Antarctica is a world of colour, brilliant and intensely pure. The chaste whiteness of the snow and the velvet blackness of the rocks belong to days of snowy nimbus enshrouding the horizon. When the sky has broken into cloude of fleece, their edges are painted pale orange, fading or richly glowing if the sun is low. In the high sun they are rainbow-rimmed.

The clouds have opened into rifts and the sun is setting in the north-west. The widening spaces in the zenith are azure, and low in the north they are emerald. Scenic changes are swift. Above the mountain plateau a lofty arch of clear sky has risen, flanked by roseate clouds. Far down in the south it is tinged with indigo and ultramarine, washed with royal purple paling onwards into cold violet and greyish-blue.

Soon the north is unveiled. The liquid globe of sun has departed, but his glory still remains. Down from the zenith his colours descend through greenish-blue, yellowish-green, straw-yellow, light terracotta to a diffuse brick-red; each reflected in the dull sheen of freezing sea. Out on the infinite horizon float icebergs in a mirage of mobile gold. The Barrier, curving to east and west, is a wall of delicate pink overlaid with a wondrous mauve—the rising plateau.

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The Bulletin of the United States Antarctic Projects Officer appears eight or nine times a year. Its objective is to inform interested organizations, groups, and individuals about United States plans, programs, and activities. Readers are invited to make any suggestions that will enhance the attainment of this objective.

In this issue, the Bulletin is pleased to present a description of The Ohio State University Polar Research Institute by its Assistant Director, Dr. Arthur Mirsky, and the first of two articles summarizing the current state of geological knowledge of Antarctica. In addition to Mr. William E. Long's article on the sedimentary rocks, a future issue will carry an article by Dr. Samuel B. Treves on the igneous and metamorphic rocks. Mr. Long is associated with the Polar Research Institute at Ohio State and is well qualified to discuss his subject by study, research, and field experience.

Other material for this issue was adapted from United States Navy and National Science Foundation press releases and from messages received from Antarctica. The photograph appearing on page 12 is a U.S. Navy photograph.

Greenwich Mean Time is used in the Bulletin unless otherwise noted. No events after 12 February appear in this issue of the Bulletin.

When notifying this office of a change of address, you are requested to make reference to the four-digit code number appearing in the lower right hand corner of the address label.

All inquiries should be directed to the United States Antarctic Projects Officer, 718 Jackson Place, N.W., Washington, 25, D.C. Telephone: STerling 3-0860, extension 3795.
MONTH IN REVIEW

Perhaps, the most important event of the month is the successful establishment of Eights Station at the base of the Palmer Peninsula. This is the first new location to be occupied by the United States for a permanent station since the beginning of the International Geophysical Year, new Byrd, of course, having been built to carry on the work of an older station in the same vicinity. The concept behind Eights of air transportable units also capable of being moved about on site to avoid burial beneath the drifting snow and ice has significance for the future.

In the construction of Eights Station, as the account elsewhere in the Bulletin indicates, Army, Navy, and Air Force personnel participated. The wintering-over party will consist of six navy men and five scientists, the latter representing four organizations carrying out research under grants administered by the National Science Foundation. This cooperation among diverse elements of the military departments and civilian organizations is typical of United States programs in Antarctica.

Although not always expressed, the same close relationship exists between the support forces and scientific parties in the field. By the end of January parties that went out early in the season began to find their way back to McMurdo. It is pleasant to be able to report in a preliminary way something of their activities and accomplishments. While it is doubtful that they will bring us many genuine surprises, they will uncover curious facts and bring back bits of information that will add to the knowledge of the world around us.

A philosopher might ponder on that most unusual bird, the penguin, not because he is a bird that does not fly - there are others in that category - or even because he often looks like a man and occasionally acts as foolish as one. Rather, the penguin, living in a most hostile environment, has developed some very special skills without which he could not survive, and ones which any mariner might envy. For example, he is able to drink sea water and eliminate the salt through his nose. Now it appears that he can navigate by the sun. All this, of course, is in addition to a happy disposition and a talent for communal living.

The penguin alluded to above, and treated elsewhere in the Bulletin more at length, is the Adelie. Perhaps, some day we shall learn whether these characteristics are shared by Gentoo, Macaroni, Chinstrap, and others of his cousins so plentiful around the Palmer Peninsula. Noted briefly in the chronology is the trip of USS STATEN ISLAND in search of a site for a biological station in this same area. Future Bulletins hope to carry an account of this trip, as they do of other events, such as the first flight of helicopters to the South Pole and the work of a geologic survey party in the Pensacola Mountains.
Origin

The Ohio State University first became involved in large-scale scientific work in polar regions as a result of the International Geophysical Year. Previously, groups had done contract research for the U.S. Army Engineers in Greenland. The immediate result of the IGY work was to establish in Columbus a reduction center for data collected during the IGY and later the IGC (International Geophysical Cooperation). In February 1960 the Institute of Polar Studies was formally organized as an outgrowth of the data reduction center.

Purpose

The stated purposes of the Institute are:

1. To plan, encourage, support, and direct significant scientific research in polar phenomena.
2. To bring together or develop inter-related polar investigations and teams of investigators.
3. To seek and to facilitate the training of research workers devoted to polar studies.
4. To make available to scientists and the public the fruits of significant polar studies.

Polar studies are defined to include investigations of any natural or cultural phenomenon peculiar to the environment where ground is permanently frozen or where glaciers and permanent snows are nearby. In general, these are the areas where mean monthly temperature does not exceed 10°C for the warmest month. Areas presently included in studies are Antarctica, Greenland, Alaska, Yukon Territory, and the Colorado Front Range.

Organization

The Institute is directed by Dr. Richard P. Goldthwait, Professor in the Department of Geology, whose polar field experience dates back more than 30 years. With the assistance of Dr. A. Mirsky, assistant director and Mr. R.L. Cameron, assistant to the director, he heads a staff which, though fluctuating slightly, currently includes 19 full-time and 20 part-time employees at the Institute offices and in the field. The 33 research personnel include regular university faculty who divide their time between the Institute and their departments of instruction on campus, graduate students using polar investigations for their dissertations, and full-time Institute research personnel. Of the six administrative personnel, four are employed full-time and two half-time.

