ANTARCTIC REPORT

U.S. ANTARCTIC RESEARCH PROGRAM

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CONTENTS

Communications regarding the Antarctic Report should be addressed to the Office of Antarctic Programs, National Science Foundation Washington, D. C., 20550.

THE NATURE OF CENTRAL ANTARCTICA*
Recent Studies by Soviet Scientists

A. P. Kapitsa

On November 21, 1963, two heavy turboprop IL-18 aircraft took off from Sheremet'evskiy Airport near Moscow and laid their course south. Aboard were 72 passengers - members of the Ninth Soviet Antarctic Expedition; of these, eight were to participate in an expedition through antarctic regions never before visited by man. Covering a distance equal to more than halfway around the Earth at the Equator, the airplanes landed enroute at Tashkent, Dehli, Rangoon, Port Darwin, Sydney, Christchurch, and McMurdo, arriving at Mirnyy 12 days after the departure from Moscow. It was the second flight from Moscow to Antarctica; however, this one was different from the first in that its practical purpose was to transport seasonal expeditionary personnel to the Antarctic a full month and a half prior to the arrival of the ships. To a group that was to prepare for and carry out a long traverse into the interior, this represented considerable savings in time.

PREPARING FOR THE TRAVERSE

Intense preparations for the traverse began immediately upon arrival of the planes at Mirnyy. The participants were flown to Vostok Station for acclimation, i.e., adaptation to the conditions under which they were to live and work. Indeed, conditions at Vostok differ radically from those in coastal antarctic areas: the height above sea level is 3,490 m. and the air temperature, even during summer, hovers at 30-50°C. below zero.

All traverse personnel had to pass a thorough physical examination including testing in a low-pressure chamber where they were "elevated" to 4,000 m. altitude. However, not even the strictest medical examination board can determine how a man will react to the severe conditions of Central Antarctica. Thus it often happens that a person brought to Vostok has to be returned to Mirnyy after a week because he did not pass the acclimation test.

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* Original Title: Priroda Tsentral'noi Antarktidy, pub. in Priroda, Sept. 1964, p. 46-56. Translated by K. G. Sandved.

Soon the traverse personnel had settled down to work. Geodesists IU. G. Bugaev and E. I. Safonov began mounting the modern geodetic equipment on the tractors. Our expedition was to be the first to employ tellurometers and optical precision theodolites for leveling of the ice surface, an operation that had previously been carried out only by optical methods. It had to be determined how the unusual conditions would effect the operation of these electronic instruments which enable determination of distances with an accuracy of 1:100,000, i.e., an error of less than 10 cm. in 10 km. Using the tellurometer to measure the distance and the theodolite to determine the angle of inclination between two tractors, the trigonometric leveling method was to be used to level a 1,000-km. section of the forthcoming traverse in order to reference the height of the Pole of Inaccessibility Station to that of Vostok Station.

The geodetic equipment was mounted on the roofs of the two tractors, in special hexahedral shields consisting of prism-shaped metal frames enclosed in tarpaulin covers. These shields protected the instruments and the observers against the wind albeit not against the cold.

Astronomical observations were taken every day in order to determine accurately the coordinates of the Vostok Station reference point. The SN-3 gravimeters, to be used for measuring gravity variations throughout the traverse, were calibrated, then placed in a specially-constructed box and shielded against temperature fluctuations and shock.

The senior scientist, candidate of physical-mathematical sciences O. G. Sorokhtin, and the author of this article were to determine the thickness of the ice cover using a portable seismic-surveying instrument. Such studies had been carried out also on previous traverses. It was known that seismic sounding work in Antarctica is beset with a number of problems, the major one being the enhanced background noise, known as seismic boom, developing in the snow-firn layer following the explosion. O. G. Sorokhtin developed an effective countermeasure to this effect:

Modifying the seismic apparatus he inserted additional filters to provide a cut-off for frequencies lower than 150 c./s., i.e., those on which the enhanced background noise propagates (the recording of reflected waves takes place on frequencies above 150 c./s.). Placing the explosives charge in a borehole not less than 40 m. deep further reduces the background noise and strengthens the wave reflected from the rock at the bottom of the ice.

Prior to departure the equipment had to be tuned, some dry runs had to be made, and certain theories had to be tested. Engineer N. I. Kazarin was in charge of the drill URB-1 which normally drilled to a depth of 30 m. Kazarin successfully extended this depth to 60 m.

While the scientific equipment was being prepared, the tractor train that had left Mirnyy in early November was approaching Vostok Station. On December 24, 1963, six vehicles arrived with supplies for the wintering group at Vostok Station as well as a cargo of fuel. The technical preparations for the traverse began on the following day.

Two heavy tracked vehicles, "Khar'kovchanka" No. 22 and 23, were selected. These powerful machines are specially equipped for intracontinental traverses. Their spacious cabs have accommodations for navigator and driver, a room for scientific apparatus, and electric kitchen, radio room, toilet, and two corridors. Six people live in each vehicle. In both tractors were short-wave radio stations, magnetic and gyrocompasses, as well as astronomic and radiocompasses. A man can drive these vehicles blindfolded. Towed by the tractors were sleds loaded with fuel, supplies, scientific equipment, spare parts, explosives, etc.

An electric kitchen and a 12 kw. power unit for the stoves and for use of the train when at standstill, were mounted on a third tractor, No. 15, which was also equipped with radio station and compasses for navigational purposes. Hooked to this tractor were several sleds with fuel and on its roof, a hexahedron shield was mounted for the geodetic instruments.

The installation of equipment (amplifier assemblies, oscillator for the SS-24-P seismic station, power supply racks) on tractors No. 15 and 22 took place after their arrival from Mirnyy. A remote-control meteorological station and a recording panel for the actinometric instruments were installed in tractor No. 12 which had been at Vostok since 1959.

On January 3, 1964, the train was ready for departure. Most of the participants in the traverse had previous traverse experience; nine of them had wintered over in the Antarctic and at this time had already spent a year there. There were 16 participants in all: A. P. Kapitsa, traverse leader (seismic exploration, thermal measurements); A. N. Lebedev, assistant leader (transportation engineer, driver); O. G. Sorokhtin, scientist (seismic exploration, thermal measurements); IU. G. Bugaev, scientist (geodesy, gravimetry, navigation); E. I. Safonov, scientist (geodesy, astronomy, navigation); V. K. Nozdriukhin, scientist (glaciology, meteorology); G. G. Sakunov, scientist (actinometry, meteorology); V. A. Kazarin, (engineer, magnetician); N. I. Kazarin, drilling engineer; S. G. Kovtaniuk, technician (radio, magnetics); N. V. Savel'ev, doctor and cook; and mechanics-drivers N. S. Borovskii, A. S. Kundelev, A. G. Temliakov, I. S. Ushakov and P. N. Shulenin.

UNDERWAY

On January 3 tractors No. 23 and 15, equipped to carry out observations in geodesy, glaciology, meteorology, actinometry, and gravimetry, left

Vostok with course for the Pole of Relative Inaccessibility. They were followed on January 6 by tractor No. 22, equipped for seismic sounding, geomagnetic, and thermal observations. Right off, the train encountered an area of loose snow in which the tractors sank 60 cm. deep. Soon the ascent began.

The tractor train was actually made up of two parts, the geodetic part of the train consisting of two slow-moving vehicles. They would come to a stop at a distance of 10-13 km. from each other while measurements were made of the distance and gradient angle between them. Then the leading tractor would remain at a standstill while the second tractor overtook it and proceeded 10-13 km. beyond. During the 5-6 hours it took to carry out this redeployment, gravimetric observations were made from the first tractor and a glaciological pit was dug, in which hardness and density of the various layers were measured and a description made of the snow structure to a depth of 3 m. When the time approached for taking meteorological or actinometric observations, the albedometer, pyranometer and pyrheliometer were mounted on a special stand and the amount of reflected, direct, and diffused radiation and solar radiation balance were recorded.

Meteorological as well as actinometric observations were made four times daily. The measurements included temperature, humidity, atmospheric pressure, wind direction and velocity, visibility, cloudiness, and atmospheric phenomena. Twice daily the meteorological data were transmitted to the synoptic office at Mirnyy for use in the preparation of charts and forecasts.

The second part of the train, tractor No. 22, proceeded at a considerably higher rate of speed. Every 20 km. it stopped for 20 min. to measure the vertical component and absolute vector of the magnetic field. The latter was measured with a proton magnetometer operated by S. G. Kovtanʃuk, the radio technician. Every 50-60 km. a two-hour stop was made for observations according to the absolute geomagnetic point program, during which time the declination of the magnetic field was measured. Every 100 km. tractor No. 22 stopped to make seismic measurements, a 10-12 hour operation. First a hole was drilled to 40-45 m. depth and the explosives charge was inserted. The recorders were located 20 m. apart along a 460 m. long profile. It was found that the background noise could be reduced considerably by placing the receivers in the tracks made by the tractors.

During each series of blasts the time required for the wave to travel to the rock surface and back was measured. (The propagation velocity of seismic waves in ice, about 3,800 m./sec., had been determined by previous expeditions. The depth to the bottom of the ice is obtained by dividing half of the wave's traveling time by the velocity, with correction for the depth of the borehole.) Every 500 km. a string of platinum resistance thermometers was inserted in a borehole and allowed

to remain for 2-3 days. Measurements of the resistance of the platinum thermometers (the four-wire circuit completely eliminated the effect of the wires) provided data on the temperature of the ice at levels from 5 to 40-45 m. depth.

The method of advancing the train in two groups was highly successful. Six to eight hours after the passage of the first tractor, the tracks become two-three times harder than the surrounding snow cover and the following tractor's advance is made easier.

TOWARDS THE POLE OF INACCESSIBILITY AND MOLODEZHNAYA STATION

On January 17 the train arrived at a point 500 mi. from Vostok where it remained for three days in order to make scientific observations and replenish the fuel supply. (We were low on fuel for the kitchen power unit and the drilling rig. Fuel had arrived in Antarctica by ship on January 15 and we were now to receive six barrels of it by aircraft). The train got underway again on January 20 and on the 23rd an aircraft reappeared and parachuted fresh fruits and vegetables. Continuing the ascent we reached the highest point on the ice cap, 3,997 m., on January 24. From this point the route would be downhill to the Pole of Inaccessibility. Again the snow became soft and the weather, which hitherto had been favorable, began to deteriorate. It became cloudy and winds of up to 8 m./sec. caused drifting. The clouds creeping in along the surface of the ice reduced the visibility to 50 m. These conditions seriously hampered the geodetic observations.

On February 1 tractor No. 22 reached the Pole of Inaccessibility Station while the geodetic part of the train was awaiting an improvement in visibility 100 km. away. Not until February 4 did the latter arrive at the station. Autumn weather had begun and since no improvement in visibility could be expected, the radio-optical leveling operations were discontinued.

