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(Continued)

Greenwich Mean Time is used throughout the issue except where otherwise indicated

A REVIEW OF THE 1966-1967 SUMMER SEASON

Introduction

Following the pattern of last year, this issue of the *Antarctic Journal* is devoted to a review of the United States' national program in Antarctica during the 1966-1967 austral summer. The review includes summaries of individual research projects of the U.S. Antarctic Research Program—conducted under the auspices of the National Science Foundation by about 150 scientists of universities, the Government, and private organizations—and reports on the logistic support provided to the program by the U.S. Navy and units of the Coast Guard, Army, and Air Force.

The season's logistic operations (*Deep Freeze* 67) and scientific programs (USARP 1966-1967) were eminently successful despite periods of poor weather, adverse ice conditions in McMurdo Sound early in the season, and an unexpected 10-day communications blackout. An indisputable highlight of the season was the acquisition of mapping-quality aerial photography of areas totalling about 335,000 square miles, twice the amount obtained during any previous season.

The effects of poor weather were hardest felt in Marie Byrd Land, where a 34-man party was to have established three base camps in order to make a complete survey of the coastal areas, using the peak-hopping helicopter techniques that had proved so successful in the Pensacola Mountains the year before. As it turned out, the party worked out of Camp No. 1 during its entire stay in Marie Byrd Land. Despite the adverse weather and the loss of one helicopter, which was later replaced, much of the coast between Cape Colbeck and Cape Burks was studied in detail.

Other investigations at field locations far from McMurdo included geological studies in the Queen Alexandra Range, the Sentinel Range, and the Horlick Mountains. A notable discovery was a large number of petrified tree trunks and stumps in the Queen Alexandra Range.

At two stations, the groundwork was laid for significant projects next year. At Palmer, the first part of a much improved station facility was constructed, and at Byrd, equipment was installed for drilling to the bottom of the ice cap—at a depth of some 2,500 meters—during the 1967-1968 austral summer.

Of considerable popular interest was the inclusion in the program of an American mountaineering expedition that climbed to the summits of the four highest peaks on the Continent (cf. *Antarctic Journal,* Vol. II, No. 2, p. 48-50).

For the second time, the United States exercised its rights under the Antarctic Treaty to examine activities and facilities at foreign stations—in this instance, carrying out inspections of stations along the coast of East Antarctica and in the South Orkney Islands. As expected, the observers found no evidence of violations of the Treaty.

The analysis and digestion of scientific field data is a long process. For this reason, the summaries on the following pages should be considered as preliminary reports, subject to revision and expansion and, most probably, publication in a more complete form in professional scientific journals. The summaries are very useful, however, for they provide a record of accomplishments during the season, and they enable scientists working in different geographic areas or in other disciplines to draw information from the whole program.

The reports published in this issue of the *Antarctic Journal* tell only part of the story of the United States' national program in Antarctica. A variety of programs is carried out at the permanent stations and aboard USNS *Eltanin* all year round, and programs that entail data reduction and analysis in laboratories are conducted throughout the year in the United States. These will be dealt with in the next issue of the *Journal* together with certain service programs carried out in the United States in support of the U.S. Antarctic Research Program. Reports on international activities, which involve the exchange of scientists with other national expeditions for the purpose of conducting research in different areas of the Continent and in different environments, are being included in these and later issues as they become available for publication.

UNITED STATES ANTARCTIC RESEARCH PROGRAM 1966-1967

The Marie Byrd Land Survey

(U.S. Navy Photo)

Marie Byrd Land Survey Camp No. 1

The largest scientific field operation undertaken by the United States in Antarctica during the 1966-1967 season was the Marie Byrd Land Survey [1] —a multidisciplinary exploration of the coastal area of Marie Byrd Land from Cape Colbeck on Edward VII Peninsula to Grant Island off Hobbs Coast. Between early November and late January, geological, biological, topographic, geophysical, and paleomagnetic observations were made by a total of 18 USARP scientists and engineers, supported by 13 officers and men of an Army aviation detachment, a Navy aerographer, and two Navy cooks.

Operations

The base of operations for the survey was a field camp located in the Ford Ranges at about 76°55′S. 144°00′W. (Two other campsites had been selected for occupation after work in the area of the first camp had been completed but, because of bad weather, the plan to move on to the other locations was abandoned.) The base camp was established on October 24, 1966, by Dr. F. Alton Wade, senior scientist [2] on the survey, and four other USARP personnel. This group was flown to the site from McMurdo Station by an LC-130F aircraft of VX-6. Subsequent flights made by VX-6 brought in the remaining personnel and a total of 400,000 pounds of fuel and supplies from McMurdo. The base camp consisted essentially of three Jamesways, one of which served as a galley and recreation area and the other two as sleeping quarters for the Army, Navy, and USARP personnel.

Scientists and engineers were transported to field locations in the area of the base camp by three UH-1D turbine-powered helicopters. The operating radius of the helicopters, which were equipped with auxiliary fuel tanks, was 175 miles. When greater distances had to be traveled, fuel caches were established by LC-130F airlift from McMurdo. Three motor toboggans were available for overland travel to localities near the base camp.

On November 5, while attempting to evacuate two scientists from a mountain, one helicopter crashed and was damaged beyond repair. Fortunately, there were no injuries, but the accident resulted in the curtailment of some of the operations that had been planned. The remainder of the early-season missions utilized the two remaining helicopters, which were required to operate within a range in which each could provide search-and-rescue service to the other in an emergency. On days when weather permitted, the two helicopters each placed two topographic engineers on selected peaks, then departed to support geological, paleomagnetic, and biological investigations, returning later to pick up the topographers. In

[1] The official U.S. ruling made on August 19, 1966, to shorten the name "Marie Byrd Land" to "Byrd Land" was rescinded on April 6, 1967. During that period this survey was called "The Byrd Land Survey."

[2] Relieved by Dr. Campbell Craddock during the latter part of the survey.

mid-December, a replacement helicopter arrived, and the investigations proceeded on the scale originally planned, except for delays caused by the weather, with geophysical studies being conducted in the third aircraft. From November 1, 1966, until January 25, 1967, when the base camp was evacuated, flights could be made on only 27 days. On those days, operations were carried out around the clock if weather permitted.

Scientific Programs

Geological studies were conducted by Texas Technological College and the University of Minnesota in all mountains of the area except the northernmost part of the Ford Ranges. A major objective of this work was to determine if the Fosdick Mountains are made up of very old rocks, perhaps of the basement complex, or if they are part of the plutonic masses which are distributed with some regularity throughout the Ford Ranges.

Botanical studies, which were conducted by the Institute of Polar Studies, Ohio State University, consisted primarily of the collection of algae, lichens, and mosses and the recording of rock-surface, subsurface, and water temperatures in the mountains. Attempts also were made to isolate airborne plant propagules at the base camp.

Paleomagnetic investigations were undertaken by Washington University (St. Louis) to determine the magnetic-pole positions indicated by rocks of Jurassic age. Comparisons of these positions with those exhibited by rocks of the same age collected in other antarctic regions will aid in elucidating the tectonic history of the Continent.

The topographic program was carried out by the U.S. Geological Survey to establish control for aerial photographic mapping of this part of Marie Byrd Land and to determine the locations of some gravity stations in cooperation with the geophysical program. (Because the topographic program involved work in other parts of Antarctica, discussion of the work done in Marie Byrd Land is included in the general report, which is presented on page 118.)

The geophysical investigations consisted of making a 6,500-km aeromagnetic survey and obtaining ice-thickness, magnetic, and gravity measurements. It was carried out by the Geophysical and Polar Research Center, University of Wisconsin.

These programs are described in the following articles by the investigators who conducted them.

Geology of the Marie Byrd Land Coastal Sector of West Antarctica

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Between October 25 and December 30, 1966, a geological field party from Texas Technological College studied and mapped bedrock exposures in an area of approximately 50,000 square km in the western portion of the Marie Byrd Land coastal sector. The four-man group was accompanied by Dr. L. V. Klimov, Soviet exchange scientist, whose contributions to our geologic interpretations are gratefully acknowledged.

The investigations were confined largely to the Ford Ranges and the mountains of Edward VII Peninsula. Portions of these ranges had been investigated by the writer in 1934 and 1940, by L. A. Warner and C. F. Passel in 1940, and by G. A. Doumani in 1959. These previously surveyed segments have now been tied together, completing the reconnaissance survey of western Marie Byrd Land.

With one possible exception, the oldest rocks in the area are a sequence of metasediments with a minimum thickness of 4,600 m. The section is comprised of a monotonous sequence of nonfossiliferous quartzites and graywackes and minor beds of quartzose shale. During a period of orogeny, these sediments were intensely folded and intruded by huge plutons of granodiorite and granite. Numerous basic dikes and irregular plutons cut the granitoid intrusives and metasediments. The axes of the major folds trend roughly west-northwest and plunge gently in the same direction. Radiometric age determinations made of granites and a biotite schist which were collected in 1940 by the writer in the Rockefeller Mountains place the time of the orogeny in the Cretaceous period. Extrusions of olivine basalts and associated tuffs occurred in the northern portion of the Ford Ranges during the Tertiary and may have continued into the Recent.

One anomalous unit was found in the Ford Ranges. It is a roughly rectangular block 100 km long and 15 km wide. It includes Mitchell Peak, Birchall Peaks, the Fosdick Mountains, and the Griffith Nunataks. It is composed of gneisses and schists which represent intensely folded and granitized sediments. Two explanations are given:

(1) A higher degree of metamorphism occurred in the area of the anomalous unit, thereby producing gneisses and schists from the same type of metasediments that are widely distributed to the south and

west. In addition, localized metasomatic emanations occurred, causing considerable migmatization and granitization.

(2) This elongated segment of the ranges is an upfaulted block of the basement complex from which the overlying, younger rocks have been removed by erosion. The schists and gneisses are thus the metamorphosed and granitized rocks of an older sedimentary sequence.

The writer favors the latter explanation. Because of the importance of this unit in the overall interpretation of the geology of the Marie Byrd Land coastal sector, detailed petrologic, structural, and geophysical investigations are recommended.

The relationships of this portion of West Antarctica to the rest of the Continent have not been established. It is hoped that the continuation of the Marie Byrd Land Survey, scheduled for 1967-1968, will provide the information necessary to solve the problem.

Geology of the Ruppert Coast

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CAMPBELL CRADDOCK [2]

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University of Minnesota

The field work undertaken by the University of Minnesota party in the 1966-1967 season was part of the Marie Byrd Land Survey, which was to have operated from several base camps in the coastal areas of West Antarctica. Because various circumstances prevented this traverse from proceeding beyond the first camp, the outcrops originally scheduled for study could not be reached. Thus it was decided to concentrate on the Ruppert Coast between Mount Shirley and Cape Burks, an area which had not been studied previously and which lay within range of the helicopters based at Camp No. 1 in the Ford Ranges. The field work was done between December 30, 1966, and January 18, 1967.

Because outcrops in this area are isolated nunataks or groups of peaks separated by large, rather strongly crevassed glaciers, transportation by helicopters is essential. During the initial reconnaissance, the two party members visited exposures together, then each worked from one end of the region toward the middle, traveling in separate helicopters. On these flights, biologists, a paleomagnetist, or a geophysicist accompanied the geologist. Dr. L. V. Klimov, Soviet exchange scientist, also worked with the group on the Ruppert Coast; valuable exchanges of ideas on geological questions resulted from his presence.

On many days, bad weather either prevented helicopter flights or caused them to be terminated prematurely. Nevertheless, due to the great mobility afforded by the aircraft, all significant outcrops in the area were visited. Approximately 140 rock specimens (mainly gneisses, metavolcanics, metasediments, and granites) were collected, structural data were obtained, and photographs were taken of several well-exposed contacts. Considerable time was spent in the area of Mount Gray, where the largest group of outcrops on the Ruppert Coast occurs. The results of these investigations are now being evaluated at the University of Wisconsin. Age determinations and other studies of the rock collections should elucidate the relationship of this region to the rest of West Antarctica.

On December 30, a successful reconnaissance flight was made to the Kohler Range to establish a campsite near some nunataks where both massive (possibly granitic) and layered (possibly sedimentary) rocks are exposed. A group of four scientists, including the writers, were to have spent about two weeks in this area with motor toboggans after work on the Ruppert Coast was completed, but attempts to place this party in the field on January 18 and 24 were unsuccessful because of very bad weather in the landing area.

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[2] Now Professor of Geology, University of Wisconsin.

Paleomagnetic Investigations in Marie Byrd Land

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The value of paleomagnetic investigations in determining large-scale tectonic movements has been demonstrated in various parts of the world. A few such investigations have been conducted in Antarctica, but the tectonic history of the Continent is yet to be fully established.

Paleomagnetic data obtained by other investigators from Cretaceous and younger rocks in the shield area of East Antarctica have established

Jurassic magnetic-pole positions that are in good agreement with a mean of 59°S. 139°W. Prior to the 1966-1967 field season, similar data had not been obtained from the insular and peninsular areas of West Antarctica, represented principally by Marie Byrd Land.* Paleomagnetic data from this area were needed to establish Jurassic pole positions and to enable a comparison to be made of those positions with the pole positions indicated by Jurassic rocks collected in East Antarctica. The combined results should reflect major tectonic features that reveal the true geologic relationship between East and West Antarctica.

During the 1966-1967 austral summer, rock sampling for paleomagnetic purposes was centered in the Ford Ranges (77°S. 144°W.). Oriented samples were collected from sites at distances of up to 320 km from the base camp. A total of 86 oriented samples of granite and basalt were obtained from 28 sites. From these samples, at least 300, and possibly more, individual cores (2.5 by 2.5 cm) will be drilled for the paleomagnetic studies.

In the Ford Ranges, samples were obtained at the following locations: Mounts "Farley," Swan, Saunders, Morgan, Rea, Blades, Atwood, Douglas, Richardson, and June; McKinley Peak, Hill Peaks, Chester Mountains, and Herrmann Nunatak; and nunataks at 76°50′S. 144°W., 76°26′S. 143°20′W., and 76°50′S. 144°15′W.

Along Hobbs Coast, samples were taken at Mount Gray and Holmes Bluff. In the area of Ruppert Coast, sampling was carried on at Mounts Hartkopf, Peddie, and McCoy, and at Lewis Bluff. Mount Franklin on the Edward VII Peninsula was visited, but only one sample was taken because the outcrops there are highly weathered.

It is certain that the study of these samples will reveal not only pole positions but other features of rock magnetism. This is especially true of the samples obtained in the Fosdick Mountains and at Mount Gray. Acidic plutonic rocks, folded sedimentary formations, and gneissic rocks occur there, indicating that a rather complex geologic problem exists. In fact, it has been suggested that Precambrian rocks somewhat similar to those of East Antarctica occur in this region. Paleomagnetic data obtained from these areas may well aid us in understanding the geologic complexity.

The rock samples are being arranged for complete magnetic analysis and fission-tract age determination.

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* Considered in terms of its rock only, Marie Byrd Land is an insular area.

Geophysical Investigations in Marie Byrd Land

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Geophysical and Polar Research Center
University of Wisconsin (Madison)

The program conducted by the University of Wisconsin in Marie Byrd Land included the measurement of gravity, ice thickness, and magnetism, mainly with helicopter support, between 132° and 154°W. and between the coast and 100-250 km inland. In addition, aeromagnetic measurements were made between 105° and 155°W.

Data on gravity were sought primarily because of their application to studies of crustal structure, isostatic balance of the land mass, and interrelationships of various parts of the Continent. Determinations of ice thickness were required for the reduction of the gravity data as well as for glaciologic purposes. Measurements of magnetism were made to obtain information on gross lithology, such as the presence of volcanic rocks, and to complement gravity data that are applied to various geologic interpretations.

The helicopter-supported program was carried out by the authors and William Isherwood by means of two LaCoste-Romberg gravity meters, a Varian M-49 magnetometer, and an Airborne Instruments electromagnetic sounder that was loaned to the University by the U.S. Army Electronics Command, Fort Monmouth, New Jersey. The sounder is used to determine ice thickness by measuring the travel time of 30-mc/s electromagnetic waves reflected from the rock surface beneath the ice.

Field operations consisted of flying along predetermined paths and landing about every 16 km to take readings. A gravity meter, an altimeter, and the magnetometer were read on the surface and, if the station was not on rock, the ice-sounding antennas were laid on the snow alongside the helicopter and the ice thickness measured. The sounder was secured inside the helicopter and operated from the aircraft's electrical system.

Although the instruments proved reliable and the system of operation very successful, poor weather restricted field work to 17 days for the entire season. During approximately 110 hours of flight time, 189 gravity and 117 ice-thickness measurements were made. U.S. Geological Survey engineers and Texas Technological College geologists aided in obtaining gravity data. Because areal coverage was limited by the weather, the station density was increased in some of the accessible areas in order to enhance the usefulness of the data.

Projects not requiring helicopter support included a gravity and ice-thickness profile across the Arthur Glacier in the immediate vicinity of Camp No. 1, and seismic reflection measurements, also near Camp No. 1. The latter provided a check on the electromagnetic-sounder results.

Approximately 6,500 km of magnetic-profile data were obtained by Thomas Horrall during a total of 35 hours of working time on flights made by a Navy LC-117 aircraft between 105° and 155°W. (Thwaites Ice Tongue and Edward VII Peninsula). Measurements were made with an Elsec proton precession magnetometer about every 0.4 km along widely spaced flight lines.

Biological Survey of Marie Byrd Land

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and
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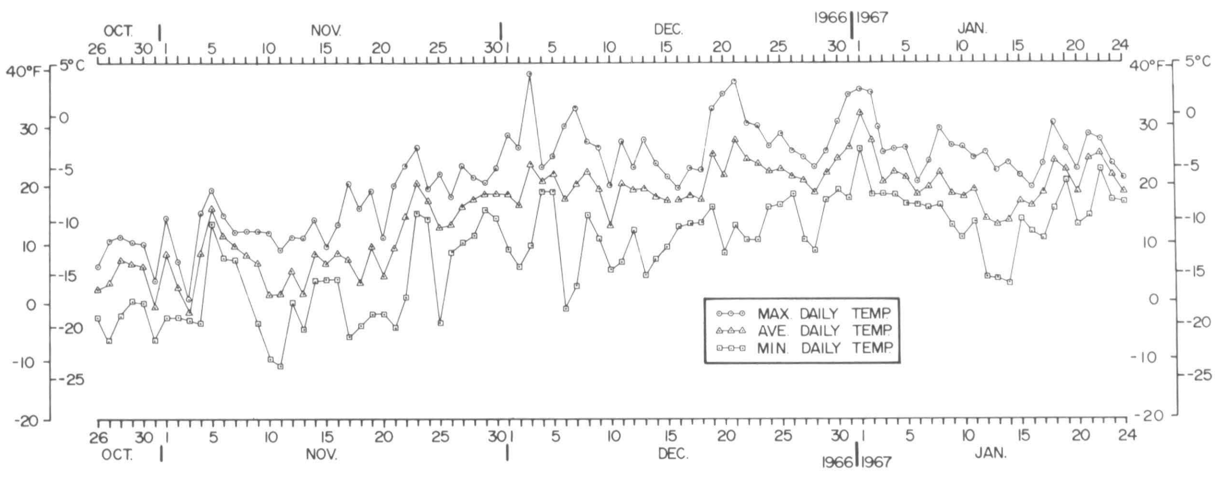
*Sites of antarctic collections.**

Locality	S. Lat.		W. Long.		Algae	Lichens	Mosses
	Deg.	Min.	Deg.	Min.			
Washington Ridge (Rockefeller Mts.)	78	06	154	48		+	
Birchall Peaks	76	29	146	20		+	
Mount Iphigene	76	31	145	54		+	
Saunders Mountain	76	53	145	40	+	+	+
Chester Mountains	76	40	145	35	+	+	+
Skua Gull Peak	76	50	145	24		+	
Lichen Peak	76	56	145	24		+	
Mount June (Phillips Mts.)	76	15	143	47	+	+	+
Herrmann Nunatak	76	16	145	00		+	
Swanson Mountains	77	00	145	00		+	
Webster Bluff	76	07	144	55		+	
Mount Richardson (Fosdick Mts.)	76	35	144	35		+	+
Mount Warner	77	05	144	00		+	
"Mount Farley"	77	00	143	50		+	
Mount Swan	76	58	143	45		+	
Mount Gray area	75	00	136	51	+	+	+
Mount Atwood	77	16	142	17		+	
Clark Mountains	77	16	142	03		+	+
Mount Shirley	75	39	142	00		+	
Mount Ekblaw	77	18	141	48		+	
Mount McCoy	75	50	141	10		+	
Lewis Bluff	75	54	140	42		+	
Mount Hartkopf	76	00	140	42		+	
Bailey Nunatak	75	42	140	16		+	
Landry Peak	75	35	140	15	+	+	
Mount Vance	75	30	139	44	+	+	
Wilkins Nunatak	75	40	140	12		+	
Kinsey Ridge	75	23	139	25		+	
Nunatak west of Coulter Point	75	15	138	38		+	
Lambert Nunatak	75	25	138	10		+	
Mount Giles area	75	07	137	46	+	+	+
Cape Burks	74	43	137	09	+	+	+
Patton Bluff	75	12	133	44		+	
Shibuya Peak	75	08	133	41		+	
Mathewson Point	74	18	132	28	+	+	+

*Plus sign indicates that a collection was made.

Biological observations made on the Marie Byrd Land Survey were limited considerably by poor weather, which curtailed helicopter support. However, the base camp was located only about six miles from the nearest rock outcrops on Mounts Swan and "Farley," which were reached easily by motor toboggan. The table indicates the localities visited and the specimens collected from mid-November through January. (The author made collections during November, and assistants Geoffrey Leister and James Detling made them in January.) All collections of algae were made in duplicate, one sample being preserved in fixative and the other being placed on sterile organic medium.

Sterile petri plates were exposed to the air for 30 minutes daily for the culture of fungal spores, and sticky slides were exposed for 24-hour periods in



Daily temperatures at Camp No. 1, October 26, 1966, to January 24, 1967.

order to collect airborne plant propagules. Less than 10 percent of the exposed petri dishes showed signs of fungal colony formation, and this was by members of the genus *Penicillium;* most of these fungi are being studied in the laboratory. The living algae collected were frozen and returned to Ohio State University, where they resumed growth under controlled environmental conditions.

The air temperatures recorded at the base camp by the U.S. Navy aerographer are given in the graph. Rock-surface, subsurface, and water temperatures were taken at many localities. Temperatures taken simultaneously on rock surfaces and two feet above them ranged from −10°C. to +20°C. and from −11°C. to +7°C., respectively, the air temperature always being the lower of the two. The highest rock-surface temperatures were recorded in mid-January on Mounts Gray and Giles. The water temperatures, all of which were taken in January, ranged from −0.1°C. to +14°C.; the highest reading (14°C.) was taken in the Chester Mountains on January 1, and the second highest (11°C.) was taken in a pond in the Phillips Mountains on January 15. The pH of the water tested ranged from 5.6 to 9.0. The three highest readings (9.0, 8.9, and 8.6) were made in the Phillips and Chester Mountains and at Cape Burks, respectively. These three aquatic localities were characterized by luxuriant algal growth.

Some animals were observed. Unbanded skuas flew over camp, and snow petrels flew overhead in large numbers at camp and field locations. The nesting sites of both birds were found among the rocks on several of the mountains visited. Two young seals were seen inland, heading away from open water, one on December 8 about 55 miles from the coast, and the other on December 12 about 70 miles inland. The latter seal, a male crabeater pup that weighed 57 pounds, was captured on the Balchen Glacier and brought back to camp, where he was fed fish. Two days later, he was flown to McMurdo, where he was tagged and released on the sea ice (cf. *Antarctic Journal,* vol. II, No. 1, p. 24).

A search was made for arthropods, but none were found.

Other Scientific Programs

BIOLOGY

Biotelemetry of Penguin Body Temperatures, 1966-1967

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Johns Hopkins University

and

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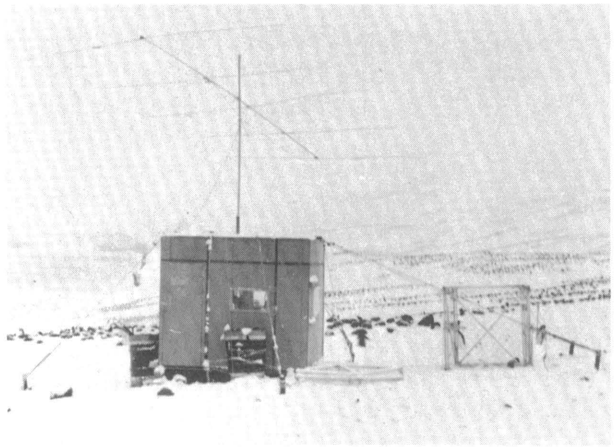
This program concerns an investigation of the factors important in the adaptation to the antarctic environment of the emperor penguin, *Aptenodytes forsteri,* and Adélie penguin, *Pygoscelis adeliae,* particularly with respect to the interaction of physiological and behavioral mechanisms of thermoregulation. The field work carried out during the 1965-1966 season (Sladen *et al,* 1966) introduced to Antarctica new techniques of biotelemetry (the instrumental technique for gaining information from a living organism and transmitting it to a remote observer) in order to monitor deep-body temperatures in the Adélie penguin.

Deep-body temperatures of these species had been studied previously by means of a mercury thermometer inserted deeply into the cloaca (Eklund, 1942; Prévost, 1961; Prévost *and* Sapin-Jaloustre, 1964) and by means of a thermistor probe placed in the proventriculus (Goldsmith *and* Sladen, 1961). Before our 1965-1966 study, biotelemetry had been used in Antarctica for determining the incubation temperatures of penguin eggs (Eklund *and* Charlton, 1959).

Our telemetry system, designed and built by Sensory Systems Laboratory, Tucson, Arizona, included several implantable thermistor-transmitter units measuring 3.7 × 1.5 × 1.8 cm and weighing 20 g. These units broadcast a 27-mc/s pulsed signal whose rate varied with temperature and whose range from a free-living bird was 9-12 m. A multichannel receiver picked up the signal, which was then modified and transmitted to decade counters that determined the time between pulses; this information was relayed to a chart recorder. After recalibration of the transmitters in the field (required because of component instability), the maximum difference observed in absolute temperature recorded simultaneously by cloacal mercury thermometers and



Observation hut with telemetry antenna at Cape Crozier Adélie penguin rookery.

abdominal thermistor-transmitter units was 0.5°C. at 39.0°C.*

The heart rates of small Adélie chicks were determined with an electrode-transmitter ECG unit, and body temperatures were monitored by thermistor probes, which were inserted 2-3 cm into the abdominal cavity and sutured externally. Skin temperatures of flippers and feet were monitored by flat thermistor probes attached at proximal and distal points of those extremities.

Field experiments were conducted from October 26, 1966, to February 8, 1967, at an observation hut erected last season at the Cape Crozier Adélie penguin rookery. Continuous telemetered recordings were made of abdominal temperatures of six nesting Adélies, as well as of one adult and three chick Adélies and three adult and four chick emperors in enclosures. The temperatures of four nesting Adélies, one of which was free-living, recorded continuously for 40 hours averaged 38.9°C. and ranged from 37.5° to 40.0°C.

The possibility that seasonal variation in mean body temperature is related to the nutritional state and behavior of Adélies was suggested by the following observation: A significant difference was noted between the mean body temperature of a bird incubating during the longest fasting period at the beginning of the season (38.0°C.) and that of an incubating bird just two days after its return from the sea at egg-hatching time (39.6°C.). Changes in posture, such as from standing to prone positions, sometimes resulted in rapid fluctuations of as much as 0.7°C. over a period of 30-60 minutes; such fluctuations were also noted to occur upon the introduction of a strange bird into a nesting pair's enclosure. However, no diurnal fluctuation in temperature was observed, and little or no change in temperature was noted during or after copulation or when, on one occasion, a skua tried to take the eggs from an incubating bird.

Body temperatures of Adélie chicks were monitored continuously while the birds were on the nest under a parent. They ranged between 25° and 39°C., depending upon the age of the chicks, the cover afforded by the parent, and the ambient conditions. The telemetered abdominal temperatures of two chicks five and seven weeks old averaged 39.0°C. and ranged from 38.3° to 39.9°C., which are not significantly higher than those of the adults. A preliminary survey of the data obtained from these two chicks shows that there is little relationship between their temperatures and the ambient temperature, but that there is a relationship between their temperatures and their behavior.

The abdominal temperatures of one molting and two nonmolting adult emperors were monitored for a total of nine hours. The temperatures of the molting bird averaged 38.8°C. (range: 38.1°-39.0°C.), whereas those of the two nonmolting birds averaged 37.9°C. (range: 37.2°-38.5°C.). During a total of 23 hours, the abdominal temperatures of two large emperor chicks were significantly higher than those of the adults, averaging 39.5°C. (range: 38.6°-40.2°C.).

In order to study the development of thermoregulation, the abdominal temperatures and heart rates of Adélie chicks of known age (1-26 days) were studied while the chicks were exposed to various ambient temperatures. Results showed that the age first associated with independent thermoregulation is dependent upon the individual circumstances and the ambient conditions, but probably is 15 days for most birds, as reported by Sapin-Jaloustre (1960) and Goldsmith *and* Sladen (1961). Temperature fluctuations of the flippers and feet were monitored from both Adélie and emperor chicks. These extremities are the most poorly insulated areas of the body and thus play an important role in thermoregulation. The ability to reduce heat loss along an extremity during cold weather was noted in the older Adélie and emperor chicks, but it was found to be lacking in an 11-day-old Adélie chick.

Nine visits were made by helicopter to the emperor rookery, which last season consisted of two parts —one in the first enclave of the ice shelf and the other 2 km south of that site in a more protected area. (Since 1964, there had been only one rookery, located in the first enclave.) Eleven adults banded

* In the 1965-1966 season, dummy transmitters were implanted in adult birds, which were then banded and released. Our examination of two of these birds more than 12 months after the implantations had been made revealed no ill effects. Five other birds with dummies implanted this season will be examined in later seasons to study possible long-term effects.

last year were observed, and modified Teflon flipper bands (Penney *and* Sladen, 1966) were put on 27 other adults and 143 chicks. Data collected on chick growth rate at approximately weekly intervals (160 weights taken from six samples) and on the movement of the rookery along the shelf cliffs (2.3 km in 42 days) agreed closely with those taken in the 1965-1966 season.

On December 12, after several days of southerly winds, the chicks of the more exposed enclave were seen floating to sea aboard pieces of broken ice. Chicks of the other enclave, which may be the site of the entire rookery next season, did not go out to sea until almost three weeks later, when the ice at that locality broke up. The consequences of the different times of rookery breakup are uncertain. The departure of the chicks of the more exposed enclave may have been premature, but many of them, under a partial covering of down, were well feathered and fat.

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Entomological Studies at Hallett Station

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During the 1966-1967 austral summer, the second season of intensive study of mite life cycles was completed at Hallett Station.

During this second season, for the first time in Antarctica, a mite, *Stereotydeus belli* (Troussart, 1963) was reared *in vitro* from the tritonymph stage through adulthood, after which one of its offspring was reared through all immature stages to the adult stage.