The Institute's physical facilities include a main office, three rooms partitioned to accommodate the research staff, a drafting-map
room, a machine shop, and a two-compartment low-temperature room. In addition, there is field and laboratory equipment gradually built up during the past several years, and a dust-free laboratory area for particulate research. Computers, X-ray equipment, and a complete line of stereoplotters are available in cooperating departments on campus.

Relation to the University

The Institute is a non-teaching research facility of The Ohio State University. As such, it is considered to be a department equal to and separate from any of the individual departments of instruction on campus. The Institute is governed and operated under the Vice-President of Research. Although the Institute does not participate directly in any teaching function, it does, however, sponsor a polar studies curriculum developed under various departments of instruction. Among the cooperating departments are the Departments of Geology, Botany and Plant Pathology, Agronomy, Microbiology, Geography, Anthropology, Civil Engineering, and Zoology.

The principal investigators on various Institute projects are usually non-student senior staff. Graduate students are available to assist these principal researchers in the various field and laboratory projects. Through this association the graduate students receive practical experience and training in the particular scientific discipline as related to their work. Also the students may take courses in various departments to gain additional instruction in subjects relating to polar areas. These courses normally are taught by the faculty-associated Institute senior staff. In addition, although the Institute does not itself have a teaching function, it has initiated the establishment of an interdepartmental polar seminar. Students sign up for this course in their respective major departments. To encourage graduate studies in polar work, the Institute also offers several fellowships for graduate study at Ohio State University and a summer fellowship to attend the University of Stockholm field station at Kebnekajse, Sweden.

The support for the Institute is mostly derived from The Ohio State University Instruction and Research budget. Complementary operational funds are also derived from the OSU Mershon Fund and from the National Science Foundation. Funds supporting research projects are granted largely from the National Science Foundation with lesser amounts from other agencies such as the Atomic Energy Commission, Ohio State University Development Fund, Quartermaster Research and Engineering, and Arctic Institute of North America. All contractual and grant business is handled by the Ohio State University Research Foundation.

Antarctic Projects

The Ohio State University became involved in research in Antarctica during the International Geophysical Year. Every year since then, some University personnel have conducted field studies on this southern continent. During the present Antarctic field season 16 men involved in six
projects are in Antarctica. All research in Antarctica is part of the U.S. Antarctic Research Program, administered by the National Science Foundation. The University is a part of this program through grants supporting research proposals of the Institute of Polar Studies. The current projects include research on glaciology, bedrock geology, glacial geology, zoology, lichenology, and bacteriology.

The glaciological studies are concerned with the Antarctic ice sheet. The usual practice has been to place two glaciologists, presently Dr. L.D. Taylor and Mr. Henry H. Brecher, on the yearly oversnow traverses conducted by the Geophysical and Polar Research Center at the University of Wisconsin. Observations include those made directly in the field and those made later on the firm cores sent back to the Institute's low-temperature rooms. The initial glaciological effort has progressed from the strictly data accumulation activities inherited from the IGY effort to the analytical work now being done by Institute personnel. Results of these studies have a bearing on the amount of annual accumulation of snow, the water budget, the physical properties and characteristics of firm, and the geologically recent history of the continent. A related OSU traverse in the area between Byrd Station and the Whitmore Mountains is expected to contribute much towards understanding ice surface movements. The members of this party are Dr. A.J. Brandenberger, Dr. C.B. Bull, and Messrs. R.B. Forrest, R.M. Koerner, and D.T. Dickson.

A two-year geological investigation of the Ohio Range in the Horlick Mountains, less than 5° from the South Pole, is nearing completion. Published phases of this work include preliminary reports on the stratigraphy by Mr. W.E. Long, and plant remains and coal by Dr. J.M. Schopf. Reports in press discuss the Glossopteris flora, Dr. A. Cridland, and Lower Devonian brachiopods, Dr. A.J. Boucot, Dr. K. Caster, Mr. D. Ives, and Mr. J.A. Talent. Reports on the igneous and metamorphic petrography of basement rocks by Dr. S.B. Treves and on glacial geology by Dr. J.H. Mercer are in final manuscript form. The final report on the stratigraphy by Mr. W.E. Long will be completed in the summer of 1963. At later dates, supplementary reports on the coal geology and plant remains by Dr. J.M. Schopf and the fauna by Dr. A.J. Boucot and others will be forthcoming.

During the Horlick Mountains work, evidence was discovered that the present site of the Ohio Range was covered by a shallow sea about 380 million years ago, had undergone an ancient glacial period about 300 million years ago, and was a swampy area with a climate not too different from present-day Great Lakes region about 270 million years ago. When the work is completed, the results will be a major contribution toward deciphering the geological history of Antarctica. A new Institute team of geologists, composed of Messrs. G.A. Doumani, L.L. Lackey, C.J. Skinner, V.H. Minshew with Dr. C.H. Summerson supervising the field work, is currently
carrying on investigations in the western Queen Maud Range. The overall geological program of the Institute includes continuing the studies northward along the so-called Antarctic Horst, eventually tying in with the geological work done in Victoria Land.

Nearly-completed petrographic studies are being made of the sedimentary Beacon rocks by Dr. A. Mirsky and the Ferrar dolerites by Dr. S.B. Treves in the Mt. Gran area in southern Victoria Land. Another petrographic study by Dr. S.B. Treves involves the igneous and metamorphic rocks collected some years ago by Dr. Robert Nichols in the Marguerite Bay area.

The glacial geology of Victoria Valley is also being studied by Mr. P.E. Calkin and is expected to contribute to our knowledge of the recent history of Antarctica. A new proposal in a related area by Dr. J.H. Mercer will work out the glacial history of a part of southern Patagonia.

Several programs exist in the biological sciences. One study is being made of the ecology of Antarctic lichens by Dr. E.D. Rudolph. Results from this 3-year study will define growth rates, adaptation to low temperatures, and perhaps afford a means for dating glacial retreat from glaciated areas which are now ice-free. An ecologic survey of Antarctic bacteria by Dr. W.L. Boyd is another current 3-year project. This study will enable a comparison to be made between bacteria in Antarctica and those previously studied in Arctic regions. Both of these programs are in their second year and preliminary results will be available after the current field season. A short account of the soil bacteria in McMurdo area is in press. A 2-year ecological and physiological study of Antarctic freshwater algae has been proposed by Dr. D.D. Koob.

The Institute has maintained one man, Dr. M.E. Pryor, as the American exchange scientist at the Russian Antarctic base of Mirnyy. His particular project is an investigation of soil arthropods. Results from this study are expected to shed much light on ways in which land invertebrates have adapted themselves to extreme climatic conditions.