The Pole of Inaccessibility Station was established in 1958 during a traverse of the Third Soviet Antarctic Expedition to the Pole of Relative Inaccessibility. The station facilities consist of a hut containing an electric power unit, kitchen, radio station, and living quarters for 5-6 people. There are food supplies for 3-4 months and a small supply of fuel. A drilling rig installed within the station was fully operable. Mounted on top of the rig was a bust of V. I. Lenin. Near the station a meteorological site was prepared and a borehole made for temperature observations. The station was reactivated and operated for six days.

On February 6, Pole of Inaccessibility Station was again secured and the train proceeded on its way with course for the center of Queen Maud Land.

The discontinuation of the geodetic work permitted the train to proceed considerably faster. Seismic measurements on this portion of the traverse were made each 150-200 km. and on February 14 the train reached the planned turning point at 78°03'S., 19°59'E.

On February 16, after a two-day sojourn, the course was set for Molodezhnaya Station. In lieu of geodetic leveling, the altitude was now determined by means of synchronous barometric leveling. (Tractors No. 23 and 15 would proceed ahead at a distance of 10 km. from each other. Stopping simultaneously, they would obtain readings on three aneroids in each tractor, checking the readings and synchronizing the observations by radio. Upon completion of the operation, the last tractor would go into the lead, mark the location with a flag, then proceed 10 km. ahead, and the measurements would be repeated).

Throughout the journey from Vostok Station astronomical observations for the determination of exact coordinates were made at each seismic sounding point and at any other point where the stay exceeded 5 hours. The entire route of the traverse as well as supporting observation points were marked by means of pyramids of empty barrels which, considering the rate of snow accumulation in these areas, should remain in existence for 20-30 years.

The journey continued at about 3,500 m. above sea level. On February 22 the train reached 73°49'S., 40°04'E. at a point 700 km. from Molodezhnaya Station. The fuel supply was exhausted with the exception of an untouched supply to be used for the preparation of a landing strip and for heating of the vehicles. Airplanes based at Molodezhnaya Station were to resupply us with fuel here. However, the arrival of winter weather forced postponement of this operation. Finally, on March 4, the first air drop was made and after refueling the train we immediately proceeded 50 km. further. Additional air drops on the 6th, 12th and 13th of March assured our continuous journey to Molodezhnaya Station.

On March 15 the train arrived at the meridian of Molodezhnaya Station at a distance of 350 km. south of it. From here the travel would be through a crevasse field. An LI-2 aircraft made an aerial survey of the area and furnished us with a map of the location of the crevasses; simultaneously a tractor left Molodezhnaya Station to meet the train and to carry out a survey of the route to 200 km. south of the Station. With the aid of aero-visual reconnaissance from the LI-2, this train, which was led by V. Mal'tsev, reached 69°24'S., 45°57'E. on March 19, having marked its route with bamboo poles and barrels. Here the two trains met.

The last 200 km. of the journey across the crevassed area took place under very difficult meteorological conditions. On March 20, moving along in a narrow corridor between crevasses, we encountered the opti-

cal phenomenon called whiteout. Only diffuse light penetrated the dense clouds, wiping out all shadows. The surface of the ice became invisible, giving the illusion that the tractors were hanging in the air. The tractor out in front, used as the point of orientation for the other drivers, disappeared. The gyrocompass was of no use without the astrocompass, which could not provide the true course under conditions of dense cloudiness. Only the experience of the drivers made it possible to proceed another 100 km. on this day.

On March 21 a severe snow storm blew in. The wind force reached 30 m./sec. and the visibility dropped to a few meters. The train had to come to a stop for 12 hours, but with a slight improvement in visibility, got underway again. That same night the train reached Molodezhnaya Station after a journey of 3,320 km. The trip had lasted for 78 days and the average speed had been 42.5 km. per day.

Throughout the journey a multidiscipline research program had been conducted of the ice cover, the atmosphere, and the magnetic and gravitational fields. Let us look for a moment at some of the results of the scientific observations and studies that were carried out.

A NEW MOUNTAIN RANGE

By means of the radio-geodetic and barometric leveling a complete profile was constructed of the surface of the ice cover along the traverse route. What were the results of the seismic soundings and what type of data was obtained from the gravimetric survey on the depth of the ice cover?

Seismic soundings were made at 21 stations at an average interval of 150 km. Between seismic stations the determinations were made from gravimetric observations. At first, free air anomalies were employed for this purpose, later the theoretical gravity was determined by means of the Cassinis ellipsoid, which in the Southern Hemisphere corresponds more closely to the geoid than does the Helmert ellipsoid. Free air anomalies were determined for all stations where gravimetric observations were made, i.e., along the entire route at average intervals of 20 km. At seismic sounding stations where also gravimetric observations were made, Bouguer anomalies were determined, using a value of 0.9 g./cm.^{3} for the average density of the ice and 2.67 g./cm.^{3} for the bedrock. Between seismic stations Bouguer anomalies were determined by means of linear interpolations between auxiliary stations. To eliminate the regional gravitational value the depth of the ice cover was determined on the basis of the difference between the free air and Bouguer anomalies. As a result, data on the depth of the ice cover were determined for 170 points, all of which were plotted on the profile.

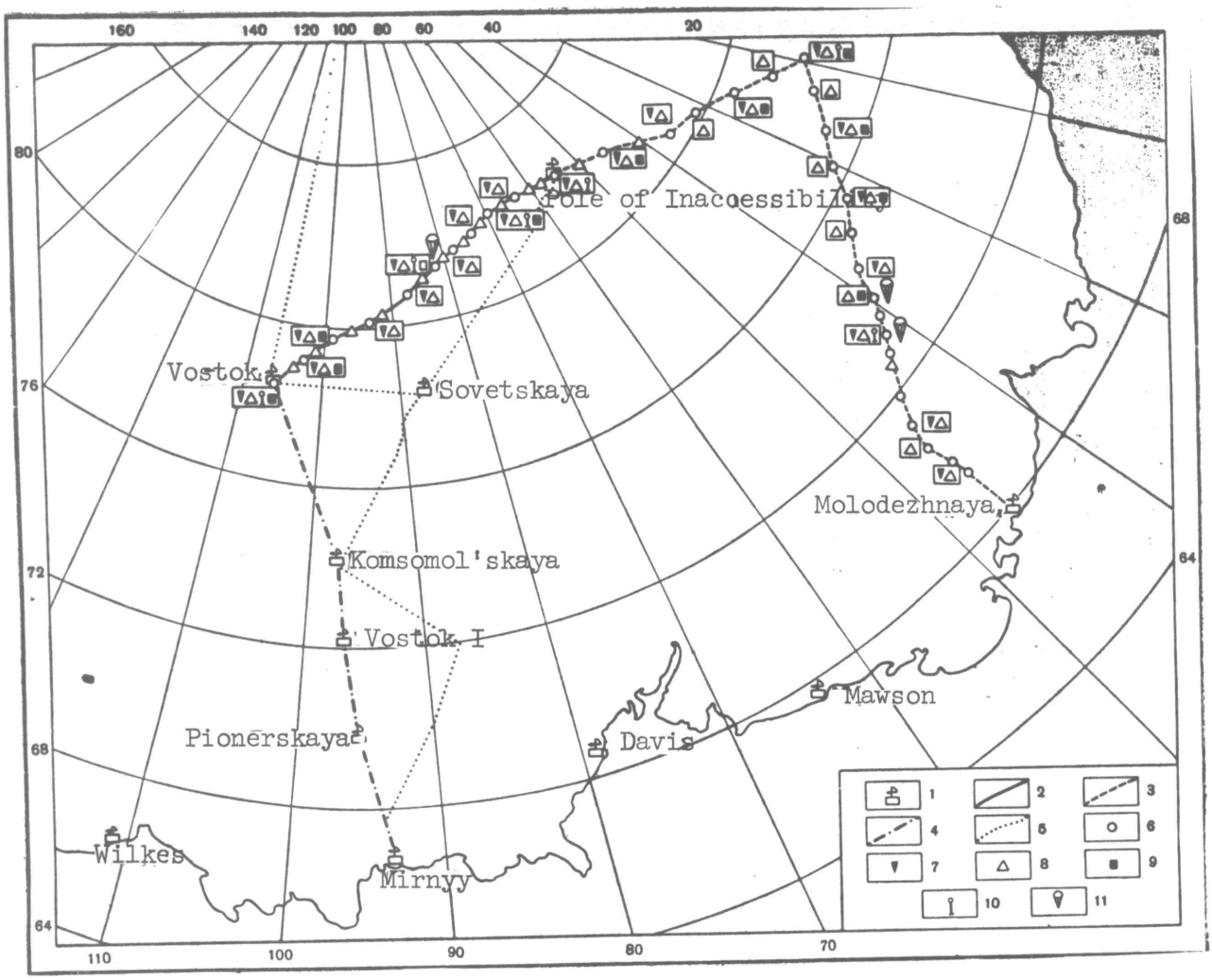

Fig. 1. Sketch of the work carried out during the Vostok-Molodezhnaya Traverse: (1) Scientific stations; (2) Geodetic route with radio-optical leveling together with gravimetric and geomagnetic measurements; (3) Barometric route, with gravimetric and geomagnetic measurements; (4) Transportation route for the supply of fuel from Mirnyy to Vostok Station; (5) Scientific traverse routes of previous years; (6) Astro-points; (7) Seismological stations;(8) Absolute magnetic stations; (9) Glaciological pits; (10) Borehole with temperature measurements; (11) Location of fuel drops.

The cross section obtained shows a rise in the height of the ice sheet to 3,997 m., hence a slope in the direction of the Pole of Inaccessibility. The height above sea level of the Pole of Inaccessibility Station, 3,718 m., was determined radio-optically. Taking into account the accuracy of the leveling on this distance and the fact that it was confirmed by gravity measurements, these data may be used to calculate the form of the geoid.

