R. Adm. Byrd dedicated at Dunedin, N.Z. The Honorable John F. Henning, U.S. Ambassador to N.Z., and R. Adm. J. L. Abbot, Jr., in attendance.
8—USCGC *Burton Island* arrived Wellington, N.Z., and reported to operational control of CTF-43.
10—USS *Mills* relieved USS *Calcaterra* on ocean station.
—USCGC *Westwind* arrived Port Lyttelton, N.Z., and reported to operational control of CTF-43.
—New Zealand party landed at Rennick Glacier by LC-130F.
13—Lt. Comdr. A. D. Kohler, Jr., CEC, USN, relieved Lt. Comdr. L. K. Donovan, CEC, USN, as Officer-in-Charge of Naval Nuclear Power Unit detachment at McMurdo.
17—First flight of season to Plateau Station; CTF-43 aboard.
—Ross Sea Ship Group (TG 43.2) activated with departure of USCGC *Burton Island* from Wellington for McMurdo.
—USCGC *Westwind* departed Port Lyttelton for McMurdo.
18—USCGC *Glacier* arrived Port Lyttelton and reported to operational control of CTF-43.
20—Lt. J. F. Johnson, MC, USNR, relieved Lt. A. B. Blackburn, MC, USNR, as Officer-in-Charge of Plateau Station.
26—USS *Calcaterra* relieved USS *Mills* on ocean station.
28—USCGC *Glacier* departed Port Lyttelton for McMurdo.

December

1—USCGCs *Westwind* and *Burton Island* arrived off Hut Point after clearing channel to McMurdo. (Breaking of ice in Winter Quarters Bay delayed to preclude early erosion and undercutting of Elliott Quay.)
2—C-47 type aircraft retired from U.S. antarctic program effective with return to Williams Field of an LC-117 resupply flight to Hallett Station.
3—Annual-ice runway at Hallett Station closed due to ice deterioration.
4—British Antarctic Survey requested aerial evacuation of Dr. John Brotherhood, injured physician of Halley Bay Station.
5—Dr. Brotherhood evacuated by a VX-6 LC-130F that departed McMurdo at 0056 and flew via South Pole to Halley Bay, then to McMurdo and on to Christchurch, completing the longest mercy flight in antarctic history.
—South Pole—Queen Maud Land Traverse (SPQMLT) III departed Plateau Station.
8—LC-130F landed at Soviets' Vostok Station; CTF-43 aboard.
9—USCGC *Glacier* departed McMurdo for Port Lyttelton.
14—First airdrop to SPQMLT III.
15—USCGC *Southwind* arrived Punta Arenas, Chile, and reported to operational control of CTF-43.
—USNS *Alatna* arrived Port Lyttelton and reported to operational control of CTF-43.
16—Japanese traverse party from Showa Station arrived at Plateau Station.
17—USCGC *Glacier* arrived Port Lyttelton.
—USS *Calcaterra* departed ocean station for Dunedin.
—USNS *Alatna* departed Port Lyttelton for McMurdo.
18—USCGC *Southwind* departed Punta Arenas for Palmer Station.
19—Japanese traverse party departed Plateau Station.
—USS *Calcaterra* arrived Dunedin.
—USS *Mills* arrived on ocean station.
21—USCGC *Southwind* arrived Palmer Station.
22—USCGC *Burton Island* departed McMurdo for Hallett Station.
—USNS *Towle* arrived Port Lyttelton and reported to operational control of CTF-43.
23—USCGC *Westwind* departed McMurdo to meet inbound USNS *Alatna*.
24—USCGC *Burton Island* departed Hallett Station area for McMurdo.
—USCGC *Westwind* started escort of USNS *Alatna*.
25—USCGC *Burton Island* arrived McMurdo.
26—USNS *Alatna*, escorted by USCGC *Westwind*, arrived McMurdo; first resupply ship of *DF 68* season.
27—USNS *Towle* departed Port Lyttelton for McMurdo.
28—USCGC *Southwind* called at Argentina's Almirante Brown Base.
—USNS *Alatna* departed McMurdo for Port Lyttelton.
—USCGC *Westwind* departed McMurdo escorting USNS *Alatna* outbound and to meet inbound USNS *Towle*.
29—USCGC *Southwind* returned to Palmer Station.
30—Season's second LC-130F flight to Vostok.
—USCGC *Burton Island* departed McMurdo for Beaufort Island.
31—USCGC *Westwind* started escort of inbound USNS *Towle*.

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PUBLISHED BY THE NATIONAL SCIENCE FOUNDATION
WITH THE ASSISTANCE OF THE DEPARTMENT OF DEFENSE