Several laboratory projects are being undertaken in connection with the Antarctic field programs. The most promising of these is a particulate study of the firn cores which were brought back from the Ellsworth Land Traverse, 1961-62. Extreme care had to be taken in furnishing a controlled dust-free room in which to house the electronic particulate counter and the necessary filtration apparatus. The problem of contamination and counter calibration has been worked out and samples are being run. Preliminary results suggest that there may, in fact, be a variation in particulate matter which corresponds to seasons. A parallel study involves petrofabric analysis of the same firn cores used in the particulate studies.
Current office studies are: (1) Theoretical consideration of the densification of snow, using the glaciological data from previous Antarctic traverses, Dr. K. Kojima; (2) analysis of the scientific observations of the Ross Sea Party of the Imperial Trans-Antarctic Expedition of 1914-17, Dr. F. Loewe; (3) analysis of Antarctic glaciological and thermal data, Dr. C.B. Bull; (4) a study to determine annual accumulation in West Antarctica by coordinating snow, firn core, and meteorological data, Mr. W.W. Vickers; and (5) a glaciological study in the Wilkes area, Mr. R.L. Cameron.

Arctic Studies

The Institute also maintains activities in the Arctic where, during the field season this past summer, eleven men were engaged in three projects. A field operation in the Glacier Bay area of southeast Alaska has been conducted each summer for the past four years. Leading personnel have included Dr. R.P. Goldthwait, Dr. L.D. Taylor, and Dr. R.J. Price. The systematic study of glacial geology and glaciology is intended to enable us eventually to work out the glacial history of this area. Another project in northwest Alaska by Mr. K.R. Everett concerns the determination of the amount and rate of soil movement in an area underlain by permafrost. In southwest Yukon Territory a study was begun last year by Mr. S. Chaudhuri concerning the sedimentation of a fast-growing delta at the mouth of a glacially-fed stream.

During the summer of 1962 operations were begun in the Sondre Stromfjord area of southwest Greenland. The Institute's interest in this particular area is that it contains the Sukkertoppen Ice Cap which is a now-isolated former part of the Greenland Ice Sheet. The Sukkertoppen Ice Cap is composed of "warm" ice and is similar to the kind of glacial ice which once covered the Great Lakes region of the United States. It is hoped that an integrated study of the Sukkertoppen Ice Cap and its environs will give us a better understanding of conditions in this part of the United States some 15,000 years ago when the last ice was here. The glaciological observations of this "warm" glacier will be compared with similar observations of the "cold" Antarctic glaciers. During the summer of 1962, a five-man Institute party undertook a reconnaissance of the Sukkertoppen area and began studies in glaciology-geophysics, micrometeorology, bedrock geology, glacial geology, and plant ecology. Investigators included Drs. C.B. Bull, F. Loewe, S.B. Treves, and J.S. McCormick. A preliminary report of the results of this work has been completed and will be distributed shortly. Next summer the Institute is planning to continue these studies as the nucleus of a five-year research program. Studies of slope movement, lichenology and fresh-water algae are planned to begin during the summers of 1963 and 1964.

Publication

The results of these research studies are prepared for publication in standard scientific journals or in the Institute report series. Since
completing the obligations of the former data reduction center which resulted in the Ohio State University Research Foundation data reports, the Institute started a new research report series to supplant the data report series. Emphasis in on analysis of data.

The primary purpose of the new series is to make available for distribution in published form the results of research which are too lengthy or too specialized for standard scientific journals. The report series also serves as an outlet for results of still-continuing research which, although preliminary, are still desirable to distribute.

U.S. ARMY HELICOPTERS IN ANTARCTICA

For the second successive year, the U.S. Army Transportation Board assigned a UH-1B helicopter unit to the Antarctic, where it has operated under the control of Navy Air Development Squadron SIX (VX-6). The principal mission of the unit has been to assist topographic engineers from the U.S. Geological Survey in carrying on surveys of previously uncharted or poorly charted areas. The turbine-powered UH-1Bs are capable of landing at altitudes difficult or impossible for conventionally powered helicopters to attain. They have, however, a comparatively short range so that, when engaged in the survey, they have operated from a base camp in the field. The camp has been established, supplied, and, on occasion moved, by VX-6 aircraft, principally LC-47s, but also LH-34D helicopters and U1-B single engine Otters. This close cooperation between Army and Navy personnel and scientists is an excellent example of the type of support that has made the United States research program so productive.

During Operation DEEP FREEZE 62, the Army unit of two helicopters under First Lieutenant John H. Greene, USA, participated in project Topo North and South, which surveyed about 85,000 square miles of the Victoria Land Coast between the Beardmore Glacier and the area of Cape Hallett. This season, the project, to which three helicopters were assigned, was named Topo East and West and, when terminated on 21 January, had surveyed another 80,000 square miles in two separate areas. Approximately half the total, lay in northeastern Victoria Land to the West of Hallett Station and was called Topo West. This part of the project began on 1 November and ended on the 28th of the same month. The second part of the project, Topo East, started from the foot of the Beardmore Glacier and proceeded in an easterly direction through the Queen Maud and Horlick Mountains. Begun on 23 December, Topo East terminated for the season on 21 January, after having surveyed an additional 40,000 square miles. The leader of the unit, this year, has been Captain Frank H. Radspinner, USA. Other Army pilots, who participated in the project were Captain Neil Early, Lieutenant Charles U. Beaman, and Chief Warrant Officers Joe R. Griffin and John P. D'Angelo.
The method of operation has been the same for both seasons. From a base camp two of the helicopters fly the topographic engineers to mountain peaks between 20 and 49 miles apart. Once on location, the engineers, using electronic devices with an accuracy of two inches in 20 miles to measure the distance. They also determine with theodolites the angles between front and rear sites and to peaks perpendicular to the traverse route. Once a station has been completed, those on the first site leapfrog over their companions to a third peak, and the process is repeated. In good weather the Army helicopter crews and topographic engineers can complete four or five stations a day. To obtain accurate positions during the traverse, the engineers took three daylight star sites, employing a technique field tested the previous year by the Geological Survey. The topographic engineers were Peter F. Bermel, Donald C. Barnett, Ezekial R. Soza, and Kenneth S. McLean.