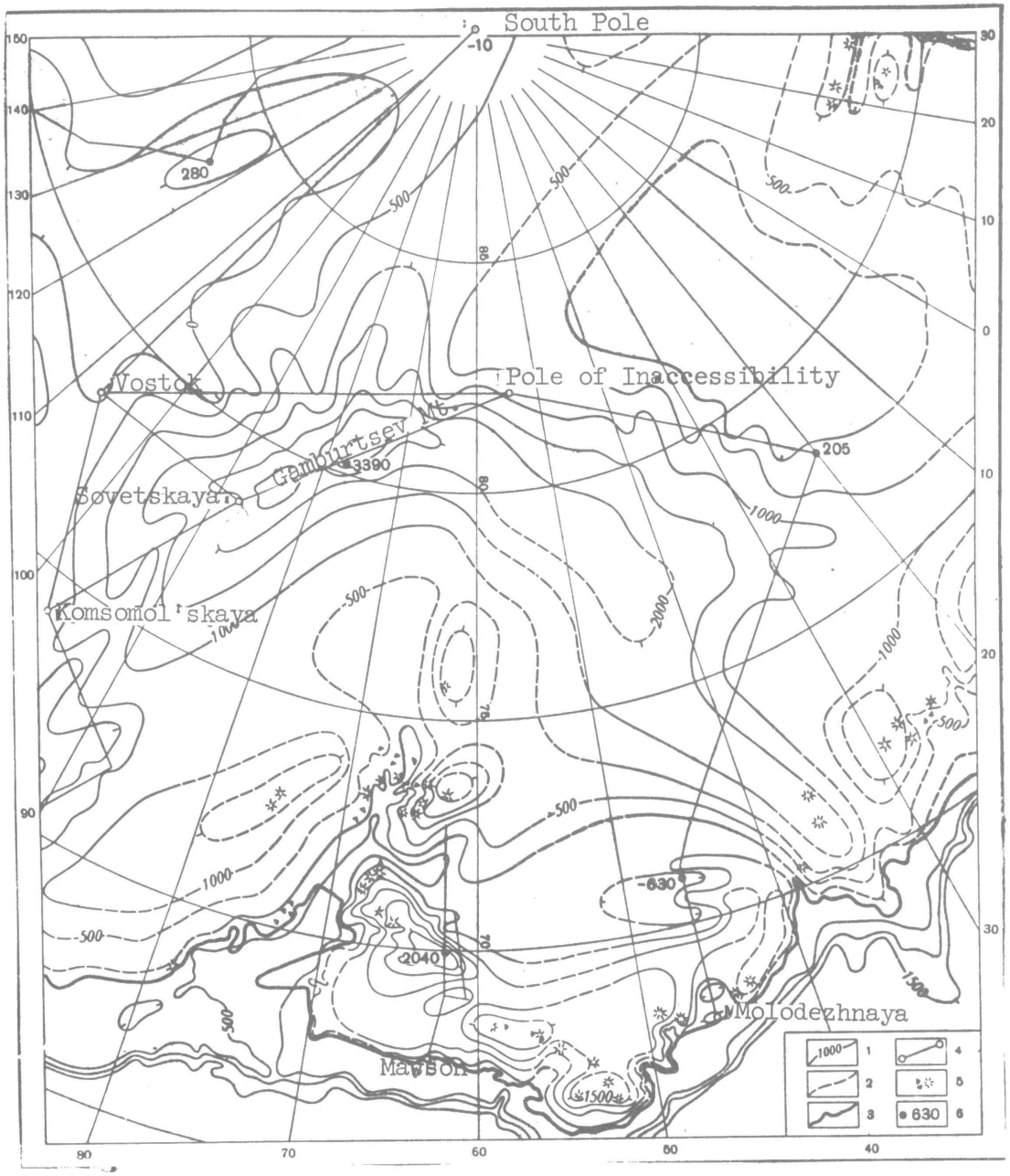

Fig. 2. Sub-ice relief map of the central sector of East Antarctica, compiled by L. I. Ivashutina, A. P. Kapitsa and O. G. Sorokhtin. Legend: (1) Contour lines; (2) Conjectural contour lines; (3) Antarctic coast line; (4) Routes of scientific traverses; (5) Rock outcrops above the ice surface; (6) Elevations of the sub-ice floor.

The maximum heights of the surface of the ice cover correspond to the maximum elevation of the bottom to a height of 2,000 m. above sea level. This rise represents an extension of the sub-ice Gamburtsev Mountains, discovered by O. G. Sorokhtin in 1958 and located to the north of our

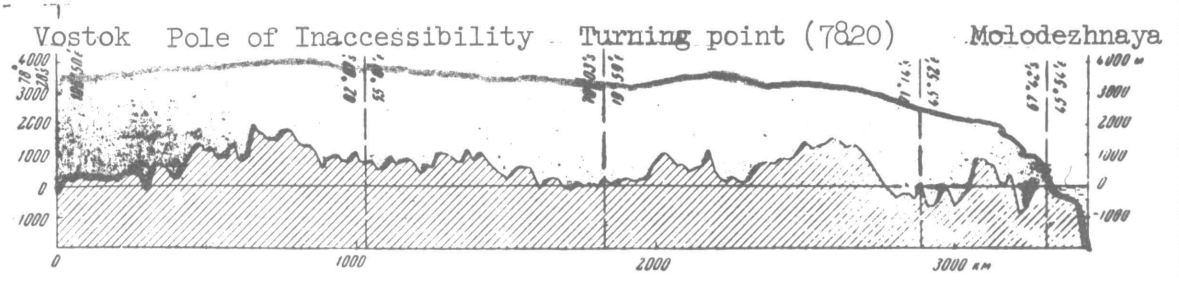

Fig. 3. Cross-section of the ice cover along the traverse route from Vostok Station via Pole of Inaccessibility Station and 78°S. 20°E. to Molodezhnaya Station. Compiled by A. P. Kapitsa and O. G. Sorokhtin.

traverse route. Along the first 300 km. of the route from Vostok Station there is a hillocky plain with heights of 300-400 m. above sea level, a continuation of the plain discovered by the author in 1959 that extends to the South Pole.

From the Pole of Inaccessibility the surface of the ice slopes slowly towards Queen Maud Land and at the turning point of our traverse route reached a low of 3,195 m. above sea level. The bottom surface on this portion of the route also takes on the character of mountainous land with heights to 1,200 m.; only at a distance of 200 km. from the turning point did the bottom surface take on the character of a plain with heights near sea level. A number of oblique reflections indicated that this portion of the traverse route crossed the extension of a mountain range whose axis is located to the northeast of the route and parallel to it. Katabatic winds and sastrugi on this part of the traverse were oriented northwards and if one calculates the deflection of the wind caused by Coriolis Force, then this is a prime indicator that an uplift was located northeast of us. Also, the stability of the wind direction along the entire traverse route from the Pole of Inaccessibility to the turning point indicates that the uplift extends along the route. After the turn of nearly 90° towards this uplift we soon found ourselves at a height of 3,500 m. above sea level. This increase in the height of the surface corresponds to an elevation of the bottom surface to 1,500 m. above sea level. Thus the existence of a mountain range, extending from the Gamburtsev Mountains towards the coast, was confirmed.

Further ahead there is a rather steep slope towards the ocean and although the sub-ice bottom has deep depressions to 800 m. below sea level and rises to 900 m. above sea level, it is hardly visible on the surface of the ice cover. Such deep canyons and ridges are typical of the coastal regions and are associated with block dislocations along the edge of the platform.

On the basis of the data obtained, O. Sorokhtin, L. Ivashutina and the author prepared a relief map of the bottom surface of the ice cover in this sector of Antarctica.

In analyzing contemporary cartographic materials it can easily be seen that the described mountain range extends to the coast near Cook Peninsula and continues out to sea as the submarine Gunners Bank.

One of the main characteristics of the mountain system is that the Bouguer gravity anomalies under the Gamburtsev Mountains, through a range extending towards Cook Peninsula, and in the area of Gunners Bank (according to data obtained at sea), indicate a thickening of the Earth's crust, i.e., the existence of "rooted" mountains. The structure extends above the surface in the form of the "mountains" observed in 1937. By studying these nunataks we may obtain data on the geological structure of the mountains and solve the riddle of the tectonics and geology of the sub-ice mountain formations of Central Antarctica, whose structure as of now can only be surmised.

Located to the west of these mountains is a vast plain which in our opinion may be part of the plain located to the southwest of the Queen Maud Mountains.

Previously, the IGY Valley was thought to extend deep into the Antarctic. The recent studies show that it actually terminates in the form of a wide cirque-icefall that collects ice flowing from the easterly and northerly slopes of the mountain system.

The main ice divide in East Antarctica must therefore now be considered as being along the newly discovered mountain range. Apparently the ice flows partly along the IGY Valley and partly westward towards Weddell Sea. These changes necessitate a re-examination of the data previously used on the surface of the ice cover as being about 4,000 m. above sea level south of the Queen Maud Land Mountains (discovered by a German expedition in 1939). It is difficult to imagine that the ice cover over a distance of 500-600 km. could rise from 3,200 m. to the enormous heights that it has only in the central regions of East Antarctica.

The glaciological observations made on the traverse require more detailed and thorough studies. Of particular interest are the observations of surface micro-relief. Sastrugi and drifts, formed by katabatic and cyclic winds, are good indicators of such elements of the micro-relief as the direction of slopes. The hardness of the windblown slab, i.e., the dense upper layer of the snow, indicates the velocity of the wind. All observations made by recording the characteristics of the surface are exceedingly important in determining the trafficability for ground transportation and for the landing of aircraft. Pit measurements of the temperature of the snow cover permit determination of the antarctic cold pole at the top of ice cap. Measurements of the snow temperature in

drill holes at a depth of 15 m., i.e., where the annual temperature fluctuation waves are extinguished, provide the long-term average of the temperature. At 82°12'S., 69°44'E., at an altitude of 3,933 m. above sea level, the temperature at 10 m. depth was -60°C., at 15 m., -59.2°C. and at 20 m. depth, -59.3°C. Compared to the long-term average temperature measured in a pit at Vostok Station, these temperatures are 2-3° lower at the same depths. A rough estimate indicates that in the coldest years, e.g., in 1960, the air temperature may reach lows of -95°C. The vertical gradient of the long-term average temperature was considerably lower than previously assumed. The change over a 450 m. height difference was only 3°C., which gives a value of the vertical gradient of -0.66°C./100 m.

The magnetic observations on the traverse showed that the declination determined for these regions deviates from the true value by up to 3°, while the deviation from the computed value has the opposite sign. It is imperative that this be taken into account during flights in the interior. Data on the vertical component and the resultant vector of the magnetic field are presently being reduced and it is too early to draw even preliminary conclusions.

The meteorological and actinometric observations carried out en route are of considerable interest. The observations at the Pole of Inaccessibility showed that even in late summer snowfall occurs, as does dense cloudiness and general snowstorms. Such weather is foreign to our ideas of the central regions and their anticyclonic conditions.

As the greatest achievement of the traverse must be considered its multidiscipline approach and the use of new instrumentation in the observation program. For the first time in Soviet antarctic expeditionary history, tellurometers and proton magnetometers were employed and distinguished themselves well under the rigorous conditions of intracontinental travel. The data collected on the traverse will be recorded in the Antarctic Atlas where Queen Maud Land so far has been shown only as a large white spot.

From an organizational point of view, the experiment in carrying out the traverse using scientists from a seasonal expedition, is tremendously important. It was made possible only by the transportation to Antarctica of the scientific staff of the expedition aboard the heavy IL-18 aircraft at the beginning of the antarctic summer. Another major result was the discovery of a safe route through the crevasse field from the ice cap to Molodezhnaya Station. This route can be traveled at any time of the year, which makes Molodezhnaya Station an important supporting base for future traverses into the central sector of East Antarctica.