Throughout the season, mites were kept in dishes containing an artificial medium upon which algae and moss were grown to supply natural food. These dishes were placed in refrigerated incubators and the mites were observed daily. The morphological changes that characterize each stage of growth were determined, enabling future identification of individuals in each stage.

A new species of mite of the family Eupodidae and genus *Protereunetes* was found and is being described. It was reared *in vitro* from the adult stage through all immature stages, but it did not complete the life cycle before the season ended. Two other species, *Eupodes wisei* Womersley and Strandtmann and *Coccorhagidia gressitti* Womersley and Strandtmann, were also reared *in vitro* from the adult stage through the tritonymph stage but not to adulthood again. These specimens did not survive the trip from Antarctica to the United States (Iowa State University).

Microclimatological data were accumulated and are being analyzed for a better understanding of the mites' ability to live in the harsh antarctic environment.

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Snow Blindness in Animals

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Part of a comparative study of snow blindness in animals was carried out at McMurdo Station in November 1966. Several animals were irradiated with known levels of short-wavelength ultraviolet light in order to determine the amount necessary to produce threshold corneal-tissue damage. Daily microscopic examinations of each eye were performed to assess the extent of the "snow blindness" that occurs and the condition of the cornea during the various stages of recovery. A complete series of observations was made of Adélie penguins and skuas. Incomplete measurements were made of emperor penguins and Weddell seals.

The unexpected findings showed that even though these animals are normally exposed to a very high level of ultraviolet radiation during the summer months, their tolerance levels are approximately the same as, or even lower than, those of other animals studied that live in regions where much less solar radiation is received.

The absorption spectra for corneal tissue of the penguins, skuas, and seals were also determined. As in the cases of all other animals previously studied, these spectra showed that the cornea absorbs almost all of the damaging ultraviolet light.

Comparative Biochemistry of Proteins

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During the past antarctic summer, a four-member team (John C. Bigler, Robert E. Feeney, Stanley K. Komatsu, and David T. Osuga) from the University of California (Davis) conducted studies for a third season at McMurdo Station and Cape Crozier on the comparative biochemistry of proteins. This continuing project has been divided into two phases: One concerns the egg and blood proteins of penguins, and the other, the proteins and associated biochemical activity of several species of fish that live in the cold waters surrounding Ross Island. During the intervals between field seasons, laboratory studies requiring more sophisticated physical-chemical equipment than is available at McMurdo have been carried out at Davis.

Egg and Blood Proteins of Penguins

During the 1966-1967 austral summer, samples of blood plasma were obtained from approximately 20 Adélie penguins. Ten of these were from a group of 16 that had received injections of two different antigens over a two-week period. The individual blood-plasma proteins of these samples are now being characterized. A sample of blood obtained from an emperor penguin is undergoing a similar examination. Of 30 Adélie eggs incubated at the McMurdo biological laboratory, 27 were fertile and 19 hatched. The birds were reared successfully for as long as 10 days on pieces of chopped fresh fish. This work was done as a prelude to a study of the role of egg proteins in the formation of blood proteins of the embryo and young penguin chick.

Proteins and Biochemistry of Cold-Adapted Fish

Approximately 2,000 fish were obtained, including 1,200 specimens of *Trematomus borchgrevinki* and smaller numbers of *T. bernacchii, T. hansoni,* and *Dissostichus mawsoni*. Thirteen specimens of *D. mawsoni,* 10 of which were alive and averaged 50 pounds in weight, were brought up the ice hole in the fish house by a "trained" seal and collected and processed immediately. From almost all species, blood was obtained and blood plasma or sera extracted from it. Samples of muscle, liver, spleen, and eyes were taken also. All of the material was kept at a temperature below 4°C. before freezing. At the biological laboratory, preliminary examinations were conducted by electrophoresis and enzyme assay, and attempts were made to fractionate certain enzymes.

Two observations made of the fish blood were particularly noteworthy: (1) The electrophoretic patterns of six blood sera of *D. mawsoni* were found to be quite different from each other. The differences were so great, in fact, as to suggest wide divergence in the species or even different species. (2) Of a large number of blood sera of *T. borchgrevinki* examined, all of those taken from females with eggs contained a fast-moving component that was not present in those derived from the apparent males.

The production of antibodies by fish kept at 0°C. in tanks in the McMurdo laboratory was studied also. During periods of as long as a month after these fish had received injections of one of several antigens, the fish were bled at different times. The sera of these fish are now being examined.

Photosynthesis and Respiration of Antarctic Lichens

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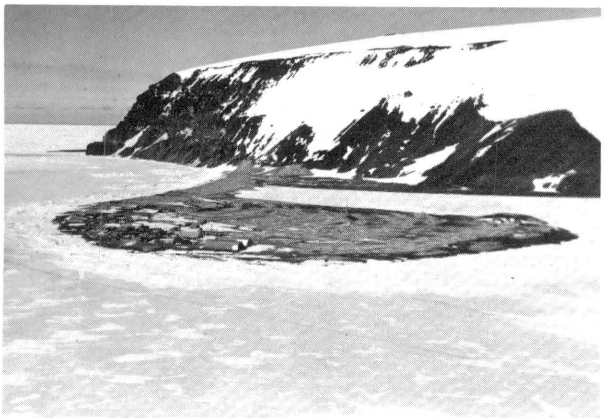
For 65 consecutive days last austral summer, the junior authors and Prof. O. L. Lange* of the University of Göttingen, Germany, studied gas exchange in response to environmental conditions in seven species of lichens in the vicinity of Hallett Station. These species are *Neuropogon* sp., *Caloplaca* sp., *Xanthoria* sp., *Candelaria* sp., *Parmelia* sp., and two *Buellia* spp. Concurrently, information was obtained on the following factors: temperature (at 30 points), water vapor, carbon dioxide, relative humidity, wind direction and velocity, light intensity, and snowfall. Seven microclimatic sites were also

* Prof. Lange acted as consultant for this project.

examined, and the data obtained from them were compared with those obtained at standard meteorological levels.

The lichens exhibited a general pattern of response to these environmental factors. It can be summed up as follows: the highest rate of gas exchange occurs at temperatures from −1° to +16°C. when the light intensity is below its maximum and when the plant is wet. Although at times the temperature of the rocks upon which the plants were growing reached 32°C. (the highest temperature recorded), this was accompanied by a reduction in the rate of gas exchange.



(U.S. Navy Photo)

Aerial view of Hallett Station.

The most important of these factors in the Hallett area is the availability of water. For optimal growth, the plant has to be wet, and for any growth at all to take place at least some water must be present. This finding is in contrast to that of Lange *and* Bertsch (1965), who observed that certain lichens could absorb sufficient water vapor from the air to achieve near optimal levels of gas exchange.

The combination of conditions that we found to be most responsible for lichen growth in the Hallett area were very much in evidence there. A light snowfall occurring when the rocks are warm is favorable in that the melting of the snow makes water immediately available. Coincidentally, the clouds overhead reduce the light intensity, which is essential for optimal growth. Occasionally, these storms last several days, permitting the plants to grow throughout all or most of the period. As these storms are usually accompanied by winds, the snow tends to accumulate in depressions, where some lichens grow. While this snow is present, it serves both as a source of water and as a shade for the plants beneath it. We observed, however, that more lichens grow along streams fed by snowfields than in any other locality. On warm days, as the snow melts, water flows down these channels. Even at "night," when the sun was behind Cape Hallett, the rocks in the stream beds often retained enough heat to sustain water flow for several hours. At the same time, the light intensity was at a low level and consequently favorable for lichen growth.

Another source of water for some lichens is the melting of snowfields which cover the plants during most of the year. Microclimatic measurements were made beneath a snowfield at a site 4 m from the melting edge. The sensors were placed at the snow-rock interface, which at that point was 38 cm beneath the snow surface. We found that during fairly warm days, the temperatures of the lichen-covered rocks under the snow were above freezing. It appeared that there was sufficient lateral conduction of heat from exposed rocks near the melting edge of the snowfield to cause melting of the snow over the rocks on which the lichens were growing. Since the light intensity was sufficiently reduced by the snow cover, conditions for lichen metabolism were optimal.

En route to the United States from Antarctica, we spent six weeks in the mountains of New Zealand making comparative studies. Further comparative work is expected to be undertaken in Antarctica at Palmer Station, in southern Florida, the northern part of the United States, and Argentina.

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Antarctic Avian Population Studies, 1966-1967

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For six consecutive seasons, the social behavior, ecology, and population dynamics of the Adélie penguin, *Pygoscelis adeliae*, and the south polar skua, *Catharacta maccormicki,* have been studied at Cape Crozier, Ross Island, in the rookery inhabited by about 300,000 Adélies. The project has concentrated on banding chicks and studying these birds in subsequent years, after they first return to their natal rookery as two- or three-year-olds (Sladen *et al*, 1966).

During the 1966-1967 season, the first major returns of 25,083 Adélie chicks banded at Cape Crozier during the five preceding years were realized when these birds appeared in sufficiently large numbers to permit examination of their productivity and of the factors affecting their success as nesters in relation to age. The histories of 9 nests of five-year-olds, 32 of four-year-olds, and 6 of three-year-olds were compiled daily from early December to early January, when crèches were beginning to form. These nests were marked for study in later years. In all cases, mates of the birds of known age were banded to provide information on mate fidelity in these young breeders.

A full clutch of two eggs was produced by only 17 percent of the three-year-old breeders, whereas a full clutch was produced by about 70 percent of the four- and five-year-old Adélies and of a control colony of 16 pairs of birds of unknown age. The five-year-old birds lost fewer eggs and chicks than the four-year-olds, but they had higher losses than the control colony of presumably more experienced breeders.

The weights of chicks within 24 hours of hatching were not related to the age of the parents; however, after this period, weights were closely correlated with the feeding behavior of the parents, which was a function of age. A chick that hatched more than 2-2½ days after its sibling had a greatly decreased chance of survival because of competition for food and nest space. The interval between hatchings decreased with increased age of the parent, with resultant chick-production figures (to crèche stage) of 0.81 per four-year-old nest, 1.11 per five-year-old nest, and 1.63 per nest in the control colony.

Although three- and four-year-old skuas have been known to breed elsewhere (Kinsky *and* Reid, personal communication), the first records obtained at Cape Crozier of known-age skua breeders were of five-year-olds. Two of these birds were found, each incubating a single egg, but neither bird hatched its egg. A number of four-year-old skuas were paired and occupied territories but did not breed. The subnormal clutch size and low breeding success of these unestablished breeders are comparable to those of the three-year-old Adélies.

Considerable effort is expended at Cape Crozier each season to locate and observe as many skuas of known age as possible. A total of 220 two-, three-, four-, and five-year-old skuas was recorded during the 1966-1967 season. This number was 20 percent of that of the chicks banded in these age groups

Birds tagged with bands designed by USARP bird-banding program,[1] July 1966 to June 1967

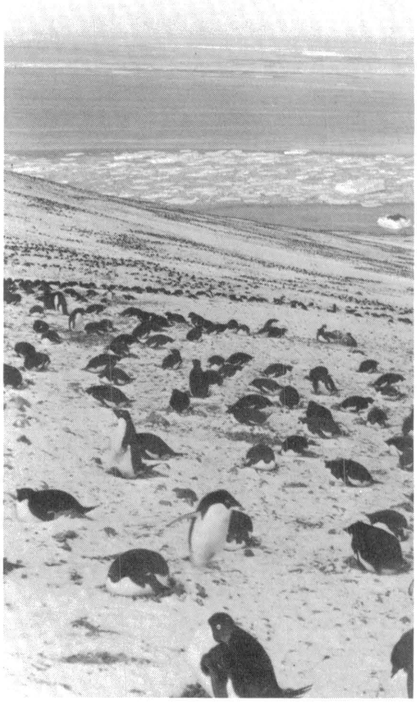
Species	Organization [2]	Area	Bander [3]	Banded as: Chick	Banded as: Adult or Sub-Adult	Total
Emperor penguin	USARP	Cape Crozier	JB, RL, RW	143	27	170
Adelie penguin	USARP	Cape Crozier	AP, MT, CS, PC, RW, JB, RL, RF	3604	67	3671
do.	NZARP	Cape Bird	EY		75	75
do.	NZARP	Hallett Station	TC			(300) [4]
do.	EPF	Adelie Coast				(600) [4]
Black-browed albatross	USARP	Falkland Is.	RN, PR	1998		1998
Giant petrel	IAC	S. Shetland Is.	BA	105	68	173
Great skua	IAC	S. Shetland Is.	BA	43	19	62
South polar skua	USARP	Cape Crozier	RW	62	220	282
do.	USARP	McMurdo Station	RW		21	21
do.	USARP	Franklin Is.	RW	27	150	177
Southern black-backed gull	IAC	S. Shetland Is.	BA	12	1	13
			Total:	5994	648	6642

[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; IAC, Instituto Antartico Chileno; JHU, Johns Hopkins University; NSF, National Science Foundation; NZARP, New Zealand Antarctic Research Programme; UC, University of California at Davis; USARP, United States Antarctic Research Program; USN, U.S. Navy.

[3] AP, A. Parker (JHU); BA, B. Araya; CS, C. Skinner (NSF); EY, E. Young; JB, J. Boyd (JHU); MT, M. Thompson (JHU); PC, P. Cieurzo (USN); PR, P. Richards (JHU); RF, R. Feeney (UC); RL, R. LeResche (JHU); RN, R. Napier (JHU); RW, R. Wood (JHU); TC, T. Choate.

[4] Indicates number of bands sent to the organization and/or individual listed; no report is available yet on the number used. These figures are not included in the totals.



(Photo by R. L. Penney)

Part of Adélie penguin rookery at Cape Crozier.

minus those known to have died since banding. Very few skuas return as yearlings, but the percentage of return increases until at least the fourth year.

The large numbers of Adélie chicks (25,083) and skua chicks (1,236) banded at Cape Crozier present a unique opportunity to study the movements of these birds before they breed and, once they attain breeding age, their emigrations to other rookeries. Observations of 42 Adélies and 14 skuas of known age that had been banded at Cape Crozier were made by Wood between 1965 and 1967 at Cape Bird, Marble Point, and Franklin and Beaufort Islands and by other persons at these and other antarctic locations. None of these birds was breeding. The most distant places at which each species has been observed are the Hallett rookery, 565 km from Cape Crozier (a three-year-old Adélie) and Franklin Island, 160 km from Cape Crozier (a four-year-old skua). As more Adélies and skuas reared at Cape Crozier reach breeding age, we should be able to measure the presently unknown extent of the interchange between rookeries.

Several other events occurred that are of interest: Two giant petrels, *Macronectes giganteus*, which had been banded as chicks six years earlier on Macquarie Island, and a dark skua, tentatively identified as *Catharacta skua lonnbergi*, were collected at Cape Crozier. A previously unreported Adélie penguin rookery was discovered at the southeastern tip of Franklin Island (76°06′S. 168°12′E.). A light rain fell for an hour on January 30 at Cape Crozier, the first ever recorded there.

A continuing phase of this program is the development of bands that will withstand the effects of seawater and low temperatures, and the furnishing of them upon request to other nations engaged in antarctic research (cf. table). During the past year, a newly designed Teflon band (Penney *and* Sladen, 1966) was put on 170 emperor penguins, *Aptenodytes forsteri*, at Cape Crozier; other bands were sent to the New Zealand Antarctic Research Programme, Expéditions Polaires Françaises, and the Instituto Antartico Chileno. Over 6,600 birds of seven different species were banded during the 1966-1967 season by four different nations.

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Microbial Activity in Antarctica

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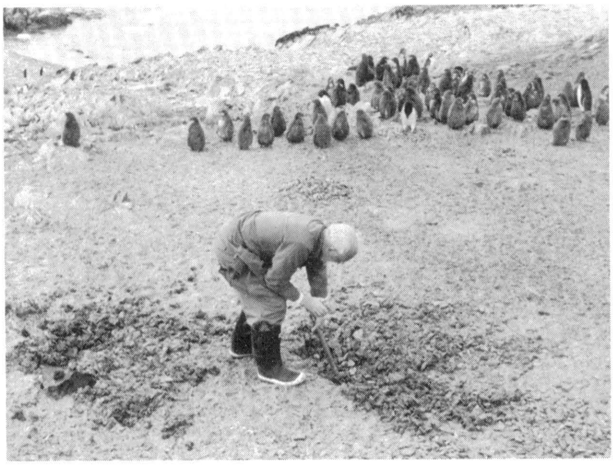
Geomicrobiological investigations were carried out by Florida State University in the sea-land boundary zone of Anvers Island during the past summer. The objectives of the program were to study the role of microorganisms in the weathering processes of rocks in an extreme environment, the early biochemical processes in guano formation in the rookeries of Adélie penguins, the microbial content of raw soils, and the nutrient contribution of the land mass to the near-shore environment.

Samples were collected from both terrestrial and marine environments. Terrestrial samples were taken during the first part of the field season near Palmer Station, on Norsel and Bonaparte Points, on Litchfield, Humble, Torgersen, and Horseshoe Islands, at the sea cave on Dream Island, and at Port Lockroy. Other sampling was done at sites between Cape Monaco and Perrier Bay during a helicopter flight along the west coast of Anvers Island. Vegetation, soil, rock, snow, and meltwater samples were collected for assay of microbial populations; petrographic determinations will be made also.

Nineteen oceanographic stations were occupied in cooperation with personnel from the University of Miami, using the Greenland cruiser of USCGC *Westwind*. The first series of these stations was aligned on a transection from the ice front in Arthur Harbor, past the Outcast Islands, to Bismarck Strait. Other stations were occupied in the approaches to Arthur Harbor, in Loudwater Cove, at Port Lockroy, in the Peltier Channel, and off Biscoe Point. An attempt to complete a transection between Biscoe Point and the Wauwermans Islands had to be abandoned because of high winds and rough water.

At each oceanographic station, samples were taken with Niskin bags for microbial analysis and with Nansen and Van Dorn bottles for physicochemical testing. Parts of the samples were deep-frozen for shipment to Florida State University. At Palmer, microorganisms were separated from the samples by running the water through millipore filters. Successful inoculations were obtained from all stations. Additional millipore filtrations were made to assay the particulate matter present in the water and for carbon analyses of the filtered material after its shipment to Florida State University.

Sediment samples were taken from the ocean bottom whenever feasible. These were analyzed for both aerobic and anaerobic bacteria, and sections



(Photo by D. Warnke)

Dr. Schwartz takes soil sample at penguin rookery on Humble Island.

were prepared for textural and chemical analyses. All samples were shipped to Florida State University for laboratory analysis.

During a two-week extension of the field season, one of the authors (Warnke) and other scientists working at Palmer Station visited Deception Island for one week. Soil and water samples were obtained from the major fumarole areas on the shores of Port Foster, and sediment and water samples were collected from lakes and lagoons near those shores and in the vicinity of the Chilean station. Although the group was based at the British station during this period, it enjoyed not only its hospitality but also that of the Chilean and Argentine stations.

The Ecology of Free-Living and Parasitic Protozoa of Antarctica

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During the antarctic summer of 1966-1967, water and soils from lakes and meltwater ponds on Ross Island and the mainland were examined for the presence of free-living protozoans. Large numbers and many varieties of these organisms were obtained. Preliminary examination of the samples collected indicates that protozoans are more prevalent in the areas visited than had been expected. More detailed searches of the soils, ponds, and lakes, including the collection of lichens and mosses, will aid in determining the population levels of protozoans.

More than 60 samples collected from a variety of habitats were examined for free-living protozoans. During the short intervals between field trips, attempts were made to culture these organisms in the biological laboratory at McMurdo. About 36 soil and water samples were sent to South Dakota, where the species they contain are now being identified and preliminary culture experiments are being made.

Studies were conducted to determine if parasitic protozoans were present in the feces and blood obtained from 62 skuas, 108 Adélie penguins, and 16 emperor penguins (4 adults and 12 chicks). The feces were subjected to fixation methods and stained with hematoxylin. Blood smears were air-dried and later treated with Wright's stain. Preliminary examinations made thus far have not revealed the presence of protozoans. At Scott Base, slides were prepared of both blood and intestinal material from four Weddell seals.

Soils were collected at the following localities: Lakes Vanda, Bonney, Chad, and Fryxell in the dry-valley area; at "Clear Lake", "Pony Lake", and other locations near Cape Royds; at "Skua Lake" and various ponds near Cape Evans; at Cape Crozier, Marble Point, and Kar Plateau; and near Mount Discovery and Hobbs Peak.

Preliminary results of the investigation of meltwater ponds near McMurdo indicate that ciliates of the genus *Nassula,* which have a pinkish red coloration, are the most dominant species. It appears that the red rotifers and red ciliates may obtain their red pigmentation from the red algae.

Living specimens identified so far include 6 species of rhizopods, 16 species of ciliates, and 3 species of flagellates. None of the rhizopods had previously been reported to occur in the McMurdo area. Further isolates will be made from the soil samples, which are being kept under refrigeration.

Oxygen Consumption in a Hemoglobin-Free Fish

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and

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Unlike any other vertebrates, fishes of the family Chaenichthyidae lack hemoglobin in their blood. These fishes are found only in antarctic and subantarctic regions. A specimen, *Pagetopsis macropterus,* was caught unexpectedly in a trap off Hut Point at McMurdo Station last November. The fish was kept in an aquarium at about −1°C. for three weeks, during which time several determinations of its oxygen consumption at rest were made. It was found that its rate of oxygen consumption was about one-third that of most cold-adapted fishes possessing hemoglobin. More striking, however, was the fact that the oxygen consumption was not markedly affected by the oxygen tension of the water. It remained constant when the oxygen tension was reduced from 150 to 30 mm Hg, indicating a very efficient system for oxygen uptake. Further physiological studies of these fishes are being planned.

Social Behavior and Acoustics of the Weddell Seal

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During the three austral summers preceding that of 1966-1967, the author and his co-workers observed that social activities of the Weddell seal, *Leptonychotes weddelli,* occur mostly underwater and that sound is an important means of communication between individuals.

In the 1963-1964 season, underwater observations of seals and the sub-ice environment were made for the first time by means of scuba diving in Antarctica (Ray *and* Lavallee, 1964), and recordings of the animals' striking underwater trill were made for subsequent analysis (Schevill *and* Watkins, 1965). During the next season, studies were conducted in cooperation with W. E. Schevill of the Woods Hole Oceanographic Institution from two huts and the sub-ice observation chamber (SOC), which were set up over 300 m of water on the sea ice adjacent to Castle Rock on Hut Point Peninsula (Ray, 1965). Detailed analyses of the acoustics and some social interactions of the Weddell seal were made, but it became obvious that most social behavior was still hidden from view. In January 1966, underwater recordings were made from McMurdo to Cape Adare in the western Ross Sea with equipment set up aboard the icebreaker USS *Burton Island* (Ray, 1966), but they revealed few or none of the trills heard during the courtship season of October and November. This observation confirmed our suspicion that the species uses sound in connection with its breeding behavior in the spring.

In October and November 1966, diving and acoustic huts and the SOC were set up at Turtle Rock in Erebus Bay, the site of a small colony of breeding seals 11 km from McMurdo Station. With the author were David O. Lavallee, a veteran of two previous seasons in Antarctica, and Michael A. de Camp, a diver.

From the first week in October, when the first Weddell seal pup was born at Turtle Rock, until late November, when the arrival of the icebreakers at McMurdo forced us to break camp, data were gathered regularly on the following conditions: surface population numbers and sex ratios, incidence of pupping and behavior of pups, pup weights, seal phonation, and weather. In addition, observations were made from the SOC and by scuba divers of seal behavior and environmental conditions, and benthic and a few planktonic organisms were photographed and collected.

The behavior of the Weddell seal, as revealed by these observations, is outlined in the following paragraphs:

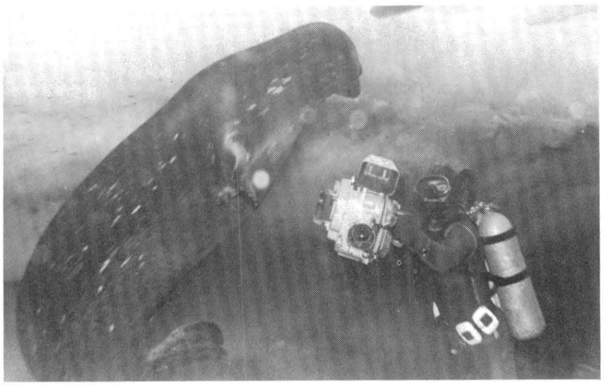
The trill is probably voiced exclusively by mature males in the establishment and maintenance of underwater territories around naturally occurring tidal or pressure cracks. Subordinate males are allowed within each territory, but their activity is restricted by the dominant male. Occasionally, when trill warnings are not heeded, fighting breaks out. Females also claim territories, individually or jointly with other females, for themselves and their pups. These territories are less well defined and smaller than those of the males; nevertheless, the females

(Photo by M. A. de Camp)

Female and pup Weddell seals under ice near Turtle Rock.

(Photo by M. A. de Camp)

A dominant male Weddell seal threatens a subordinate under the ice near Turtle Rock.



(Photo by M. A. de Camp)

A diver and a Weddell seal under the ice near Turtle Rock.

defend them by a variety of sounds. Relatively few males were observed on the ice at the height of the courtship season, probably because most of them were engaged in courtship activity underwater.

Females actively lead their pups to water in the first week or so after birth. The first swims by the pups are short, but by the time the lanugo is lost, they are made over distances of several dozen meters and to depths of at least 10 m. In late November, mother and pup separate for the first time and perhaps permanently. Presumably, mating by adult females follows this separation, since, prior to that time, mating was not observed and females drove males from their immediate vicinity by means of both sound and fighting.

A detailed report is in preparation on the social interactions of the Weddell seal and the role of its wide array of sounds in the course of such behavior.

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Prostigmatic Mites and Other Terrestrial Arthropods of Antarctica

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This investigation of arthropods was restricted to the area within a 160-km radius of McMurdo Station. Collections were made as far south as Moraine Bluff on Skelton Glacier, latitude 78°47′S., and as far north as Point Retreat on Mackay Glacier, latitude 76°55′S.

Mites invariably were found only in areas moistened by melting glaciers or snowbanks. Algae are probably their chief food. Mosses and lichens were not always present and did not appear to be the source of food when they were. Three species of mites and two species of Collembola were present, frequently all together under the same pebble. The mites were *Stereotydeus mollis* Womersley and Strandtmann, *Nanorchestes antarcticus* Strandtmann, and *Tydeus setsukoae,* sp. novo. By far the most abundant species was *Stereotydeus mollis,* a red mite almost 0.5 mm long. It is interesting to note that there were no oribatid or predaceous mites. The absence of predatory mites was particularly interesting because they have been found both farther north, at Hallett Station, and farther south, at Beardmore Glacier. Why none occurs in this area is still a mystery. Of interest also was the fact that in the dry valleys, mites are most abundant near a melting glacier and become less and less numerous downstream. This pattern was particularly noticeable in Wright Valley, where mites and Collembola were very abundant close to Goodspeed, Hart, and Meserve Glaciers and progressively less numerous downstream. Along the Onyx River, which collects the runoff from these and other glaciers, no mites were found, possibly because of a lack of insulative snow cover there in the winter.

The thriving mite populations that occur in the dry valleys could not very well depend upon aerial

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* Now at Bernice P. Bishop Museum, Honolulu, Hawaii.

dispersion from skua or penguin rookeries to satisfy their nitrate requirements. It has been demonstrated that nitrogen-fixing blue-green algae abound in the dry valleys, so it would seem more logical that the algae are the source of the nitrates.

Several thousand specimens of *S. mollis* were collected in the areas we investigated. Those which occurred at the limits of the known range of the species in these areas are being subjected to a statistical analysis to test for intraspecific variability.

Approximately 50 live, adult Adélie penguins were examined at Cape Royds, Ross Island. Only one Mallophaga was found on these specimens; mites were not present. At Cape Crozier, Ross Island, 25 young and 10 adult Adélies that had died of natural causes were inspected. From these, only five specimens of the nasal mite *Rhinonyssus sphenisci* ssp. *shelli* Fain and Hyland were found. From one dead emperor penguin examined at this locality, one Mallophaga was obtained.

From 51 live skuas inspected at Cape Royds, two species of Mallophaga and three species of feather mites were collected. Of the feather mites, one species may be new to science. Fifteen dead birds were examined for nasal mites, but none was found.

We examined the heads of 12 Weddell seals of various ages, but no mites were found on them.

Adélie Penguin Orientation

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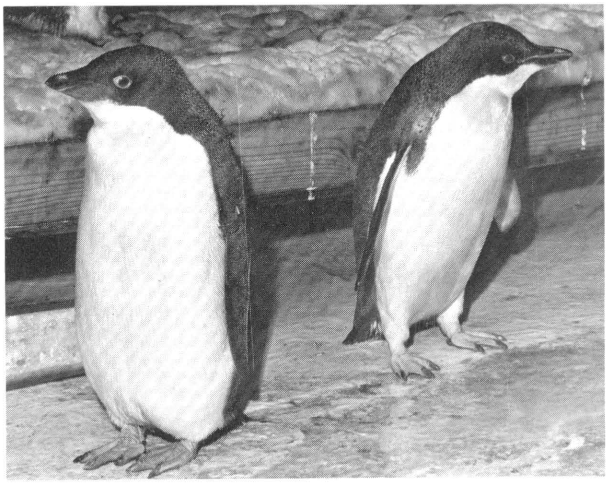
Experiments on Adélie penguins, conducted on the Ross Ice Shelf and in other relatively featureless areas of Antarctica, have shown that penguins rely upon the azimuth position of the sun and a sense of time in choosing and maintaining a constant direction of travel. This ability is thought to have survival value in steering lost birds to their offshore feeding grounds, and it may also help them to perform the remarkable homing feats for which they are noted. One intriguing question derived from field studies concerns the source of variability in direction selection between individuals released at the same unfamiliar location: A 30-degree difference has been observed in the departure direction taken by some birds. Is this difference due to errors the birds make in determining horizontal angles from the sun, or is it due to errors they make in estimating



(Photo by New York Zoological Society)
Two of three Adélie penguins that were hatched and reared in captivity.

time? An attempt is being made to answer questions of this nature through studies of captive penguins.

On November 5, 1966, 14 pairs of Adélie penguins were captured at Cape Crozier. With the assistance of field and flight support personnel, these birds were returned to the United States for housing in a specially constructed room which partially simulates the natural environment of the species. The majority of the penguins continued to display normal breeding behavior, and three pairs were successful in rearing three chicks. The behavior and physiology of these captives are being monitored in an effort to discover rhythms related to their sense of time. Adults are being trained to perform certain tasks for food rewards before being tested for direction orientation in a 21-m-diameter sun simulator.

Thermal-Metabolic Relationships in Stenothermal Fishes

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A collection of fishes was obtained at McMurdo Station during the past austral summer. Preliminary studies of the specimens were conducted at the McMurdo biological laboratory, and more detailed analyses are now under way.

What appears to be a major result of this research is the discovery that the saccular otoliths of *Trematomus bernacchii* are piezoelectric. Hence, at least in theory, the otolith constitutes a mechanism that the animal may use in depth (pressure) perception and/or frequency analysis of sound waves.