In most cases, the helicopters were able to land on or near the peaks at altitudes up to 13,000 feet, thus reducing the task of carrying equipment to the summit. On one occasion, a helicopter hovered near a peak with one skid resting on rock while the equipment was unloaded and then landed further down the mountainside. When the station was completed, the helicopter returned to pick up the engineers. The Army pilots and crews developed a great interest in the project and, whenever possible, assisted the engineers in their work.

As the range from a base camp increased, aircraft from VX-6 flew out from McMurdo Station to move it and at these and other times kept the project supplied. Some idea of the logistic effort may be obtained from the fact that LC-47s alone flew more than 17,000 miles and carried over 64 tons of cargo.

While concentrating on its principal mission, the Army unit has also assisted both logistic and scientific operations in other ways. During DEEP FREEZE 62, for example, it delivered 21 tons of cargo from the Coast Guard icebreaker EASTWIND, when that ship was damaged by ice off Hallett Station. This season, the traverse line passed close by an Ohio State University party engaged in a geological survey of the Mount Weaver area. In a few days, with the help of the UH-1Bs, the party was able to carry out investigations that would have required a month of travelling by motor toboggan. Included was the first ascent of Mount Howe at 80°10'S, 149°20'W, the world's southernmost mountain.

At the conclusion of Topo East, the three helicopters flew on 4 February from Mount Weaver to the South Pole Station, the first helicopters ever to reach that remote spot. For this flight, VX-6 provided an LC-130F as escort. While at the station, the engineers determined its exact position by a multiple star shot. A repetition of this fix in the future will make it possible to determine whether the station is moving and, if so, in what direction.
At the South Pole, the helicopters were dismantled for shipment to McMurdo Station in the cargo bay of VX-6 LC-130Fs. From the latter place they will be sent to the United States for overhaul.

DISTINGUISHED VISITORS

A final group of distinguished visitors from the United States visited Antarctica between 8 and 12 February. The visitors were Major General Lester C.W. Clark, USA, Deputy Chief of Research and Development; Colonel Gerald W. Homann, Director of the U.S. Army Polar Research and Development Command; Colonel D. Harold Byrd, cousin of the late Admiral Richard E. Byrd; Colonel Elmer F. Clark, USA (Ret.), of the Army Material Command; Mr. William Mills of the Department of State, Mr. Frank Uhlig of the United States Naval Institute, and Mr. Ralph Becker, prominent Washington lawyer, who participated in the drafting of the Antarctic Treaty.

Accompanied by Rear Admiral James R. Reedy, the group visited the South Pole and Byrd Stations, as well as McMurdo Station and such attractions of the McMurdo area as New Zealand's Scott Base and Scott's and Shackleton's huts at Cape Evans and Cape Royds. Colonel Homann was especially interested in Byrd Station because Camp Century in Greenland, which served as a prototype for Byrd, falls within his command. General Clark emphasized that the Army and Navy could learn much from one another's experiences at the opposite ends of the earth. On the return from the South Pole to McMurdo, the aircraft made a detour to pass over the Harold Byrd Mountains so that Colonel Byrd could see and photograph the mountains named for him by his cousin as a result of the first Byrd Antarctic Expedition.

SCIENCE NOTES

As scientific parties return to McMurdo from the field, the National Science Foundation has issued a number of interesting releases on the preliminary results and on many of the sidelights of this year's activities. Some of these of general interest to Bulletin readers are summarized below.

PENGUIN NAVIGATION

Dr. John T. Emlen and Mr. Richard L. Penney of the University of Wisconsin have been observing the homing instincts of penguins as part of a larger study of the behavior of these curious birds. About 100 Adelies were used as subjects. Most of them were taken from the rookery at Cape Crozier, although about 10 were removed from the vicinity of Hallett Station.
With assistance of VX-6, the scientists and their charges were flown out 180 miles on the Ross Ice Shelf, to a point in Victoria Land 290 miles northwest of McMurdo Sound, and to Byrd Station over 850 miles east of Cape Crozier. At the point of release the birds were placed in snow pits that were covered with muslin to prevent their observing the sun. The penguins were set free singly and tracked by theodolites out to distances of three miles. Usually they disappeared from sight within 20 minutes. Some, however, proved to be slow starters, and forced the two investigators to man their theodolites for considerable periods in chill winds. A few preferred just to sit, and these were popped back into the pit. On a second try, most took off without hesitation.

It was observed that the birds headed north, which in most parts of Antarctica would also be the shortest route to the sea, the penguin's preferred highway. Food was not a problem because the period of the experiment coincided with the normal fasting season. The northward orientation seemed to indicate that the penguins navigated by the sun, a fact confirmed by two other observations. On overcast days the quality of the birds' performance noticeably deteriorated. Also, a group of birds were submitted to alternating periods of artificial light and dark. When released their erratic behavior showed their navigational equipment had been thrown out of adjustment.

As any Boy Scout could testify, this method of navigation is not a simple one. It presupposes the ability to correct for the apparent movement of the sun. This the penguin can do because at the date of the press release, 26 January (local time), 12 of the birds had returned to Cape Crozier, having averaged six miles a day. There was no way to determine how the penguin divided his time between actual travel and periods of rest.

ROSS ICE SHELF STUDY

Scientists from the University of Michigan continued their study of the Ross Ice Shelf during the current season. The six men involved returned to McMurdo Station on 27 January after a motor toboggan journey of 860 miles. Leader of this year's party was Walter Hoffman. Other participants were William J. Campbell, Egon Dorrer, John Heap, Klemens Nottarp, and Arthur S. Rundle. Hoffman and Rundle left McMurdo Station on 1 November, and the others followed two days later. The party used four motor toboggans each pulling two sledges.

They first proceeded eastward about 400 miles to Camp Michigan, established in 1957. Along the way they measured distances between ice movement stakes with a Tellurometer, determined the angles between points with a theodolite, and set out 81 new aluminum poles for future measurements. Comparison between past and future position figures will reveal information about the direction and speed of ice movement at the forward
edge of the shelf. Strain stake patterns set out in 1959-60 were re-measured, and snow accumulation calculated at 2,000 stakes planted the same year. Pits to measure snow density were also dug along the route.