TRANSLATIONS PUBLISHED

The following English translations of Russian books have recently been published and are available as indicated at the end of the citation:

RUSIN, N. P. Meteorological and radiational regime of Antarctica [Orig. title: Meteorologicheskiĭ i radiatsionnyĭ rezhim Antarktidy, pub. 1961]. Translated by Israel Program for Scientific Translations, Jerusalem, 1964, pursuant to an Agreement with the U.S. Dept. of Commerce and the National Science Foundation. iv, 355 p.

Available from the Clearinghouse for Federal Scientific and Technical Information, U.S. Dept. of Commerce, Springfield, Va. 22151. Cost $7.00 (Request OTS 64-11097).

SHUMSKIĬ, P. A. Principles of structural glaciology [Orig. title: Osnovy strukturnogo ledovedeniia, pub. 1955]. Translated by David Kraus. 1964. xi, 497 p.

Available from Dover Publications, Inc., 180 Varick Street, New York 14, N. Y. Price $3.00.

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CORRECTION: In the list of foreign personnel aboard the USNS Eltanin, which appeared in the October issue of the Antarctic Report, p. 17-18, two names were inadvertently left out, namely:

Brazilian Personnel

Miniussi, I.	Cruise 8	Biology	Sao Paulo Univ.
Murillo, A.	" 7	"	" " "

Also, N. F. Kudriavtsev should have been listed under Eltanin personnel as a participant in Cruises 7 and 8, rather than under U.S.S.R. personnel for 1964-65.

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PUBLICATIONS

The following publications received at the Office of Antarctic Programs during November and December pertain to work supported in whole or in part by the National Science Foundation under the U.S. Antarctic Research Program:

ANTARCTIC MAP FOLIO SERIES, Folio 1, Aeronomical maps for the Antarctic. By Roy R. Penndorf, T. M. Noel, G. F. Rourke, and M. A. Shea. New York, American Geographical Society, December 1964. 6 p., 9 maps incl. fold. col.

BRICE, N., Stanford Univ. Maximum duration of discrete very low frequency emissions. (J. of geophysical research, Nov. 1, 1964. vol. 69, no. 21, p. 4698-4700.)

BROWN, J. A., JR. and E. J. PYBUS, USA Ballistic Research Laboratories. Stratospheric water vapor soundings at McMurdo Sound, Antarctica: December 1960-February 1961. (J. of the atmospheric sciences, Nov. 1964. vol. 21, no. 6, p. 597-602.)

EMLEN, J. T. and R. L. PENNEY, Univ. of Wisconsin. Distance navigation in the Adélie penguin. (Ibis, 1964. vol. 106, p. 417-431.)

GRESSITT, J. L., C. E. FEARON and K. RENNELL, B. P. Bishop Museum. Antarctic mite populations and negative arthropod surveys. (Pacific insects, Nov. 10, 1964. vol. 6, no. 3, p. 531-540.)

HARGREAVES, J. K., H. J. A. CHIVERS, and J. D. PETLOCK, National Bureau of Standards. A study of auroral absorption events at the South Pole. (J. of geophysical research, December 1, 1964. vol. 69, no. 23, p. 5001-5007.)

HARRIS, LARRY G. and ELLSWORTH C. DOUGHERTY, Univ. of California. Continued cultivation of the antarctic bdelloid rotifer Philodina gregaria. (American zoologist, August 1964. vol. 4, no. 3, Abstract 259.)

HELLIWELL, R. A., Stanford Univ. Whistlers and VLF emissions. (In: Research in geophysics, vol. 1. Cambridge, Mass., M.I.T. Press, 1964. p. 319-331.)

HELLIWELL, R. A. and N. BRICE, Stanford Univ. Very low frequency emission periods and whistler-mode group delays. (J. of geophysical research, November 1, 1964. vol. 69, no. 21, p. 4704-4708.)

JONES, T. O., National Science Foundation. New U. S. research station in the Antarctic Peninsula. (Nature, London, November 28, 1964. vol. 204, no. 4961, p. 825-826.)

RAY, CARLETON and DAVID O. LAVALLEE, New York Zoological Society. Self-contained diving operations in McMurdo Sound, Antarctica: Observations of the sub-ice environment of the Weddell Seal, Leptonychotes weddelli (Lesson). (Zoologica, Fall 1964. vol. 49, issue 3, p. 121-136.)

FIELD REPORT NO. 72 - DECEMBER 1964

NOTE: In general, material included in the Field Report is summarized from regular reports by personnel of Federal agencies, universities and institutions carrying out scientific research in the Antarctic under National Science Foundation grants and with logistic support by the U.S. Navy. In order to ensure that the work of the individual scientists and their institutions is clearly understood, it is requested that prior to using any of this material for public dissemination, such use be discussed with the Office of Antarctic Programs in the National Science Foundation or with the originators of the research as named.

GENERAL

Byrd Station: Station activities during December included logistic support for field parties operating from the station and preparations for the installation of a satellite telemetry system. A new diesel-electric generator was installed and a new fuel tunnel completed.

Eights Station: Although outdoor work was hampered by frequent strong winds, station personnel uncovered and relocated several caches and began an overhaul of the Traxcavator. The station roof continued to leak during a month of record high temperatures. Conditions were favorable for amateur radio communications in the 14 Mc./s. band.

USNS Eltanin: Cruise 15 had several objectives, viz.: locating the Antarctic Convergence between longitudes 90°W and 155°W and sampling the waters, ocean bottom, and marine life in the area; collecting geological and biological bottom samples from the seamount reported at 55°S 130°W; surveying the trend, bottom topography and extent of the so-called "Eltanin Fault Zone" between 123°W and 135°W; obtaining marine biological collections in the coastal waters of Chile and on the New Zealand continental shelf for comparison with organisms of higher southern latitudes; and transversing the area centered at 54°09'S 156°03'W, which is geomagnetically conjugate to Jim Creek, Washington, for recording artificially stimulated emissions during echo activity of the VLF transmitter, NPG.

Delayed departure from Valparaiso, Chile (October 1), engine trouble, and rough seas necessitated readjustments of the schedule throughout the cruise. The extension of the cruise by four days and the economic use of time compensated for some of the lost hours. Mid-water trawling, for

instance, was accomplished chiefly while cruising toward a station and terminating upon arrival, or while steaming away from the station following operations from the drifting ship. Utilizing two winches simultaneously for over-the-side work also reduced time on stations.

The original scheme of transecting the Antarctic Convergence with three complete stations on each south-to-north traverse, then steaming from the northernmost point on the traverse diagonally across longitudes to the southernmost point on the traverse line to the west was seldom followed, owing to the elusive nature of the Convergence. Locations of the Convergence previously determined by the Discovery, the Ob', the Vema, and the Eltanin were frequently as much as two degrees of latitude (120 nautical miles) off that obtained on Cruise 15. One week spent in surveying the fault zone on the South Pacific Rise provided an interlude in the program of Convergence stations. Bountiful hauls in two otter trawls off the coast of the Chatham Islands proved the value of this collecting device in shallow waters. The cruise terminated at Auckland, New Zealand, on December 4.

Hallett Station: Station personnel cooperated in a general clean-up and installed metal storage lockers in the Biolab for supplies formerly kept in the adjoining Jamesway hut.

McMurdo Station: A rock saw was installed temporarily in the shell of the Earth Sciences Laboratory building. Electrical wiring progressed in the Biolab, in the Jamesway hut J-21, and at the warehouse. All Kilo air shipments were received and accounted for and some of the Kilo ship equipment arrived. Benefitting from excellent air support, all field parties were operating on or ahead of schedule.

On December 5 a helicopter from the icebreaker USS Staten Island crashed on the ice within 50 yards of the ship during a photographic mission; the pilot and two passengers escaped uninjured.

On the 12th a U.S. Navy C-130 aircraft made an exploratory flight via South Pole Station to the Sør Rondane Mountains in East Antarctica and back to McMurdo. The USARP Representative accompanied the flight. Peaks thought to be the western extension of the Shackleton Range were photographed.

The sub-ice observation chamber was removed from the ice on December 15. It was not reinstalled because of limited visibility underwater resulting from the plankton bloom at this time of the year. The chamber was free from corrosion and rust.

South Pole Station: Operations normal.

BIOLOGY

USNS Eltanin

Marine Biology, University of Southern California: Twenty-nine marine biological stations were completed on Cruise 15 and another 10 samples (7 IKMWT, 2 otter trawls, 1 Peterson grab) were taken en route to and from the Antarctic Convergence work area. Results of the collections are summarized below:

SUMMARY OF BIOLOGICAL COLLECTIONS

Gear	Attempted	Successful
Isaacs-Kidd Midwater Trawl	63	61
Blake 5' Trawl	8	4
Blake 10' Trawl	10	9
Menzies Trawl	10	7
Otter Trawl	2	2
Petersen Grab	1	-
Dip Net	3	3
Phleger Corer	22	17

Relatively few organisms were collected in the Antarctic Convergence area by bottom sampling, although a good collection of corals was made from the crest of a ridge at 550-640 m. depth. A total of 56 mid-water trawls provided collections of fish and invertebrates used for separate biomass analysis. Fish biomass was greatest below 678 m., peaking at 1,250 m. Squid biomass peaks were recorded at 875 m., 1,750 m., and 2,250 m. In general, deeper tows were more successful in collecting larger organisms; catches were greatest at night and during twilight. Supplementary trawls off Chile and New Zealand revealed that many deep-water genera seen in the Convergence zone extend to temperate latitudes.

Unusual fishes collected included the angler fish (Ceratius holbolli and Diceratiid sp.), whalefish (Cetomimus sp.), gulper eel (Eurypharynx sp.?), lantern fish (Hintonia candens), a citomimiform (Rondeletiid) and a ribbon fish (Trichipterus sp.?).

Plankton Program, Columbia University, Lamont Geological Observatory: A total of 29 plankton stations were made (12 in the Convergence zone, seven south of the Convergence, and ten north of it), resulting in 175 plankton samples:

Gear	No. of Samples
Multiple plankton sampler (MPS)	69
Bathypelagic sampler 1 (BPS-1)	24
Bathypelagic sampler 2 (BPS-2)	3

Gear	No. of Samples
Microplankton net	45
1/2 m. square frame	34

In addition, 54 nannoplankton samples were obtained.

All samples were run through the IKMWT coarse and fine mesh nets, #8 plankton net, and #20 microplankton net to determine the percentage of different size groups and displacement volume for the USC program. Half of the samples were preserved in buffered formalin, the remainder was dried in a low-heat oven and frozen. A series of 0-100 m. tows at five stations was made to collect Foraminifera for the Living Foraminifera Laboratory of the American Museum of Natural History. Eighteen plankton cultures were prepared for study of algal, bacterial and fungal growth at Lamont Geological Observatory.

Microbiology, Columbia University, Lamont Geological Observatory:

SUMMARY OF MICROBIOLOGICAL SAMPLING

No. of Stations	Purpose	No. of Samples
88	Phytoplankton	608
76	Carbon^{14}	379
73	Chlorophyll	306
28	Bacteria	34

All samples were taken from standard depths between the surface and 150 m. In addition to laboratory incubations, three *in situ* incubations were made at 0, 10, 20, 30 and 50 m. All the stations showed normal phytoplankton densities except at 58°21'S, 134°38'W, where densities were exceptionally high.