Other studies in progress or completed include research on the respiratory properties of the blood of four species of fishes, the metabolism of a chaenichthid, *Pagetopsis macropterus,* and the fatty acids of the central nervous system and some characteristics of the urine of *T. bernacchii.*

A calorimeter for measuring heat production by aquatic animals has been constructed around a Hewlett-Packard two-probe quartz crystal thermometer.

GEOLOGY

Late Paleozoic Glacial Rocks in the Sentinel and Queen Alexandra Ranges

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The Pagoda Tillite of Permian (?) age at the head of Tillite Glacier in the Queen Alexandra Range is approximately 180 m thick and of three distinct lithologies: (1) gray, dense diamictite that contains striated stones up to 1 m in diameter; (2) channel sandstone that is crossbedded and iron-stained; and (3) gray, massive siltstone containing scattered stones that are generally less than 15 cm in diameter. Although the direction of ice movement is uncertain, measurements of boulder pavements in the lower half of the section indicate that the ice movement had a northwest-southeast sense. The sandstone beds, which comprise 10-25 percent of the thickness, occur throughout the diamictite as lenses and stringers 0.2-10 m thick. The sandstone beds generally display evidence of deformation prior to lithification. Laminae are as a rule only slightly warped, but in places beds 6 m thick have been overturned. At one outcrop below Pagoda Peak, a sandstone bed is displaced vertically 50 m by faulting that occurred before lithification of the sediment. The direction of dip of the crossbeds ranges through 300 degrees, but the frequency of dip determinations is highest in the southeast quadrant and indicates that most currents flowed in this direction. These sandstone beds are interpreted as representing a fluvioglacial phase of sedimentation. The siltstone beds, which are restricted to the upper half of the section and commonly contain plant fragments, probably are of glacial-lacustrine origin.

In the Sentinel Range, the Whiteout Conglomerate, a diamictite of Late Paleozoic (?) age, rests conformably on strata of the Crashsite Quartzite. Because the diamictite is folded and faulted, the total accumulation is difficult to determine, but it appears to be between 650 and 1,000 m thick. At its top, the Whiteout Conglomerate grades into thin-bedded shale. The transition zone is 3 m thick and contains sparsely scattered pebbles 2-4 cm in diameter. The contact is sharp, but it appears to be conformable. The diamictite forms a monotonous sequence from top to bottom that is broken at one horizon on the north flank of Mount Lymburner by an 11-m-thick unit of alternating siltstone and very fine grained sandstone that displays load forms at its base. Graded beds and exotic stones up to 20 cm in diameter are present, and in places the diameter of the stones is from six to eight times greater than the thickness of the beds. These stones are interpreted as having been dropped by floating ice. Balls of rolled sandstone up to 3 m in diameter that are scattered sporadically in the diamictite indicate deformation of sand beds before lithification. We interpret the Whiteout Conglomerate as being composed of glacially derived sediments deposited subaqueously, all or in part on a slope where slumping was common. Structures that reveal current directions are not found in the Whiteout Conglomerate, but on the basis of measurements of ripples in the immediately underlying Crashsite Quartzite and the immediately overlying Polarstar Formation, the paleoslope is inferred to have been inclined to the north.

Petrology of the Upper Division of the Beacon Sandstone

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Field work carried out by University of Massachusetts geologists during the 1966-1967 season was a continuation of the petrologic study of the Beacon Sandstone begun in southern Victoria Land during the previous season (Matz *and* Hayes, 1966). Fossils collected during the first field season enabled dating of the lower part of the section as Devonian and the upper part as Permian-Triassic. These two units are separated by a major Carboniferous unconformity.

(Photo by Paul R. Pinet)

Figure 1. Authors' camp and the section at Mount Feather.

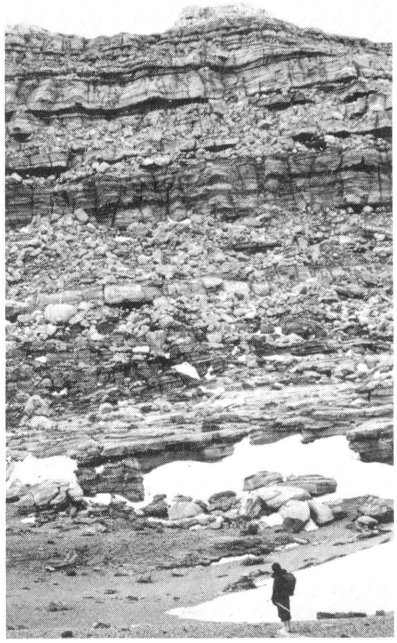

Figure 2. Permian coal measures.

(Photo by David B. Matz)

During the past season, attention was focussed on the Permian-Triassic rocks. Stratigraphic sections were described at Mount Feather (Fig. 1), Robison Peak, Mount Fleming, and Mount Crean. Goals of the study were to establish the position of the Permian-Triassic boundary and to continue our general survey of the paleocurrents, petrology, and paleogeography of the Beacon sediments.

The Permian-Triassic boundary appears to be conformable; the upper limit of the Permian is indicated by the appearance of a Triassic plant, *Dicroidium* sp. The Permian rocks were subdivided into the following discrete, mappable units: The lower unit, which contains coal (Fig. 2), consists chiefly of crossbedded arkosic sandstone; the middle unit lacks coal and is conglomeritic; and the upper unit consists of a cyclic succession of sandstones, siltstones, and claystones. The Triassic rocks, which also contain coal beds, are predominantly fine-grained feldspathic sandstones. At Mount Feather, these units have the following thicknesses: lower unit (Permian), 166 m; middle unit (Permian), 160 m; upper unit (Permian), 91 m; Triassic, at least 76 m. Paleocurrent data gathered from festoon crossbeds in the sandstones indicate a northwestward transport direction. This direction of transport is further indicated by textural changes within the middle unit (Permian), which grades from a conglomerate at the southernmost section (Mount Feather), to a sandstone in the northern sections.

Of special interest was the discovery of a discontinuous, pebbly mudstone along the unconformable Devonian-Permian contact at Mounts Feather and Fleming. This unit, which attains a maximum thickness of 18 m, appears to be correlative with the Permo-Carboniferous Pagoda and Buckeye Tillites (Grindley, 1963; Long, 1965) that occur near the geographic South Pole.

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Petrologic Investigations in the Area of Scott Glacier—Wisconsin Range

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In the central Transantarctic Mountains, a basement complex of igneous and metamorphic rocks is nonconformably overlain by nearly flat-lying Beacon rocks. The LaGorce Formation, the oldest metasedimentary rocks in the area, is composed of rhythmically bedded greywackes and phyllites which have been metamorphosed to the greenschist facies. The Wyatt Formation, which overlies the LaGorce Formation, is composed of pyroclastic rock of rhyodacitic composition; in the area of Scott Glacier, the formation varies in metamorphic grade in a south to north direction from unaltered pyroclastics to rocks of the biotite zone. The Leverett Formation, which contains a Middle Cambrian trilobite fauna, overlies the older rocks with angular unconformity and has been metamorphosed to the zeolite facies. As with the Wyatt Formation, the metamorphic grade of the Leverett Formation seems to increase in a northerly direction. These metamorphic rocks are intruded by a series of granitic plutons of various ages.

The Beacon rocks are composed at the base of a tillite that grades upward into a shale-siltstone-sandstone sequence; these strata are disconformably overlain by coal measures. Pyroclastic detritus first appears in the basal conglomerate of the coal measures and culminates in dacitic tuffs and ash falls in the upper part of the formation. The Beacon rocks below the coal measures were derived from a granitic and high-grade metamorphic source area; during deposition of the coal measures, volcanic detritus obliterated sediments from this crystalline source.

The Beacon rocks have been metamorphosed to the zeolite facies by the Jurassic diabase sills. Laumontite, heulandite, prehnite, and albitized plagioclase, minerals characteristic of the zeolite facies, are widely distributed in the Beacon rocks.

Geology of the Beardmore Glacier Area

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During the 1966-1967 field season, a four-man party from Ohio State University's Institute of Polar Studies carried out a geological investigation of the Queen Alexandra Range (Fig. 1).

The rocks examined have been described in general terms by Grindley (1963). In ascending stratigraphic order (Fig. 2), they are orthoquartzites of the Alexandra Formation (Devonian), the Pagoda Formation (most of which is of glacial origin), dark shales of the Mackellar Formation, and the Buckley Coal Measures (Permian). These beds are overlain by a thin orthoquartzite unit, a thick mudstone and fine sandstone unit containing channel sandstones, and the Falla Formation (Triassic), a more or less cyclic sandstone-shale sequence. Above the Falla

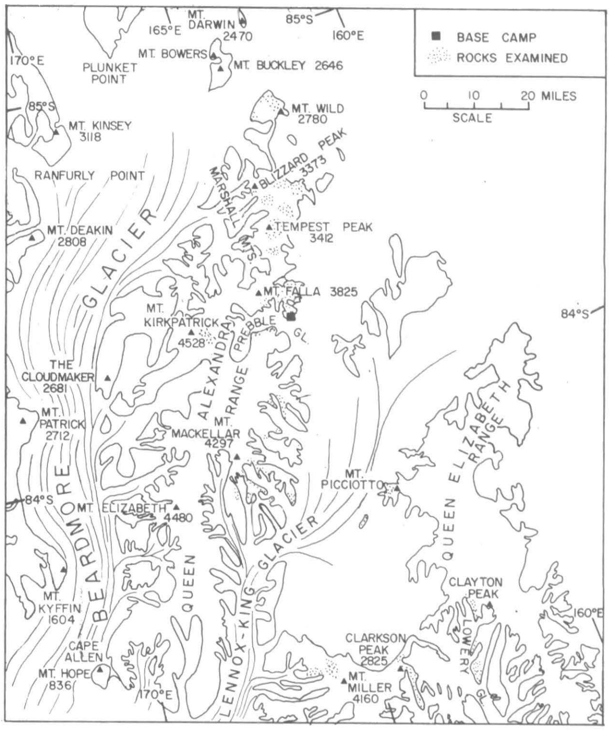
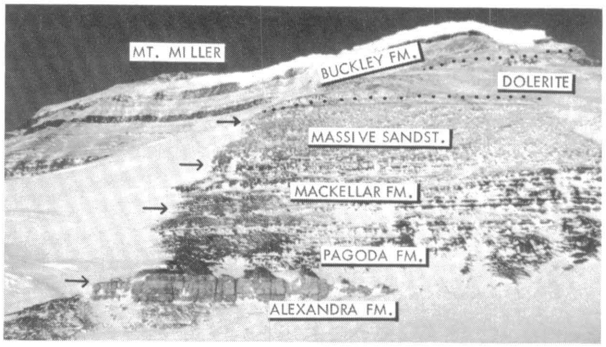
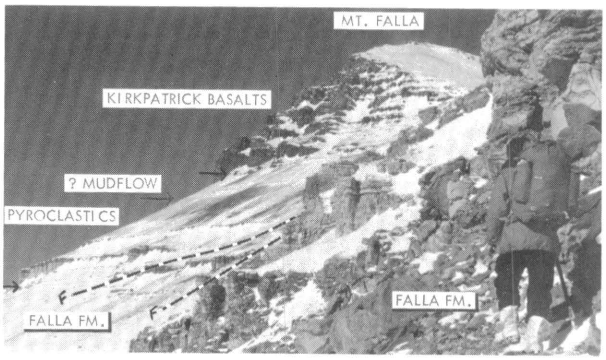


Figure 1. Area investigated by Ohio State University party.



(Photo by J. F. Lindsay)
Figure 2. Southeast face of Mount Miller. Most of the lower 1000 m of Beacon rocks in the area investigated are exposed here.



(Photo by P. J. Barrett)
Figure 3. View along west ridge of Mount Falla, showing the youngest Beacon rocks in the area studied and the overlying volcanic rocks.

Formation there are up to 250 m of pyroclastic beds, which are capped by the Kirkpatrick Basalts (Jurassic) (Fig. 3). The whole sequence has been intruded by Jurassic dolerite sills.

The Alexandra Formation, which nonconformably overlies basement phyllites in the range, consists mainly of well-sorted orthoquartzite. A relatively complete section on Hampton Ridge, which is to the north of Mount Mackellar, is more than 365 m thick. At a few localities, notably at Mount Miller, some thin units of dark shale and grey-to-black limestone occur. Observations of crossbeds indicate that paleocurrents flowed in directions ranging from northeast through southeast to southwest, though most were in a southeasterly direction. The lower contact of the formation, which was seen at only one locality, appeared quite sharp and unweathered.

The Pagoda Formation, which disconformably overlies the Alexandra Formation, is about 120 m thick and is composed mainly of massive sandy tillite that can be divided into as many as 13 beds. In the lower part of the formation, the tillites are interbedded with lensoidal units of crossbedded channel sandstone, most of which are of limited extent, although near Mount Mackellar one large channel at least 60 m wide could be traced for almost 8 km. Higher in the formation, particularly near the contact with the overlying Mackellar Formation, dark fissile mudstone is dominant. Grooved, soft-sediment pavements and striated boulder pavements were found at most localities visited. The lower contact of the formation at Mount Miller is defined very sharply by a deeply grooved surface, with up to 2 m of relief, cut in orthoquartzite of the Alexandra Formation. Four other striated surfaces were observed here also. Striae with associated "crag and tail" features indicate a paleoice flow to the southeast, a direction recorded consistently from outcrops as far apart as 95 km. Paleocurrents, as indicated by crossbeds, flowed mostly to the south and southeast. The only fossils found were plant fragments that occur in a tillite located high in the formation at Mount Mackellar.

The Mackellar Formation, a predominantly dark shale unit about 90 m thick, conformably overlies the Pagoda Formation, and is overlain conformably by a 120- to 180-m-thick massive crossbedded sandstone (the lower part of Grindley's Buckley Coal Measures). The transition zone between this sandstone and the overlying coal measures, which are at least 600 m thick, contains discontinuous lenses of well-rounded vein-quartz pebbles. The coal measures locally contain abundant *Glossopteris* leaves. Coal seams are not common, although one 10-m-thick seam was found at Painted Cliffs. In this lower part of the postglacial Beacon sequence, the regional paleocurrent direction is to the south and southeast.

The upper contact of the Buckley Coal Measures was observed only in the central part of the Queen Alexandra Range, where a 125-m-thick, massive, burrowed orthoquartzite disconformably overlies the coal measures. The orthoquartzite is conformably overlain by a sequence of at least 600 m of greenish mudstone and fine sandstone, with many channel sandstone units up to 20 m thick. The upper part of the unit contains parts of fossilized plants, including longitudinally ribbed stems (*Neocalamites*), some logs as long as 20 m that have well-preserved growth rings, and zones up to 1 m thick containing root impressions. Several stumps, still in place and associated with the logs, as well as elements of the *Dicroidium* flora (Triassic), were found at the mouth of the Prebble Glacier. These beds are overlain by the Falla Formation (upper Falla Formation of Grindley), which is a cyclic sequence of orange-weathering channel sandstone and carbonaceous shale (the latter also contains well-preserved *Dicroidium*). In contrast to the paleocurrent directions from the lower Beacon strata, which are southward and southeastward, those from the beds above the Buckley Coal Measures are northwestward.

Volcanic rocks are abundant from 335 to 580 m above the base of the Falla Formation on Mount Falla. The lower beds are probably acid to intermediate tuffs. They are overlain by, and apparently have a gradational contact with, a 60-m-thick, massive, buff, poorly sorted conglomerate that contains volcanic and sedimentary pebbles. Samples of this conglomerate are very similar to those of the Mawson Tillite of South Victoria Land (Gunn *and* Warren, 1962). Above the sediments of the Falla Formation at other localities in the central and south Queen Alexandra Range there are agglomerates, tuffaceous sediments, and (locally) poorly sorted conglomerate.

The pyroclastic rocks in this area are overlain by lavas (the Kirkpatrick Basalts), which attain a maximum thickness of 550 m in the Marshall Mountains. The basalt lavas are between 1.5 and 150 m thick, and the maximum number measured at any locality was 23, on Mount Falla. Most of the lavas have a thin, vesicular lower contact zone and a much thicker, vesicular upper part, which has been baked by the overlying basalt; selvedges, geodes, and veins of secondary minerals are not common. The nonvesicular parts of the flows vary between a very fine grained black basalt and a coarse-grained, red-weathering rock similar to the underlying intrusive dolerite sheets. Fossil wood was found in the upper part of several flows. A thin shale unit occurs near the top of the section on Blizzard Peak and in a section to the northwest of that locality. At both localities, well-preserved conchostracans (*Lioestheria*) and ostracods were found. At two localities in the Marshall Mountains, the underlying sediments are cut by features that are probably volcanic vents.

Dolerite sheets are conspicuous throughout the Queen Alexandra Range. Concordant or only slightly transgressive sills as much as 150 m thick occur in the northern part of the range and at Painted Cliffs, but from the Prebble Glacier southward to Mount Wild, relationships are more complex. In the latter area, there are a few dolerite dikes up to 18 m wide. Most of the sheets there are steeply inclined and transgressive, but a few are concordant over considerable distances. Field observations revealed only inconspicuous differentiation within the sheets.

The Permian part of the stratigraphic sequence from the base of the Pagoda Formation to the top of the Buckley Coal Measures was found to be similar to lower Beacon strata in the Queen Maud and Horlick Mountains. Not enough is known of upper Beacon rocks (mainly Triassic) of other areas to attempt regional correlation, but a similarity was noted between the pyroclastic and flow rocks above the Falla Formation and the Jurassic volcanic suite of Victoria Land.

Gravity measurements were taken at 11 rock outcrops and 9 snow stations at campsites between Mount Wild and Pagoda Peak. The station gravity has been calculated for all localities, but as yet the data have not been interpreted.

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Antarctic Fossil Conchostracans and the Continental Drift Theory

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Branchiopod conchostracans are freshwater creatures. Valves of the extinct ribbed form (leaiids) occur as fossils in rocks of Permian age in South America, Africa, Antarctica, and elsewhere—all of which are presumed to be components of the Gondwana land mass. A closer proximity of the southern continents to one another during the Permian appears to be the only satisfactory way to explain the distribution of these fossils. Accordingly, a program was devised to collect conchostracans and to gather other paleolimnological data from the Ohio Range and to search for conchostracans in the Polarstar Formation of the Sentinel Range.

Some of the considerations upon which the study was based and the preliminary results of the field work are given in the following paragraphs. Inasmuch as the discussion has been drawn primarily from field notes, some modification of it may be required when laboratory analysis has been completed.

Ohio Range

Do leaiid beds recur above and/or below the "*Leaia* Ledge" of the Mt. Glossopteris Formation? The answer to this question is important to the establishment of intercontinental correlations and the continental drift theory. For example, a single leaiid bed is reported to occur in the Brazilian and South African equivalents of the "*Leaia* Ledge" of the Ohio Range. Field data obtained in the Ohio Range also indicate the occurrence of a single leaiid bed. However, at least four beds of the same lithology (carbonaceous argillite) as that of the leaiid bed are present in the Mt. Glossopteris Formation. This observation, which was surprising, will foster some comparative geochemical studies.

Can the "*Leaia* Ledge," which is bounded by faults, be traced? Although time did not allow adequate exploration, two observations were made that indicate that lateral tracing of the ledge may be possible. One is the occurrence of a pebble conglomerate far downslope from the "*Leaia* Ledge." The other is the occurrence, at a considerable distance to the southwest of the ledge, of a lithology—also well above a pebble conglomerate—that is equivalent to that of the leaiid bed.

What does the biostratigraphy of the "*Leaia* Ledge" show? The ledge proper can be traced for about 30 m laterally and about 1 m vertically. Thin beds, barren of conchostracans but containing plant fossils, occur between the conchostracan beds; the latter beds also contain plant fossils. Thus, despite the thinness of the ledge, several distinctly separate leaiid occurrences are represented. These data, as well as information obtained from the study of a large collection of fossil conchostracans that also includes some cyzicids, will permit a fuller reconstruction of the paleolimnology than was previously possible.

Sentinel Range

Cursory sampling of the *Glossopteris* beds of the Polarstar Formation, previously studied by Craddock and his party, did not yield any fossil conchostracans. Since retrieval of even one or two such fossils sometimes requires the processing of a considerable amount of sample material, the question of their presence in the *Glossopteris* beds is still open. Difficulties encountered in crossing the rugged terrain make it clear that for systematic study and bulk sampling, helicopter support is necessary.

Potentially fossiliferous carbonaceous slates and argillites were sampled in many Polarstar Formation outcrops and in several Crashsite Quartzite outcrops.

A facies of trails and tracks, which was observed in the Polarstar Formation on a ridge near the top and behind Mount Weems, and well below the *Glossopteris* beds of Craddock, was found to have a different species composition than a similar facies traceable along most of the east ridge of Polarstar Peak and also well below the *Glossopteris* beds.

Conchostracans have been found in four antarctic localities—one Paleozoic (Permian) and three Mesozoic (Jurassic). This spotty vertical and horizontal occurrence in itself points to a more widespread distribution than has been discovered so far in beds of Permian through Jurassic age.

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Geomorphic Studies in Southern Victoria Land

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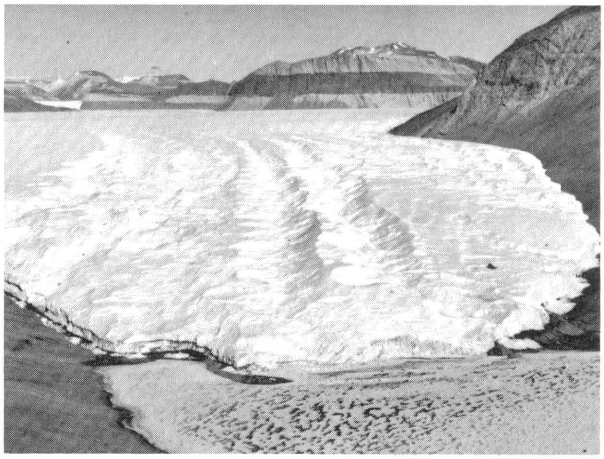
During the 1966-1967 antarctic summer, the University of Kansas field party, which included Edward Derbyshire of Australia's Monash University (now at Keele University, England), continued studies, begun the preceding year, of glacial deposits and landforms in middle Taylor Valley and of the interstratified sand-and-ice glacier near Bull Pass.



(U.S. Navy Photo)
Lower portion of Taylor Glacier and upper end of frozen Lake Bonney.

In middle Taylor Valley, it was determined that the so-called strand lines supposedly cut into the valley sides during a high-level stage of Lake Bonney (known as Glacial Lake Washburn) are actually lateral moraines built against the slopes during progressive down-wasting of an earlier stage of Taylor Glacier. It is unlikely that the level of Lake Bonney has at any time been more than a few feet higher than it is now. In the same area, clear evidence was found to support and strengthen the hypothesis formed last year that only a few thousand years ago the climate of the area of the dry valleys and the nearby coasts was sufficiently warm and humid to permit vigorous action by expanded glaciers of the temperate or warm type.

An unexpected bonus of the Taylor Valley studies was the discovery of the fresh carcass of a young crabeater seal on the ice of Lake Bonney (cf. *Antarctic Journal,* Vol. II, No. 1, p. 23-24).

At Sandy Glacier, near Bull Pass, pits dug in the névé area on the backslope of the cirque revealed a sharp contact between thin firn and hard glacier ice. It is believed that the entire glacier was recently undergoing wastage and that the existing firn cover is the result of accumulation during perhaps no more than the last 15-20 years. Samples of sand were obtained from the névé, the glacier itself, and from dunes in the mouth of Bull Pass for later laboratory analysis. Dr. Fred Roots of the Canadian Polar Continental Shelf Project participated in this continuation of studies in the Sandy Glacier area.

The final phase of field work was a continuation of last season's study of unusual sodium sulphate minerals in the ice-cored moraine area in front of Hobbs Glacier. The extensive occurrences appear to be divisible into horizontally bedded deposits of considerable lateral extent and contrasting piercement deposits with a nearly vertical, pipelike form.

* After conducting these studies, Dr. Dort represented the U.S. Antarctic Research Program on the 8th Japanese Antarctic Research Expedition; cf. *Antarctic Journal,* Vol. II, No. 3, p. 78-80.

Geochemical Studies in Wright Valley

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Ohio State University

The objective of this project is to determine the origin of the salts in the saline lakes of the dry valleys by measuring the isotope composition of strontium in lake water, glacial meltwater, and soils.

The isotope composition of strontium changes as a function of time because of the decay of naturally occurring Rb^{87} to Sr^{87}. The Sr^{87}/Sr^{86} ratio of a geological sample, therefore, depends on the age of the sample, its Rb/Sr ratio, and the Sr^{87}/Sr^{86} ratio at the time the sample (*i.e.,* rock or mineral) was formed. The isotopes of strontium are not fractionated by natural processes, so that the Sr^{87}/Sr^{86} ratio of the water in Lake Vanda, for example, will not be affected by evaporation of water or crystallization of salts. Thus the isotope composition of strontium in the saline lakes may serve as an indicator of the source of the strontium and of the other elements. Possible sources of the salts are, among others, (1) volcanic activity, (2) influx of sea water, and (3) chemical weathering of the rocks in the valleys.

During the 1966-1967 field season, extensive collections were made of meltwater, soils, and bedrock in Wright and Taylor Valleys. Water samples from Lakes Vanda and Bonney were obtained through the courtesy of Dr. Derry D. Koob of Ohio State University.

A summary of the data available at this time is given in the table. It is clear that the average Sr^{87}/Sr^{86} ratio of 15 water samples taken along a depth profile of Lake Vanda is very significantly greater than that of basalts of the McMurdo volcanics and water of the Ross Sea. On the other hand, the strontium leached from a sample of soil from Wright Valley and strontium obtained from the Onyx River have isotope compositions that are identical, within the limits of precision of the measurements, to that of Lake Vanda.

These data indicate clearly that the bulk of the strontium in Lake Vanda could *not* have been derived from a volcanic or marine source. Instead, the data suggest strongly that the strontium and perhaps also other elements in the water were derived primarily by chemical weathering of the exposed rocks in Wright Valley.

A similar study is in progress to determine the source of salts in Lake Bonney.

Summary of isotope analyses of strontium from Wright Valley, Antarctica.

Material and Source	(Sr^{87}/Sr^{86})*	Remarks
Basalt, McMurdo volcanics	0.7043	Average of 4 samples
Water, Ross Sea	0.7094	Average of 2 samples
Water, Lake Vanda	0.7149	Average of 15 samples along depth profile
Water, Onyx River	0.7148	
Strontium leached from soil (0.5 N HCl), Wright Valley	0.7145	
Eimer and Amend $SrCO_3$, isotope standard	0.7084 ± 0.0003	Average of 13 analyses

*Corrected for isotope fractionation by assuming that $Sr^{86}/Sr^{88} = 0.1194$.

Antarctic Fossil Plant Collecting During the 1966-1967 Season*

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The simple, linear or spatulate leaves of plants of the genus *Glossopteris* often have been confused by laymen with those of some common forms of *Eucalyptus*. Such associations can be misleading, because similarities in leaf architecture are not necessarily indicative of close taxonomic relationships between plants. In the past, some paleobotanists believed that *Glossopteris* might be closely allied with some ferns that have net-veined leaves. More information on the fertile structures of *Glossopteris* was needed, however, to provide convincing evidence of glossopterid relationships. For a long time this evidence was lacking.

The most convincing evidence concerning the kind of fertile structures borne by *Glossopteris* was provided by Edna Plumstead (1952). She showed that stalked capitula were adnate to the proximal part of very ordinary looking vegetative leaves of the *Glossopteris* type. The anatomy and even the symmetry of the capitula have remained questionable, however, because of deficiencies in preservation. These structures are startlingly different from fertile structures of ferns and would seem to bear closest resemblance to the staminate structures of some Paleozoic pteridosperms. They have generally been accepted as evidence that the glossopterids were seed plants. Ever since Plumstead's original announcement, paleobotanists have been searching for similar fertile structures in a better state of preservation.

* Publication authorized by the Director, U.S. Geological Survey.

Fertile structures of the glossopterid type were first collected in the Ohio Range at "*Leaia* Ledge" by the writer while accompanying George Doumani on a brief collecting trip in January 1962. Some additional information was provided by this material, but as the morphologic interpretation of the structures remained inconclusive, another visit was made to this locality in January 1967. Four new specimens were obtained that illustrate further a new type of fruiting structure that is similar to the capitula described earlier by Plumstead. On one of the four specimens, illustrated in Fig. 1, the marginal plates are inflated, suggesting that they are receptacles of seeds that have been shed. A fully satisfactory interpretation of the morphology of the capitulum has not yet been made, but we now have reason to believe that this structure was dorsiventrally flattened and unisexual. The suite of similar specimens, 10 in all, is subject to further analysis and study.

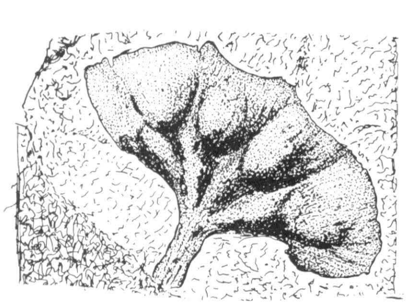
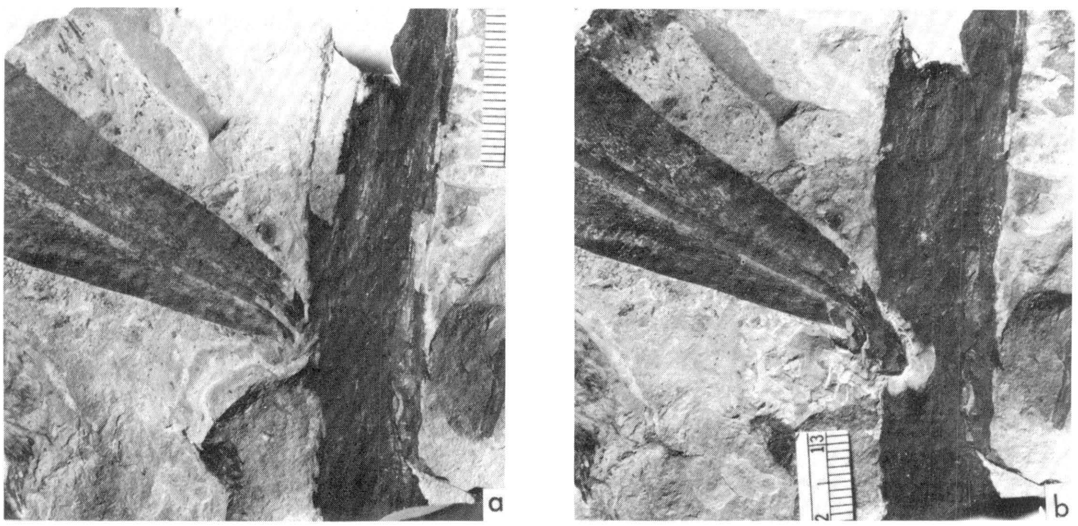


Figure 1. Glossopterid fertile structure, ovulate (?), from "Leaia Ledge" on Mercer Ridge, Ohio Range. Specimen ANT671-2a, taken Jan. 27, 1967. Photo-line tracing, × 2.5.