From Camp Michigan the party turned south and travelled approximately 200 miles to $82^\circ S$, $167^\circ W$. A new ice-movement stake pattern was set up on this leg of the traverse. Upon the return to Camp Michigan the party tried to reach the site of Little America III, set up in 1939, but were stopped by impassable crevasses. At Camp Michigan, they were picked up and returned to McMurdo by a LC-47 of VX-6. Throughout the journey, they received support from Naval aircraft of the same squadron which six times landed alongside with fuel and supplies and on one occasion air-dropped a much needed piece of equipment.

**LAKE VANDA - HEAT FROM BELOW?**

Two University of Wisconsin Scientists, Dr. Robert A. Ragotzkie and Dr. Gene E. Likens, continued the investigation of the thermal regimen of Lake Vanda, in which bottom water of high temperature was first reported in 1960.

The Lake, about $3\frac{1}{2}$ miles long, 1 mile wide, and 218 feet deep, is covered with 12 to 15 feet of ice. Beneath the ice is a layer of fresh water that increases in temperature during the first 30 to 45 feet until in summer time it stabilizes at about 47° Fahrenheit. It remains constant through a mixed middle layer and then increases to about 80° in the saline water near the bottom.

The scientists' findings indicate that water in the upper layers is being heated by solar radiation. Although about 50 per cent of the radiant energy is lost by direct reflection, enough passes through the ice to warm the upper layers. The heat in Lake Vanda, however, cannot be explained by this process alone. The two scientists believe that there is a good possibility of some thermal activity under the floor of the lake which would account for the unusually high temperature of the bottom water. The existence nearby of an active volcano, Mt. Erebus, and many extinct volcanoes must be considered as possibly contributing to the phenomenon.

**POLAR PLATEAU TRAVERSE**

On 28 January, three Sno-cats of the University of Wisconsin traverse party returned to the South Pole. The traverse had been conducted in two pie-shaped sectors from the South Pole Station - one toward the Queen Maud Range and the other in the direction of the Horlick Mountains. Between sectors the return was made to the South Pole for fuel and supplies. In all the party travelled over 950 miles and occupied 25 major scientific stations with seven to ten minor scientific stations between each major one. At major stations, seismic studies were made, and at all
stations the scientists investigated gravity, magnetism, and glaciology, and surface elevations were measured. A seismic shot near the South Pole gave an ice thickness of 9,315 feet.

In addition to the 25 shots to determine ice thickness, all of which were believed to be successful, the party made three long refraction shots to measure thickness and composition of underlying rock layers. Ice cores and other data collected on the trip will be returned to the United States for study and analysis.

The leader of the traverse was Edward S. Robinson, a seismologist from the University of Wisconsin, who was assisted by Perry E. Parks, also a seismologist, and Jack B. Long and Raymond J. Koski, both traverse engineers. Attached to the party were two glaciologists from Ohio State, Laurence D. Taylor and Henry Brecher, and David M. Perkins, a geomagneticist from the United States Coast and Geodetic Survey. Don Pfarrer of the Milwaukee Journal volunteered and went along to serve as cook.

The traverse party had the good fortune to be held up only one day by poor weather. The travelling surface, however, was consistently bad with three and four foot sastrugi making the going very rough. Much time was spent in repairing the vehicles which suffered from the constant pounding.
PICKET SHIP

South of New Zealand, about half-way between Christchurch and McMurdo Sound, a small ship tosses restlessly. Fighting high winds and frequently mountainous seas, she claws to maintain her position, usually at 60°S, 170°E. Seldom sighted by those who fly overhead, many of the scientists and others who visit Antarctica are probably unaware of her existence; yet the small ship has an important role in their successful coming and going.

Ever since DEEP FREEZE II, a United States Navy ship has performed this duty. During DEEP FREEZE 62, as it did again this year, the New Zealand Navy has also assigned a ship to ocean station so that her United States counterpart can slip off to port for fuel and supplies and a few days recreation for the crew without interrupting flying schedules. Also, on the current operation the United States Navy sent a second vessel of its own to help out. The three ships involved during DEEP FREEZE 63 have been USS DURANT (DER-389), USS FORSTER (DER-334), and HMNZS ROTOITI, a frigate.

The ship on station is available for search and rescue, should a plane go down on that long overwater flight. Fortunately, none has yet been called upon to perform this duty. More important has been the weather service and the existence of a check point for aircraft passing back and forth. The crew is beefed up a little from the complement found aboard such ships going about their normal routines. Included are a six-man team of aerographers mates, who twice daily launch a weather balloon, which is tracked by radar and also carries a radio that automatically transmits information about conditions overhead. When the aerographers have interpreted the findings, they forward the results to U.S. Naval Support Force headquarters at Christchurch and other interested parties. Planes passing overhead are also informed about conditions.

Since the beginning of the International Geophysical Year, a number of stations regularly report weather from the Antarctic. A gap exists, however, between Antarctica and the land masses of the southern hemisphere. Without the weather in between it is difficult to forecast what may occur at either end. The reports from the picket ship help to plug this gap in one small sector of great importance to our operations.

The usual turn at sea lasts about 25 days followed by four or five days in port. On the way to and from New Zealand, the ships usually stop briefly at Campbell Island, a lonely Sub-Antarctic outpost where the New Zealanders maintain a small station for meteorological observations and other scientific work.

The crew aboard one of these picket ships will refer to their vessel as "the loneliest ship in the Navy". Paradoxically, the same
crew will contain a large percentage of volunteers who have asked for this very assignment. The secret appears to be the people of Dunedin, which the ships use as a homeport during the operating season. "Tops in the fleet for liberty" the sailors, who have been there, say, and the word has gotten around. Not only is Dunedin a lovely town set in a picturesque countryside, but also its inhabitants have taken the visiting sailors to heart, providing entertainment and inviting them into their homes. A few happy days in port more than compensate for a lonely vigil at sea.

PERSONAL

Rear Admiral David M. Tyree, USN, United States Antarctic Projects Officer, returned to Washington, D.C. on 2 February 1963. After being relieved by Rear Admiral James R. Reedy as Commander U.S. Naval Support Force, Antarctica, on 26 November, Admiral Tyree returned to New Zealand. Accompanied by Mrs. Tyree, he left that country early in December and returned to the United States by the way of South Asia and Europe.

On 4 February, Captain Alexander E. Anthony, Jr., USAF, and Mr. Raymond A. Butler of the Office departed from Andrews Air Force Base for a brief trip to the Antarctic to acquaint themselves with current activities and developments.