Ornithological Notes (Bernice P. Bishop Museum Observer):
A record was maintained of birds sighted from October 1 to December 4 (cf. table). The number of albatrosses increased from morning till late afternoon, and decreased rapidly with the arrival of dusk. In the Mid-Pacific, birds appeared to avoid the ship.

BIRDS SIGHTED ON CRUISE 15 OF THE USNS ELTANIN

Diomedeidae		Remarks
Wandering albatross	(*Diomedea exulans*)	Mostly juveniles. Maximum numbers seen near Chatham Is.; minimum near 54°49'S, 129°48'W.

Birds Sighted On Cruise 15 of the USNS Eltanin - (Cont.)

Diomedeidae		Remarks
Black-browed albatross	(Diomedea melanophris)	Observed between 54°49'S, 129°48'W & Chatham Is.
Light-mantled sooty albatross	(Phoebetria palpebrata)	Observed in greatest numbers central portion of Convergence. None near Chatham Is.
Procellariidae		
Pintado petrel	(Daption capensis)	Observed throughout the cruise; highest number near Chilean Coast, lowest from Convergence to Chatham Is.
Silver-grey fulmar	(Priocella antarctica)	In East Pacific prior to & during first Convergence station.
Antarctic petrel	(Thalassoica antarctica)	Briefly along the Convergence in East Pacific.
White-headed petrel	(Pterodroma lessonii)	Central & West Pacific on Convergence only.
Prion	(Pachyptila sp.)	Observed throughout most of area except near Chatham Is.
White-chinned petrel	(Procellaria aequinoctialis)	In Central Pacific along Convergence & in decreasing numbers to Chatham Is.
Giant petrel	(Macronectes giganteus)	Occasionally along Convergence stations; increasing in numbers toward Chatham Is.
Hydrobatidae		
Storm petrel		One observed at Convergence in Mid-Pacific

Birds Sighted On Cruise 15 of the USNS Eltanin - (Cont.)

Spheviscidae		Remarks
Macaroni penguin	(Eudyptes sp.)	Possibly one or two observed on three occasions along Convergence in Mid-Pacific.
Victoria penguin	(Eudyptes pachyrhymchus)	Observed twice near last stations.

Entomology, Bernice P. Bishop Museum: Off the Chilean coast debris of uncertain origin was found in the nets. Insects were first collected along the New Zealand coast on the 63rd day of the cruise. Between 1900 GMT December 1 and 2000 GMT December 2, one crane fly and 50 Drosophila-like flies were found in the nets. On this date, winds were southwesterly and land was approximately 23 miles southwest. An additional crane fly was collected on December 3.

McMurdo Station

Biolab, Stanford University: Cabinet units were installed in the microbiology room and in the north laboratory area to replace double-door enclosures. The inventory of laboratory equipment and supplies was completed, and rewiring and general summer maintenance of the facility continued. Work was started on the renovation of the drainage system, and exterior painting of the lab was completed.

Seal Physiology, University of Arizona: Seal orientation and diving observations from the sub-ice observation chamber were completed, and the chamber was removed from the ice. Six scuba dives were made in different areas during the plankton bloom.

At Cape Crozier leopard seals were observed for four days in a comparative study of behavioral traits of the leopard and Weddell seals. A Weddell seal rookery was found near Helen Glacier Tongue and 40 pups were tagged, completing the major tagging operations this year. Twenty-three seals tagged last year have been found including a pup. Milk and urine samples were obtained, and the analyses of the freezing point depression of urine and urea nitrogen were finished. Analysis was begun on milk samples.

Insect Ecology, Bernice P. Bishop Museum: A search for insects in the Whitmore Mts. produced no specimens. In the Shackleton Glacier area the field investigators visited 36 sites and found Collembola, mites, and plants, possibly the farthest south records of life in Antarctica. Following are the latitudes and elevations of the samples: Rotifers to

84°53'S, 1,065 m. (3,500 ft.); mites to 84°58'S, 1,370 m. (4,500 ft.); Collembola to 84°47'S, 760 m. (2,500 ft.); lichens to 85°11'S, 2,140 m. (7,000 ft.); algae to 85°09'S, 1,550 m. (5,250 ft.); and moss to 84° 35'S, 700 m. (2,300 ft.). The investigators left the Shackleton Glacier area on December 18 to investigate the western Horlick Mts. No animal life was discovered, but lichens were found as far south as 85°58'S, at 1,920 m. (6,300 ft.) elevation.

Twelve sites were visited in the McMurdo Sound area. The investigators obtained new records of mites in the Taylor Valley and Collembola on the dais of the Wright Valley. In the Biolab, ecological studies are being performed on mites from the Hallett Station area. Cultures made of the soil flora from the Shackleton Glacier area are being identified as possible food sources for soil arthropods.

Penguin Populations, Johns Hopkins University: A study of the feeding habits of the Adélie penguin was initiated and continued through the month. A total of 141 banded penguins of known age and 85 Adélies banded as adults was recovered. The behavior and movement studies on these birds continued. Two and three year old skuas were observed during the month. A total of 107 pairs of breeding skuas was studied with emphasis on pair-bond and nest-site tenacity.

Penguin Navigation, Johns Hopkins University: Three navigational experiments were completed. On December 13 the investigators established a field camp on the ice cap at 86°S, 180°E. Birds from Mirnyy Station showed a shift in mean departure direction after three weeks under sunny conditions on the Ross Ice Shelf. Ten birds from Cape Crozier, released and recaptured at the South Pole, showed a northerly orientation with respect to home. Radio tracking by aircraft was partially successful. Two birds, 35 and 50 miles from the release site, were observed continuing their initial northward route.

Seal Ecology and Acoustics, New York Zoological Society and Woods Hole Oceanographic Institution: The investigators completed field studies early in the month and returned to the United States.

Marine Algae, Old Dominion College: Thirty-five scuba diving surveys were carried out at the following locations: Turks Head, Charcot Bay, The Flatiron, Cape Evans, Big and Little Razorback Islands, Cape Armitage, Marble Point, Heald Island, Black Island, White Island, Hut Point, Backdoor Bay (north and south sides), and Cape Bird.

Fructifying Rhodophyta were found growing in all areas investigated under an ice cover varying from 0.5 to 2.5 m. in thickness. These observations confirm theories that antarctic algae are capable of photosynthetic production under ice. Measurements indicated that 3% of the incident sunlight passes through a one meter layer of sea ice with snow cover. Iridaea obovata, Phyllophora antarctica, and Hildebrandia lecannellieri

grow luxuriantly in the upper part of the sublittoral region only along the Ross Island and Victoria Land shores. Adenocystis utricularis and Monostroma hariotii were also observed. Selection, preservation, and identification of samples were carried out in the Biolab.

Vertebrate Parasites, Roanoke College: Fish species examined or preserved for examination included 54 Trematomus bernacchii; 51 T. borchgrevinki; 8 T. centronotus; 4 T. hansoni; 1 T. lepidorpinus; 3 Dissostichus mawsoni; 54 Rhigophila dearborni; 2 Pleuragramma antarcticum and 1 Chaenichthys rhinoceratus. All Acanthocephala (127 specimens) were stained and mounted before specific analyses were undertaken. One hundred smears of piscine blood and 32 specimens of Rhigophila dearborni were returned to Roanoke College for histological preparation, microscopic examination and post-mortem study. Another 100 piscine blood smears were stained with giemsa and examined for helminths.

Work continued on the preparation of a host-endoparasite list for antarctic vertebrates. Forty percent of the Adélie penguins examined yielded an average of 6.13 intestinal worms per bird with concentrations ranging from 1 to 39 worms per infected bird. In one bird the helminth fauna consisted of two phyla. Three phyla of helminths are represented in worms recovered to date from this species.

Fish Metabolism and Growth, Stanford University: Studies were continued on the tissue metabolism of fishes of the genus Trematomus. A deep water collecting site was established to permit capture of the zooarcid species Rhigophila dearborni, and studies were begun on the tissue metabolism of this species. Other studies were initiated on the pathways involved in glucose catabolism. A buzz-shock system installed on the Fiske osmometer enabled more precise measurements of the freezing points of the blood of the fishes.

Algal Ecology, Ohio State University: Water and algal samples were collected at Lakes Bonney, Vanda, "Vashka", Webb, "Péwé", and Fryxell, in ponds in the Wright and Taylor Valleys, and at Cape Evans. Dried algal samples brought from the Shackleton Glacier were inoculated into organic nitrogen media. Replicate samples were placed in growth chambers at 20°C. Unialgal cultures of three Chlorococcalean genera, two species of Chlamydomonas, Stichococcus bacillaris, Oscillatorea sp., and Nostoc commune, were obtained in the growth chamber.

CARTOGRAPHY

U.S. Geological Survey: Topographic engineers working from Byrd Station, extended the network of snow stakes to a point 106 mi. from the station. They reached a maximum snow surface elevation 102 mi. from Byrd. Nodwell vehicles used for the trip performed well except that the smaller model became easily stuck in soft snow. The party returned

to Byrd Station on January 1.

U.S. Navy: Aerial photography for mapping obtained during November 22 - December 28 included:

Heritage Range	100%
Pensacola Mountains	100%

Special flights:

Ice movement in McMurdo Sound (periodic flights).	
Reconnaissance of planned plateau station site partially completed.	
Pensacola Mountains	95%
Nunataks (two areas)	100%
Nunataks (two areas)	50%

GEOLOGY

Byrd Station

University of Minnesota: The field party investigating nunataks west of the Sentinel Mts. returned to Byrd Station from the Sonntag and Pagano Nunataks and on December 6 moved to the Whitmore Mts. The party completed the field work on December 18 and returned to McMurdo Station.

Ohio State University: The party working in the Wisconsin Range of the Horlick Mts. received U. S. Army turbine helicopter support during the week of December 14.

Texas Technological College: The field party continued geological mapping operations after the U. S. Army turbine helicopter team moved eastward at mid-month to support the Ohio State University group.

Falkland Islands

University of California: University personnel have begun their studies of the tillites of the Falkland Islands.

McMurdo Station

Ohio State University: This field study of the volcanic rocks of Ross Island began on December 4. Geologic mapping was carried out and specimens for petrographic and petrologic studies were collected at the following places: Cape Bird, Cape Crozier, Cape Barne, Dailey Islands, Tent Island, Big and Little Razorbacks, Turks Head, Tryggve Point, Inac-

cessible Island, and Gneiss Point.

Short visits were made to Capes Royds and Evans to confirm previous observations and collect additional specimens. Mapping and collecting were started on Brown Peninsula, Black Island, White Island, and at McMurdo Station. Heald Island and the floors of the Taylor and Victoria Valleys were searched for related volcanic rocks.