An extraordinary efficiency in abscission of seeds and leaves may explain our difficulties in evaluating the morphology, which is the key to understanding ancestry and taxonomy among the glossopterids. As Plumstead (1958) later observed, banks of isolated *Glossopteris* leaves, although very common in the southern coal measures, are rarely found attached to a stem. One such rare specimen, illustrated by Etheridge (1895), showed a stem tip with spirally arranged leaves. Other botanists, notably Thomas (1952), have suggested that some glossopterid leaves were arranged in verticils, the most convincing examples of which were illustrated by Dana (1849). Similar leaf "whorls" of the related genus *Gangamopteris* have recently been found by J. F. Rigby in specimens collected in Australia (personal communication, June 1966; also, Rigby, 1967), but both he and I agree that these, as well as the verticils of Dana, might have been produced in a tight apical spiral. Such a leaf arrangement is likely to be a conservative characteristic that would also contribute evidence of the botanical alliance of glossopterids. Thus, when a *Glossopteris* leaf specimen in apparent isolated attachment to its stem was discovered at "*Leaia* Ledge", much care was taken to bring it back intact.

Fig. 2a is a photograph of the leaf counterpart as collected. A small chip of matrix obscures the actual stem connection, but because the petiole is convincingly decurrent toward the stem, interpretation seemed assured. The occurrence appeared to match that of the specimen of *Gangamopteris* previously described by Teichert (1942). A dimorphic ar-



(Photos by Orrin G. Oftedahl)

Figure 2. Leaf of Glossopteris communis *Feistmantel. From "Leaia Ledge" on Mercer Ridge, Ohio Range. Specimen ANT671-3, collected Jan. 27, 1967. Natural size. a. Specimen, as collected, in simulated attachment to a compressed woody axis. b. Same specimen after rock dissection to uncover the plunging continuation of the petiole below and away from the associated axis.*

rangement of leaves on short shoots (for those simulating whorls) and long shoots (as indicated in this example) seemed quite reasonable. Such arrangements are fairly common among both modern and fossil gymnosperms.

Unfortunately, microdissection has failed to confirm this example of "attachment." As shown in Fig. 2b, when the chip of matrix was removed and an effort made to uncover the actual scar of the cicatrix, it was found that the narrow petiole continued in its course below the associated stem compression and curved away below it. Therefore, this specimen affords no evidence that would be provided by a specimen showing authentic attachment of a *Glossopteris* leaf to its stem. The leaf apparently shows well-preserved characteristics of the common Lower Gondwana species *G. communis* Feistmantel. The axis shows traces of gymnospermous wood but is otherwise indeterminable.

During the past season, observations of stratigraphic interest were obtained at the northern end of the Sentinel Range, near the area where Craddock and his associates collected a *Glossopteris* flora in 1964 (Craddock *et al.,* 1965). The lower part of the Polarstar Formation, which is much faulted and folded and estimated to include 600-900 m of thin-bedded carbonaceous shale and siltstone, apparently occurs in the same relationship with plant-bearing beds above and diamictite (tillite?) below that has been observed for the Discovery Ridge Formation of the Ohio Range (Long, 1964). The thin-bedded black shale that occurs in the upper member of the Discovery Ridge Formation forms correspondingly steep slopes in the Sentinel Range. Both show an extraordinary number of trace fossils along bedding planes, although the most distinctive types of trails are probably different in each mountain range. Large sideritic concretions are very characteristic of the Discovery Ridge Formation, and similar large concretions occur in the lower part of the Polarstar Formation. They are, however, not accompanied by cone-in-cone layers, nor are they as calcareous. In both localities, sandier beds at the top are followed in apparent conformity by repetitive nonmarine cycles of arkosic sandstone in prominent benches, separated by layers of carbonaceous shale containing coaly beds and abundant fossil plants. The resemblance in apparent stratigraphic relationships and facies is most striking between the lower part of the Polarstar Formation and the Discovery Ridge Formation in spite of an apparent fourfold (?) increase in thickness in the Sentinel Range. The difference in thickness may not be as significant as the similarity of facies since the Ohio Range locality is nearly 1,000 km southwest of the Sentinel Range.

During the past season, the writer received additions to the antarctic fossil flora from other localities, chiefly Victoria Land, as a result of collecting by Paul Pinet and David Matz of the University of Massachusetts, Peter Barrett of Ohio State University's Institute of Polar Studies, and Toby Rose, who was associated with the University of New South Wales' party under the direction of Dr. C. T. McElroy. To all of those thus contributing to a more adequate knowledge of antarctic plant life of the past, the writer is grateful.

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Patterned Ground Studies in Victoria Land

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Patterned ground studies were begun in 1960 in Victoria Land to define the environment of sand and ice wedges and to determine their rate of growth for dating of various surfaces. The thermal regime of the ground is being monitored continuously by recorders at McMurdo and in Taylor Valley. During the 1966-1967 field season, the writers serviced the thermal stations and studied salt deposits in Taylor Valley, at the Hobbs Glacier, and at other localities nearby where the salts are related to patterned ground and to surfaces of supposedly different ages.

In Taylor Valley, observations were made of the kinds and distribution of salts from the front of Canada Glacier to Goldman Glacier and to the top of Nussbaum Riegel, crossing the entire sequence of moraines from youngest to oldest. The saline discharge area at the terminus of Taylor Glacier in Lake Bonney was reexamined and sampled in detail. Observations also were made and samples collected of salt-bearing basal drift up glacier.

One hundred and thirty-three salt bodies were examined at the ice-cored moraine in front of the Hobbs Glacier, which is cut by a youthful system of wedges. The moraine contains numerous salt bodies and locally associated algae within as well as on top of the ice. The moraine apparently originated largely from the formerly expanded Koettlitz Glacier. Additional observations were made and samples collected of salt deposits in Miers Valley and along the west margin of the Koettlitz Glacier up to Pyramid Trough. Salts were also collected at McMurdo, Cape Evans, and Cape Royds. All the collections are now undergoing laboratory study.

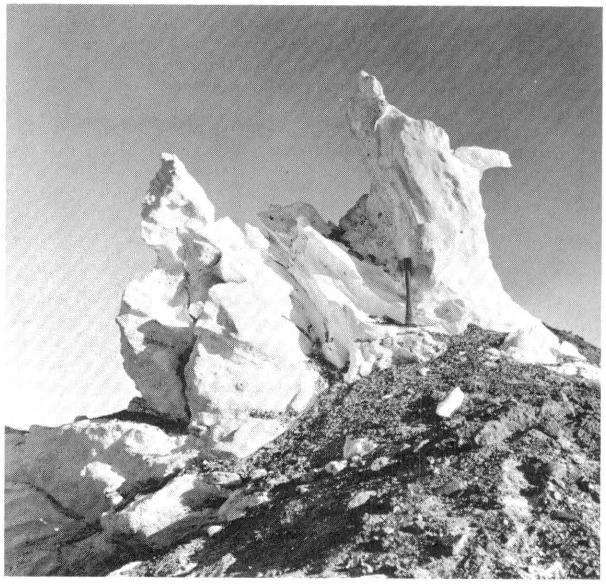
Some Observations and Tentative Conclusions

One or more compounds dominate a complex of salts in the various places. At the ice-cored moraine in front of the Hobbs Glacier, the salt bodies and local algae are found from sea level to the basal shear moraine of the Hobbs Glacier, at about 200 m elevation. The salts consist mostly of mirabilite ($Na_2SO_4 \cdot 10H_2O$) with surface alterations of thenardite (Na_2SO_4). Some bodies are many tens of meters thick. Bizarre pinnacles are seen locally (Fig. 1). Salts are emerging today from the basal shear moraine of the active ice of Hobbs Glacier (Fig. 2). Other bodies with algae represent pond concentrates whose structure and relationship to structures in the ice show clearly that they were subsequently overrun and carried along in either the Koettlitz or Hobbs Glaciers. Large single crystals of mirabilite are "weathering" out of glacial ice fronting on McMurdo Sound. In Miers Valley, gypsum predominates over mirabilite in the exposures visited.

A former saline discharge from the face of Taylor Glacier crystallized in part to ice, mirabilite, halite, calcite, and aragonite. Superficially similar salts were collected from basal drift about 300 m up ice from the terminus of Taylor Glacier and about 20 m above the level of Lake Bonney.

During the past year, Taylor Glacier advanced a few meters, and part of the terminus slumped into Lake Bonney. In the axis of the valley these movements produced parallel arcuate folds in the four-meter-thick perennial ice of Lake Bonney and, toward the margins of the glacier, *en echelon* tension fractures in ice-cored moraines and in the lake ice. The wavelength of the folds is 40-50 m and the amplitude 0.5-3 m.

The abundance and variety of salts in the drifts near Nussbaum Riegel do not increase significantly with supposed age as they clearly do in Wright Val-



(Photo by R. F. Black)

Figure 1. Pinnacle of mirabilite about 200 m above sea level at terminus of the active ice of Hobbs Glacier. Original stratification is isoclinally folded and sheared.

(Photo by R. F. Black)

Figure 2. Basal shear moraine of the active ice of Hobbs Glacier about 200 m above sea level. The white bloom on the upper part is thenardite that has been altered from mirabilite; the bloom has been removed from the lower part.

ley. In Taylor Valley, thenardite and calcite are especially abundant in the vicinity of volcanic extrusives. However, available evidence does not prove nor disprove that volcanism provided the abundance and variety of salts found in Victoria Land. In Taylor Valley, the paucity of salts in supposedly older moraines, perched stones, disturbed ventifacts, cavernously weathered stones, patterned ground, and high-level beach ridges all point to a recent geomorphic event such as uplift above the sea.

GRAVITY AND TOPOGRAPHY

Anvers Island Gravity Survey, 1967

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From January 1 to March 25, 1967, Ohio State University's Institute of Polar Studies conducted a gravity survey of the Anvers Island area with a La-Coste-Romberg gravimeter. The survey involved four phases: The intercontinental calibration of the instrument and the establishment of internetwork ties; the establishment of a regional network; the measurement of ice-cap profiles; and the execution of a detailed survey of the edge of the ice cap.

The first phase involved the occupation of previously established stations during stops at airports and seaports on the journeys to and from Antarctica and at accessible locations on the Continent to calibrate the instrument with respect to established gravity reference points. It also involved tying the Anvers Island survey to the gravity networks of the University of Wisconsin and the British Antarctic Survey.

The second phase was carried out to obtain a gravity gradient for the Antarctic Peninsula—Anvers Island region by making observations along the coasts of Anvers Island, the adjacent peninsula, and on various islands in the region.

The ice-cap profiles, which comprised the third phase, were obtained by making several hundred observations at spacings of 1-3 km along surveyed lines laid out on the Anvers Island ice cap. These data will aid in determining the thickness of the ice and the topography of the surface beneath the ice.

The fourth phase of the program entailed a detailed investigation in the vicinity of Palmer Station of the shape of the ice cap's edge and of the ice-rock interface. Approximately 30 stations were occupied for this purpose.

The data obtained during phases two, three, and four were augmented by both continuous and point-by-point observations of the total magnetic field along selected profiles.

Preliminary data reduction suggests that the 700- to 800-m-high plateau of the southwestern half of the island consists of a layer of ice that is more than 500 m thick.

Topographic Mapping: Field Operations, 1966-1967

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U. S. Geological Survey

During the 1966-1967 season, four topographic engineers from the U.S. Geological Survey were assigned to make control surveys for antarctic mapping and to contribute to other USARP programs. For the seventh consecutive season, the Survey furnished Air Development Squadron Six (VX-6) with a mapping specialist who planned flight lines, provided navigational assistance during photographic missions, and advised on the quality of the developed photography.

In the western sector of Marie Byrd Land, 1,490 km (925 miles) of electronic-distance traverse were completed. This traverse began near Cape Colbeck on Edward VII Peninsula and extended eastward across Saunders Coast to Forrester Island on Hobbs Coast. In addition, measurements covering a total distance of 480 km (300 miles) were made in areas off the main traverse line where control points were needed. This work furnished control for about 60,000 square miles of topographic mapping.

Although the Marie Byrd Land Survey traverse was the primary undertaking of the Geological Survey this year, its engineers also performed surveying operations in support of other USARP programs. This work included establishing a geodetic tie at McMurdo between the "Camp Area" astronomic station and the geodetic satellite tracking facility of New Mexico State University, remeasuring the ice-movement stakes on the annual and fast ice between Hut Point and Koettlitz Glacier (for the Naval Civil Engineering Laboratory), determining an astronomic azimuth for the beginning point of the Byrd Station—Whitmore Mountains ice-strain network (for Ohio State University), and establishing four new stations for the second-order triangulation network at McMurdo (for the Naval Facilities Engineering Command).

The Geological Survey also planned and prepared detailed mapping specifications for aerial photography covering more than 425,000 square miles, the largest single-year requirement to date. Owing to the concerted effort made by VX-6 personnel throughout the austral summer, approximately 335,000 square miles of mapping-quality photography was obtained. This is almost double the amount obtained during the 1964-1965 season, the previous record year for mapping-quality photography. (During *Operation Highjump,* 1946-1947, three Navy task groups obtained 460,000 square miles of photography, but only about 100,000 square miles of this was suitable for mapping; cf. *Antarctic Journal,* Vol. II, No. 1, p. 5-12.) Flying a C-121J Super Constellation out of Punta Arenas, Chile, a VX-6 crew photographed the Antarctic Peninsula south of 68°S. and the eastern side of Alexander Island. Cameras aboard an LC-130F Hercules based at Byrd Station photographed the areas of Byrd Land and Ellsworth Land that had been planned for coverage. Near the end of the season, an LC-130F based at McMurdo flew photographic missions along the eastern edge of the Ross Ice Shelf, over the Balleny Islands and Roosevelt Island, and over areas near McMurdo, the last for various scientific projects.

GLACIOLOGY

Electromagnetic Sounding of Glacial and Shelf Ice

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Electromagnetic sounding (EMS) of ice thickness was conducted by the University of Wisconsin in five areas in Antarctica during the 1966-1967 field season. Two complete EMS systems were used. One, loaned to the University by the U.S. Army Electronics Command, was operated in Marie Byrd Land (Beitzel *and* Bentley, 1967). The other, which belongs to the University and consists of an SPRI-II transmitter and receiver manufactured by Randall Electronics, St. Albans, England, and a Hewlett Packard H20 175A oscilloscope, was used at Byrd Station, on Skelton and Meserve Glaciers, and on the ice shelf near McMurdo Station.

Byrd Station

No bottom echo was received from soundings made in the main tunnel at Byrd Station, but two distinct reflections were observed within the top kilometer of ice at Byrd substation. A 2.5-km wide-angle reflection profile was made to determine velocities within these near-surface layers. The average vertical velocity to the first reflector, located about 400 m below the surface, was approximately 190 m/μsec, and the mean velocity to the second reflector, at a depth of about 1 km, was 172 m/μsec.

Skelton and Meserve Glaciers

A transverse profile was made of Skelton Glacier in the region of Clinker Bluff to determine the shape of the underlying valley. Two detailed wide-angle reflection profiles were made along perpendicular lines by using a common reflecting point. The best fits to the T^2-X^2 plots for each profile indicated a velocity of 175 m/μsec. Near-surface reflections indicate a velocity of 180 m/μsec for the top 350 m of ice.

Near-surface velocity measurements were made over a one-way travel path by lowering the two antennas into parallel crevasses about 200 m apart and laying a cable between the transmitter and receiver to transmit the time of pulse initiation. Velocities of 173 m/μsec and 164 m/μsec were obtained for two antenna spacings.

In the upper portion of Meserve Glacier, two ice-thickness profiles were made for Ohio State University across the névé region; a third profile, along the axis of the glacier, was partly completed when the generator failed and the work was discontinued.

By means of the 55-m tunnel in the base of the lower tongue of the glacier (cf. p. 123), attempts were made to obtain a one-way measurement of velocity vertically through the ice. The transmitter was placed on top of the tongue and the receiver was set up in the tunnel directly below it. Because of the uncertainty of the travel path, the data obtained were unreliable.

Ice Shelf Near McMurdo

On the ice shelf south of Ross Island, profiling was carried out over a distance of 150 km. In addition, one wide-angle reflection profile was completed, and an experiment was performed to determine velocities above, on, and below the firn. The work was done with the assistance of a team led by Mr. William Lucey from the Antarctic Division, Department of Scientific and Industrial Research, New Zealand.

A sharp boundary in apparent ice thickness was found to run north-south approximately along 167°15′E. The indicated thickness on the west side of the boundary was 40-50 m, whereas a few meters to the east it was 95-120 m. A corresponding change in surface elevation, which is not readily detectable by eye, occurs across the boundary.

The wide-angle reflection profile, centrally located between White and Ross Islands, gave a velocity of 182 m/μsec. To measure velocities near the surface, the transmitter and receiver were located 300 m apart and connected by a cable. No change in travel time was observed when the antennas were placed on the snow or at heights of 1 and 2 m above it. When the antennas were buried at a depth of 2 m, a velocity of 270 m/μsec was obtained.

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Installation of Deep-Core Drilling Equipment at Byrd Station (1966-1967)

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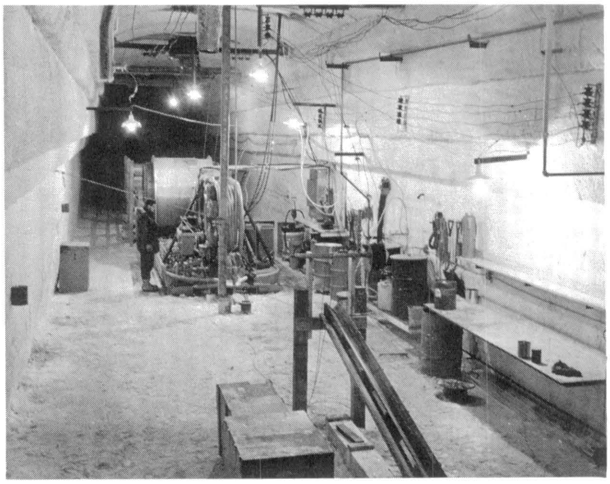
The deep-core drilling program of the Cold Regions Research and Engineering Laboratory (CRREL) began at Byrd Station on November 20, 1966, with preparations for installing equipment and facilities, and it ended for the season on February 18, 1967, after the drill had been put in operation and successfully tested to a depth of 227 m. This preparatory work was done with the assistance of U.S. Naval Construction Battalion Unit 201, the Byrd Station complement of Antarctic Support Activities, and Air Development Squadron Six.

The main installation consists of an electrohydraulic hoist (Fig. 1) with 3,600 m of 1-inch armored cable and a 21-m-high aluminum tower (Fig. 2) with hydraulic cylinder and sheave.

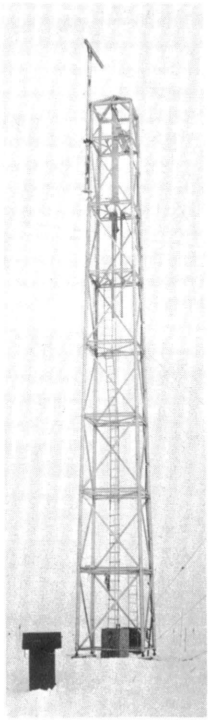
The site selected for the drill hole was in the main tunnel (M-1), approximately 30 m south of tunnel L-7. Above this site, two holes were augered through the tunnel ceiling and the 6.4-m-thick layer of snow covering it to permit passage of the armored cable from the hoist up to the sheave and then down to the drill hole. One of the holes was made large enough to permit passage of the drill and the drill-hole casing. The latter is required to contain the drilling fluid in the upper, 65-m-thick layer of permeable snow.

Between December 4 and 23, the CRREL drill cut two holes 20.3 cm in diameter and 30 cm apart to depths of 75 and 35 m (Fig. 3). The deeper hole was cased in preparation for subsequent drilling to



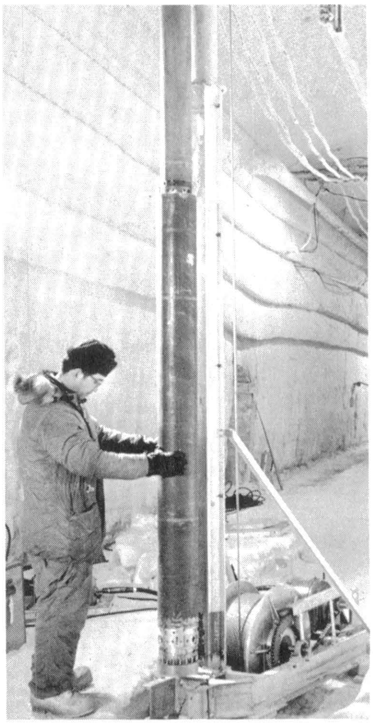
(Photo by H. T. Ueda)

Figure 1. Deep-core drilling hoist.



(Photo by H. T. Ueda)

Figure 2. Seventy-foot-high drill tower.



(Photo by H. T. Ueda)

Figure 3. Hole is drilled for casing with CRREL drill.

greater depths, and the other was reserved for temporary storage of the assembled drill.

To enable heavy equipment to be moved to the drilling site, the end of the main tunnel had to be excavated to form an inclined ramp 120 m long and 12 m deep. A D-8 tractor equipped with a blade began this work on December 27, 1966, and completed it on January 6, 1967. During this period, work had commenced in the tunnel on the construction of a 2.5- by 10-m workshop, the installation of the electrical system to provide power for the hoist and drill, and the installation of plumbing fixtures and hundreds of meters of pipe. In addition, wooden foundations were laid on the tunnel floor to support the hoisting unit and on the snow surface above the drilling site to support the tower.

During January 8-12, most of the 60 tons of cargo required for the project was flown from McMurdo to Byrd. It included the hoisting winch, 3,600 m of cable, the tower, steel casing, and many drums of ethylene glycol, which is used to remove the cuttings from the hole.

From January 10 to 16, construction in the tunnel was being completed: The 10-ton winch was moved into position and the 10-ton cable reel was installed on it, the workshop was made ready for use, racks were set up to store 3,000 m of core, the steel casing was installed in the hole, 85 drums of ethylene glycol and 24 drums of trichlorethylene were moved into the tunnel, and the final work on the plumbing and electrical systems was finished.

The erection of the 21-m-high tower began on January 17 and was completed on the 21st. After the tower had been properly guyed, the hydraulic cylinder and cable sheave were raised into position and two ventilation ducts, which extend from the tunnel ceiling to a height of 1.5 m above the snow surface, were installed.

By January 28, all preparatory work on the machinery had been completed and the Electrodrill was being assembled. Drilling started on February 2 on a single-shift schedule and continued until February 18, when a depth of 227 m was reached. The operation was then suspended for the season.

Antarctic Glaciological Studies

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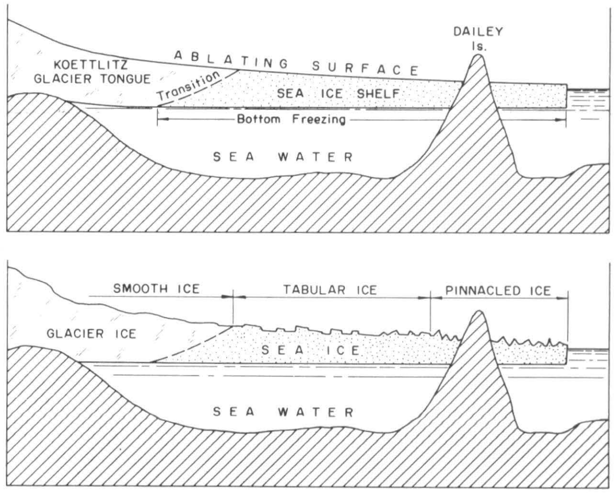
Investigations begun in November 1963 of the composition, structure, and mass balance of the Koettlitz Glacier tongue were substantially completed during November 1966. Studies conducted during December 1966 included further measurements of snow accumulation and an examination of snow-crystal nuclei at Byrd Station.

Koettlitz Glacier Tongue

The study conducted last summer was concerned principally with core analyses and measurements of ice flow and surface ablation. It was determined that the lower half of the 60-km-long ice tongue is composed of sea ice varying in thickness from 9 to 15 m along the centerline. This transformation of a glacial ice tongue into a sea-ice shelf is accomplished by the combined processes of seawater freezing onto the underside of the ice and surface ablation. Ablation of the order of 0.5 m/yr was observed in the general vicinity of the Dailey Islands, and all indications are that a comparable thickness of ice is accreting annually onto the bottom of the ice tongue. Measurements showed that the ice tongue is moving very slowly—5-10 m/yr. At these rates of accretion, ablation, and forward movement, it is estimated that the bottom ice should reach the surface in less than 50 years and that, as the ice tongue traverses the final 30 km to the terminus, it should reconstitute itself at least fiftyfold. This process is also accompanied by a progressive increase in the quantity of surficial debris (which originally was frozen into the glacier's bottom) towards the terminus.

Cross sections depicting the composition and structure of this ice tongue and the patterns of surface relief associated with differences in both the composition of the ice and the concentration of surficial debris are given in the figure. Whereas the surface formed by ablation of glacial ice is smooth and has relatively little relief, that formed by the ablation of relatively dirt-free sea ice is characteristically blocky or tabular in appearance. As debris



Cross sections of Koettlitz Glacier tongue. Not drawn to scale.

accumulates on the ice, the blocky structure of the surface is slowly transformed into so-called "pinnacled ice."

Snow Accumulation

Further measurements of snow accumulation made at stakes placed on the undulating surface near Byrd Station show that the depressions in the surface are still accumulating appreciably more snow than the crests or ridges. At the present rates of accumulation, one might expect that the depressions would be filled in less than 50 years. However, it is now believed that the undulations are migrating across the surface and thus perpetuating themselves. The stake lines will be resurveyed later to determine if such migration is occurring.

Snow-Crystal Nuclei

Studies are now being made of the relative abundance and composition of nuclei in freshly precipitated snow crystals collected near Byrd Station. Results obtained so far indicate that approximately 50 percent of these crystals contain solid-particle nuclei and that most of the nuclei are composed of clay.

Glaciological Studies at Plateau Station

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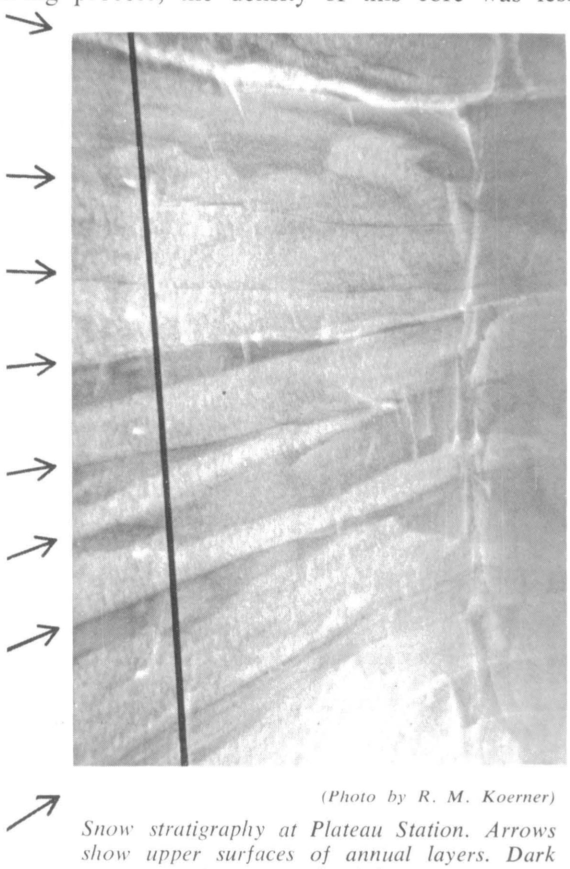
Institute of Polar Studies
Ohio State University

Between December 4, 1966, and February 5, 1967, the Institute of Polar Studies carried out investigations at Plateau Station of snow stratigraphy (Koerner and Olav Orheim) and snow chemistry (E. E. Picciotto*) and conducted a deep-drilling program (Kane and H. H. Brecher). Olav Orheim, of the Norwegian Polar Institute, cooperated in an investigation of the development and metamorphosis of the snow surface, particularly of sastrugi and other irregularities.

As an introduction to the snow/firn stratigraphy near Plateau Station, 64 shallow pits were dug in early December to examine the accumulations of the 1966 winter and the previous summer. The winter snow was found to be relatively loose (cf. figure), whereas the summer accumulation was thin and hard. At the end of January, 50 more pits were dug through a layer of snow about 20 cm thick that represented a two-year accumulation. By late January, the surface layer was 10 times harder than it had been in early December, and grain growth had taken place. Data obtained on the patterns exhibited by summer and winter layers served as a basis for analyzing the stratigraphy of the snow observed at greater depths—in three pits 1 m deep, one pit 2 m deep, and one pit 10 m deep. Over the 10-m range, 118 annual layers were identified. Inasmuch as the analysis of snow layers near the surface had indicated that no accumulation would be detectable for 1 out of every 12 years, the 118 layers represented 128 years of accumulation. The mean annual accumulation in this period was 2.8 g/cm^2. For the year 1966, stake-field and 50 shallow-pit measurements indicated that the mean accumulation was 2.5 and 2.6 g/cm^2, respectively.

Photomicrographs were taken of thin sections of firn, and several samples of snow collected between the surface and the 10-m depth were shipped back to the Institute of Polar Studies for further analysis.

The CRREL portable thermal drill was erected in a Jamesway, and coring operations were begun on January 8, 1967. Most of the core obtained from the upper 26 m of firn was not usable because of the production of considerable meltwater during the drilling process; the density of this core was less



(Photo by R. M. Koerner)

Snow stratigraphy at Plateau Station. Arrows show upper surfaces of annual layers. Dark lenses are hard layers.

* To be reported in the *Antarctic Journal*, Vol. II, No. 5.

than 0.54 g/cm³. Almost all of the core cut below that depth was recovered in good condition. The maximum depth reached was 71 m, at which level the density was 0.71 g/cm³. At this point, on January 19, the drill froze in the ice, preventing further penetration. It was finally freed and returned to the surface on February 2.

The core was weighed, to determine its density, and then stored. Selected specimens were returned to the cold rooms of the Institute of Polar Studies, where grain size and structure will be examined along with the geochemistry and composition of microparticles.

Measurement of Ice-Surface Movement by Aerial Triangulation

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In the 1962-1963 austral summer, the Institute of Polar studies began a program to measure surface movement of the ice sheet between Byrd Station and Mount Chapman (82°34'S. 105°55'W.) by aerial triangulation of markers spaced approximately 4 km apart across the 360-km distance.

The author accompanied this party in order to remeasure some of the elements in the ground control for the aerial triangulation. The control arrays at Byrd Station and at Mount Chapman were resurveyed and the lengths of the baselines remeasured. Azimuths of the two baselines were measured by observations on the sun, and part of the traverse near Mount Chapman was repeated.

In spite of the fact that the reflectors could not be satisfactorily acquired on the aircraft's radar, the photo mission was flown successfully on November 30, 1966, with the aircraft maintaining the proper track by following the Sno-Cat's tracks on the surface. The aerial triangulation is now in progress in the Department of Geodetic Science at Ohio State University under the supervision of Dr. S. K. Ghosh.