GEOLOGIC TIME SCALE

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Years in Millions</th>
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<tr>
<td>Cenozoic</td>
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<td></td>
<td>Ordovician</td>
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<tr>
<td>Precambrian</td>
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Introduction

Little geological investigation was accomplished anywhere in the Antarctic until the beginning of this century when British and Scandinavian expeditions made extensive explorations of Victoria Land and the Palmer Peninsula. The results of both Scott's expeditions and Shackleton's expedition are of high quality. The Swedish South Polar Expedition, 1901-1904, also did excellent geologic work. Since the turn of the century many groups have worked on the continent. The Australians in Adelie Land and the Americans during the Byrd and Ronne Expeditions did valuable geologic work. Perhaps the longest single period of study is that of the Falkland Island Dependencies Survey (now the British Antarctic Survey) which has supported yearly scientific investigations on the Palmer Peninsula since 1914.

The next major period of investigation started in 1957 with the International Geophysical Year. Although geology was not a specific objective of the I.G.Y. program, additional knowledge of Antarctic geology resulted from the studies. Observations made on the I.G.Y. glaciological traverses yielded information about areas never before seen or visited.

The result of these initial investigations was the beginning of a geologic program that saw parties working in many portions of the continent in the following years. It is obvious now that much more detailed work is needed, but as a result of work already accomplished the broad pattern of Antarctic geology is beginning to emerge.

Sedimentary Rocks

The sedimentary rocks of the southern continent represent geologic periods from Devonian through the Pleistocene. (See scale, p. 13) This includes the interval starting about 400 million years ago and extending through the recent ice age, which still exists in Antarctica. Older sedimentary rocks are known but they are much more altered and considered part of the ancient basement complex. Sedimentary rocks of Devonian age or younger are known to exist in Victoria Land, Adelie Land, along the Amery Coast, the Queen Maud Coast, in the Theron Mountains, the Palmer Peninsula, the Ohio Range of the Horlick Mountains and in the Queen Maud Range on the southern edge of the Ross Ice Shelf.

Paleozoic sedimentary rocks occur in Victoria Land, the Queen Maud Mountains, the Ohio Range, the Theron Mountains and the Amery Coast, areas which border the stable continental block of East Antarctica. The attitude of the sedimentary rocks is usually horizontal. These rocks are unmetamorphosed except in the vicinity of local diabase intrusions.
The oldest Paleozoic sedimentary rocks now known are those of the Devonian system, but, isolated cobbles of limestone with Cambrian fossils, which may be 150-200 million years older than this, have been found. Prior to the International Geophysical Year, only isolated fragments of Devonian rocks had been found in glacial debris near Granite Harbor during the British Antarctic (Terra Nova) Expedition, 1910-13. They contained fish scales, which according to Woodward, are of late Devonian age, and are comparable with some fish remains in the black shale of Ohio. During the I.G.Y., however, the Marie Byrd Land traverse party found early Devonian marine fossils (brachiopods) in place in the basal sandstone of the Ohio Range in the Horlick Mountains. Subsequent study of these deposits, now called the Horlick formation, revealed a rich Early Devonian marine fauna. Also, intervening shale beds include remains of a primitive Devonian swamp flora. New Zealand parties during the same I.G.Y. period discovered silt-stones in Victoria Land which contain fish remains of middle to late Devonian age. All of the fossil remains are currently being studied.

The thick sequence of sedimentary rocks that overlies Devonian age deposits has been studied in two areas of Antarctica, in the Ohio Range and in Victoria Land. Difficulty arises because of the lack of fossils for age determination in parts of the rock column, and because important lithologic features differ in the two areas. In spite of these difficulties, the plant fossils that have been discovered are in substantial agreement and the further studies now in progress will undoubtedly help to clarify the regional differences.

In the Ohio Range an ancient glacial deposit called tillite occurs above the Early Devonian sandstone. The tillite rests on a glacial pavement with striae and grooves which cut the Devonian rocks and in some areas cut through all sedimentary rock to form a pavement on basement rock. This pavement and unconformity represent a lapse of time.

In Victoria Land the tillite has not been observed. Instead, thick nonfossiliferous sandstones rest on the late Devonian siltstones, and there is no apparent break in deposition, so that the sequence seems relatively complete. It is doubtful that the sandstone above the fish beds in Victoria Land was laid down at the time the tillite was deposited in the Ohio Range.

In the Ohio Range a distinctive thinbedded siltstone and black shale formation, named for its occurrence on Discovery Ridge, lies with slight disconformity on the tillite. Only some plant microfossils are known from it. These are similar to those in the coal measures rocks above. A thick (1800 ft.+) succession of coal-bearing, shaly, and sandy rocks with abundant plant fossils and mineralized woody stems, occur in conformable relationship above the Discovery Ridge Formation and is called the Mt. Glossopteris Formation. These coal measures have been the most widely correlated strata of the continent.
In Victoria Land the sandstones above the Devonian fish beds are hard to interpret due to disconnected outcrops and numerous intrusions of diabase. In the upper part of the succession coal measures occur which contain the same types of plant fossils and woody stem material as the Horlick formation of the Ohio Range, but there are fewer fossils and less coal.

Moreover, the Victoria Land succession continues above the coal measures, apparently with slight change in sedimentary regime, into beds that include plant fossils of a younger type which have not been found in the Ohio Range. The latter types of fossils show that the Victoria Land succession passes above the range of the Paleozoic into at least the early, and perhaps into the middle part of the Mesozoic. In the Ohio Range the coal measures, or Mount Glossopteris rocks, are abruptly terminated by diabase intrusions, and the upper part of the deposits present in Victoria Land is missing. The coal measure rocks in both areas, however, carry the same kinds of Glossopteris fossils and must be regarded as closely equivalent in age.

Rock units containing coal beds and plant fossils are known from other localities in Antarctica including Mt. Buckley at the head of the Beardmore Glacier, the Theron Mountains which are near the Weddell Sea, and a locality near the Amery Ice Shelf. Plant fossils from these widespread coal measures in Antarctica compare closely with the Permian fossils of other successions in the Southern Hemisphere, and from this paleobotanical evidence the coal measures are considered Permian.

As yet no rocks of Carboniferous age have been recognized in Antarctica. In Victoria Land, Mesozoic sedimentary rocks are found and are the youngest rocks known in this large region.