An attempt was made to determine the number and nature of eruptive sequences and the interrelationship of sequences. It is suggested that each volcanic sequence started with olivine basalt in the explosive phase. In two instances it appears that sodium differentiates were produced. Shell fragments occurring in till outwash and volcanic agglomorate were collected on the flanks of Mt. Birch, where also a single piece of coquina was found. The nature, distribution and abundance of erratics was noted.

METEOROLOGY

Byrd Station

U.S. Weather Bureau: Two new snow fields were prepared at the end of the month and another will be set out before the end of summer. The new fields, containing 200 stakes and located 1 and 5 km. from the station, will make it possible to study snow drift at various distances from the main sources of drift.

The average wind velocity of 15.8 mph. was the highest for the month of December in the eight years of station records, and the minimum pressure of 23.900 in. was the highest minimum on record. The records at the end of the year show that 1964 was the warmest in the history of the station with an average temperature of -27°C. The average maximum temperature was -23.4°C. and the average minimum, -32.3°C. The absolute maximum was -7.2°C. on the 2nd of December, and the absolute minimum was -62.2°C. on August 12. The highest wind gust was 84 mph. on the 26th of June.

The absolute maximum ozone level decreased to 150 mb. A secondary maximum occurred at 85 mb. with a marked minimum of 196 μmb. at the 100 mb. level. The maximum ozone pressure of 389 μmb. was less than the high of 419 μmb. recorded in November. The maximum surface ozone concentration occurred on the 5th, and the Mast and Regener instruments recorded comparable values of 2.54 and 1.46 pphm., respectively. All the ozone instruments and the Dobson spectrophotometer performed well.

Eights Station

U.S. Weather Bureau: The outstanding meteorological feature this month was a warming trend that pushed the temperature to 2.2°C. on

the 17th.

A prominent mirage occurred on the 26th during which three distant mountain peaks and one unknown peak were observed several hundred feet above the horizon ENE of the station. The combination of upright and inverted images lasted several hours.

The Campbell-Stokes sunshine recorder was put into operation on the 6th. Operation of the sunshine switch was discontinued on the 31st. Records obtained from the two recorders did not correlate and it is thought that the photocell of the sunshine switch is too sensitive for use over snow. There were 358 hr. 33 min. of sunshine this month, approximately 50% of the possible sunshine.

The major snowfall for the month occurred between the 7th and the 17th and amounted to 28 cm. (10.1 in.). Another major storm began on the 27th and continued through the end of the month. The greatest snowfall in 24 hours was 11 cm. (4.3 in.) on the 8th and 9th. The average net change on 49 snow stakes was 9 cm. (+3.6 in.).

Operation of the Mast surface ozone equipment was normal throughout most of the month, although some of the data are questionable owing to sensor contamination. The assembly was removed and cleaned and the membranes replaced on December 3, and new mercury cells were placed in both the Mast and the Varian recorder on December 5. The ozone values were generally low throughout the month.

The atmospheric electricity program was inoperative until the 28th, when new DC amplifiers were received.

USNS Eltanin

U.S. Weather Bureau: A decrease in low-level cloudiness from previous cruises was observed. Visibility averaged above five miles. The average wind was northwesterly at 22 knots with gale force observed on 14 occasions and storm force on three. Seas averaged 3.5 m. (11 ft.). The mean temperature was 6.6°C. and the average temperature dew point, 4.3°C.

Radiosonde observations were very successful with 55 out of 61 balloons reaching the bursting point. The average height of all soundings was 27,400 m. Rawinsonde observations were made to an average height of 19,900 m. Helium storage space was increased by adding a rack for four helium bottles in the balloon inflation shed.

A total of 264 surface observations were taken at six-hourly intervals throughout the cruise. Salinity tests made on precipitation samples showed that the average salinity of samples from the windward gauges was 1.1°/oo higher than that of the leeward gauges. The average

salinity of all samples was $4.2^{o}/_{oo}$.

Eleven CO_2 samples were taken at five stations for analysis at the Scripps Institution of Oceanography.

No noctilucent clouds were observed despite favorable conditions.

Hallett Station

Dec. 64

U.S. Weather Bureau: Supplies were inventoried and repairs made on station equipment. Near the end of the month, the Baker hydrogen generator was brought into operation, and holes in the radome were patched with plexiglass in preparation for the installation of additional insulation. Three new climatic records were set: the highest average temperature, 1.4°C.; the highest average cloudiness, 6.9; and the highest station pressure, 29.63 in. A record average height of 31,785 m. was attained by 62 radiosondes.

South Pole Station: The average net change of 50 snow stakes was 0.5 cm. (0.2 in.). The observational program continued satisfactorily.

OCEANOGRAPHY

USNS Eltanin

Bottom Photography, Alpine Geophysical Associates, Inc.: Thirty-one camera stations were taken during Cruise 15. A Model 312 Alpine camera was used for black-and-white photography with Tri-X-Pan film (ASA 400). A new camera (Model 311) was used mostly for color photography because of its brighter strobe light. Color films exposed in this camera were Anscochrome D200 and Ektachrome ER (Type B).

The technician experimented with film and developing time to improve the quality of the photography. Doubling the recommended developing time for Microdol X (25 min. in stock solution at 20°C.) was found to improve the background exposure of black-and-white negatives. After station 12, Acufine developer was used for all stations and produced more evenly exposed fine-grained negatives with better contrast.

Light cases and cameras were inverted to protect the electrical connections from damage on the bottom. Tests without the light reflector indicated that the reflector causes some shading, but prevents stray light from entering the camera lens and producing white specks on the film. The angle of the light was then changed from 50° to 70° from the perpendicular to eliminate the reflector shading and better illumiate background areas.

Physical Oceanography, Columbia University, Lamont Geological Observatory: Thirty-seven hydrographic stations were taken in nine north-south profiles, with complete stations at each degree of latitude and shallow casts to 1,000 m. depth at 30-ft. intervals. The thermograph recorder was used with every cast. Phleger core samples were obtained infrequently due to a shortage of core weights. A modified Nansen bottle was developed to obtain samples of bottom water. For surface water temperature, a total of 950 BTs were taken at intervals of one hour or 10 miles.

The thermograd recorder was operated on 36 hydrographic stations with excellent results. Temperature, depth, and time traces were obtained for all stations. Thermograd records revealed a more complex thermal structure in the water column than was evident from the reversing thermometers. They showed several sharp temperature reversals between the depths of reversing thermometer measurements, occasionally as much as 1.3°C. in 10 or 15 m. Preliminary analysis indicated that temperature gradients often changed between the time the thermograd was lowered and the time it was raised to the surface. Thermograd records were used to verify several temperatures obtained by reversing thermometers that appeared doubtful on a temperature-depth curve.

Standard determinations of nitrate, phosphate, silicate and pH were carried out and several special studies were performed. Surface samples taken within two miles of an iceberg indicated a decreasing silicate and phosphate content as the ship approached the berg, while the nitrate concentration tended to increase. Interstitial water from piston cores was analyzed for silicates, nitrates and phosphates. Compared to bottom water, this combination of interstitial and bottom water showed higher silicate values and lower phosphate and nitrate concentrations. Water samples within 2 m. of the bottom were compared with water from core samples. In another experiment, washed sediments were mixed with surface sea water and stored for several days before the sample was analyzed. The results indicated that reactive silicates were not entirely removed by washings and exist in interstitial water and in the sediments as they precipitate. Nitrate and phosphate concentrations were lower than the original sample. An attempt was made to leach minerals from sediments at the top of the piston core with distilled water. Analysis of this water showed a higher silicate content than bottom water. The concentration of phosphate and nitrate was lower than in bottom water.

Thirty-five water samples were filtered through millipore filters for trace metal analysis. The residue will be analyzed for aluminum and possibly chromium and beryllium. Comparative measurements of pH between the surface and 50 m. showed a consistently lower pH at the surface. Differences in silicate, nitrate, and phosphate content were found between water samples taken in the first Nansen bottle of a hydrographic cast (1 to 3 m. depth) and water from the ocean surface. Silicate con-

centrations at the surface were plotted against the surface temperature for each hydrographic station. Results indicated an inverse relationship between temperature at the surface and silicate concentration.

Fracture Zone Topography, Columbia University, Lamont Geological Observatory: A survey was made of a selected portion of the Pacific Ocean floor known as the Easter Island Ridge or the South Pacific Rise between longitudes 120°W. and 135°W. at about 55°S. latitude. Cruise 14 had made five crossings of a steep-walled trench, trending 291°, that intersects the rise obliquely to its path. One of the purposes of the Cruise 15 traverses was to obtain additional crossings and to determine, if possible, the northwesterly limits of the trench.

An unpublished epicenter map of the South Pacific by Sykes was used as a base for speculation about the area to be surveyed. After several crossings of the southeasterly portion of the feature, it was noticed that three straight lines could be drawn through the epicenter positions in this region. One line fits the position and trend of the known and explored trench. Possibly two other, similar sea floor features are represented by the second and third lines. A similar set of en echelon fractures transects the Mid-Atlantic Ridge in the equatorial region, producing an offset similar to that indicated in the South Pacific Rise.

The presence of a second trench was partially verified as the ship proceeded away from the first trench line. A precipitous hole in the sea floor was found which was similar in morphology to the area just covered. This trench was over 3,000 fathoms deep, and was bounded on the northeast by a ridge rising in places to less than 300 fathoms from the surface. Because a seamount had been reported in this locale (55°S., 130°W.), an attempt was made to find it, thus affording several crossings of this second trench feature. The seamount, as such, was not found; it is concluded that what was called a seamount in this area is in fact part of the high ridge associated with this second trench.

On 16 November a deep spot was traversed at 56°02'S., 143°48'W. and on the 17th another, similar deep was crossed during trawling operations at 55°20'S., 145°03'W. Both of these holes were in excess of 3,000 fathoms deep. A line connecting these two positions trended northwesterly, but not quite parallel to the original lines to the east. Since the ship was due to recross the extended line of these two points further to the northwest, a check was kept for unusual depths. On 19 November another deep spot was crossed. The topography was rough and scale changes on the precision depth recorder were numerous. As nearly as could be determined the depth was in excess of 2,400 fathoms, perhaps 2,600 fathoms. These three points fall on a line which extends to one of the heavier epicenter points along the crest of the South Pacific Rise.

It is tentatively concluded that an en echelon pattern of steep-walled

trenches intersects the South Pacific Rise over a span from 120°W. to 135°W. This pattern probably reflects a series of en echelon transcurrent faults on the ocean floor whose location and alignment are marked by the lines of the three epicenter groupings. The first line probably does not extend much farther to the northwest than was roughed out on Cruise 14. Shoaling of the trench bottom on the most northwesterly crossings on Cruises 14 and 15 indicated that the feature was beginning to die out.