Snow accumulation was measured again along the entire line of markers. Accumulation between Byrd Station and a point 300 km southeastward was only 11.0 g/cm²/yr in 1965-1966, as compared with 16.1 g/cm²/yr for 1962-1965. In the vicinity of Mount Chapman, however, the accumulation for the two periods was the same (21.3 g/cm²/yr). It was interesting to note that the variation of accumulation along the line of markers was strikingly similar during the two time intervals.

Investigation of Meserve Glacier

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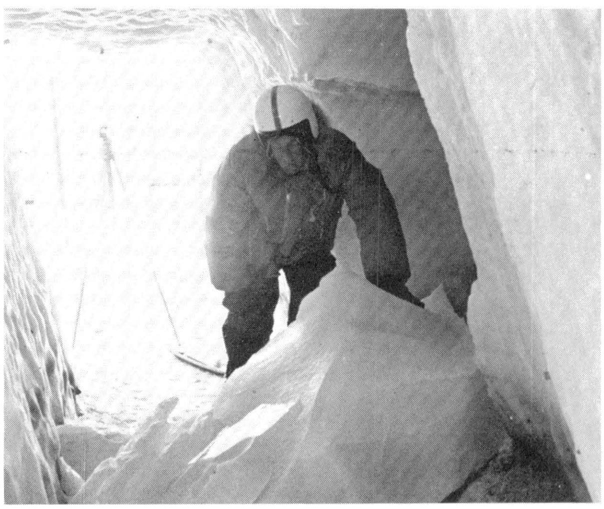
Institute of Polar Studies
Ohio State University

During the austral summer of 1965-1966, investigations were begun to determine the conditions of ice flow at the base of the Meserve Glacier in Wright Valley (cf. *Antarctic Journal,* Vol. I, No. 4, p. 138). The program was continued in the 1966-1967 season, with emphasis being placed on the remeasurement of certain of the dynamic parameters involved. The sampling of ice for laboratory analysis was resumed.

Last season, the tunnel in the base of the glacier was driven to a point 55 m from the ice cliff. Including lateral drifts, a total of 112 m of tunneling

(Photo by G. Holdsworth)
Lower ice tongue of Meserve Glacier. Note surface "steps." The ice cliff is 15-20 m high.



(Photo by G. Holdsworth)
View of interior of Meserve Glacier tunnel showing dislodged ice block at a drift corner.

was achieved. These tunnels were fully instrumented for deformation studies.

Cavities beneath the sole of the glacier were examined in detail. Salt deposits on rocks exposed in the cavities suggest that the salt was derived from the basal ice itself, which has a salt concentration seven times that of the clear ice above. The mechanism of salt deposition in a cavity surrounded by ice containing salt at −18°C. will be studied in the laboratory.

Vertical holes 22 and 34 m in length were drilled from the glacier's surface to the tunnel ceiling, and temperature and deformation data were obtained from them. A temperature of −18°C. was recorded at the base, whereas midway between the base and the top surface, a temperature of about −20°C. was recorded, the latter at the peak of a cold wave. Flow velocities were found to vary from about 1 cm per day at the surface to zero at the base. At a level 3 cm above the base, in the "dirty ice," the movement was about 7.5×10^{-3} cm per day, and in the basal clear-ice zone, which extends from the ice cliff to a point 20 m within the glacier, it was an order of magnitude less.

Certain aspects of the glacial geology were studied to aid in understanding the physical processes taking place beneath and at the margins of the ice tongue. These included mechanical analyses of the morainal debris, measurements of the volume of this material, the location of "tracer" or index rocks, and the structure of the moraine.

Micrometeorological investigations were continued, both on the moraine and the glacier surface.

UPPER ATMOSPHERE PHYSICS

The Conjugacy of Visual Aurorae

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and
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Aurorae are the luminous manifestation of the penetration of charged particles into the upper atmosphere along geomagnetic lines of force. A symmetrical injection of particles into an undistorted geomagnetic field would be expected to cause aurorae similar in form and intensity at the conjugate ends of magnetic field lines. Evidence obtained from satellites, however, indicates that the geomagnetic field is distorted by anomalies and the solar wind, and that the field lines at very high latitudes are in fact swept away from the Earth in the antisolar direction to form a magnetospheric "tail." Under these conditions, aurorae would be expected to be only grossly conjugate and to become progressively less conjugate with increasing geomagnetic dipole (dp) latitude.

This behavior of aurorae has been confirmed through measurements of associated effects on such phenomena as magnetic variations, ionospheric absorption, and X-ray emissions. An examination of the detailed spatial and temporal conjugacy of particle precipitation would be best accomplished by making direct conjugate measurements from rockets and satellites. However, such measurements would be difficult to make and coordinate, and they would be severely restricted in space and time. The most informative approach at the present time appears to be to compare conjugate visual aurorae by means of all-sky cameras and photometers.

Using all-sky camera data obtained on four clear nights at conjugate stations near dp latitude 61°, along with data obtained on one night near dp latitude 64°, DeWitt (1962) found that aurorae near these latitudes were similar in form, motion, intensity, and temporal variation. In a later, unpublished analysis of observations made on six nights at a pair of conjugate stations located at a higher (70°) dp latitude (Reykjavik, Iceland, and Showa, Antarctica), DeWitt noted considerably less similarity in auroral features.

An excellent review of the present knowledge of magnetoconjugate phenomena has been made by Wescott (1966).

Experimental Program

Few pairs of conjugate polar stations are suitably located and equipped to make optical observations of aurorae, and those in existence can provide simultaneous observations only during brief periods of coincident darkness in the two polar regions (*i.e.*, at the time of the equinoxes). Further limitations are imposed by the likelihood that clouds will obscure the sky during at least part of the period of darkness and that some instrument failures will occur.

To permit a detailed study to be made of the extent of conjugacy of aurorae observed optically at a

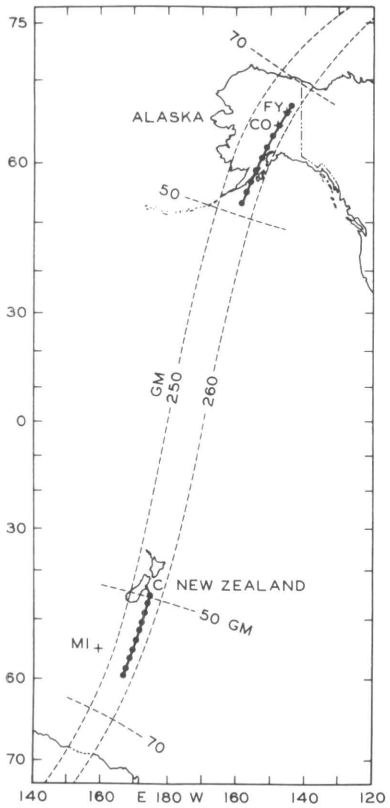


Figure 1. Aircraft flight paths in Northern and Southern Hemispheres. Solid circles indicate conjugate locations reached simultaneously.

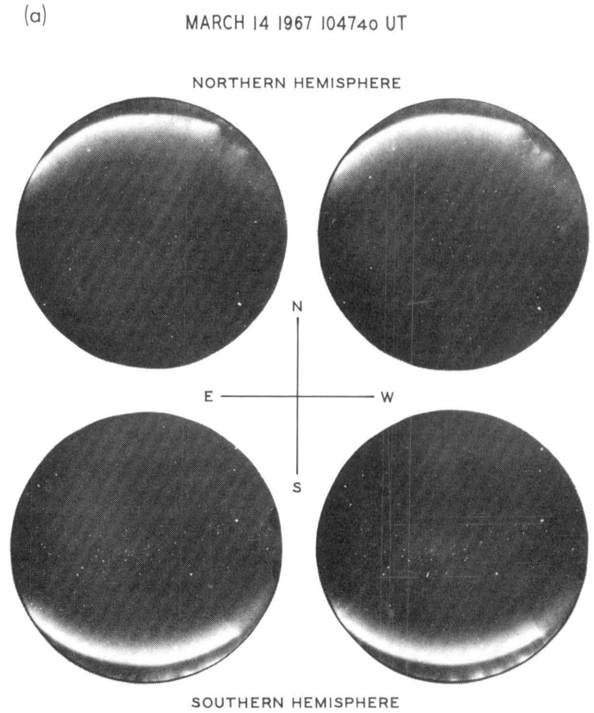
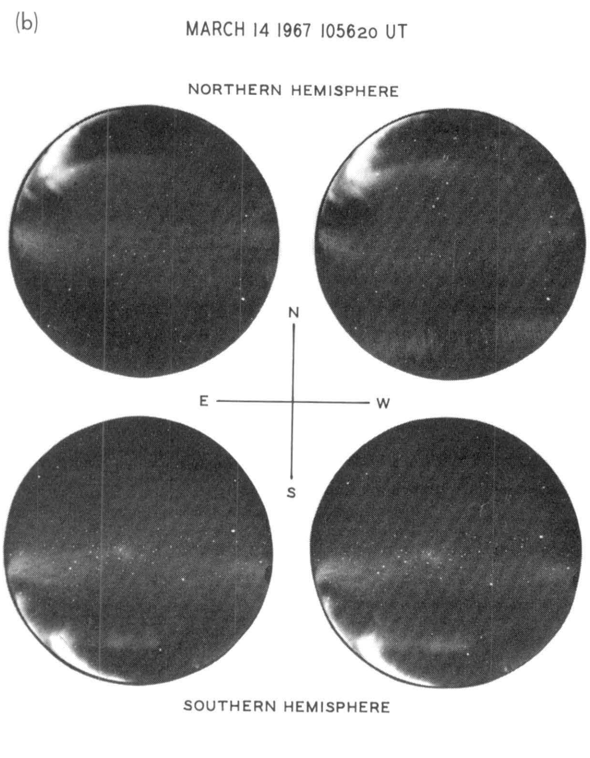
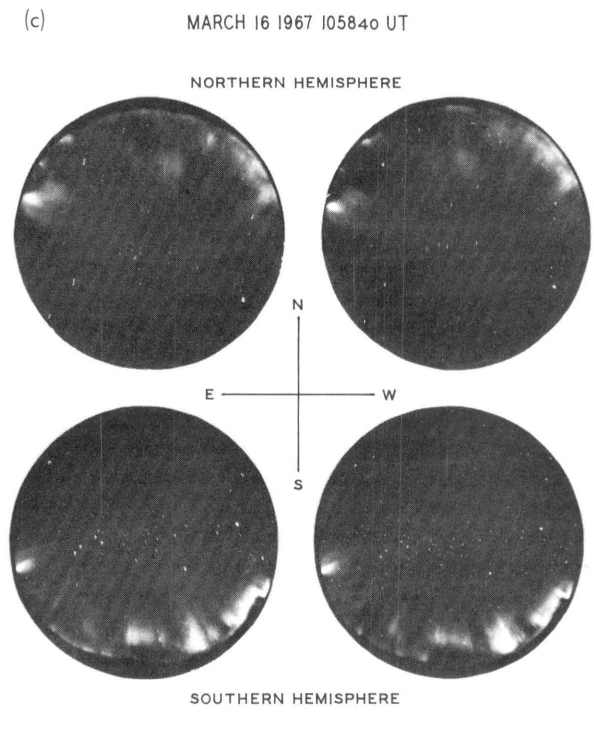


Figure 2. (Above and left and right below.) Examples of all-sky camera photographs showing the conjugacy of aurorae in Northern and Southern Hemispheres. See text.





variety of latitudes, two NC-135 jet aircraft, equipped with all-sky cameras and photometers, were flown on three round trips across the northern and southern auroral zones (Fig. 1). On the figure, the solid circles (10 over Alaska and 10 over areas south of New Zealand) indicate conjugate locations which were to be reached simultaneously by both aircraft at intervals of 15 minutes. The conjugate points were calculated from a model of the magnetic field represented by the time-dependent coefficients of Hendricks *and* Cain (1966). The dashed lines enclosing the flight paths show dipole latitudes and longitudes. The differences between the respective locations of conjugate points and dipole coordinates illustrate the departure of the geomagnetic field from that of a centered dipole. The apparent difference in the length of the northern and southern flight paths is largely due to the use of a Mercator map projection.

The aircraft were equipped with Fairchild all-sky cameras having an aperture of *f*/1.5 and a field of view of 160°. Eight-second exposures were taken every 10 seconds. The synchronization of the north and south exposures was within 0.1 second, so that auroral structures and intensities could be directly compared. The aircraft were also equipped (by other experimenters) with narrow-field cameras, zenith photometers, a meridian-scanning photometer, a magnetometer, and VLF receivers.

The flights were timed to permit observations to be made around magnetic midnight. Magnetic activity was very slight during all three flights, with reported College *K*-indices and *K*-sums of 2 and 2 on March 12; 2 and 4 on March 14; and 0 and 2 on March 16. Nevertheless, aurorae were recorded poleward of dp latitude 65° on all three flights.

Results

At the time of this writing, only the data obtained from the all-sky cameras have been studied, and no corrections have been applied for aircraft deviation from the intended location or for heading and pitch and roll. Thus, the results presented here must be considered as very preliminary.

Figures 2a, b, and c are representative samples of the data obtained when aurorae were observed and the aircraft were in approximately conjugate locations. Two consecutive photographs taken from each aircraft are shown in each figure. The time given is that of the beginning of the exposure for the right photograph. Gross conjugacy of northern and southern aurorae was observed in all photographs. In addition, most photographs show surprisingly detailed conjugacy in the shape, intensity, and temporal variations of aurorae observed between dp latitudes 65° and 70°.

Figure 2a illustrates the kind of data obtained when the aircraft were near dp latitude 65°. The conjugate, truncated auroral arc is located near dp latitude 67.5°. The rayed arc appearing on the horizon in the photographs taken in the Southern Hemisphere is just below the horizon in those taken in the Northern Hemisphere. Details of conjugacy of these aurorae are expected to be more apparent when corrections have been made for the fact that the southern aircraft was flying east and south of its intended position.

Figure 2b shows data taken when the aircraft were near dp latitude 66.5°. The southern aircraft was somewhat north of its intended position. The eastward auroral loop, whose lower branch is near dp latitude 70°, shows close conjugacy. The faint and diffuse auroral arc, located in the zenith, and tentatively identified as the "quiet hydrogen arc" on the basis of ground data, is observed to be closely conjugate.

Figure 2c represents one of the best examples obtained of detailed auroral conjugacy—the bright ray bundle with its faint "tail" on the equatorward side (the eastern edge of the photographs). The rest of the auroral display is a complex rayed structure, near dp latitude 69°, having apparent dissimilarities. The significance of these dissimilarities will be determined through analysis of the photographs in conjunction with the aircraft navigation data. The viewing of rayed auroral structures is very aspect-sensitive, *i.e.*, the details of the structure look different from stations separated by as little as 10 km. In the instance cited, the aircraft flying in the Northern Hemisphere was slightly west and south of its intended position.

Conclusion

The preliminary analysis of the data obtained provide some unique examples of surprisingly detailed auroral conjugacy at high latitudes. The subsequent analysis will involve accurate determination of the locations of clearly identifiable features of the aurorae and a comparison of them with the calculated model of the magnetic field developed by Hendricks and Cain. The photometric data may provide information on the temporal relationship of luminosity fluctuations of the conjugate aurorae. If these measurements confirm the detailed spatial and temporal conjugacy of aurorae suggested by the photographs presented here, they will constitute evidence that, during magnetically very quiet times, aurorae in the vicinity of the statistical auroral zone (dp latitude 66.5°) are caused by a symmetrical injection of electrons and protons near the equatorial plane and along magnetic field lines which are closed, relatively stable, and not greatly stretched toward the magnetospheric tail.

Acknowledgments

This research project benefitted greatly from the expert and splendid cooperation of many people, too numerous to mention individually. We thank in particular Mr. Ray R. Heer, Jr., of the National Science Foundation; Dr. T. Neil Davis and Messrs. William Nichparenko, Neal Brown, and Eldon Thompson of the Geophysical Institute; Mr. Clifton Lilliott and his assistants at the firm of EG&G, Inc.; and Lt. Col. Neil Garland, USAF, chief of flight operations for the project. We also express our gratitude to Dr. Eugene Wescott, of NASA's Goddard Space Flight Center, for the computation of conjugate-point locations, and to the Stanford Research Institute for the loan of two Fairchild all-sky cameras.

The Geophysical Institute's participation in this project was funded by the National Science Foundation through its Office of Antarctic Programs. The aircraft operations were funded by the Nevada operations office of the Atomic Energy Commission. The participation of the Los Alamos Scientific Laboratory and EG&G, Inc., occurred under the auspices of the Atomic Energy Commission.

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Study of Particle Precipitation and Magnetospheric Phenomena by Means of Balloon-Borne Instrumentation

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Department of Physics
University of Denver

From January 8 to February 7, 1967, a series of high-altitude balloon flights was made from Byrd Station. The purpose of the flights was to study the frequent precipitation of energetic electrons out of the magnetosphere and to investigate features of solar cosmic ray enhancements at high magnetic latitudes in the Southern Hemisphere. The payloads consisted of scintillation counters and Geiger-counter telescopes, associated pulse-discrimination and counting circuits, and telemetry equipment.

The polyethylene balloons used had a capacity of 80,000 cu ft and carried the payloads to a nominal floating altitude corresponding to approximately 8 mb. Owing to some extended periods of severe weather near the surface, only 12 releases could be attempted during the time available for the program. However, the performances of both the balloons and payloads were excellent. Extremely light winds in the stratosphere permitted reception of useful data for an average of about 40 hours, which was about equal to the battery-limited lifetime of each payload.

The period during which these experiments were conducted was a fairly active one geophysically, being marked by the occurrence of three geomagnetic storms and two energetic solar proton events. While the analysis of our observations during these disturbances is only preliminary at this time, it seems worthwhile to call attention briefly to some interesting features which we have recognized.

Observations of a Geomagnetic Storm

On January 13, 1967, at 1202 UT (0402 Byrd local time), a Storm Sudden Commencement (SSC) occurred. The scintillation detector carried by a balloon released about 30 hours earlier clearly responded about 100 seconds after the SSC to an initial weak maximum in bremsstrahlung X-rays from energetic electron precipitation (Fig. 1). The explanation of the delay is not clear, but it seems likely that it was related to an important characteristic time for acceleration and release of energetic electrons following the impulsive magnetic perturbation. About

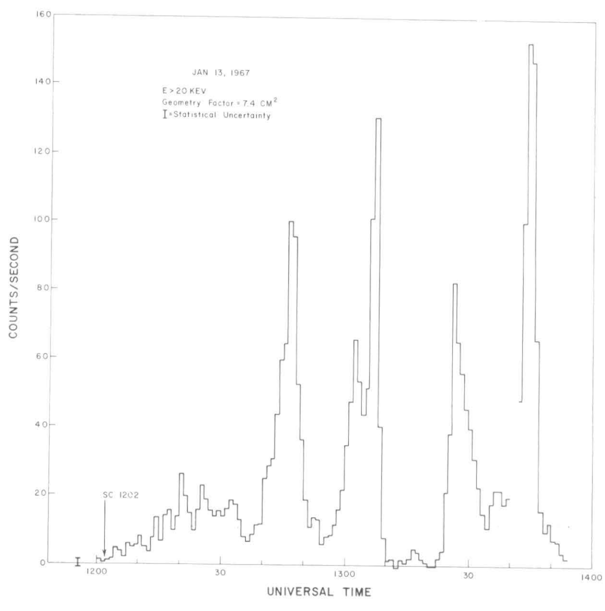

Figure 1. Bremsstrahlung X-ray intensities recorded over Byrd Station after the Storm Sudden Commencement on January 13, 1967.

40 minutes of sporadic precipitation followed the SSC, then the influx broke dramatically into a pattern of pulsations which completely dominated the bremsstrahlung activity until the cessation of the disturbance over Byrd Station at about 1400 UT. The pulsations are remarkable for their large relative amplitude, which is indicated by the fact that the intensity minimum approached the background level of activity. Furthermore, consideration of the temporal spacing of the major pulsations strongly suggests a quasi-period of approximately 20 minutes, which is unusually long (Barcus *and* Christensen, 1965). It has recently come to our attention that intense bursts of ultra- and very-low-frequency emissions were observed both in Antarctica and the Northern Hemisphere in close time coincidence with these X-ray pulsations. In addition, throughout this same period, magnetometer measurements carried by the ATS 1 geostationary satellite at 6.6 Re (Coleman *and* Cummings, 1967) indicate a pronounced compression of the geomagnetic field with superposed fluctuations that may have a hydromagnetic origin. We are currently exploring the possibility that interaction of energetic electrons with either electromagnetic or hydromagnetic waves might quantitatively account for the electron flux which the observations revealed to have occurred.

Solar Proton Events

Increases in the intensity of particles of cosmic ray energies arriving at the Earth were observed to commence on January 28 and February 2. The event of January 28 (Fig. 2) was of major proportions and is particularly noteworthy for the following reasons:

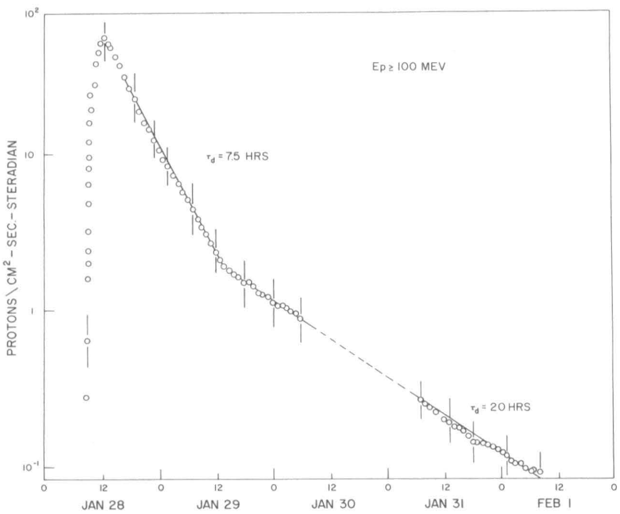

Figure 2. Intensities of cosmic ray particles over Byrd Station between January 28 and February 1, 1967.

(1) There had been no report of a large solar flare nor of extensive solar radio emissions to which the particle event could be linked. (A small, class 1B flare occurred at 0728 UT on the 28th, however.)

(2) The proton energy spectrum extended well into the Bev range, which resulted in a significant increase in the arrival of these particles at sea level at middle latitudes—the first such increase during the present solar cycle.

(3) No related Forbush decrease nor geomagnetic storm occurred.

These features appear to be consistent with the occurrence of a large eruption behind the eastern limb of the sun. In particular, our preliminary analysis of the temporal profile for protons having energies greater than 100 Mev indicates an average diffusion coefficient of 1/36 (AU^2)/hr, a delay time from injection to arrival at Earth of about 80-90 minutes, and a time from injection to intensity maximum of approximately 6 hours. The exponential decay ($\tau_D \approx 20$ hr) observed for the particle intensity late in the event suggests that the diffusion mechanism is effective within 2.0-2.5 AU but that beyond that range the particles find relatively easy escape from the inner solar system. These results are similar to Winckler's (1963) analysis of the September 3, 1960, event which had its origin in a very large flare on the eastern limb of the sun.

Acknowledgments

Many persons, too numerous to mention individually, contributed to the success of this program. We wish to thank the USARP and U.S. Navy personnel who provided excellent support. To the men at Byrd Station, many of whom assisted in the inflation and release of balloons, we are especially indebted. This research was supported by the Office of Antarctic Programs of the National Science Foundation (GA-522) and the National Aeronautics and Space Administration (NsG 518).

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Other Research Projects Active During the Past Summer

Identification and Physiology of Antarctic Microorganisms. Virginia Polytechnic Institute; Robert E. Benoit, Principal Investigator.

Molecular Biology of Ancient Frozen Tissues. Northwestern University; Mario A. Marini, Elmon L. Coe, and Mary Faith Orr, Principal Investigators.

Dry-Valley Ecology and Soil Microbiology. California Institute of Technology; Roy E. Cameron, Leader. (This project received only logistic support.)

Sampling of Trace Gas in the Atmosphere. National Center for Atmospheric Research; William H. Fischer, Leader. (This project received only logistic support.)

Spherules and Radioactivity in Antarctic Ice. University of Wisconsin; Larry A. Haskin, Principal Investigator.

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Ellsworth Mountains—*American Antarctic Mountaineering Expedition* (All members of American Alpine Club)

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Corbet, Barry
Evans, John P.
Fukushima, Eiichi
Hollister, Charles D.
Long, William E.
Marts, Brian S.
Schoening, Peter K.
Silverstein, Samuel C.
Wahlstrom, Richard W.

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Gless, Elmer E., Biology, Bishop Museum (USARP Coordinator)
Lange, Otto L., Biology, Clark Univ.

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Baldwin, Howard A., Biology, Johns Hopkins Univ.
Benoit, Robert E., Biology, Virginia Polytechnic Inst.
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Richter, Joseph J., Biology, Florida State Univ.
Schwartz, Wilhelm, Biology, Florida State Univ.
Warnke, Detlef A., Biology, Florida State Univ.

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Orheim, Olav, Glaciology, Norsk Polarinstitutt, Norway
Picciotto, Edgard E., Glaciology, Free Univ. of Brussels, Belgium
Stroschein, Leander A., Meteorology, USA Natick Lab.
Weller, Gunter E., Meteorology, Univ. of Melbourne, Australia

Sentinel Mountains and Ohio Range

Schopf, James M., Geology, USGS
Shaffer, Bernard L., Geology, Wichita State Univ.
Tasch, Paul, Geology, Wichita State Univ.

British Antarctic Expedition

Merrill, Theodore R., Jr., Biology, Bur. Comm. Fisheries

Expéditions Polaires Françaises (Dumont d'Urville)

Katsufrakis, John P., Ionospheric Physics, Stanford Univ.

Japanese Antarctic Research Expedition

Dort, Wakefield, Jr., Geology, Univ. of Kansas

Soviet Antarctic Expedition (Vostok)

Hessler, Victor P., Ionospheric Physics, Univ. of Alaska

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* Wintered over in 1966.
DES = Division of Environmental Sciences
ESSA = Environmental Science Services Administration
ITSA = Institute for Telecommunication Sciences and Aeronomy
NASA = National Aeronautics and Space Administration
NCAR = National Center for Atmospheric Research
NSF = National Science Foundation
OAP = Office of Antarctic Programs
USC&GS = U.S. Coast and Geodetic Survey
USGS = U.S. Geological Survey

OPERATION DEEP FREEZE 67

(U.S. Navy Photo)
From their arrival to departure, summer scientists were supported in many ways.

During the past summer season, operations in support of the United States antarctic program were highly successful. Undoubtedly, much of this success is the result of the experience acquired during the 11 preceding years. The U.S. Naval Support Force, Antarctica has learned the lessons of the past and has applied them imaginatively to the problems of the present.

Supply and Transportation

The general narrative of this year's operations has been presented in previous numbers of the *Antarctic Journal,*[1] and certain important aspects have been presented in articles prepared by the men who were engaged in them. Commander Joseph McNally, for example, has written on "Cargo Movement in Support of *Deep Freeze* 67."[2] While recognizing fully the role of aviation in the antarctic supply system, he pointed out the continuing importance of ships as the principal means of delivering dry cargo and fuels to McMurdo Station for distribution inland by air.

Ships still play other important roles in antarctic operations. Cargo vessels and tankers plying antarctic waters frequently require the support of icebreakers to clear a channel or to provide escort. Ships may also serve as mobile platforms from which to make weather observations. This function is particularly important to the success of long flights over ocean areas where no other means of obtaining weather information exists. This past season, the destroyer escorts USS *Mills* and USS *Thomas J. Gary* were assigned to rotate as picket ships in the vicinity of 60°S. 160°E. From that location, they sent vital weather information, acted as a communications link, and in case of need, could have provided search and rescue services. Late in the season, when ice conditions have improved, icebreakers may be released from their primary duties to support other activities. During the past season, they were used to assist in the supply of Hallett and Palmer Stations and to support scientific and other projects. In this issue, one icebreaker-supported activity is described in detail by Captain Lewis O. Smith—the inspection of eight foreign stations by a United States team carried aboard USCGC *Eastwind* (cf. p. 145).

Historically, men have reached Antarctica by ship, and inland travel was a long and arduous undertaking. Today, however, in the United States system, most men arrive in the Antarctic by air. Those who wish to move inland go by the same means, and once there are supported by goods and equipment delivered by aircraft. Commander McNally clearly set forth the magnitude of the supply operation, and in this issue (cf. p. 133), the former commanding officer of Air Development Squadron Six, Commander Daniel Balish, explains the way in which this and other air operations were carried out during *Deep Freeze* 67. In his article, Commander Balish mentions the part played by aircraft of the Air Force's Military Airlift Command and discusses the helicopter support rendered in Marie Byrd Land by an Army detachment. Also rendering helicopter support were icebreaker-based units of the Navy and Coast Guard. (All of the icebreakers were from

[1] Vol. I, No. 6, p. 243-254; Vol. II, No. 1, p. 1-4, No. 2, p. 33-40, and No. 3, p. 57-61.

[2] *Antarctic Journal,* Vol. II, No. 3, p. 69-71.

the Coast Guard, but all of the helicopter detachments, except the one aboard *Eastwind,* were provided by the Navy.) To conduct aerial reconnaissance of ice conditions along the Antarctic Peninsula and to obtain photography for the mapping of Palmer Land, VX-6 for the first time based one of its aircraft in South America, where assistance was received from the Chilean Navy and Air Force. Also for the first time, the squadron suffered no major accidents, a reflection of the skill acquired during 11 years of flying in a dangerous and unpredictable area.

Stations

To support both scientific and logistic programs, the United States maintained five year-round stations during *Deep Freeze* 67. There were also two summer stations, Hallett and Brockton; their function was to take weather observations necessary for aircraft operations, and Hallett was also the locale for some scientific work. Of the permanent stations, two are somewhat unique. McMurdo, although the site of important scientific programs and facilities, is primarily a logistics staging base. From it were supported the inland stations—Amundsen-Scott South Pole, Byrd, and Plateau—and the two summer stations. Through it streamed scientists on their way to field locations and construction and other support personnel who were headed inland. Palmer, on the other hand, is distant from the other United States stations and has a separate line of logistic support: it is supplied entirely by ship from the United States via South American ports.

When the decision was made to remain in the Antarctic after the end of the International Geophysical Year, it was found that existing stations required renovation if they were to be permanently occupied. The original Byrd Station had to be replaced when the pressure of snow and ice threatened to crush it, and the same situation is developing at South Pole Station. In other cases, the exigencies of the scientific program have called for changes at existing stations or for the building of new stations at different sites. Out of these necessities has developed a continuing construction program which seeks to apply advances in building techniques and the experience of the past to the current situation. The objectives of this program are to improve habitability, increase efficiency, and provide the scientists with up-to-date facilities.

A significant step toward improved habitability occurred at McMurdo Station where the water distillation system went into full-time operation last December and later (on January 16) started using heat from the nuclear reactor. The reactor itself, after five years of operation,[3] showed greater reliability than ever before. Its availability increased from 36 percent in 1964 to 77 percent in 1966, and it achieved one continuous run of 3,390 hours, at that time a record for a United States shore-based military reactor.