Discovery of Mesozoic rocks of Victoria Land is a direct outcome of I.G.Y. studies which provide a link in geologic history with those at the tip of the Palmer Peninsula. As a result of the early Swedish expeditions, Halle had described a Rhaetian plant assemblage at Hope Bay which is usually regarded as early Jurassic. The rocks of the Palmer Peninsula are disturbed by later Andean folding and isolated from the Antarctic shield areas that were previously mentioned. Mesozoic marine fossils are associated with the Rhaetian plants and later Mesozoic and Cenozoic deposits containing marine fossils are also present in this region. Most of the later Mesozoic and Cenozoic deposits of the Palmer Peninsula are similar to those which are well represented in the southern Patagonian tip of South America. Only study of plant microfossils has provided a hint that Cenozoic rocks may be represented farther south in the interior area of Antarctica.

Two episodes of volcanic and igneous activity complicate the interpretation of the sedimentary succession of the Antarctic Continent. One
consists of widespread diabase intrusions as sills and dikes during the mid-Mesozoic in rocks of the Permian coal measures. These intrusions have induced displacement, faulting, and alteration of sedimentary beds in many areas. Much of the coal has been devolatilized as a result. In Victoria Land a thick nonstratified deposit which has been interpreted as another tillite seems to have been associated with this episode of plutonism. Based on plant fossils and nearby radioactive dating, these tillites are probably of Jurassic age. The other period of volcanic activity occurred during Cenozoic and Recent times and is characterized by vents and lavas on Ross Island. This later vulcanism is related to the vulcanism prominently displayed in Tierra del Fuego and the Andes.

In summary, the sedimentary rocks that have been studied so far in the Antarctic only partially represent the geologic time scale. Since the age of sedimentary rocks must be ascertained by fossils, only a few strata are dated. Of the Paleozoic rocks, Lower Devonian beds with invertebrates and plants are known from the Ohio Range while later Devonian fish remains occur in Victoria Land. Permian plant fossils associated with coal are found in widespread and distantly separated areas.

No rocks of Mississippian or Pennsylvanian age are known as yet, although some nonfossiliferous successions may represent these systems. While the Cambrian, Ordovician and Silurian systems are not represented in the non-metamorphosed sedimentary rocks, they may be included in the metamorphosed sediments of the basement. Coral-like fossils in the basement complex indicate Cambrian age for some marbles. Mesozoic rocks have been known for many years from the Palmer Peninsula and recently have been found in Victoria Land. Tertiary rocks are present in the Palmer Peninsula and are closely related to South American rocks.

Geological studies in Antarctica have a broad significance but they necessarily depend on a detailed understanding of stratigraphy, structure, and composition of the rocks. Less is known about the geology of Antarctica than any other continent, although it is clear that the presence of this land mass has an important bearing on several outstanding and long continued problems of earth history, such as continental drift. At the present time Antarctica represents a vast frontier of exploration for geologic knowledge, equivalent to that represented by submarine geology of the ocean depths. The acquisition of this knowledge is important and no one can foresee all its possible effects.

All that one may be sure of is that the knowledge of any land mass of this vast magnitude will contribute evidence bearing on many problems. Most of this information will be supplied in the future by detailed, painstaking investigation.
ADDITIONS TO THE LIBRARY COLLECTION

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Assur, Andrew, *Composition of Sea Ice and its Tensile Strength*. U.S. Army Cold Regions Research and Engineering Laboratory, Corps of Engineers, Hanover, N.H. December 1960, 49p., illus., tables, appendixes. (Research Report 44.)


Behrendt, John C., *Summary and Discussion of the Geophysical and Glacio-
 logical Work in the Filchner Ice Shelf Area of Antarctica*. The University of Wisconsin, Geophysical & Polar Research Center, Department of Geology, Madison, Wis. April 1962. 66p., illus., tables, appendixes. (Research Report No. 62-3.)


Buffalo Evening News (New York), *DEEP FREEZE 1960-61 - Bud Wacker (author).*


Corte, Arturo, Relationship Between Four Ground Patterns, Structure of the Active Layer, and Type and Distribution of Ice in the Permafrost. U.S. Army Cold Regions Research and Engineering Lab., Corps of Engineers, Hanover, N.H. Feb. 1962, 79p., illus., maps, tables, appendixes. (Research Report 88.)


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Dykins, J.E., and A.I. Funai, Point Barrow Trails - FY 1959; Investigations on Thickened Sea Ice. U.S. Naval Civil Engineering Lab., Port Hueneme, Calif. 23 April 1962., illus., tables. (Technical Report R-185.)


Engineering and Mining Journal, Antarctica's Operation DEEP FREEZE - by Finn B. Domaas.


New York Mirror, Articles on Antarctica - by Selig Adler.


Popular Mechanics, Civilization Comes to Antarctica - by Richard F. Dempewolff. May 1961 issue.

ANTARCTIC CHRONOLOGY
(Greenwich Mean Time, unless otherwise noted)

10 Jan - Two medical patients were flown from Byrd Aurora Sub-station (Delta Sub One) to Byrd Station for treatment.

10 Jan - New wintering-over party for Wilkes Station arrived at the station.

10 Jan - Commander Task Group 43.1 (Palmer Peninsula Party) reported sighting first iceberg at 62°24'S/144°-20'W.

12 Jan - CDR Ronald K. McGregor, USN, resumed duties as Commander, Antarctic Support Activities, relieving CDR Marvel effective 0700 hours.

13 Jan - USS FORSTER arrived in Dunedin, N.Z. at 2230 hours.

14 Jan - USNS CHATTAOOCHEE departed McMurdo enroute to Port Lyttelton, N.Z.

15 Jan - RADM Reedy departed Christchurch, N.Z. at 2125 hours and arrived at McMurdo at 0552, 16 Jan.

16 Jan - USS ARNEB arrived at Port Lyttelton, N.Z. at 1944 hours.

17 Jan - USS DURANT departed Ocean Station for Campbell Island.

17 Jan - USS FORSTER departed Dunedin, N.Z. at 2130 hours for Campbell Island.

17 Jan - USS EDISTO departed McMurdo enroute to rendezvous in the vicinity of Campbell Island with USS TOMBIGBEE.

17 Jan - USS STATEN ISLAND (with Palmer Peninsula Party aboard) arrived at Adelaide Island.

18 Jan - USS ARNEB departed Port Lyttelton, N.Z. at 0700 hours and arrived in Wellington, N.Z. at 2209 hours where she was drydocked to effect necessary repairs.