Marine Geology, Florida State University: Bottom sediment samples were recovered by the piston corer and associated Phleger corer at 26 of the 29 stations occupied on Cruise 15. On two occasions the piston corer failed to obtain a sediment sample and at one station (17) no coring was attempted because of the unsuitable nature of the bottom. The maximum number of 22-ft. core pipes rigged on this cruise was three. Rigging of multiple pipes during the latter half of the cruise was almost entirely precluded because of the rugged bottom.

As all stations occupied subsequently to station 13 (58°S., 120°W.) were located on or near the East Pacific Rise an excellent opportunity was afforded to study the relative depths of calcareous and siliceous deep-sea deposits. The carbonates, without exception, occurred above the 2,000-fathom contour, while only two predominantly siliceous samples were found to occupy this range.

Rock samples collected during the cruise came from the Blake trawls (9 samples) and Menzies trawls (3 samples). Four samples were obtained through the use of the rock dredge when the bottom topography exhibited moderate to high relief. Several of the rocks received appeared to have been broken out of a layer of manganese, as opposed to the distinct nodule mode of precipitation appearing commonly in bottom photographs of this cruise.

SEISMOLOGY

Byrd Station

U.S. Coast & Geodetic Survey: The reconstruction of the seismic vault was completed on the 3rd, and normal operations were resumed. Seismometers were operational throughout the month, although the boom of the long-period vertical instrument had to be centered frequently. The aluminum arch above the vault continued to deteriorate but will be shored up before winter. The long period galvanometer arrived and is ready for installation.

South Pole Station

U.S. Coast & Geodetic Survey: Annual maintenance was per-

formed on the equipment.

TRAVERSE OPERATIONS

The South Pole-Queen Maud Land Traverse left the South Pole Station on December 5. The following position reports were received in December:

Date	Position	Remarks
13	87°56'S., 58°E.	
22	86°47.5'S., 47°36.0'E	Immobilized by
25	86°40'S., 31°E.	equipment trouble
27	86°23'S., 22°07'E.	
31	85°47'S., 8°48'E.	

UPPER ATMOSPHERE PHYSICS

Byrd Station

Aurora and Airglow, Arctic Institute of North America: A trip was made to the auroral sub-station to recover, among other things, a visual observation dome which can be used in the observation program.

Forward Scatter, National Bureau of Standards: The Byrd-Pole transmitter was relocated and the antenna repairs were completed. Except for trouble in the final stage of the transmitter, the equipment appeared to be in good working order.

Geomagnetism, U.S. Coast & Geodetic Survey: The variations building was rewired after a deforming tunnel wall tore loose a wire from the circuit box. Several power failures this month resulted in the loss of time marks and caused temperature variations in the recording rooms. An independent timing system was put in operation on the 29th. The system uses a Hamilton marine chronometer which has a constant loss rate of approximately 0.5 sec. per day. The average values of 12 sets of monthly absolute measurements were:

declination	70°30.1'
horizontal field	16,312 g.
vertical field	57,814 g.

Ionospheric Absorption, National Bureau of Standards: The riometer operated normally.

Ionospheric Soundings, National Bureau of Standards: An erratic power supply caused some loss of data. Following repairs, echoes were observed as low as 250 Kc./s., which is believed to be the

lowest echo frequency ever observed at Byrd. However, some modifications and repairs remain to be performed on the equipment. The maximum foF2 was 5.9 Mc./s. qualified at 1800 local time. The minimum median foF2 was 4.5 Mc./s. unqualified at 0600 and 2300 local time. Values for foF2 were obtained 52% of the possible time. The missing values are accounted for by blanketing (4%), absorption (3%), equipment failure (10%), spread echo (16%), and stratification and absorption near the critical frequency (15%).

Micropulsations, National Bureau of Standards: Some data were lost during preparations for the installation of additional micropulsation units. Intermittent power failure also caused some loss of data. Operations were normal at the end of the month.

VLF and ELF, Stanford University and Pacific Naval Laboratory: A pit was completed for the footings of the POGO telemetry system tower. The new power line was completed as far as the end of the seismic tunnel, and receivers for monitoring the beacons of the S-66 satellites were installed and are operating properly. The new spectrum analyzer, capable of analyzing frequencies up to 120 Kc./s., was operated continuously as a monitor of the VLF spectrum. A new technique for recording the spectrum analyzer output allows the reproduction of frequency and amplitude information of VLF phenomena in various forms. A new battery-powered, solid-state programmer was installed which will independently control the timing of all recordings and charts.

Eights Station

Aurora and Airglow, Arctic Institute of North America: The all-sky camera and the NBS Varian recorder were repaired and installation of the NBS photometer equipment was begun. The WWV antenna was completed.

Geomagnetism, U.S. Coast & Geodetic Survey: The normal magnetograph film, drying rolls and Varian observation forms were received. An adjustment of the traces on the 28th of December caused a baseline change.

The coordinates of Eights Station were calculated as $75^{\circ}14.7'$S., $77^{\circ}11.3'$ W. The accuracy of this calculation is probably not better than 0.5' because of an unknown refraction correction over the ice. The azimuth reading on the auxiliary mark was calculated as $295^{\circ}31.4'$. Sixteen sets of absolutes were taken with the following averages:

declination	$32^{\circ}35.7'$
horizontal field	21,044 g.
vertical field	48,308 g.

There were two sudden commencement storms, one on the 16th at 0323 GMT and the other on the 29th at 0645 GMT.

Ionospheric Absorption, National Bureau of Standards: Two riometers became operational after the 13th of the month, using a new stub matched antenna and the rebuilt original antenna. Both riometers were calibrated with the same oscillator and test diode.

Ionospheric Soundings, National Bureau of Standards: A new ionosonde building was constructed 213 m. east of the old Sky-Hi station site. The original tower was moved, but strong winds hampered antenna construction. The equipment was installed and was operational at the end of the month.

VLF and Micropulsations, National Bureau of Standards: The micropulsation equipment was operational throughout the month, with only three hours of data lost due to power failure. Conditions were generally disturbed during the first week of the month, and a large disturbance was noted on the 3rd. Long-period micropulsation activity on the 16th was correlated with VLF pulsations. Forty hours of VLF data were lost due to relocation of the equipment and failure of the 60-cycle standard. A low-frequency hiss was noted during the first week and again in the last few days of the month. On the 1st and the 16th, there were pulsations with periods up to two minutes. On the 23rd, a two-hour rising hiss was observed, and on the 30th one hour of continuous whistler activity was taped.

VLF-ELF, Stanford University and Pacific Naval Laboratory: The interior of the VLF building was rearranged to accommodate the expanded NBS riometer program. The equipment remained in about the same location, but the snow tunnel was lengthened and a new entrance was completed. The rebuilding of the antenna preamplifier entrance offers improved access to and safety for the housing. The newly completed 500-ft. rhombic antenna mounted 12 ft. above the snow surface enables reception of WWV for 18 hours a day. A secondary control is provided by mixing the signal from NBA with WWV. All the equipment was operational as the month ended, although there were many peripheral failures during the early part of the month. Forty hours of data were lost due to the failure of the 60-cycle standard.

December activity was moderate, but of good quality. The 1st and 16th showed good emission activity, and the 12th and 20th were marked by good multi-phase hiss and numerous echo whistlers. The 4th was the most active day for whistlers and on the 16th, an apparently new phenomenon, termed the "warbling whistler", was detected. The 16th was also marked by a strong hiss coincident with the end of long-period micropulsations. Simultaneously, strong, slow risers began and were followed by the "warbling whistler" activity. Altogether, 3.5 hrs. of continuous recordings were made on the 16th. Recording of OGO-A satellite passes proceeded normally.

USNS Eltanin

Aurora and Airglow, University of Alaska: Airglow photometer operation was discontinued after Cruise 14.

Cosmic Rays, Bartol Research Foundation (Stanford University Observer): The meson telescope was overhauled during the port period in Valparaiso. All associated electronic circuits were checked and necessary modifications made. A 60-cps, 24-hour timing device was installed.

Considerable difficulties were encountered in the right meson telescope, and its counter was not operational in the early days of the cruise. The telescope was later repaired and a new standardization was performed on the entire system which, with the exception of drifting caused by power fluctuations and failures, then worked satisfactorily during the balance of the cruise. The barograph malfunctioned in the third week of the cruise and was repaired.

Ionospheric Absorption, University of Alaska: Operation of riometers was stopped after Cruise 14, and the equipment stored aboard ship.

Radio Noise, National Bureau of Standards: Recording equipment continued to perform well. Two unreliable receiver units were returned to the United States for repair. Shock excitation from the ship and amateur radio transmitters was found to damage the vacuum tubes of the preamplifier. At present, fiducial marks from the radio transmitters are made on the radio noise records so spurious signals can be positively recognized and edited.

VLF, Stanford University: Experimental programs were performed without significant malfunctions. Broad-band recordings from 50 to 52 min. after each hour, and narrow band recordings (NPG, 40 to 44 min. and NSS, 50 to 52 min. after the hour) were made each day of the cruise. In addition, continuous recordings were made to coincide with the Pole-to-Pole orbital passes of the Alouette satellite. A Stanford University VLF and LF experiment aboard the OGO-A satellite required continuous 15 ips. broad-band recording on 10 different days during Cruise 15. Some of these recordings lasted five hours.

Whistlers and other VLF activity decreased from Cruise 14. The most intense whistler activity occurred during the period from October 27 to November 3. The average incidence rate for this period was 4.4 whistlers per minute, approximately five times lower than the peak whistler activity during Cruise 14. The average whistler rate for 44 recorded days was 1.8 whistlers/min. VLF emissions were heard only on November 23.

Continuous broad-band recordings were made during hours of strong NPG echo activity and VLF emissions while the Eltanin was in the vicinity of the conjugate point of NPG. The first echoes were received on October 23 at approximately 60°S., 105°W. On November 4, at 56°S., 121°W., NPG echo activity increased and was continuously received until the 26th at about 50°S., 168°W. Signal intensity increased very strongly as the Eltanin approached the NPG conjugate point. On November 23 from 1425 to 1635 GMT, interesting VLF emissions were received. Closely spaced risers, isolated events, and constant, slowly varying events were recognized while NPG echoes were being received and recorded. To insure that the induced field of the narrow-band loop antenna was not changing during the approach to the NPG conjugate point, the ship held a steady course for approximately 100 mi. The continuous NPG recording during the 100-mi. traverse of the conjugate area lasted from 2221 GMT on the 23rd of November till 0827 GMT on November 24. Echo activity from NPG was received and recorded on 25 days.

McMurdo Station

Cosmic Rays, Bartol Research Foundation: Operations normal.

Forward Scatter, National Bureau of Standards (Bartol Research Foundation Observer): A new chassis was installed in the forward scatter equipment which resulted in lower internal noise. A 6.25 KVA emergency generator was installed. The Byrd-McMurdo link was brought to near peak efficiency on December 18.

Ionospheric Absorption, Douglas Aircraft Company: Operations were normal except for two days when a chronometer motor was being repaired. A sink and complete fire alarm system and a 5 KVA emergency generator were installed.