In this issue, Major Donald Pope reviews the progress made in the construction program during the year and outlines some of the plans for the future (cf. p. 137), and Lieutenant Richard Whitmer and Chief Petty Officer George Kelley describe what was accomplished on Anvers Island toward the construction of permanent facilities at Palmer Station, which should be completed by the end of next season.

Support Services Improved

Deep Freeze 67 also witnessed a steady improvement in the operations and services for which the Commander, Antarctic Support Activities is responsible. For example, experience with the requirements of antarctic operations, supplemented by new warehousing, permitted the introduction of more efficient supply procedures. Meteorological services were enhanced by the use of information from polar-orbiting weather satellites, and it was found that data from this source could be received even when other radio communications were blacked out.[4] It is by such applications of new techniques and good management practices throughout the Naval Support Force that expenditures were kept within a fixed monetary limit.

Operation Not Over

In the past, when the last ships and aircraft left the Continent at the end of the summer season, the stations were isolated for the winter and could not expect physical contact with the outside world for six months or more. The success of four winter medical evacuation flights in the past six years made it seem possible to make regular winter flights. For *Deep Freeze* 67, two such flights were scheduled (one in June 1967, the other in August) for the principal purpose of taking scientists to Antarctica after the end of one academic year and returning them before the beginning of the next. The first flight has been successfully completed and will be reported on in a future issue of the *Journal.* Although it is perhaps premature to state that antarctic flight operations, like many of those in the Arctic, can be carried on routinely throughout the year, the advances steadily being made do hold promise for the future.

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[3] *Antarctic Journal,* Vol. II, No. 2, p. 38-40.

[4] An article on the applications of weather satellite data in Antarctica will appear in the next issue.

Deep Freeze 67 Air Operations

DANIEL BALISH [1]

Commander, USN

Bureau of Naval Personnel

Deep Freeze 67 was a very fruitful and satisfying season of antarctic air operations. Resupply goals were exceeded, more high-quality aerial photography of the Antarctic was obtained than in any other season, the placement and retrieval of field parties very closely matched the planned timetables, and no serious injuries or aircraft accidents occurred. These achievements are a tribute to the pilots and airmen of the Antarctic Air Group and to the many dedicated personnel who participated in preparing the plan of air operations.

Plan Paves Path

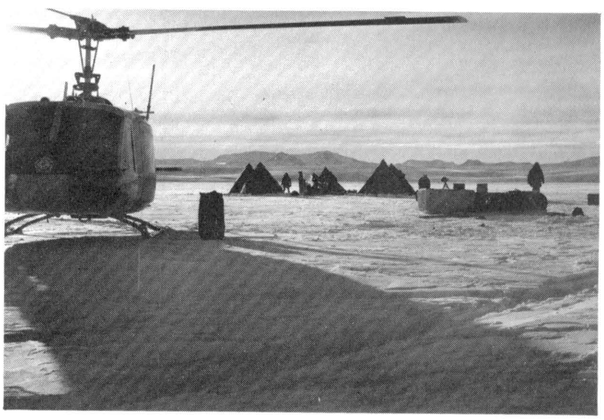
Careful planning is the path to success, and *Deep Freeze* 67 air operations actually began in conference rooms in early 1966. Prior to the drafting of the Task Force operation order, numerous meetings and discussions were conducted by the staff of the U.S. Naval Support Force, Antarctica with participating military aviation commands: the U.S. Navy's Air Development Squadron Six; the U.S. Army Aviation Detachment (Antarctica Support); and Air Transport Squadron Seven, which was a Navy squadron under the operational control of the Air Force's Military Airlift Command.

Information on the many complex scientific projects to be supported was considered in the light of those logistics planning factors that are most important to a smooth, orderly flow of personnel and materials to and within the Antarctic. Consultation with the National Science Foundation was constant in order to assure that the emerging air operations plan would be complete and accurate. Mr. William MacDonald of the U.S. Geological Survey contributed immeasurably to the aerial photographic survey plan. The preliminary discussions completed, the operation order for *Deep Freeze* 67 was published by the Commander, U.S. Naval Support Force, Antarctica on July 22, 1966.

The unit of the Antarctic Aviation Group scheduled to deploy first was, of course, Air Development Squadron Six (VX-6). Upon receipt of the operation order, briefings and discussions were conducted to acquaint everyone within the squadron, from the commanding officer to the most junior airman, with the details of the order. Aircraft were checked, rechecked, and tuned for antarctic service. Personnel were assisted in arranging their personal affairs for the fast-approaching six-month deployment to Antarctica, and leave schedules were adjusted to accommodate the inescapable last-minute details. It was a scene familiar to those who had been with the squadron during a previous deployment, and in varying forms it was reenacted in Virginia by the Army helicopter unit preparing for its 10-week deployment, and in California by the Navy Transport Squadron for its scheduled two months in Antarctica.

Evacuation From Byrd Station

By mid-August, VX-6 was prepared in all respects for an orderly deployment to Antarctica to commence *Deep Freeze* 67 operations according to plan, but the validity of the old adage about best laid plans was once more demonstrated. A major change to the plan that had been so carefully prepared for *Deep Freeze* 67 occurred when word was received that a scientist wintering at Byrd Station was seriously ill and aerial evacuation was recommended. Air Development Squadron Six was alerted, and within 12 hours of a report on September 9 that the patient's condition was worsening, an LC-130F Hercules, manned by a volunteer crew, had departed Quonset Point, R. I., for Antarctica. (A second LC-130F left later to serve in a reserve and rescue capacity.) The evacuation plane proceeded directly to Christchurch, New Zealand, stopping only for fuel (at Alameda Naval Air Station, California; Hickam Air Force Base, Hawaii; and Nandi, in the Fiji Islands). On arrival at Christ-



(U.S. Navy Photo)

Army turbine helicopters have supported field parties since Deep Freeze *62 (above). This season they were used in Marie Byrd Land.*

[1] Operations Officer and Executive Officer of Air Development Squadron Six from April 1964 to June 1966, when he assumed command. He was detached from VX-6 in April 1967.

church, about 39 hours after departing Quonset Point, the crew readied the aircraft for antarctic operations before turning in for a welcome 10-hour rest. The morning of September 12 found the crew rested, the aircraft ready, and the weather along the route to Antarctica favorable.

The evacuation flight departed for McMurdo at 1000. When it arrived there nine hours later, fog and poor light conditions prevailed, requiring a ground-controlled approach to landing. The crew was greeted by tired but happy wintering-over personnel of the McMurdo Detachment who had prepared the landing facilities on extremely short notice. The evacuation plan called for the aircraft to proceed immediately to Byrd Station for a daylight landing, but Nature played one of her high cards—bad weather at Byrd Station. The weather forced the plane to wait at McMurdo for 10 hours, after which it was decided to press on with the evacuation even though Byrd Station would be shrouded in black antarctic night.

The September 13 flight to Byrd was conducted without any particular difficulty and, except for temperatures of −63°C. (−82°F.),[2] the crew considered it uneventful. The seriously ill scientist was carefully settled in the aircraft, and 35 minutes after its arrival, the aircraft was winging its way back to Christchurch via McMurdo. Before the day ended, the ailing scientist had been admitted to Christchurch General Hospital. Less than 100 hours had elapsed from the time the flight was ordered to the time the aircraft completed a mission which had required it to fly halfway around the world.

Once the emergency flight had been completed, VX-6 resumed operations on the basis of the original plan, the instruments of which were four LC-130F Hercules, three LC-117s, two C-121J Super Constellations, one C-47 Skytrain, and five LH-34 Seahorse helicopters. Three helicopters and two of the LC-117s had remained at McMurdo in winter storage, and the C-47 was in Christchurch, where it had been completely overhauled in the shops of the National Airways Corporation of New Zealand. Both of the Constellations had been employed since mid-August in transporting advance personnel from the continental United States to Christchurch. Two LH-34s were shipped aboard USNS *Towle,* and the remaining aircraft—two LC-130Fs and an LC-117—departed Quonset Point, Rhode Island, on September 19, 1966, as scheduled.

(The ferry flight of the LC-117 is a tale in itself. Piloted by Lt. Comdr. C. D. Moran, USN, the aircraft arrived at Christchurch in early October after the 10,000-mile trip from Quonset Point. It was expected that the plane would proceed to McMurdo shortly after arriving in New Zealand, but—belonging to an earlier and less powerful generation of aircraft than do either the Hercules or the Constellation—the LC-117 needed near-perfect conditions for its flight to Antarctica: clear weather at McMurdo for a 24-hour period, a headwind component of not more than 10 knots, and an atmosphere free of ice. To predict the concurrence of these conditions, the meteorologists of Task Force 43 spent many hours analyzing weather data on a round-the-clock basis, but almost two months passed before the weather criteria for the flight could be met. Finally, in late November, the plane departed Invercargill, New Zealand. Some 15 hours later, the trusty old aircraft landed at Williams Field, and her crew was greeted by a jubilant welcoming committee of squadron mates.)

Season Starts on Schedule

By September 23, the four Hercules and the two Constellations had completed their part in moving personnel and cargo to Christchurch, after which all aircraft were subjected to further checks and outfitted for antarctic operations, scheduled to start on October 1. On the stroke of midnight, Christchurch time, the first of four LC-130Fs commenced its takeoff run for the eight-hour flight to McMurdo. On board for the initial fly-in were Rear Admiral Bakutis, the Task Force commander, Captain H. M. Kosciusko, the commander of Antarctic Support Activities, the commanding officer of VX-6, and 35 military and civilian personnel essential to the expansion of operations at McMurdo Station. Cargo on the first aircraft included mail and priority spare parts for machinery at McMurdo. The other three Hercules departed Christchurch at two-hour intervals with additional priority passengers and cargo. All four planes flew to McMurdo without incident and arrived on schedule; *Deep Freeze* 67 was in full operation. After a two-hour refueling and servicing period at McMurdo, two of the aircraft returned to Christchurch to pick up more passengers and cargo for McMurdo as part of the plan to relieve the station's wintering-over party at the earliest practicable date.

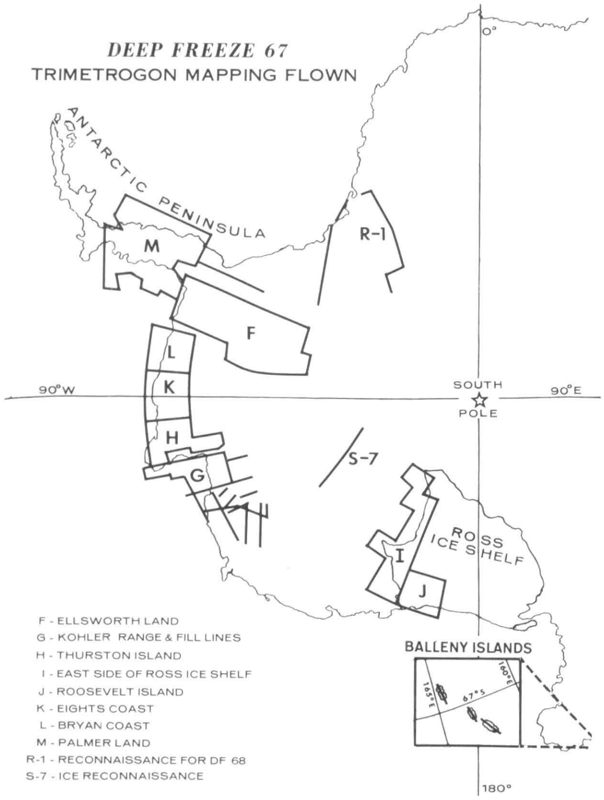
With the arrival of the summer support personnel at McMurdo, preparations were immediately made for the Hercules to transport the first crew and cargo of the season to Hallett Station, to establish Brockton weather station, and to make the official opening flight to Byrd Station. All three of these flights were dispatched on October 3. The resumption of flights to the stations signalled the commencement of

[2] Because of the many problems created, flight activities are usually suspended when temperatures descend to −65° F.

annual resupply operations that would continue, weather permitting, on a 24-hour basis for the entire five-month austral summer period. Another event on the 3rd was the arrival at Williams Field of the season's first C-121 flight, with 68 passengers. The second of the Constellations remained on station in Christchurch as a possible rescue craft, a silent sentry role that the two aircraft alternately filled from October 2 to October 20. This course of action was prescribed in the air operations plan to permit the maximum number of people to be transported to McMurdo in the shortest time and—by thus freeing the LC-130Fs for resupply and photography missions—to allow operations on the Continent to proceed at an accelerated pace.

Aerial Photography Program a Great Success

The aerial photography program for the 1966-1967 austral summer was the most ambitious in the history of *Operation Deep Freeze,* calling for some 24,000 flight-line miles to be flown to obtain



coverage of more than 350,000 square miles. Included in the task was the photographing of a large area of the Antarctic Peninsula.[3] One LC-130F and one C-121J were assigned to the program. To photograph the Antarctic Peninsula, the C-121 staged out of Punta Arenas, Chile, for two months, and the LC-130F simultaneously staged out of Byrd Station. By this method of operation, the Hercules could provide search and rescue coverage for the C-121 since the respective areas of operation were compatible in a time-distance frame; this meant that the remaining aircraft were free to continue resupplying the permanent stations (Byrd, Pole, and Hallett) as well as the temporary weather station (Brockton) and remote mobile field camps.

VX-6 was very successful in meeting the aerial photography plan: 23,380 flight-line miles of tri-camera aerial mapping had been requested, and 24,504 were flown. Special photography requirements were also exceeded (521 flight-line miles requested, 593 flown); and of 800 flight-line miles of reconnaissance photography requested, 741 were flown. All told, flight photographers logged more than 3,200 flight hours over Antarctica on photographic missions.

The smooth start of the summer resupply and field programs appeared to be a favorable omen for the summer's work, but all was not well at Plateau Station: the diesel generators, which had been a source of concern to the wintering-over party since late July 1966, began to malfunction again in early October. It was considered essential to the party's continuation of vital scientific programs that Plateau receive necessary repair parts from McMurdo. Between the 8th and 10th of October, plans were formulated for early penetration of the antarctic plateau, and on the 13th, an LC-130F was dispatched to Plateau Station with the generator repair kit, and so another chapter was written into antarctic aviation history. The extreme cold at the station (− 57°C., − 70°F.) caused minor damage to the aircraft, but a successful takeoff was effected and the airplane returned by way of McMurdo to Christchurch, where repairs were made. Five days after arriving in Christchurch, the LC-130F returned to Antarctica.

C-141 Flight

An event during *Deep Freeze* 67 of potentially great significance to the future of antarctic aviation was the November 14 landing on the ice runway at Williams Field of a C-141 Starlifter.[4] The aircraft delivered the largest payload ever flown to the Continent in a single flight by a U.S. aircraft (12.5 tons), demonstrating the feasibility of pure-jet operations in the Antarctic and their vast superiority in terms of cargo movement. Even the failure of the aircraft's first attempt on November 10-11 showed its superior capabilities: deterred by strong winds at McMurdo, it retraced its route back to Christchurch, a feat

[3] *Antarctic Journal,* Vol. II, No. 2, p. 37.

[4] *Antarctic Journal,* Vol. II, No. 1, p. 21.

of range—and therefore of safety—that cannot be matched by the aircraft currently used on that hazardous route.

Marie Byrd Land Survey

Late October saw the opening of Marie Byrd Land Camp No. 1 as the first step in a planned three-camp, multidisciplinary survey of the coastal area of Marie Byrd Land. The camp was located at the head of Arthur Glacier, some 700 miles from McMurdo Station. After ground support personnel had been placed at the campsite, helicopters of the U.S. Army Aviation Detachment (Antarctica Support) were readied for flight to the camp. On November 2, the detachment's three UH-1D Iroquois helicopters departed McMurdo Station to rendezvous with a fuel-bearing LC-130F in the vicinity of Roosevelt Island. The aircraft met on schedule, and the refueled helicopters proceeded directly to Camp No. 1, where the speedier LC-130F had taken station to provide navigational assistance by acting as a radio-homing beacon for the helicopters. With the arrival of the helicopters—which provided the scientists with 370 hours of support in 93 flights—the scientific activities increased, and Camp No. 1 became a prime customer for Hercules logistic support.

The major difficulty encountered in Marie Byrd Land was adverse weather. Although the prevalence of bad weather in this area had been considered in the preseason planning, the extent of the delays exceeded expectations, and early in the field program a UH-1D helicopter was lost as a result of the weather. (The accident occurred under poor visibility conditions while the helicopter was recovering a field party marooned for two days on a mountaintop.) Fortunately, flight operations in Marie Byrd Land continued without incident for the remainder of the operating season, although the weather remained unfavorable.

To compensate for the weather problem, fuel caches were placed east and west of Camp No. 1. These caches appreciably lengthened the range of helicopter operations and served as emergency camps for small scientific parties for extended periods. In this way, the frequent spells of bad weather were made less of a handicap, and a maximum of scientific activity was permitted over a broader geographical area. Camp No. 1 was closed in late January, and all personnel and the helicopters returned to McMurdo for transportation from the Continent. The survey was not what it was planned to be, but, on reflection, those concerned with its scientific yield were satisfied with the results obtained in the face of adverse circumstances.

Other Field Support

The effort to place a party at Beardmore Glacier in early November was from the outset plagued by difficulty. The LC-130F assigned the mission landed on an apparently favorable snowfield north of the upper Beardmore Glacier. On touchdown, however, the aircraft's port ski struck a hidden ice berm, causing the ski to collapse. Repairs were made by the crew members while the field party's equipment was unloaded, and all personnel boarded the aircraft to return to McMurdo, where careful inspection of the aircraft revealed no unrepairable damage. A search was begun to locate a safe landing area on the polar plateau about 30 miles from the equipment cache. (Although this would result in a traverse for the field party, it would ensure the safety of the aircraft, one of the most valuable resources in the antarctic science program.) A suitable landing site was soon located, and the field party was delivered without incident some three days later.

As a result of this nearly disastrous incident, a decision was made to reconnoiter each and every open-field landing area. This action cost only a few flight hours and paid great dividends in safeguarding valuable aircraft. The long-term advantage of this procedure will be to help the overall program by significantly decreasing the possibility of aircraft damage in future field operations, as well as reducing the hazard to personnel.

The aerial placement and recovery of field parties in the vicinity of the Polarstar Formation in the Sentinel Range (where geological and paleontological studies were conducted) and in the Ohio Range were completed without incident. The most publicized field party to receive aerial support this last season was the American Antarctic Mountaineering Expedition, whose goal was to scale Vinson Massif, the highest mountain in Antarctica, and other peaks in the Sentinel Range. After a preliminary reconnaissance flight, the party and its equipment were loaded aboard the aircraft at McMurdo for what was expected to be a normal delivery, but when the plane arrived at the landing site, the area was blanketed in low-lying fog, and an alternate landing area, some three miles from the chosen site, had to be used. The party was unloaded and the plane started back to McMurdo. All was considered to be going well when word was received at McMurdo that the party was unable to locate a fuel cache that had been placed during the reconnaissance landing, but a later message stated that the cache had been located and the climb was proceeding as planned. The group was eminently successful, and approximately three weeks later, an LC-130F recovered the party and returned it to McMurdo on the first leg of a triumphant return to the United States.[5]

Helicopter Support Near McMurdo

In addition to the previously mentioned Army Aviation Detachment's operations in Marie Byrd Land, helicopter support for science was provided by Air Development Squadron Six, which operated its LH-34s within a 200-mile radius of McMurdo Station on a daily basis, completing more than 100 percent of the planned program. The helicopters also proved valuable in familiarizing working visitors and distinguished guests of the New Zealand and United States Governments with the area around McMurdo. (McMurdo-vicinity helicopter operations were the only flight activities that were not cancelled by a communications blackout that started on January 29. The magnetic storm persisted unabated until February 4. Normal operations resumed on the 6th, but solar flare activity continued to cause communications problems through the remainder of February.)

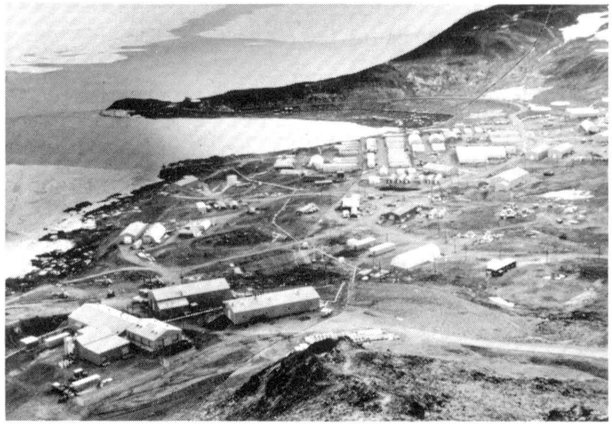
The squadron's helicopters completed their tasks without a major accident or incident, although on one occasion a helicopter was forced to land in the treacherous and confined moraine area near Koettlitz Glacier. The cause of the forced landing—failure of the oil-pump drive shaft in the main-rotor gearbox—presented a very significant problem to the maintenance department since this major repair is normally performed at an overhaul depot. To add to the difficulties, a major storm was reported to be brewing, and the forecasters predicted its arrival in the McMurdo area within 12 hours of the time of the forced landing. The estimated time to complete repairs was 12 - 15 hours, but rather than suffer the loss of the helicopter, a maintenance crew was dispatched to the scene. Working in sub-zero temperatures without the benefit of special tools that a depot uses, the mechanics completed the repairs in nine hours. A half hour later, the helicopter was snugly secured at the McMurdo heloport, where it successfully rode out the storm.

The helicopter rescue episode and the LC-117 ferry flight point out the dependence of air operations everywhere—but certainly nowhere more so than in the Antarctic—on capable, dedicated maintenance personnel to care for the aircraft, skilled meteorologists to predict the weather conditions for safe flying, and many others to tend the ground facilities. Too numerous to cite individually, they share with the Army, Navy, and Marine Corps aircrew members in the success of the Antarctic Air Group during *Deep Freeze* 67.

[5] *Antarctic Journal*, Vol. II, No. 2, p. 48-50.

Construction Report: *Deep Freeze 67*

DONALD R. POPE[1]
Major, USA
United States Military Academy



(*U.S. Navy Photo*)
Composite photograph of McMurdo Station showing extent of facilities.

The construction program this past season was carried out essentially as planned. Although the program was highly successful and the accomplishments were many, perhaps the most significant aspect of the *Deep Freeze* 67 construction program was not *what* was done, but *who* accomplished it. On May 1, 1966, a new unit was commissioned at Davisville, Rhode Island, by the Commander, U.S. Naval Construction Battalions, Atlantic Fleet to provide construction support in Antarctica. This new organization, U.S. Naval Construction Battalion Unit (NCBU) 201, is unique in that it is the only Seabee operating unit in the Atlantic Fleet that does not—because it was formed for a very specific and continuing mission—carry the "mobile" designation.

Previously, antarctic construction had been performed by various mobile construction battalions that were assigned on a year-by-year basis. Although an annual effort was made to carry over from unit to unit some personnel experienced in antarctic construction, the mobile battalions did not enjoy the degree of continuity and the resulting efficiency that could be provided by a regularly as-

[1] Formerly on the civil engineering staff of the U. S. Naval Support Force, Antarctica.

signed unit tailored for antarctic construction. In its first season, NCBU 201 deployed under the command of Lt. (jg.) Richard D. Whitmer with a total of 4 officers and 127 enlisted personnel, including the 1 officer and 25 enlisted men in the platoon at Palmer Station. (NCBU 201's strength for *Deep Freeze* 68 is expected to increase to 5 officers and 208 enlisted men with about 35 of these deploying to Palmer Station.)

McMurdo Station

The majority of the *Deep Freeze* 67 construction effort was at McMurdo Station. Major projects there included the first phase of the new personnel facility, a new public works and transportation center, a supply warehouse for Air Development Squadron Six (VX-6), several additions and improvements to the water and sewer systems, increasing the fuel storage capacity for both diesel and jet fuels, and the addition of a radiological waste disposal building to the PM-3A nuclear power plant's facilities. Additionally, several minor projects and the preparatory work for several *Deep Freeze* 68 projects were completed. Five old buildings were demolished, and foundation pads were prepared at three new building sites.

The work done on the new personnel facility included the erection of the building shell and partial installation of the utilities for the single-story portion of the structure—the galley, utilities room, and laundry. Completion of this portion of the building and construction of the shell of the remaining two-story barracks section are scheduled for next season. Hopefully, the entire facility will be operational by the end of *Deep Freeze* 69. When completed, this structure will decidedly improve living conditions at the station by providing a large, modern laundry and a galley which, with two serving lines, will feed 1,000 persons, 272 of them at one sitting. The barracks section will be capable of housing a total of 257 persons. One- and two-man rooms will be provided for 21 officers, three-man rooms for 24 petty officers, and four-man rooms for 212 enlisted men. Also to be included are toilet facilities, a ship's store, a barber shop, and lounges. Officers and chief petty officers will each have a lounge, and there will be a lounge on each floor for the enlisted personnel. With overall dimensions of 318 feet by 165 feet and a total floor space of 68,000 square feet, the building will be by far the largest ever constructed in the Antarctic.

The public works and transportation center, which was completed this season, provides McMurdo Station with much-needed maintenance facilities. This structure is unique in that it is the only permanent building at McMurdo that was not wholly prefabricated prior to shipment from the United States. The building was constructed by covering a steel frame (originally intended for construction of an aircraft hangar, but cut down to a smaller size before shipment) with galvanized sheet metal insulated with fiber glass. The building is actually a structure within a structure: inside the main building, which measures 122 feet by 112 feet, is a two-story structure that contains the public works office, engineering spaces, transportation and maintenance offices, storage space, and machine, metalworking, and carpentry shops. The floor space not occupied by the interior structure (nearly 8,000 square feet) serves as a vehicle and equipment maintenance shop.

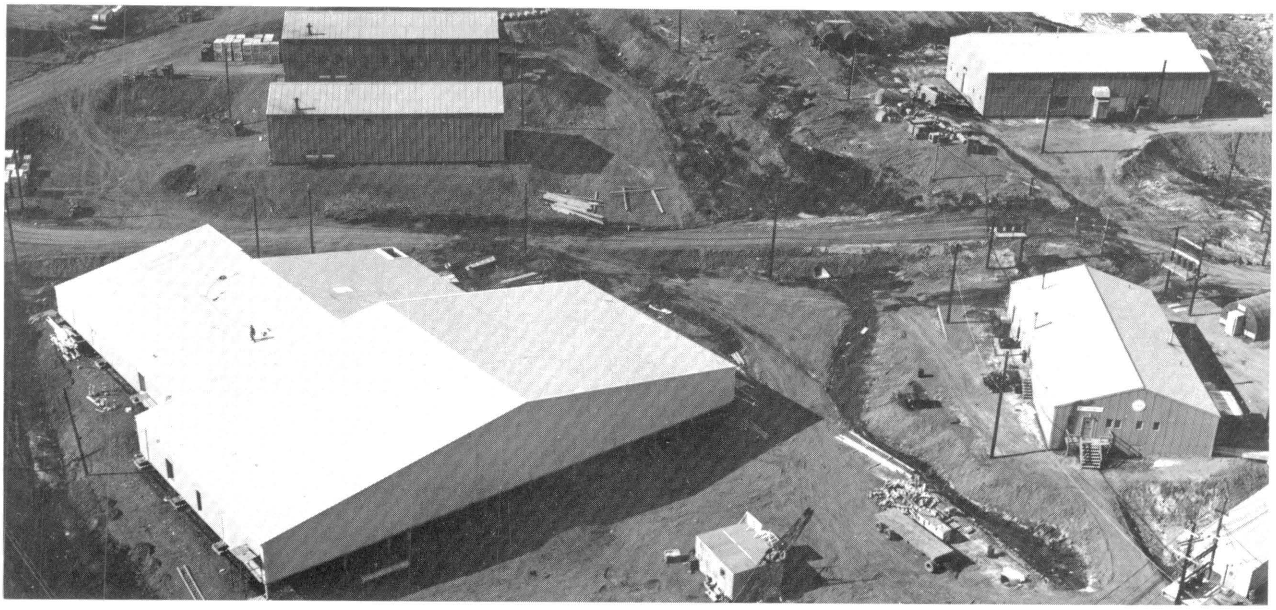
The VX-6 warehouse, a 40- by 100-foot two-story Robertson building, is similar to the five permanent warehouses constructed during previous seasons. It was, however, modified to permit installation of a rawindome and balloon tracking equipment atop the building. This modification was completed except for installing the dome itself, which did not arrive as expected on the resupply ship.

Water Systems Improved

Several improvements were made to the water supply and sewage disposal systems. A new saltwater intake was constructed by installing a culvert in the form of an inverted T near the end of a new rockfill jetty which was built 110 feet seaward from the saltwater pumphouse. The culvert descends 20 feet into the jetty, and each arm extends 50 feet perpendicular to the axis of the jetty, thereby placing the intake openings beneath the depth of annual ice formation. The top of the culvert opens within a small intake house which is heated to keep the water in the culvert from freezing, and permanent, heated piping connects the intake shelter with the pumphouse. This system is believed to be an optimum solution to the problem of obtaining sea water under all types of ice conditions, but in view of the damage caused by severe waves during a post-summer storm, it is apparent that additional reinforcement and protection is required for both the intake shelter and the piping placed on the fill.[2]

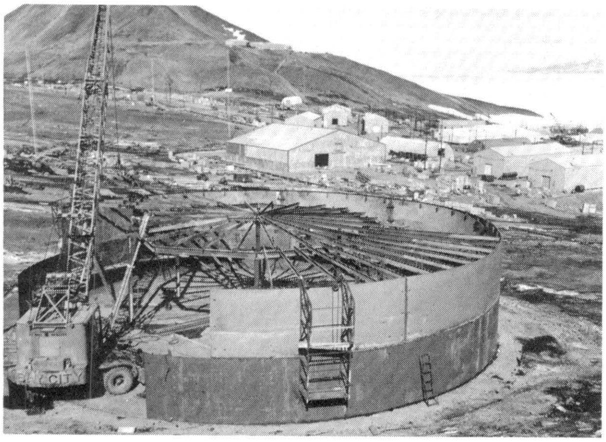
The two 55,000-gallon salt and fresh water storage tanks, located in the water distillation plant on Observation Hill, received anticorrosion treatment. Prior to reactivating the distillation unit, the inside surfaces of both tanks were sandblasted and protective epoxy coating applied. The coating should significantly extend the life of the tanks. Some work

[2] Winter personnel have restored the system to operation.