18 Jan - USS EDISTO rendezvoused with USS TOMBIGBEE at 77°12'S/166°13'E at 0130 hours and escorted and towed her to McMurdo Sound.

18 Jan - USS STATEN ISLAND hove to southwest of Adelaide Island. Party landed at the British Base and consulted with British expedition members.

18 Jan - USS TOMBIGBEE arrived at McMurdo at 0600 hours and was moored to the ice shelf by 1100 hours.
19 Jan - USS FORSTER arrived at Campbell Island and offloaded food stores and mail by 0730 hours.

19 Jan - USS STATEN ISLAND was underway from Adelaide Island at 2330 hours enroute to Palmer Peninsula.

20 Jan - USS FORSTER relieved USS DURANT as ocean station vessel.

21 Jan - TOPO EAST terminated.

21 Jan - New wintering-over party at Wilkes Station took over operation of the station.

21 Jan - USS DURANT arrived in Dunedin, N.Z. at 0001 hours.

21 Jan - RADM Reedy departed McMurdo Station at 2200 hours for Eights Station and returned via Byrd Station to McMurdo at 1114 hours on 22 January. He then departed McMurdo Station at 1707 hours for South Pole Station and returned again to McMurdo at 0010 hours on 23 January. At 2101 hours, then, he departed McMurdo Station for Christchurch, N.Z.

22 Jan - USS EDISTO towed USS TOMBIGBEE through the channel at McMurdo to open water and detached her at 1645 hours. She is enroute to Port Lyttelton, N.Z.

22 Jan - USS GLACIER departed McMurdo enroute to Hallett Station.

22 Jan - USNS CHATTAHOOCHEE arrived in Port Lyttelton, N.Z.

23 Jan - USS GLACIER stopped at Hallett Station enroute to Wellington, N.Z.

23 Jan - The Australian-American Traverse party returned to Wilkes Station from Vostok Station after four months on the plateau.

25 Jan - Eights Coast Traverse party resumed movement after repairing D-8 tractor.

25 Jan - RADM Reedy departed Christchurch, N.Z. at 0001 hours for an official visit to Dunedin, N.Z.

26 Jan - USS ARNEB departed Wellington, N.Z. for Lyttelton, N.Z.

26 Jan - USNS CHATTAHOOCHEE departed Port Lyttelton, N.Z. for McMurdo.

26 Jan - At 1800 hours, USS EDISTO broke her lower crank shaft of number 1 main engine thus restricting her operational readiness and seriously reducing her capability to assist shipping in the channel.
27 Jan - Eights Station construction completed, Mobile Construction Battalion 8 personnel returned to McMurdo.

28 Jan - USNS MERRELL is at McMurdo and is 100% offloaded and backloaded.

29 Jan - USS GLACIER entered drydock at Wellington, N.Z. at 2100 hours.

29 Jan - USNS MERRELL departed McMurdo Sound for Lyttelton, N.Z.

30 Jan - USS DURANT departed Dunedin, N.Z. for Campbell Island.

30 Jan - USS TOMBIGBEE arrived in Port Lyttelton, N.Z. at 0400 hours.

30 Jan - RADM Reedy returned to Christchurch from Dunedin at 0553 hours.

31 Jan - Eights Station, logistic traverse from Byrd Station arrived at 0330 hours.

31 Jan - USS FORSTER departed Ocean Station for rendezvous with USS DURANT in the vicinity of Campbell Island.

1 Feb - USCGC EASTWIND arrived Hallett Station 1200 hours, discharged cargo and departed for Cape Adare at 2020 hours. Since ice condition precluded use of boats, she used USS EDISTO's helicopter and airlifted the cargo in 63 flights.

2 Feb - RADM Tyree, U.S. Antarctic Projects Officer, returned to Washington, D.C.

2 Feb - USS DURANT arrived Ocean Station at 2200 hours.

2 Feb - USS FORSTER arrived Dunedin, N.Z. at 2000 hours.

2 Feb - USCGC EASTWIND arrived Cape Adare 0400 hours.

2 Feb - LC-47 from Byrd Station transferred three scientists from Pensacola Mountains base camp to Neptune.

3 Feb - USNS CHATTahoochee arrived at McMurdo.

3 Feb - USS FORSTER departed Dunedin, N.Z. for Hobart, Tasmania, 2000 hours.

3 Feb - USS EDISTO made rendezvous with HMNZS ENDEAVOUR and towed her to berth arriving 1200 hours.

4 Feb - Three U.S. Army UH-1B helicopters arrived at the South Pole Station from Mt. Weaver at 0515 hours, escorted by an LC-130F.
4 Feb - USNS MERRELL arrived at Port Lyttelton, N.Z. at 2100 hours.

4 Feb - USCGC EASTWIND arrived off Beaufort Island from Cape Adare at 1000 hours. She continued on to McMurdo arriving the same day.

5 Feb - USS EDISTO departed McMurdo Sound to take oceanographic stations at 1530 hours.

5 Feb - Survey party evacuated from Pensacola Mountains by LC-47 from Byrd Station.

6 Feb - USNS PRIVATE JOSEPH A MERRELL departed Port Lyttelton, N.Z. about 0001 hours and returned to operational control of Commander Service Force, Pacific Fleet.


6 Feb - USNS CHATTAHOOCHEE completed discharging her cargo and departed McMurdo for Port Lyttelton, N.Z.

7 Feb - RADM Reedy, USN, departed Christchurch, N.Z. at 1014 hours and arrived McMurdo Station 1803 hours.

7 Feb - USS FORSTER arrived at Hobart, Tasmania at 2200 hours.

7 Feb - RADM Reedy inspected South Pole Station and returned to McMurdo Station.

10 Feb - USS EDISTO completed a total of 19 Oceanographic Stations and departed for Cape Adare arriving at 1314 hours where she completed her 20 Oceanographic Station and picked up the Cape Adare personnel.

10 Feb - HMNZS ENDEAVOUR completed discharging diesel fuel and departed McMurdo at 1200 hours under escort by USCGC EASTWIND.

10 Feb - RADM Reedy inspected South Pole Station and returned to McMurdo Station.

11 Feb - RADM Reedy departed McMurdo and arrived in Christchurch, N.Z. at 0910 hours.

12 Feb - USS ARNEB arrived Hallett Station at 0625 hours and made rendezvous with USS EDISTO. She commenced offloading her cargo at 0800 hours.