South Pole Station

Aurora and Airglow, Arctic Institute of North America: A special events camera was installed, and inventories were checked. No observations were made.

Cosmic Rays, Bartol Research Foundation: Shielding and grounding the cosmic ray equipment successfully eliminated contamination of the records by the ionosonde. A new coincidence gate was installed on the meson telescope, and the inverter circuit was modified to give a full 13 volt output. The Hewlett-Packard counters were modified to accept only positive pulses from the meson telescope, and the neutron monitor counters were modified to accept only negative pulses from the Hammer amplifier. Work is progressing on the new six-volt chassis which is necessary for converting the neutron monitor to the new counting equipment.

Forward Scatter, National Bureau of Standards: The Byrd-Pole receiver operated well throughout the month, but no success was attained in contacting Halley Bay on the Pole-Halley Bay link.

Geomagnetism, U.S. Coast & Geodetic Survey: The annual maintenance and orientation of geomagnetic equipment was performed. The proton magnetometer had been giving doubtful data, and a comparison with the quartz horizontal magnetometer was performed. The averages of the absolute values were:

declination	27°46.3'
horizontal field	15,984 g.
vertical field	56,490 g.

Six sets of baseline values were taken.

Ionospheric Absorption, National Bureau of Standards: The activity remained at a very low level. A power failure late in the month caused some temporary difficulties with the timing system.

Ionospheric Soundings, National Bureau of Standards: There was very little equipment trouble, and the scaling is up-to-date. The recordings are largely of spread echo and the sounder is presently making good records on schedule. Some electronic improvements were made in the equipment. Numerical values for foF2 were recorded 27% of the time.

VLF, Stanford University (National Bureau of Standards Observer): The equipment operated well with only minor problems. Chorus and hiss were observed every day.

U.S. SCIENTISTS AT FOREIGN STATIONS

Melchior Island

Parties from Harvard University and Lamont Geological Observatory arrived on November 27 and began studies in marine biology with the logistic assistance of the Argentine Naval Hydrographic Service.

Mirnyy Station

George H. Meyer from the University of Texas and U. S. Exchange Scientist with the Soviet Antarctic Expedition, continued his microbiological studies.

Vostok Station

Two C-130 flights were made from McMurdo to Vostok. Supervisory personnel from the Geophysical Institute at College, Alaska, and the National Bureau of Standards, Boulder, Colorado, installed two new riometers (a 20 Mc./s. and 30 Mc./s.) as well as micropulsation equip-

ment and telluric current measuring devices. Consistent correlation between the telluric current activity and micropulsations seems to warrant the continuation of the old equipment (VLF and forward scatter). Operation of the equipment will be turned over to a Soviet geophysicist in mid-January.

Shipboard

Scientists from Texas A & M University and Lamont Geological Observatory conducted marine biological studies aboard the Argentine Naval icebreaker General San Martín.

FOREIGN SCIENTISTS AT U. S. STATIONS

Byrd Station

The Soviet Exchange Scientist, Dr. V. S. Ignatov, departed for McMurdo Station on December 20 preparatory to rejoining the Soviet Antarctic Expedition at Vostok.

Hallett Station

Dr. Dietland Müller of the Forstzoologisches Institut, University of Freiburg, continued his observations on the behavior of the Adélie penguin.

McMurdo Station

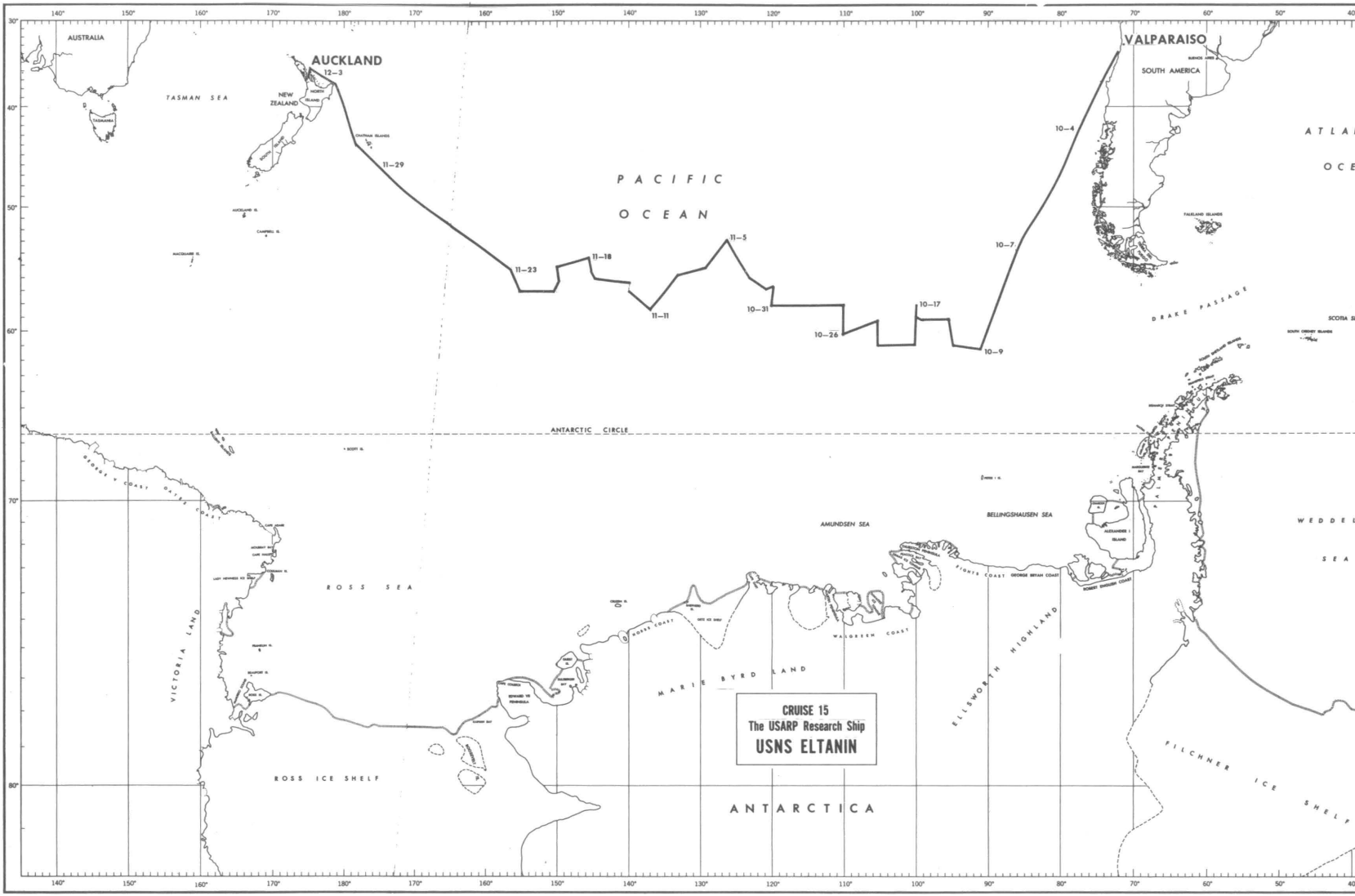
A five-man Japanese biological team arrived at McMurdo to carry out field observations in the Dry Valleys.

Geologists from the University of Sydney continued their studies in the McMurdo Sound area.

SUMMARY OF METEOROLOGICAL OBSERVATIONS - DECEMBER 1964

	Byrd Station	Eights Station	McMurdo Station	So. Pole Station	Hallett Station	Little Jeana	Litt Rock
Temperature, (°C.)							
Average	-11.8	-11.3	- 5.6	-29.1	- 1.4	- 7.4	- 5.
Highest	-7.2/02#	2.2/17#	2.2/17#	-22.9/21#	2.8/%	- -	3.
Lowest	-26.1/08#	-23.9/03#	-10.3/08#	-32.4/08#	- 7.8/10#	-16.7/08#	-14.
Station Pressure (Inches)							
Average	24.159	27.904	29.202	20.35	29.348	29.272	27.1
Highest	24.430/04#	29.902/16*#	29.641/05/*#	20.66/27/#	29.63/5*#	29.617/1/18/*#	28.4
Lowest	23.900/12#	29.152/02*#	28.941/10/*#	20.14/12/#	29.02/10*#	29.233/3/8/*#	27.8
Precipitation (Inches)	0.33	0.67	- - -	Trace	0.29	0.97	0.21
Snowfall (Inches)	5.2	10.1	- - -	Trace	4.2	Trace	- -
Wind							
Prevailing Direction	N	S	S	ENE	SW	SSE	ENE
Average speed (Knots)	13.4	9.0	14.6	7.3	5.9	9.0	6.8
Fastest mile (MPH)	37/N/09#	36/S/29#	- - -	24/NNW/21#	- - -	51/S/09#	- -
Peak gust (Knots)	- - -	33/S/29#	67/SSE/10#	- - -	49/S/22#	- - -	- -
Average Sky Cover	6.9	6.0	7.1	4.3	6.9	7.0	7.0
No. clear days	6	11	0	11	7	2	2
No. partially cloudy	9	5	7	13	5	6	5
No. cloudy days	16	15	24	7	19	23	24
No. days with visibility less than 1/4 mile	4	9	3	0	0	5	- -
No. Radiosondes	62	- - -	57	55	62	- - -	43
Avg. height of Radiosondes (m)	29,497	- - -	25,113	30,590	31,785	- - -	19,83
No. Ozonesondes	5	- - -	- - -	6	- - -	- - -	- -
Avg. height of Ozonesondes (m)	32,598	- - -	- - -	26,026	- - -	- - -	- -
No. Radiometersondes	- - -	- - -	- - -	- - -	- - -	- - -	- -
Avg. height of Radiometersondes (m)	- - -	- - -	- - -	- - -	- - -	- - -	- -

All figures above have been taken from radio messages and are unconfirmed
* Sea-level pressure
** North defined along 0° Greenwich
# Date of occurrence
% 03, 09, 11, 22


AUSTRALIA
TASMAN SEA
AUCKLAND
12–3
NEW ZEALAND
NORTH ISLAND
SOUTH ISLAND
CHATHAM ISLANDS
11–29
PACIFIC
OCEAN
11–23
11–18
11–11
11–5
10–31
10–26
10–17
10–9
10–7
10–4
VALPARAISO
SOUTH AMERICA
FALKLAND ISLANDS
DRAKE PASSAGE
ATLANTIC
OCEAN
ANTARCTIC CIRCLE
ROSS SEA
VICTORIA LAND
ROSS ICE SHELF
AMUNDSEN SEA
BELLINGSHAUSEN SEA
MARIE BYRD LAND
ELLSWORTH HIGHLAND
PILCHNER ICE SHELF
WEDDELL SEA
ANTARCTICA
CRUISE 15
The USARP Research Ship
USNS ELTANIN