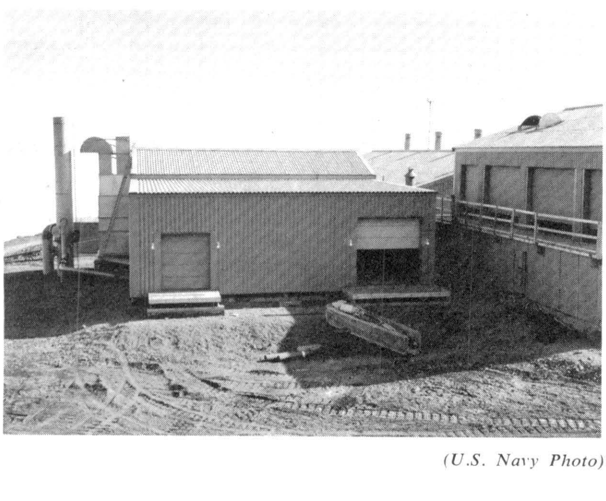


(U.S. Navy Photo)

When completed, personnel building at McMurdo will be largest structure in Antarctica. (Note man on roof.) Barracks section will occupy level area in foreground. Adjacent structures are (clockwise) two VX-6 warehouses, diesel generator building, and dispensary.



(U.S. Navy Photo)

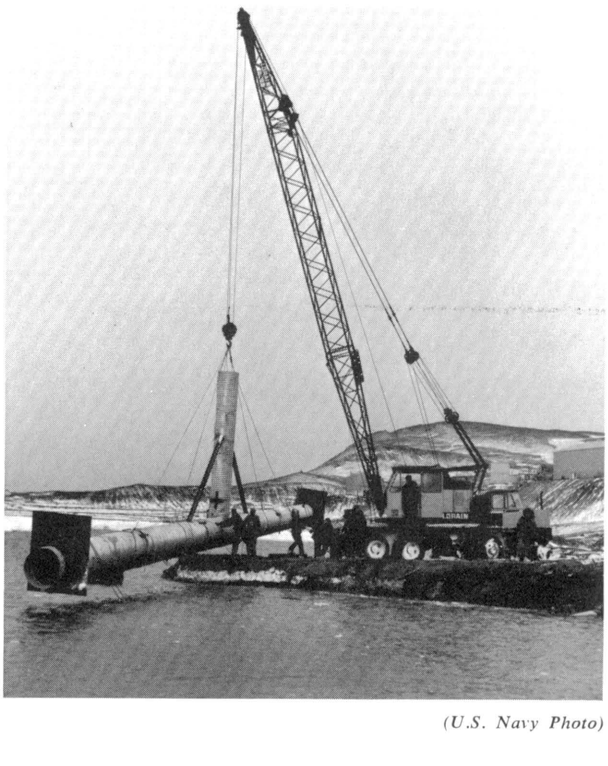


(U.S. Navy Photo)

Fuel storage tanks (left) were enlarged by adding ring at base. Public works building, under construction, appears in immediate background.

Addition to PM-3A complex (lower left) was completed in early January.

Installing saltwater intake in early February.



(U.S. Navy Photo)

was done to improve the water distribution system; this included installing a new pressure-reducing station, constructing spurs to the flag and staff quarters and to a latrine, and installing a T-joint to provide for a future spur to the personnel building. A related remodeling project provided an enlisted latrine with complete facilities, including flush-type commodes—the first community facility to be so equipped at McMurdo—and a discharge pipe was installed that extended the sewer system to the area of the dump so the system could be placed in operation.

Installation of a system to monitor the temperature of all water and sewer lines, which are warmed with electrical heating tape, was begun. This project was not completed because certain materials were not received, but completion next season is expected. The system will consist of temperature-sensing devices placed every 200 feet. If the temperature in the line drops too low, an audio-visual alarm is sounded in the diesel generator buildings and the location of the trouble is indicated on a schematic panel. Remote, manually operated dump valves will allow quick removal of water from a faulty section, if required. When completed, this monitoring system should greatly increase the integrity and operational reliability of the water distribution and sewer systems.

A 10-man contract crew from the Chicago Bridge and Iron Company performed two tasks at McMurdo during the months of December and January. One was doubling the capacities of three 250,000-gallon storage tanks, two for diesel fuel and one for jet fuel, by disassembling and rewelding the tanks with the addition to each of an 8-foot-high bottom ring. The other was the addition of a radiological waste-disposal building to the PM-3A complex. This structure will allow the reactor's crew to process the waste more efficiently and, by means of a special press in the building, the contaminated materials can be compressed to a smaller volume before shipment back to the United States for disposal.

Other miscellaneous and smaller projects were completed, such as the installation of a 1,000-gallon emergency water tank in the equipment room of the dispensary, completion of a carbon dioxide fire prevention system in the building that houses the communications receivers, installation of ventilation fans and commodes in the senior scientists' quarters, and the leveling of an area for use as an alternate helicopter pad. The location of this pad, in the pass north of Observation Hill that leads from McMurdo to Scott Base, will allow helicopters to remain over land during the critical low-altitude phases of flight. This is of special value to heavily-laden helicopters taking off during those periods when McMurdo Sound is free of ice.

Some work was done in preparation for three future buildings: Foundation pads were constructed for the second VX-6 warehouse, a building to house the squadron's shops and offices, and the USARP field-party processing and equipment center. Additionally, Jamesway housing was constructed to accommodate the increased number of NCBU 201 personnel who will work at McMurdo next season. Work also commenced on temporary Jamesway offices for the Seabees. (The present offices will be demolished to make way for the new administration and operations building.)

Palmer Station

Initial construction of the new facilities at Palmer began this season. Platoon Alpha of NCBU 201, 25 Seabees under the command of Lt. (jg.) Walter B. Garrott, worked at the new site from January 8 to March 20, 1967. During this time, they constructed a wharf of steel and crushed rock, two 3,000-barrel (126,000-gallon) fuel tanks, and the foundation and subflooring for the new permanent building, which will be a metal Robertson building.[3] The remainder of the construction, including the completion of the main building, will be accomplished during a similar period next season. Because the permanent station will have as its principal mission the support of biological studies, including research-vessel operations, the station building, in addition to providing living spaces for scientific and naval personnel, will contain a biology laboratory and storage space for biological and research-vessel supplies.

Construction at Inland Stations

Construction at inland stations was minimal as compared with *Deep Freeze* 66 when both Plateau Station and the Byrd VLF substation were constructed. The most significant project in this category was the installation at Byrd Station of the U.S. Army Cold Regions Research and Engineering Laboratory's deep drill.[4]

At Plateau Station, a 102-foot micrometeorological tower and two Jamesways were constructed. One of the 16- by 32-foot Jamesways provides additional indoor storage, and the second structure, which has electrical heating and additional insulation, provides recreation space for the station personnel.

[3] A detailed account of the construction work appears on p. 142.

[4] A report on this research project appears on p. 120.

The remainder of the work done at the inland stations was maintenance. At Byrd Station, the roof of the hydrogen-generation building was reconstructed. The roof trusses, which had originally rested on the ice walls of the tunnel, had failed during the previous winter. The roof and the trusses were removed, supporting columns installed, and the trusses and roof reinstalled. At the nearby VLF substation, the generator air-intake duct was raised some 16 feet to prevent blowing snow from entering the duct. Also at the substation, a fan was installed to prevent the recurrence of a problem encountered during the previous winter when a sub-floor pocket of warm air caused the foundation to shift. The end wall of the generator tunnel at Pole Station was rebuilt, and at Plateau Station the comfort of the enclosed "perma-walk" area was increased by the installation of a louvered air-intake and an exhaust fan that will expel the excess heat that accumulates in this area during the warmer summer periods.

Next Year's Plans

The *Deep Freeze* 68 construction program is shaping up to be the most ambitious attempted in recent years, due principally to the increased strength of NCBU 201 and the prepositioning of materials during *Deep Freeze* 67. Several major projects have already been mentioned—the continuation of work on the personnel building, the completion of the pipeline alarm system, and the completion of the main building for the permanent Palmer Station. Other major projects include the construction of a second VX-6 warehouse and the VX-6 shops and offices building. The completion of these two structures, and the demolition of the temporary buildings they will replace, will bring about a noticeable change in the appearance of the squadron's area at McMurdo. Of all the structures present in this area at the beginning of *Deep Freeze* 67, only two will remain at the end of *Deep Freeze* 68 or the beginning of *Deep Freeze* 69—the helicopter hangar and the electronics shop, both of which are permanent buildings.

Currently under study is a proposal to construct a new road to Scott Base. The proposed road, to start at the middle of the pass, would provide a less precipitous, permanent route to Williams Field than does the existing road. The permanent pipeline which transports diesel and jet fuel from the four storage tanks in the pass will be extended along the new road to a terminal north of Scott Base. From there, it will be possible to transfer the fuel to Williams Field in hoses placed over the permanent ice shelf, thus eliminating the danger of losing the hoses during the breakup of the annual ice. Other fuel system modifications are also planned. These include increasing the automotive gasoline storage capacity by 250,000 gallons, extending the present aviation gasoline pipeline to a terminal point in the pass (and to a storage tank scheduled to be built near the station's helicopter pads), and altering the pumping system to increase the speed of ship-to-shore transfer.

For several seasons, Elliott Quay has been subject to noticeable erosion. A three-year project to prevent further erosion will be initiated during *Deep Freeze* 68. Plans call for installation in each of the three years of a 300-foot-long section of sheathing supported by cantilevers anchored in the ice quay. Several other improvements are planned for McMurdo: a second 14,400-gallon-per-day water distillation unit will be installed to provide for increased future consumption and to serve as a back-up; the electrical distribution system will be improved (this includes relocating one of the switching stations to an indoor site); and the power lines on the side of Observation Hill will be lowered in order to eliminate the hazard now posed to helicopter operations.

Work at Byrd Station will consist of rehabilitating the garage tunnel and entrance ramp, installing a total energy system which will decrease fuel consumption by using waste generator heat to warm certain of the station's buildings, and installing a cold air plenum to help keep the generator tunnel cold, a condition very necessary to the prevention of excessive ice movement and subsequent arch failures.

Stockpiling for 1968-1969

The materials for other McMurdo Station structures will be procured and delivered to Antarctica during *Deep Freeze* 68 for use during the following season. On the procurement list are materials for the interior of the personnel building's barracks section (the final phase of this project), the frozen-food storage building, the administration/operations building, the USARP field-party processing and equipment center, and additional portable housing for Williams Field personnel. Most of these prefabricated structures will be shipped on the last *Deep Freeze* 68 cargo ship to provide a stockpile of materials for *Deep Freeze* 69 construction, but an attempt will be made to procure the field-party structure in time to load it on the first cargo ship scheduled to reach McMurdo next season. If this attempt is successful, initial construction of this building may begin during *Deep Freeze* 68, thereby allowing an earlier *Deep Freeze* 69 completion date.

Construction at Palmer Station

RICHARD D. WHITMER[1]
Lieutenant (jg.), CEC, USN
and
GEORGE J. KELLEY
Chief Petty Officer, USN
Naval Construction Battalion Unit 201

The task of building a permanent antarctic research station on Anvers Island, near the tip of the Antarctic Peninsula, was assigned to Naval Construction Battalion Unit (NCBU) 201 in the spring of 1966. To be constructed in two phases, the new facilities are scheduled to be placed in operation near the end of *Deep Freeze* 68 as a replacement for the temporary station that was commissioned in February 1965. Such replacement had been considered for several years as part of the U.S. long-range plan. The current Palmer Station essentially consists of a prefabricated metal-panel building and a converted British hut that was built in 1955.

During *Deep Freeze* 66, a representative from the Naval Facilities Engineering Command visited Anvers Island and selected a site approximately 1½ miles from the existing station. Design of the permanent station was started at once. It will consist of a main building housing a complete biological laboratory and other facilities, two welded steel fuel tanks, and a metal-and-rock wharf for the research vessel now under construction for the National Science Foundation.[2]

The *Deep Freeze* 67 phase of the construction program included the receipt of all construction materials, erection of the fuel tanks, installation of as much fuel piping as possible, construction of the wharf, blasting of a trench for the saltwater intake, and preparation of the site for the main building.

Special Platoon Formed

Twenty-five members of NCBU 201 were selected to perform the Palmer construction. The group was designated Construction Platoon Alpha, and Chief G. J. Kelley was appointed Chief-Petty-Officer-in-Charge. In October 1966, Lt. Walter B. Garrott, CEC, USNR, was assigned as Officer-in-Charge of the platoon. When the main body of NCBU 201 deployed to McMurdo Station in mid-October 1966, the 26-man platoon remained at Davisville, Rhode Island, for later deployment.

January 1, 1967, was deployment day for Platoon Alpha. The planning and training for the project had been completed, and the platoon departed Quonset Point Naval Air Station in a Military Airlift Command C-130. Flying by way of Louisiana, Panama, and Santiago, the plane delivered the group to Chabunco Airport in Punta Arenas, Chile. Waiting at Punta Arenas to embark the platoon was the Coast Guard icebreaker *Westwind*. In addition to transporting the Seabees to Palmer, *Westwind* would support the construction effort with her boats (see article on page 154), helicopters, and personnel. *Westwind* sailed from Punta Arenas on January 3 and delivered the Seabees to Palmer Station on the 8th. Lieutenant Garrott and Chief Kelley were flown to the construction site by helicopter for their first look at the area. The ground upon which the new facilities were to be built was solid rock. Adjoining it on one side were the water and ice of Arthur Harbor, and on the other sides was a large ice and snow field.

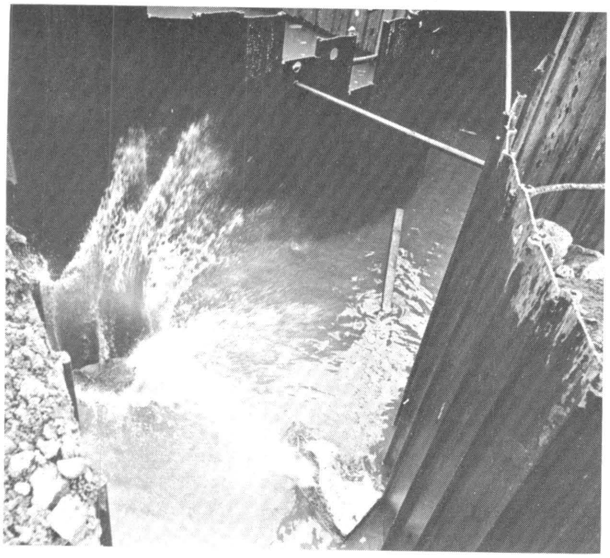
As a preliminary to the construction program, the cargo brought by *Westwind* had to be unloaded, a temporary camp set up for the use of the Seabees, a small-boat landing site prepared on the beach, and a John Deere 1010 tractor brought from Palmer Station to the new site. (There was some doubt that the little tractor could adequately serve as the principal mover of materials, but it proved to be a valuable and vital piece of equipment.) To carry out an around-the-clock working schedule, the platoon was divided into two sections on 12-hour shifts. Air compressors, rock drills, explosives, and the materials for the construction camp were quickly moved ashore. Four Jamesway huts were set up to provide berthing and messing, and the boat ramp and a storage area were prepared for the arrival of USNS *Wyandot,* which would bring more than 750 tons of cargo, including a Northwest 25 crane, a Universal rock crusher, two 955 Traxcavators, and the station building materials. A small dam was constructed to hold glacial meltwater, creating a pond about 3 feet deep, 40 feet wide, and 60 feet long. The pond was more than sufficient for the camp's needs, so the Seabees were able to provide fresh water to the icebreaker, which was having problems with its evaporators at this time.

Drilling for the blasting operations was soon commenced. The first blast was set off to aid in the building of a roadway from the boat ramp to the construction site. That detonation was the start of

[1] Now on the staff of the Commander, U.S. Naval Construction Battalions, Atlantic Fleet.

[2] Station and research-vessel design are illustrated on p. 80 and 81, *Antarctic Journal,* Vol. I, No. 3.

(U.S. Coast Guard Photo)
Construction required divers to set underwater charges.



(U.S. Coast Guard Photo)
Cells of wharf in different stages of filling. Distance to water is 20 feet.

an intensive program of blasting and quarrying, and from that day on, there were from one to five blasts each day. The underwater trench for the base of the wharf was blasted with special explosives procured from the Jet-Set Corporation. After the initial blast, bangalore torpedos were used to clear the loose rock. Although assisted by divers from *Westwind,* two Seabee divers, CES3 James F. Vaughn and BUL3 Larry R. Parker, spent as many as 7 hours a day in the water. During this operation, the divers had a steady audience of seals who seemed to be very interested in the humans' activities.

With the boat ramp, access road, and building site levelled, the next task was to prepare the site for the two fuel storage tanks. The pads, which were to be 20 feet larger in diameter than the 37-foot diameter of the tanks, had to be blasted out of the rock surface. This task was prolonged by high winds from the south which stopped all work for nearly 24 hours.

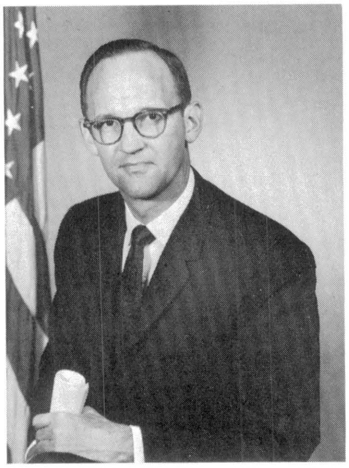
Wyandot Brings Supplies

USNS *Wyandot* arrived early on January 28. Unloading commenced at once and went rather smoothly, considering that the procedure was entirely dependent upon the small boats. The rock crusher went into operation as soon as it came ashore. Unloaded in six days, *Wyandot* departed for McMurdo on February 4. The erection of the fuel tanks and the construction of the wharf were now in full swing. As the days became noticeably shorter and the weather colder and stormier, an additional effort was expended by the entire crew.

Wind and wave action made construction of the wharf extremely difficult and hazardous. The project required construction in the water of three cylindrical cells of sheet steel—each about 27 feet in diameter—arranged in a triangular pattern. These cells were to be connected with more sheet steel to form a round-cornered triangle, its apex pointed toward the shoreline and its base parallel to it. The cells were then to be filled with rock and connected to the shore by a 20-foot-wide ramp so as to form a durable pier. The third cell was nearly finished three times, but wind and rough water interfered with the use of a template to position the pilings, and icebergs knocked the supports from under the template. Fortunately, the fourth effort was successful, and the filling of the cells and construction of a fender system to protect the research vessel could proceed.

By March 15, the wharf had been completed, the fuel tanks erected and painted, and some of the fuel distribution pipeline installed. The final blasting at the 128- by 100-foot building site was completed in time to allow erection of the building's foundation and subflooring. The entire area was cleaned up, construction materials rearranged and inventoried, and on March 20, a tired but proud crew of Seabees embarked on *Westwind* for the trip to Punta Arenas. From Punta Arenas, an Air Force plane flew the Seabees to Quonset Point, Rhode Island, where they arrived on March 27.

The first phase of the construction of the permanent Palmer Station was completed on schedule, in keeping with the Seabees' succinct motto: *Can Do.*



(U.S. Navy Photo)

John T. McNaughton Dies

The Honorable John T. McNaughton, Assistant Secretary of Defense for International Security Affairs, was killed in an airplane accident on July 19, 1967, near Asheville, North Carolina. The midair collision took the lives of all 82 persons aboard the two planes, including Mrs. McNaughton and one of the McNaughtons' two children, Theodore. The nomination of Mr. McNaughton as the 59th Secretary of the Navy had recently been confirmed by the Senate.

As Assistant Secretary for International Security Affairs, Mr. McNaughton, 45, had been a member of the Antarctic Policy Group, which was established in 1965 to coordinate United States antarctic affairs. (Chairman of the Group is the Assistant Secretary of State for International Organization Affairs; the third member is the Director of the National Science Foundation.) Mr. McNaughton entered Government service in 1961. Prior to moving to his last position in March 1964, he had served the Department of Defense as Deputy Assistant Secretary for Arms Control and as General Counsel.

Mr. McNaughton received a baccalaureate degree from DePauw University in 1942, after which he served as a naval officer in the Caribbean and the Pacific. He resumed his studies after the war and was awarded a law degree by Harvard University in 1948. He was also a Rhodes scholar at Oxford University. In 1951, he joined the faculty of Harvard Law School, where he taugh until entering Government service.

In announcing Mr. McNaughton's death, Robert H. B. Baldwin, the Acting Secretary of the Navy, said: "He had a distinguished record of public service and would have brought great ability, integrity, and imagination to the Department of the Navy. His loss will be deeply felt in the Government."

Lloyd V. Berkner Dies

Lloyd Viel Berkner, a member of the first Byrd Antarctic Expedition (1928-1930) and the proposer of the International Geophysical Year (1957-1958), died in Washington, D.C., on June 4, 1967, at the age of 62, apparently of a heart attack. Dr. Berkner was in Washington to attend a meeting of the Council of the National Academy of Sciences, of which he was treasurer.

From 1960 to 1965, he was president of the Graduate Research Center of the Southwest, in Dallas, Texas. Before that, from 1951 to 1960, he had served as president of Associated Universities, Inc., a group of eastern schools which was formed to administer an Atomic Energy Commission research center, the Brookhaven National Laboratory. He also served, from 1958 to 1962, as chairman of the National Academy of Sciences' board on space science.

Dr. Berkner received his B.S. in electrical engineering from the University of Minnesota in 1927, following which he did graduate work in physics at George Washington University. After serving as an engineer with the Airways Division of the Department of Commerce from 1927 to 1928, he joined the Byrd Expedition as the radio engineer aboard one of the expedition's two ships, *City of New York*. On February 18, 1929, he flew with Admiral Byrd in a Fokker piloted by Bernt Balchen; during the 4-hour, 400-mile flight, approximately 65,000 square miles of antarctic terrain were observed.

Dr. Berkner's prominence in antarctic affairs is based on the same act which earned him the sobriquet of "Father of the IGY." On the evening of April 5, 1950, during a conversation in suburban Washington, D.C., Dr. Berkner suggested to a group of friends that the time had come for a third polar year to extend the work performed during those of 1882-1883 and 1932-1933 but, unlike them, to be conducted during a time of maximum solar activity. Among those at the gathering was Dr. Sidney Chapman, a famous British geophysicist. With the encouragement of those present, Drs. Berkner and Chapman enlisted additional support for the proposal, which was adopted by the International Council of Scientific Unions and expanded to encompass worldwide rather than strictly polar geophysical investigations. Dr. Berkner subsequently served as a member of the U.S. National Committee for the IGY and as vice-president of the Special Committee for the International Geophysical Year (CSAGI).

A naval aviator, Dr. Berkner attained the rank of Rear Admiral, USNR, in 1955. He was the recipient of many awards, including the Legion of Merit, and of a number of honorary doctorate degrees.

U.S. Observers Inspect Foreign Antarctic Stations

LEWIS O. SMITH
Captain, USN

United States Arms Control and Disarmament Agency

On March 20, 1967, the Department of State announced that a five-man United States team of Observers had completed an inspection of eight antarctic stations under the terms of the Antarctic Treaty.[1] The announcement and a later report indicated that the Observers had received cordial welcomes at each station visited. Buildings, installations, and equipment were made readily accessible, and explanations of scientific programs and support operations were freely given by host personnel. Equipment and scientific instruments were examined by the Observers in sufficient detail to determine their use.

The team reported having seen no indication of any Treaty violations. All activities witnessed gave every appearance of conforming to the spirit and provisions of the Treaty. Observations of personnel, equipment, and work programs all agreed essentially with advance information on those subjects provided through Treaty-established channels.

In Perspective

Before examining these summary findings in greater detail, it seems quite appropriate to answer the question, "How did this inspection come about, and why?" Actually, numerous inspections of antarctic stations have been undertaken by the United States and other Treaty powers in previous years. Most of these inspections have taken place at the more accessible stations located around McMurdo Sound and on the Antarctic Peninsula in West Antarctica. U.S. inspection activity in East Antarctica had been limited to visits to Vostok and Mirnyy and an overflight of Dumont d'Urville Station, all of these occurring in January 1964. Thus the opportunity to observe stations in East Antarctica during an icebreaker voyage from New Zealand to the Weddell Sea was very welcome. This trip was already scheduled for January-March 1967 to obtain information on ice conditions and the coastal terrain. Another such chance might not have occurred for several seasons.

An icebreaker is well suited to manage the twin and always troublesome problems of transportation and life support. Its helicopters and boats permit ship-to-shore movements under a wide variety of weather and terrain conditions (Fig. 1). This and a number of other benefits, which are quite obvious or easy to infer, led to the convenient marriage of missions and machines.

During the fall of 1966, a team of five persons was selected from a list of U.S. Observers designated by the Secretary of State. According to the Treaty, Observers must be citizens of the nation they represent and must be duly accredited by their government. Their special status as Observers must be communicated officially to other Treaty parties entitled to designate Observers. Only in this way can the nation's right and privilege to observe be conveyed to an individual. What is this right and privilege? In this connection, the Treaty succinctly speaks for itself: "Each Observer . . . shall have complete freedom of access at any time to any and all areas of Antarctica . . . [and] all stations, installations and equipment within those areas, and all ships and aircraft at points of discharging or embarking cargoes shall be open at all times to inspection. . . ."

The preamble of the Treaty reflects themes that Antarcticans have come to regard as the spirit of the Treaty: international cooperation, the continuance of international harmony, and the reservation of the Continent for peaceful purposes. Official recognition of that spirit is reflected in the accrediting letters issued to Observer-team members by the Department of State. Observers are instructed that:

> *While performing inspections, you should bear constantly in mind that all states active in Antarctica have been both friendly and coopera-*

(U.S. Dept. of State Photo)
Figure 1. Helicopters from Eastwind *pick up inspection team at SANAE. Partial whiteout caused several hours delay.*

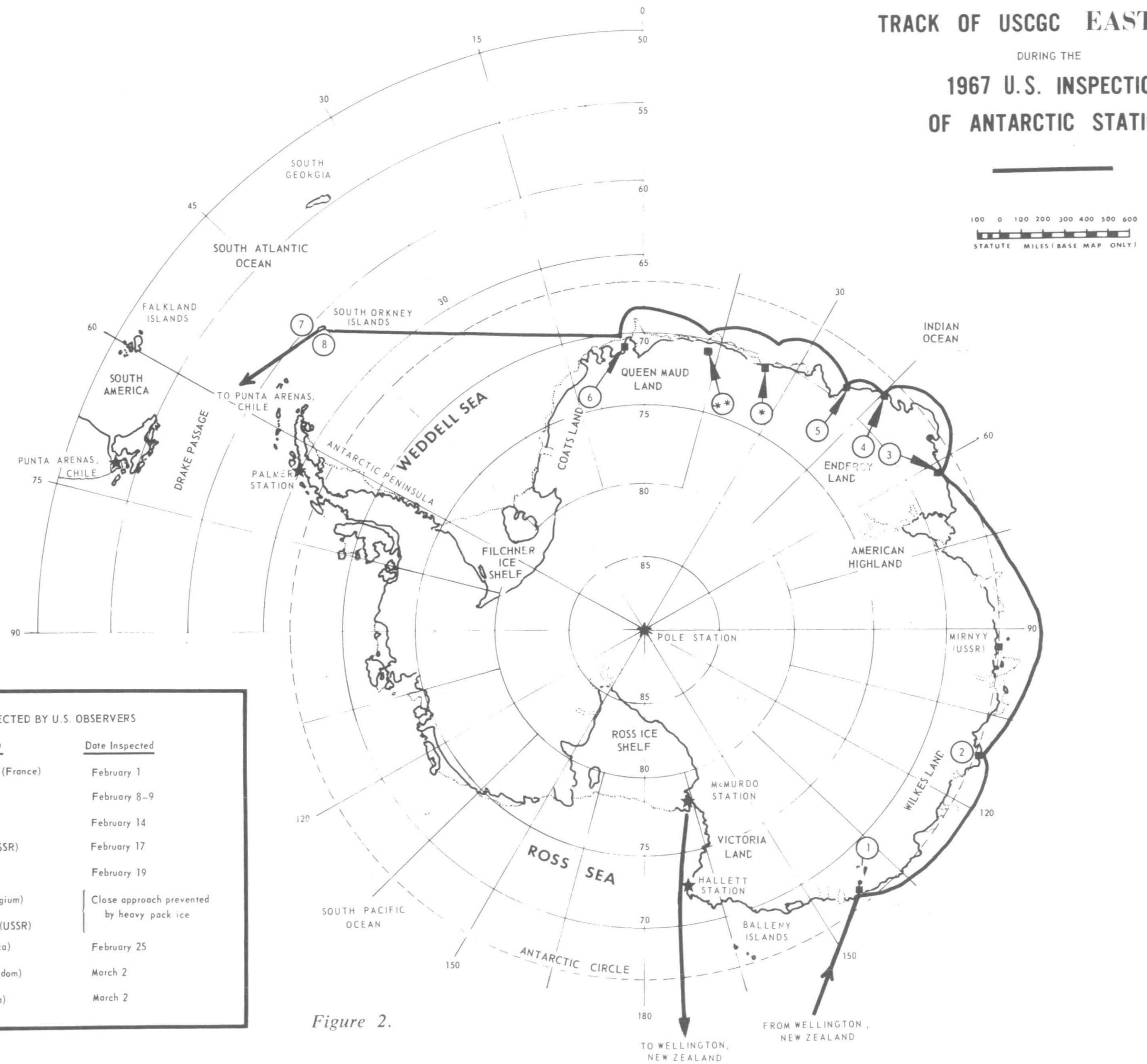
[1] The Antarctic Treaty was signed on December 1, 1959, and entered into effect on June 23, 1961. A list of signatories and acceding parties appears in the *Antarctic Journal,* Vol. II, No. 3, p. 76.

APPROXIMATE

TRACK OF USCGC EASTWIND

DURING THE

1967 U.S. INSPECTION OF ANTARCTIC STATIONS



STATIONS INSPECTED BY U.S. OBSERVERS

Symbol	Station	Date Inspected
1	Dumont d'Urville (France)	February 1
2	Wilkes (Australia)	February 8–9
3	Mawson (Australia)	February 14
4	Molodezhnaya (USSR)	February 17
5	Showa (Japan)	February 19
*	Roi Baudouin (Belgium)	Close approach prevented by heavy pack ice
**	Novolazarevskaya (USSR)	Close approach prevented by heavy pack ice
6	SANAE (South Africa)	February 25
7	Signy (United Kingdom)	March 2
8	Orcadas (Argentina)	March 2

Figure 2.

tive with the United States in matters relating to the continent, and it is the policy of the United States to preserve and enhance this situation. You should conduct your activities in compliance with this policy.

It was against this backdrop that the selection of Observers took place. Those selected had an impressive array of diplomatic, scientific, technological, and linguistic skills. Mr. Frank G. Siscoe, a senior Foreign Service Officer, was designated leader. Other members of the team were Mr. Merton Davies, a scientist from the RAND Corporation, Colonel Ernest F. Dukes, USAF, Mr. Karl Kenyon, U.S. Fish and Wildlife Service, and Mr. Cyril Muromcew, Department of State. During December 1966, team members were briefed on current antarctic operations to supplement and update their prior knowledge.

What do Observers observe? Most readers of the *Antarctic Journal* need no recitation of activities prohibited by the Treaty. Nevertheless, some outline of the main points will serve the casual reader, and a review of the Treaty's peaceful provisions is always a refreshing experience. In bold strokes, the Treaty prohibits ". . .any measures of a military nature, such as the establishment of military bases and fortifications, the carrying out of military maneuvers, as well as the testing of any type of weapons."[2] It also prohibits any nuclear explosions and the disposal of radioactive waste material in Antarctica.[3] It should be emphasized here that this year's inspection was a routine action—one prompted by the availability of icebreaker support rather than any suspicion of Treaty violations.

Eight stations operated by seven nations were visited and inspected during *Eastwind*'s five-week, 8,500-mile voyage from Wellington, New Zealand, to Punta Arenas, Chile (Fig. 2). In addition, the Danish ship *Thala Dan*,[4] under charter to the French and Australian expeditions, was inspected while unloading cargo at Wilkes Station (Fig. 3). The number of facilities inspected and the distances involved indicate the magnitude of the inspection. The Observers' efforts over this time and distance were aided substantially by two important factors. First was the open nature of antarctic programs and the cooperative attitude of all persons encountered. The second factor was the support given by *Eastwind,* which guaranteed the Observers complete self-sufficiency in transportation, food, survival equipment, and the like. Certainly this independence and mobility contributed greatly to the team's efficiency.

(*U.S. Dept. of State Photo*)

Figure 3. Thala Dan *at Wilkes. The Treaty permits inspection of ships at antarctic ports.*

Results

As noted earlier, all welcomes were cordial, all doors open, and all programs explained. Almost all buildings, equipment, and instruments were examined. From this, the team reported a number of observations, specifically: there were no indications of nuclear energy being used, even for peaceful purposes; the only weapons seen were a few small arms being used for limited purposes under controlled conditions, *i.e.,* to obtain small quantities of animals under self-imposed quotas, either for study or to provide fresh seal meat for dog teams. The Observers noted that while all stations were adhering to sound principles for the conservation of living resources, variations in practice were quite extensive. Advance information about personnel, equipment, and scientific programs exchanged under Articles III and VII of the Treaty tallied closely with observations made at the scenes. In short, the Observers saw no indication of any Treaty violations.

The results of the inspection stimulate certain reflections. Over 10 years ago the International Geophysical Year was responsible for greatly increasing the tempo of exploration and research in Antarctica. More than seven years have passed since the 12 countries then engaged in antarctic operations devised a "code of conduct" and voluntarily bound themselves to it by solemn treaty. Although many changes in governments and in the international political climate have occurred during the intervening years, the spirit of antarctic cooperation has continued to grow under Treaty aegis.

[2] Article I, which, however, specifically permits the use of military personnel and equipment for scientific research or other peaceful purposes.

[3] This provision of Article V does not prohibit peaceful uses of nuclear energy.

[4] Assistance rendered to *Thala Dan* by *Eastwind* is described in the *Antarctic Journal,* Vol. II, No. 2, p. 35, and No. 3, p. 57.

Summary of Research at U.S. Antarctic Stations During April and May 1967

Byrd Station

Several interesting scientific events occurred during the April-May period in the conjugate-point program conducted by the Institute for Telecommunication Sciences and Aeronomy (ITSA) of the Environmental Science Services Administration (ESSA). On April 6, a very strong, periodic magnetic storm was observed, accompanied by coincident absorption. The strongest absorption in April, 10.5 db, occurred on the 17th, while the strongest micropulsation activity was recorded on the 24th. There was a noticeable decrease in activity in May, but a strong magnetic storm with an average period of 8 minutes occurred on the 3rd. At the same time, strong aurorae and heavy absorption were noted. The greatest activity of the month was recorded on the 26th during the polar cap absorption (PCA) event which began as a Storm Sudden Commencement (SSC) on May 25. The maximum level of absorption during this event, 10.1 db, occurred on the 30th.

The ionospheric and spectrophotometric equipment of ITSA performed well, as did other instruments operated by ITSA personnel, viz., the forward-scatter equipment of the Bartol Research Foundation and the all-sky cameras of the National Research Council of Canada. Many good auroral displays were observed, and the all-sky cameras were placed in continuous operation beginning April 25.

All synoptic observations were made on schedule in Stanford University's very-low-frequency (VLF) program. Also, continuous chart recordings were made of the intensity of the 5577A auroral line and of ionospheric absorption of cosmic radio noise at 29.850 mc/s. Telemetry recordings were made in April of 34 passes of the POGO satellite. The British geophysical satellite UK-E was tracked for the first time only 29 minutes after its launch on May 5 and subsequently on 47 passes during its first 10 days in orbit. On behalf of ITSA, phase and amplitude chart recordings were made of the VLF stations NBA, NPG, NSS, and NPM, while three components of micropulsation activity and the vertical component of extremely-low-frequency (ELF) transmissions were recorded on slow-speed tape for the Pacific Naval Laboratories, Canada.

The programs in seismology and geomagnetism, conducted by the Coast and Geodetic Survey of ESSA, proceeded normally. The seismograph system consists of the following instruments: a short-period (1 sec) vertical Benioff seismometer, two Wilson-Lamison 6-sec-period horizontal seismometers, and two Sprengnether long-period (15 sec) horizontal seismometers. In April, the temperature in the recording room was lowered from 24°C. to 13°C. to reduce drift in the long-period horizontal seismograph records.

The University of Colorado's auroral-hydrogen program acquired spectroscopic data during 20 nights of May. Preliminary analysis of the data shows a marked diurnal variation of hydrogen movement. The movement begins in the south and is toward the north, reaching to or past the northern horizon, where it occurs close to magnetic midnight, after which it is toward the south.

The meteorological program of ESSA's Weather Bureau proceeded on schedule. April was characterized by near-normal winds, subnormal temperatures, and ice fog, which left thick deposits of hoarfrost on outside facilities. May, on the other hand, was unusually warm, with a maximum temperature of −11.7°C. and an average of −28°C., which is a new record average high for May. The "heat wave" was apparently caused by a huge storm which was centered over the western Ross Sea in mid-May.

At the long-wire-antenna site, the University of Washington's whistler transmission schedule was increased to one transmission per hour (at peak power in excess of 30 kw) following the activation, in April, of the University's recording station at Friday Harbor, Washington. The *D*-region experiment recorded VLF reflection heights that fluctuated between 80 and 90 km until May, when new equipment for this experiment was installed to obtain data on the wave-polarization of the *D*-region echo. The Schumann-resonance and micropulsation systems recorded significant ionospheric activity commencing on May 25, following several days of extreme quiet. The event also produced large increases in *D*-region ionization. Input impedance measurements made on the 21-mile antenna during late May showed a resonant frequency of 3 kc/s, as compared with 1 kc/s in April.

The Stanford University representative at the long-wire site began synoptic VLF recordings in April. Special transmissions were made at 88 kw in the 13-19 kc/s range during a number of passes of the POGO satellite. A successful experiment was conducted on April 17, when a natural electrostatic field was observed to correlate with magnetic bays having gradients greater than 300 gammas/min. A strong east-west field and a weak north-south field were observed to exist in coincidence with a strong, geomagnetically aligned east-west aurora that drifted from geomagnetic north to south.

All transmitters at the substation were closed down for 24 hours, beginning at 0001 UT on May 25, to allow for undisturbed recordings of the SSC that began at 1235 UT on that day.

South Pole Station

A brief interruption in the research programs occurred in mid-May, when the contents of a five-gallon container of carbon tetrachloride were accidentally spilled and the resulting fumes spread through the ventilating system. As a precautionary measure, the personnel stayed at the emergency camp for 24 hours. Otherwise, operations were generally smooth except for several power failures in April.

The recording of cosmic ray and forward-scatter data by the Bartol Research Foundation continued on schedule. April and part of May were characterized by low radiation activity, but Forbush decrease commenced on May 25 and lasted through the 31st. The forward-scatter transmitter was not on during this event.

Electrical problems were experienced with the seismological equipment of the Coast and Geodetic Survey in both April and May. The geomagnetic program progressed normally.

The earth-tide program of the University of California (Los Angeles), which is new this year, operated well until May 29, when troubles occurred in the power supply.

The psychophysiological study being conducted by the University of Oklahoma also progressed on schedule. The first phase of the sleep recordings was completed in April; the second phase began on May 29. Several minor equipment failures occurred.

Most data recordings were on schedule in the meteorological program of the Weather Bureau (ESSA), even though equipment problems developed.

Some of the auroral equipment was reactivated by ITSA on April 22. ITSA maintains micropulsation equipment, an ionospheric sounder, and a riometer, all of which operated normally except that the antenna wire for the sounder broke on May 29. Reports indicate that good data were obtained on the May 25 PCA event.

Plateau Station

For a period of several hours in April and several days in May, both of the main-camp generators were inoperable, and power had to be supplied to the station from the emergency-camp generators. Early in May, one of the generators failed again and could not be used during the remainder of the month.

ITSA's micropulsation equipment was inoperable during April and May. Although ITSA's VLF-phase program progressed satisfactorily until mid-May, an equipment failure occurred at that time, preventing further observations during the month. In April, difficulties were encountered also in Stanford University's VLF program, but these were overcome, and operations were normal during May.

The U.S. Army Natick Laboratories' micrometeorological program was carried out on schedule. In April, an extraordinary temperature inversion of 19.5°C. was observed between a height of 4 and 8 m; data from other levels on the tower indicated an undisturbed, strong oscillation of the lowest air layer.

The general meteorological program at Plateau is conducted by representatives of the U.S. Weather Bureau and the University of Melbourne. Radiometersonde observations commenced on April 18 with a few soundings to test the equipment and establish tracking procedures. During May, 20 ascents were made, most of which provided good data. During both months, fresh to strong winds caused the formation of complex patterns of shallow snow dunes (the average wind velocities during April and May were 10.5 and 11 knots, respectively). The density of the surface snow, as determined in April by measurements of 450 samples, averaged 0.3029 g/cm^3. The Siemens subsurface radiation recorders were inoperative during much of the period because of power failures and voltage variations. These observations were discontinued on April 23 for the remainder of the winter.

Normal records were obtained in the Coast and Geodetic Survey's geomagnetic program and in the Arctic Institute of North America's auroral program.

In cooperation with the University of Oklahoma's psychophysiological study at South Pole, the Navy medical doctor at Plateau recorded sleep activity patterns for one week in April. He also obtained the fourth and fifth sets of electrocardiograms on all station personnel.

Palmer Station

This year's biological program at Palmer, which is being conducted by the Virginia Institute of Marine Science, is concerned with parasites. In April, 25 fish representing 6 species were collected. One of these, a specimen of *Trematomus borchgrevinki,* was new to the collection. Forty more specimens were caught in May, bringing the total collected since January to 185 specimens. The May collections included *Notothenia coriiceps, N. nudifrons, N. gibberifrons,* and *Trematomus bernacchii.* The surfaces of the *N. coriiceps* specimens were heavily infected with ectoparasitic trematodes. Ectoparasitic copepods were also prevalent on this species.

As was the case last year, the glaciological program is being conducted by Ohio State University. Observations were made both near the station and, as feasible, on the ice cap behind the station. The following glaciometeorological data were obtained at the station during April: precipitation, 1.9 cm water equivalent; average temperature, −0.9°C.; and average wind, 10 knots, from the north. In May, the following corresponding observations were made: precipitation, 4 cm water equivalent; average temperature, −5.7°C.; and average wind, 8.5 knots, from the northeast.

In April, ice at sea was limited to occasional brash and a few bergy bits. In May, new ice formed in some parts of the harbor, but inshore areas were still clear of ice on May 31.

Considerable wildlife was observed in May, including about 75 elephant seals near the station, cormorants, and snow petrels. Dominican gulls and sheathbills maintained their vigil for food at the station.

McMurdo Station

The only notable scientific event of the two-month period occurred on May 25, when major absorption was recorded by the Douglas Aircraft Co.'s riometers. Concurrently, a small increase in radiation was recorded at the Bartol Research Foundation's cosmic ray laboratory. Peak absorption of more than 4 db occurred at about 1230.

Midwinter Message from The President

On June 17, President Johnson sent the following message to the personnel at 5 United States and 27 foreign stations in and near Antarctica and to those aboard the research ship *Eltanin*:

Your determined effort for scientific discovery in an atmosphere of harmony and self-denial in the depth of the winter darkness stimulates the imagination of all mankind. Your example provides men of goodwill with living proof that trust may flourish despite diversity, that fellowship finds no barriers in languages, that cooperation unites peoples of various cultures. It is my pleasure, this year as before, to greet you all on Midwinter Day and wish you well at the midpoint of your long isolation.

Eltanin Cruise 27

During this cruise, *Eltanin* worked south of the pack-ice belt for the first time and made her first port calls at a U.S. antarctic station and an Australian port. After departing Wellington, New Zealand, on December 30, 1966, she headed southward into the Ross Sea, visited McMurdo Station on January 22, 1967, and then proceeded to Melbourne, Australia, where she arrived on February 28 (Fig. 1). Aboard the ship on the approximately 7,500-mile, 59-day cruise were 35 scientists and support personnel (including four foreign exchange scientists, one of whom embarked at McMurdo) and an MSTS crew of 48 under Captain Lawrence G. Wirth. Dr. George A. Llano of the Office of Antarctic Programs, National Science Foundation, served as USARP Representative.

On Cruise 27, *Eltanin* improved her record for the southernmost point attained: 77°57′30″S. 178°09′E. The previous record was established during Cruise 11, when, on January 22, 1964, the vessel reached 70°26′S. 99°52′W. Although 190 bergs were observed, no floe ice was encountered except in the vicinity of McMurdo Sound.

Nine programs were carried out by 20 representatives of eight universities. A total of 50 stations at which work was done in almost all programs were occupied at sea, landings were made on Antipodes, Franklin, and Ross Islands to conduct investigations, and a visit was paid to the Australian station on Macquarie Island (Fig. 2). The Balleny and Scott Islands (Fig. 3) were approached, but rough weather prevented landings. During the stay at McMurdo, the personnel also visited New Zealand's Scott Base.

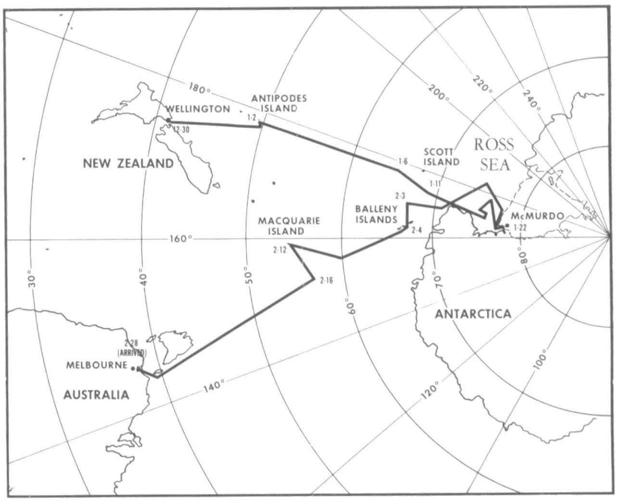


Figure 1. Eltanin's *track, Cruise 27.*

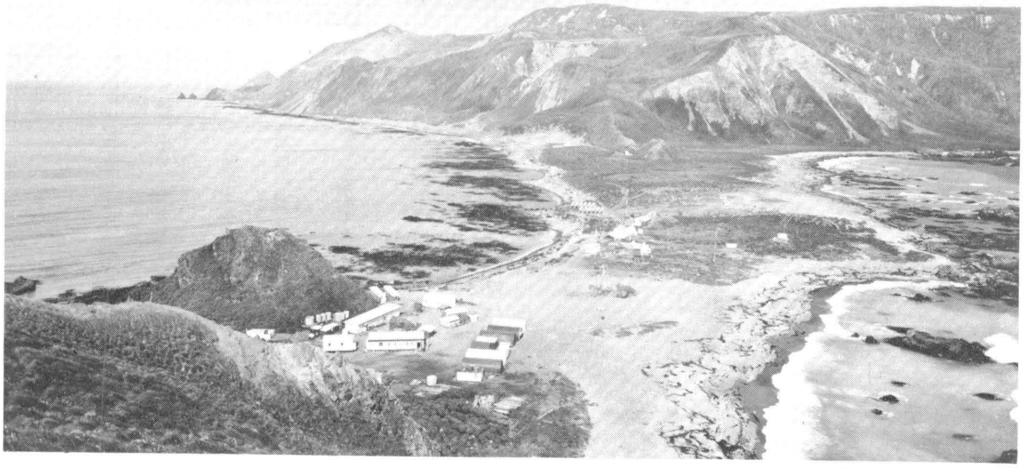


Figure 2. ANARE Station on Macquarie Island. The view is southward from North Head.

(Photo by F. O'Leary)

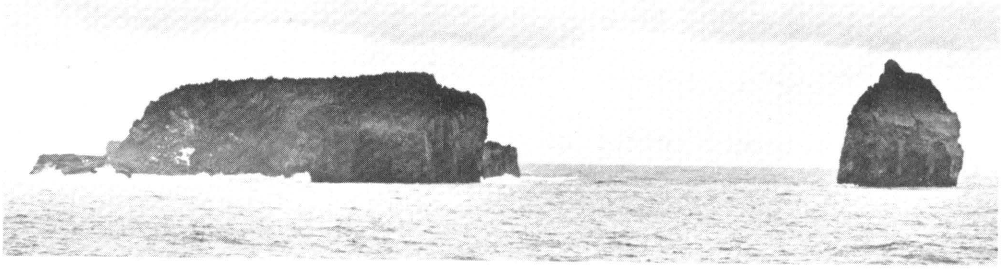


Figure 3. Scott Island.

(Photo by P. C. Harper)

From the time of departure until the ship reached the boundary of the Ross Sea, scientific work centered on seismic profiling. In the Ross Sea, all programs involved station work, except seismic profiling, which was done while the ship steamed between stations. On the voyage northward from the Balleny Islands, the emphasis was on hydrography and biological collecting.

In Lamont Geological Observatory's oceanographic program, 70 hydrographic stations were occupied, 44 for making salinity-temperature-depth (STD) casts and 26 for standard hydrographic sampling. At the same time, samples were taken for the phytoplanktonic and fungal studies of the University of Miami. Bathythermograph (BT) casts numbered 566, not counting those taken at the request of Texas A&M and the University of Miami. A surface-salinity sample was taken with each BT cast. Short gravity cores were also taken at 10 stations for these two institutions. Along the Balleny Islands—Melbourne track, surface- and deep-water samples were collected for shipment to Lamont for CO_2 and trace-metal analyses.

The Surface Activated Multiple Sampling unit (SAMS) program was very successful. Besides providing data for use in the final analysis of STD accuracy, it permitted regular sampling of temperature and salinity maxima and minima. Thermometers reversed in a SAMS bottle near the Ross Ice Shelf confirmed a low of −2.11°C. recorded by other instruments. Over the continental shelf off Cape Adare, a sharp decrease in temperature was observed near the ocean bottom in an area in which bottom photographs revealed the presence of a strong bottom current.

Seismic and magnetic profiling, also conducted by Lamont, provided almost continuous records along 6,300 miles of the ship's track. Total sediment penetration was achieved over most of the track, the chief exception being in the Ross Sea, where the shallow waters tended to cause multiple reflections. Two crossings were made over the Balleny Basin, where the average sediment thickness was represented by 1 second of signal travel time.

Thirty piston cores, 27 Phleger cores, and 16 "camera" cores were obtained for Florida State University's marine geology program. The longest piston core measured 21.78 m; the average length was about 5 m. A large number of rock samples were collected for the program from the University of Southern California's bottom trawls.

On four occasions, an inclinometer/azimuth compass was placed on the piston corer and carried to the bottom, where it recorded the magnetic orientation of the sediments obtained. Entanglement of auxiliary wires and difficulties encountered in mounting the compass thwarted other attempts to acquire such data, so the project was discontinued.

Texas A&M personnel collected water samples at 28 stations from eight depths between the surface and the bottom of the euphotic zone and from three lower levels in order to measure primary productivity and the amount of dissolved and particulate organic carbon present. Phytoplankton and zooplankton collections totalled 212. A preliminary analysis of the primary-productivity data showed a high rate of photosynthesis in the waters south of the Antarctic Convergence and in the Ross Sea and a very high rate near the antarctic islands.

Water samples were collected at 540 locations for the University of Miami's phytoplankton study. The species present in 160 of the samples were identified aboard ship. They included 53 diatoms, 9 dinoflagellates, and 1 silicoflagellate. As on previous cruises, the collecting of phytoplankton was coordinated with the Lamont hydrographic work. Forty sediment samples were also obtained.

In another University of Miami study—of the distribution of marine fungi—collections were made at 29 stations, again in conjunction with the hydrographic casts. Material obtained at 17 stations was cultured aboard ship, resulting in the isolation of approximately 200 yeasts and molds. Soil, snow, and intertidal water samples were collected from Antipodes, Franklin, and Macquarie Islands to determine the kinds of microorganisms present.

The University of Southern California (USC) party made 136 collections of benthic and midwater organisms—31 with the 5-foot Blake trawl, 34 with the 10-foot Blake trawl, 48 with the Isaacs-Kidd midwater trawl, 18 with the Phleger corer, 4 with the "camera" grab, and 1 with a dip net. USC was most successful in the Ross Sea, where 34 Blake and 24 Isaacs-Kidd hauls were made. The Blake hauls yielded 45 species of fish, including nearly all of those reported previously to occur in the Ross Sea. An excellent collection of sea anemones, including 65 species of actinarians, was obtained from the bottom hauls.

A specialist from Harvard University assisted the USC project in segregating brachiopods. Fifty percent of the Blake hauls yielded specimens, about 9,000 in all. South of 70°S., 76 percent of the hauls contained brachiopods. At least 9 genera and 10 species, representing one order of the class Inarticulata and all living orders of the class Articulata, were obtained.

Foreign exchange scientist P. C. Harper of the Dominion Museum, Wellington, New Zealand, resumed an ornithological study that he had conducted on six previous *Eltanin* voyages. On Cruise 27, he recorded the occurrence of 42 species of birds and collected specimens of 14 of these.

Three other foreign exchange scientists were aboard: Mr. Jean Vicariot, Service Central Hydrographique, France (who embarked at McMurdo); Mr. R. K. Falconer, Victoria University, New Zealand; and Mr. B. F. Jones, Department of External Affairs, Australia. They participated in the seismic and hydrographic programs.

A grab sampler attached to the bottom camera was used in collecting brachiopods during this cruise. Of the eight attempts made to operate the device, six were successful. Bottom photographs were taken routinely at 30 stations—384 in black-and-white and 31 in color.

Notes

U.S. Exchange Scientist Reports from Mirnyy

Dr. E. E. MacNamara, 1967 wintering-over exchange scientist with the Soviet Antarctic Expedition at Mirnyy Station, reported in a letter dated March 14 that he has found the Mirnyy locality to be of considerable geologic and biologic interest. Rock weathering and aeolian activity are apparently extensive, and moss cover is quite common in protected areas.

Dr. MacNamara further reported that he has been sampling the moisture regime of different soils and will conduct a study of soil dynamics. He has also sampled freshwater lakes and their drainage areas to determine the chemical composition of the runoff, and he has collected samples of bedrock for analysis during the winter. As a sideline, he has collected lichens and mosses for examination by other scientists after his return to the United States.

New Issue in Map Folio Series

Folio 5 in the Antarctic Map Folio Series was published in July. Entitled *Terrestrial Life of Antarctica,* it was prepared by S. W. Greene, J. L. Gressitt, D. Koob, G. A. Llano, E. D. Rudolph, R. Singer, W. C. Steere, and F. C. Ugolini. It is for sale by the American Geographical Society, Broadway at 156th Street, New York, New York 10032, at $7.50 a copy.

The Antarctic Map Folio Series is sponsored by the National Science Foundation. Vivian C. Bushnell is editor of the Series.

Winter Flight Completed

The first scheduled winter flight to Antarctica (cf. *Antarctic Journal,* Vol. II, No. 3, p. 81) was successfully completed on June 18, when a Navy LC-130F aircraft flying from Christchurch, New Zealand, landed at Williams Field, seven miles from McMurdo Station. The aircraft brought five scientists, an automotive engineer, and three tons of mail to the community, which had been isolated from personal contact with the outside world since February 24.

Two Navy men who had become ill earlier in the winter and a USARP field assistant returned to Christchurch aboard the aircraft.

Philatelic Mail for *Deep Freeze* 68

The U.S. Naval Support Force, Antarctica, has announced that philatelists may send covers to be postmarked at Byrd and South Pole Stations in Antarctica during the 1967-1968 antarctic season. Covers may also be sent to those *Deep Freeze* ships which will operate post offices. Collectors are limited to one cover from each station and ship. Philatelists in foreign countries may use International Reply Coupons to defray postal charges for the covers if appropriate U.S. postage is not affixed.

Byrd and South Pole postmarks may be obtained by placing two addressed covers, bearing United States postage at the letter mail rate, in an envelope addressed to:

DEEP FREEZE PHILATELIC MAIL
U.S. Naval Construction Battalion Center
Davisville, Rhode Island 02854

One cover will be sent to Byrd Station and the other to the South Pole for postmarking. If only one cover is submitted, the cancellation desired should be indicated by writing the word "Byrd" or "Pole" in the lower left corner of the cover. Philatelic mail to be cancelled at these stations must reach Davisville by September 1, 1967, in order to be processed during the antarctic winter. (Because transportation to and from Antarctica is limited and workloads are heavy during the austral summer, philatelic covers are shipped to Antarctica as surface cargo and cancelled at the stations during the winter-over period.) Collectors may expect to receive the postmarked covers between October 1968 and March 1969.

Cancellations may be obtained from participating ships by sending covers to:

DEEP FREEZE PHILATELIC MAIL
(Name and address of ship from which postmark is desired).

Six *Deep Freeze* 68 ships will operate post offices; their addresses and the 1967 deadlines for receipt of covers are:

USS *Calcaterra* (DER-390) FPO New York 09501	August 7
USS *Mills* (DER-383) FPO New York 09501	August 15
USCGC *Glacier* (WAGB-4) P. O. Box 20900 Long Beach, California 90801	September 15
USCGC *Burton Island* (WAGB-283) P. O. Box 20820 Long Beach, California 90801	September 15
USCGC *Westwind* (WAGB-281) FPO New York 09501	September 15
USCGC *Southwind* (WAGB-280) FPO New York 09501	November 1

Official Deep Freeze *cachet.*

Covers postmarked aboard these ships will be returned to collectors as expeditiously as postal workloads and operations permit. The ships may apply either their individual cachets or the *Operation Deep Freeze* cachet to philatelic covers.

Philatelic mail will be returned unprocessed when more than the authorized number of covers is submitted, if insufficient or foreign postage is provided, if covers are received after the cutoff date, if it appears that a commercial motive is involved, or if the covers are submitted to a ship or unit which does not operate a post office.

Antarctic Journal Index

Because of technical difficulties, the index to Vol. I of the *Antarctic Journal,* scheduled for publication in this issue, has been postponed to a later issue.

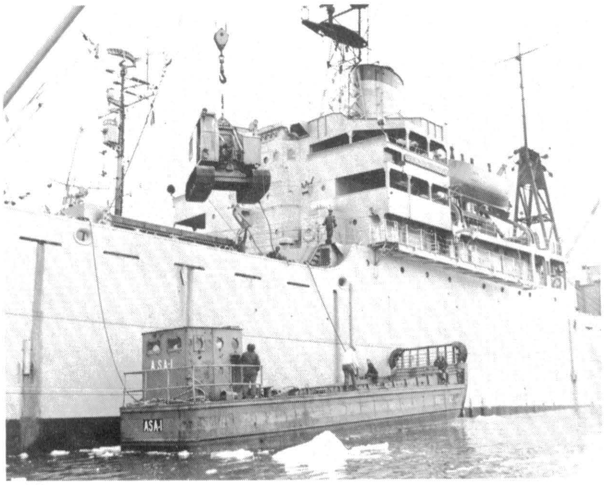
Antarctic Place-Names Changed

The following official changes have been made in the names of antarctic features:

Old Name	*Presently Approved Name*
Byrd Land	Marie Byrd Land
Byrd Mountains	Harold Byrd Mountains
Ronne Ice Shelf	Edith Ronne Ice Shelf

Small Boat Operations

The phrase "supported by ship's boats" in an order or final report may understate the activity involved, as indicated by this summary of *Westwind*'s small boat operations during *Deep Freeze* 67:



(U.S. Coast Guard Photo)

A crane is lowered from Wyandot *onto an LCM.*

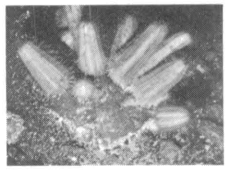
Sorties by Westwind*'s boats during* Deep Freeze *67*

Type of Sortie	Number of Sorties	Time Under Way (hours)	Distance Covered (nautical miles)
Construction site support	313	123.2	230.4
Palmer Station support	216	180.6	349.7
Cargo to construction site	69	54.8	93.4
Cargo to Palmer Station	24	25.3	39.3
Scientific support	32	123.2	524.8
Diving support	7	18.0	20.0
Miscellaneous*	143	90.1	316.2
Totals:	804	615.2	1,573.8

* Some of these sorties were not made in the Arthur Harbor area.

In addition to the sorties made by *Westwind*'s boats in the Arthur Harbor area, an LCM carried aboard *Wyandot* made 76 trips in the harbor to discharge cargo. Counting these, well over 700 sorties were made there by the boats of *Westwind* and *Wyandot*, making Arthur Harbor a rather busy place.

Benthic Organism Identified



(NSF Photo)

Through the efforts of Mr. Harrison Sheng, curator of *Eltanin* bottom photographs at the Smithsonian Oceanographic Sorting Center, the organism pictured on page 43 of the *Antarctic Journal,* Vol. II, No. 2, and again on this page, has been identified by Dr. Richard Chesher, Harvard University, as belonging to the Echinoidea. According to Dr. Chesher, the name of the rarely seen species is *Dermechinus horridus,* as reported by T. Mortensen in his *Monograph of the Echinoidea,* Vol. III, Pt. 3, p. 112-117. At the time of the publication of that monograph (1943), only a handful of specimens had been recovered, all in the Southern Hemisphere and at depths of 180-560 m.

Translations Available and in Progress

Another Russian monograph on polar research has been translated for the National Science Foundation under the Israel Program for Scientific Translations. Priced at $3.00 a copy, it is available from the Clearinghouse for Federal Scientific and Technical Information, U.S. Department of Commerce, Springfield, Virginia 22151:

Gaigerov, S. S. Aerology of the Polar Regions. Moscow, Hydrometeorological Service, 1964. viii, 280 p., illus. (TT 66-51060).

The following additional monographs have been submitted for translation:

Academy of Sciences of the U.S.S.R. Interdepartmental Commission on Antarctic Research. Antarctica: Commission Reports, 1962. 1963. 179 p.

Academy of Sciences of the U.S.S.R. Zoological Institute. Biological Results of the Soviet Antarctic Expedition (1955-1958), Vol. III. Edited by A. P. Andriiashev and P. V. Ushakov. 1967. 412 p.

Solopov, A. V. Oases in Antarctica. (Academy of Sciences of the U.S.S.R. Interdepartmental Geophysical Committee. Results of International Geophysical Research Projects: Meteorology, No. 14.) 1967. 141 p.

Erratum in Vol. II, No. 3, p. 88: The last chronology entry for February 4 should read ". . . partial resumption of flight operations. . . ." Normal operations were not resumed until February 6.

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